

Camera-based face and infrared temperature sensing of learner's affective state in the remote learning context using machine learning

Jurriaan Den Toonder¹, Yoon Lee¹, and Marcus Specht¹

¹Delft University of Technology

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Abstract

Remote learning, learning from home using online available materials, is becoming increasingly more common. This paper focuses on reading activities during remote learning. An important part of learning is keeping sustained attention on the learning materials, as a shift from sustained attention to internal thought or mind-wandering oftentimes decreases the learning performance. Yet this shift is very common during daily activities. It is therefore important for a remote E-learning system to be aware of these attention shifts and allow it to intervene when necessary. Prior research indicates that facial emotion detection and participant's body temperature are generally missing as data modalities. Especially facial emotion recognition may contribute to this area of research, as facial emotions may indicate a learner's affective state during the learning process, and detection of this can be done using a simple consumer laptop web camera. Therefore this paper aims to investigate the feasibility of using a standard laptop web camera to detect facial emotions and a cheap Infrared Temperature sensor (IR-sensor) to detect the loss of sustained attention. Two experiments were conducted to gather attentive and inattentive data. From this data, features were extracted which were used in multiple machine learning models. The created Machine Learning (ML) models worked well on synthetic test and validation data, but they performed poorly in practice. Our main hypothesis for this is overfitting of the ML models on the data, as due to the Coronavirus disease (COVID-19) no more than three participants partook in the user studies. Overall, the conclusion is that both emotional facial detection and participant body temperature show great potential to detect sustained attention, but further research needs to be done with a larger group of participants to confirm this.

1 Introduction

As COVID-19 started to rapidly spread throughout the world in 2019 and 2020, more and more educational institutions shut down face-to-face education and moved lessons online (Ali, 2020). In fact, universities worldwide are moving educational material online anyway, and remote learning is becoming increasingly more common (Ali, 2020; Chen & Wu, 2015). This paper investigates methods to detect sustained attention of a learner in the remote learning context, using different sensors and data inputs. Remote learning entails learning activities which a learner generally does from home, such as reading course materials or watching video lectures, this paper focuses on reading course materials.

An important aspect of (remote) learning is attention. Attention can be divided up into multiple categories, namely sustained attention, focused attention, selective attention and divided attention (Yildiz & Çetinkaya, 2017). Sustained attention is the focus of this paper and refers to the learner keeping focus on the educational materials, without shifting to *internal thought* or *mind wandering*. Said shift from an attentive state to internal thought or mind-wandering is defined in this paper as an *attention shift*. An attention shift away from the learning material oftentimes decreases learning performance, but such a shift is very common in daily activities (Huang et al., 2019). Therefore, as they describe, it can be very helpful for an E-learning system to be aware of such an attention shift. The system can then allow the learner to regain their focus by introducing a short break or allow the learner to review missed materials at a later time.

It is clear that it is important for an E-learning system to be aware of the learner's attentive state, and be aware when an attention shift occurs. Noroozi et al. (2020) performed a systematic review of data modalities used to investigate cognitive, motivational and emotional learning processes and found that facial recognition and body temperature are rarely used in experiments. However, these modalities can be indicative of the emotional states of the human body and mind (Henriques et al., 2013). And even if research is done on facial expressions or eye movements, it is generally done using specialised hardware, such as a Tobii eye tracker (Huang et al., 2019). This is expensive and not readily available to all learners in practice. The usage of this specialised hardware limits the practical applications of said research in a 'real-world' context. This study, therefore, aims to contribute to this growing area of research by exploring the viability of using data sources that are commonly available during remote learning (a laptop webcam), and data sources that seem to be missing from most research (an IR-sensor to detect body temperature). Nowadays, most modern laptops have a built-in webcam.

In short, this study mainly aims to contribute to these detection systems in remote learning contexts by using a data source that is very commonly available, namely a standard laptop webcam, but also a data source that has yet to be researched properly, namely the learner's body temperature.

Once the viability of facial emotional detection and body temperature have been proven, this study will attempt to link both data sources to sustained attention using the circumplex model of affect. "The circumplex model of affect proposes that all affective states arise from two fundamental neurophysiological systems, one related

to valence (corresponding to a pleasure-displeasure continuum) and the other to arousal, or alertness” (Russell, 1980, as cited in, Sarraipa et al., 2016, page 3). A visual representation of the model can be seen in Figure 1, in which the expected mapping from the model to attention is drawn on top of the original model by shading expected ‘attentive areas’ as green and ‘inattentive areas’ orange.

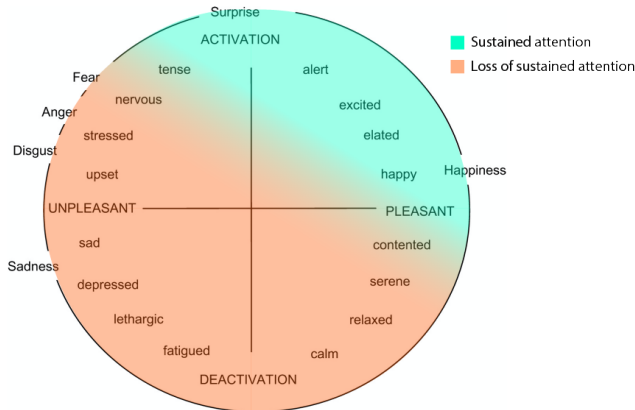


Figure 1. Arousal and Valence in Circumplex Model of Affect (from Yarwood, 2018), with expected link to sustained attention as defined in this paper.

1.1 Research questions

The main research question is “To what extent can camera-based face and infrared temperature sensing of a learner’s affective state in the remote learning context be used to indicate loss of sustained attention?” This is then divided up into the following sub-questions:

- RQ1)** “What are typical emotions experienced during (remote) learning?”
- RQ2)** “How can facial recognition using a webcam feed be used to indicate a learners affective state?”
- RQ3)** “Does a person’s body temperature correlate to emotional changes?”
- RQ4)** “What does affective state say about a learner’s sustained attention?”

Which results in the following hypotheses:

- H1)** “A standard consumer laptop webcam can be used to detect basic emotions such as: happy, sad, anger, fear and surprise.”
- H2)** “Basic emotions can be mapped to the 4 quadrants in the circumplex model of affect.”
- H3)** “A change in a learner’s measured body temperature indicates a change in emotional state.”
- H4)** “A learner’s affect shifting from the ‘activation / pleasant’ quadrant to the ‘deactivation / unpleasant’ quadrant is an indication of loss of sustained attention.”

2 Methodology

As there are no data sets available that include the required data sources (a video feed of a learner’s face, body temperature, and attentive/inattentive indications), some

data gathering was required. For this reason, two experiments were conducted. The experiments were done in two phases to get to a workable data set. The first phase was purely a recording phase during which no processing of the data was done, only the multiple data sources were recorded and stored. The important data sources for this paper are the *body temperature* and *facial emotions*. However, as facial emotion detection is computationally expensive, a second phase was introduced during which the data was processed to extract the detected emotions. Only during the first phase were the participants required, the second phase could be done at any later time as it only depended on the already recorded data from the first phase. An overview of the experiments is shown in Figure 2, this figure does not show the first and second phase but rather the ultimate data flow of the experiments. The second phase and the analysis of the gathered data are discussed in section 3.

As there were multiple data sources and two phases of the experiments, it became important to be able to sync up multiple data streams while recording in phase one, and more importantly, being able to process the recorded data in phase 2 and sync the derived data sets up as well. For this purpose *Microsoft Platform for Situated Intelligence (PSI)* is used (Bohus et al., 2021). PSI is written in C# and offers a multitude of functions that made it easy to record and synchronise data streams during the first and second phase, but also during the later analysis phase. On top of that, it also allows easy visualisation of the data using *PSI-Studio*.

2.1 Defining a ground truth

The main difficulty of this paper is finding a reliable ground truth for the *loss* of sustained attention. The loss of sustained attention is related to mind wandering, and obtaining a detection system for this is challenging (Huang et al., 2019). This data is, however, crucial to be able to test the proposed new detection system against. Therefore, there must be some method to detect if and when a participant has lost their attention during the experiment. To achieve this, a detection concept introduced in Huang et al. (2019) is applied. The key idea revolves around gradually blurring the content the participant is looking at until the participant notices the blur. When the participant notices the blur, they press a button and the content is immediately deblurred. The time it took the participant to deblur is measured from the start of the blur until the button press, and is called the *deblur-time*.

Even when a participant is fully attentive, they take some amount of time to notice that the blurring has started (Huang et al., 2019). The time it takes a participant to notice this blur is influenced by many factors, one of them being the blurring speed. The maximum amount of blur that was applied is a blur of radius 4px, over a time span of 4 seconds, resulting in a blurring speed of 1px/s. This blurring speed was chosen by means of some manual testing beforehand in such a way that the blur was not very noticeable, yet fast enough such that multiple blurs could be done during the shorter experiments. However, as not all factors can be controlled, an average time to deblur the material when attentive should be measured,

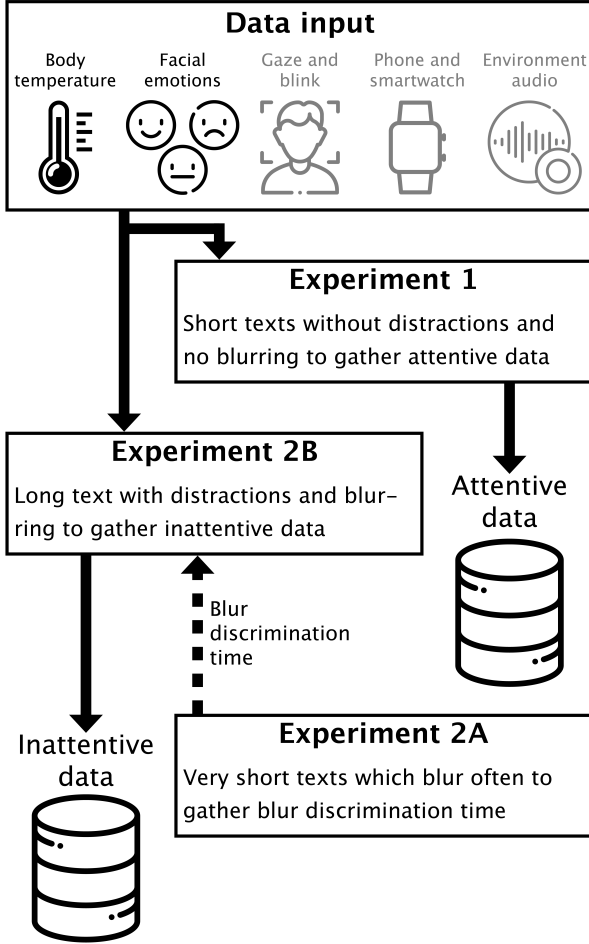


Figure 2. An overview of the different data inputs and their data flow in the experiments. Designed using icons from flaticon.com

and this time is called the *blur discrimination time* T_d . This blur discrimination time is measured in experiment 2A. Huang et al. (2019) conclude that when a learner is not attentive, e.g. they have lost attention or they are mind-wandering, they will have a slower deblurring time than when they are fully attentive. Therefore the blur discrimination time determined in experiment 2A is used in experiment 2B. If a deblur action took longer than the blur discrimination time, that specific time-point is flagged and this can then, later on, be processed as ‘inattentive data’. A visual representation of this process can be seen in Figure 3.

As Huang et al. (2019, p. 10) notes: “Human blur perception is affected by multiple factors, including motion, luminance, depth, and screen attributes. In real use, screen attributes are a factor we can hardly control for. Since the depth in our video stimuli is rather consistent, this study focuses on the remaining three factors of blurring speed, scene motion, and luminance”. They conclude that scene motion and luminance do not affect the deblur actions in an obvious way. Only the blurring speed makes a noticeable difference in the deblurring times. This conclusion has implications for this paper, as one can conclude that there should be no large differences between video and text-based analysis, and thus it can be expected

that their introduced paradigm of gradually blurring the video content until the participant notices will also work well with text content.

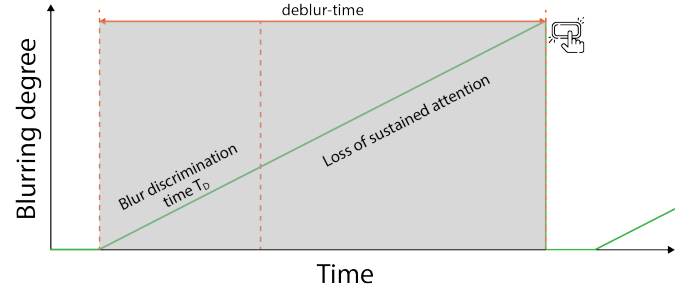


Figure 3. An visual representation of the deblur-time and blur discrimination time T_d

2.2 Experiment 1

In order to identify what facial expressions and body temperatures a learner has during fully attentive learning, experiment 1 is conducted. During this experiment, a series of ten very short texts [mean 205, Standard Deviation (SD) 39] is displayed (Appendix H). The participant is asked to read these texts thoroughly whilst being very concentrated. Hence these texts need to be short to allow the participant to be fully attentive. If at any time during the experiment the participant indicates that they lost focus, the data is deleted and the experiment is re-done at a later time. The entirety of the data collected during experiment 1 is tagged as ‘attentive’.

2.3 Experiment 2A & 2B

Experiment 2 is split up into two sub experiments for clarity. As stated before, the blur discrimination time measured in experiment 2A is used in experiment 2B to determine whether the participant was inattentive.

Experiment 2A

To measure the blur discrimination time, a series of 10 very short texts [mean 150, SD 27 words], was displayed to each participant in random order (Appendix I). The participant was asked to read the text, but to keep most of their focus on deblurring the text. Every blur during this experiment started at a random time interval, between two and six seconds after the last deblur. After every text, the participant could rest until they pushed a button to view the next text. This allowed the participant to ensure they could be fully focused during the next text. The deblur-time was measured from the start of the blur until the participant pushed the space bar to deblur. Important to note is that the environment of this experiment is exactly the same as during experiment 2B to prevent subtle differences in the environment which may otherwise affect the blur discrimination time.

Experiment 2B

During experiment 2B, the participant had to read a long text of approximately 10.000 words (Appendix J). The key idea behind this experiment is the fact that the participant is likely to lose their attention a few times. The experiment was created in such a way to emulate a learning

experience, thus before and after reading the text every participant had to fill in the same survey to assess their already existing knowledge of the subject of the text and to test how much they still remember after reading the text. Especially the difference between the correct number of answers before and after the text is interesting, as this should provide a rough indication of how attentive the participant was overall during the experiment.

While reading the text, blurs occurred at a random time between 30 and 90 seconds after the last deblur event. The large random interval was important as it was important to prevent the participant from finding a pattern on which they could anticipate. As in experiment 2A, the deblur-time was measured from blur start until the participant pushed the space bar to deblur. If this time was larger than the blur discrimination time, an ‘inattentive’ tag was stored at that specific time in the data.

On top of detecting inattentiveness using the above-described deblur-time, the participant also had a second self-report button, the left control key, to indicate they felt distracted. When they pushed this button, a ‘distracted’ tag was stored at that specific time in the data.

2.4 Data inputs

As stated in section 2, the recording of data happened in two phases. Phase two derived facial emotional data from the recorded webcam stream. The emotions were detected by feeding every webcam frame to the Facial Emotion Recognition (FER) python package (Shenk, 2021). This then gave a normalised score between 0 and 1 for every frame for one of these basic emotions: *happy*, *sad*, *neutral*, *angry*, *fear*, *disgust* and *surprise*. That means to say, for every frame, the combined total score of all emotions together is 1 at every frame, and it is possible to have a score of 0.6 neutral and 0.4 happy. The package itself comes bundled with a Keras model that is already trained to detect emotions. This model is trained on the dataset by Goodfellow et al. (2013). These detected emotions were then written back to a PSI-Store such that it was synced up with the originally recorded data and could be viewed in PSI-Studio. This proves **hypothesis 1**.

Once all the recorded data from experiment 1 and 2 was processed during phase two there were 8 data points available. One for every basic emotion, and one for the participant’s temperature. As stated before, the webcam recorded at roughly 30 frames per second (fps), some of the frames were dropped when the machine could not keep up. However, the participant’s temperature was measured fewer times per second. To be able to do an analysis on every frame, for every webcam frame the nearest temperature measurement in the future or past was chosen.

The total number of raw data inputs thus is: (1) happy, (2) sad, (3) neutral, (4) angry, (5) fear, (6) disgust, (7) surprise and (8) body temperature.

2.5 Experiment materials, environment and participants

All experiments have been conducted on a Windows laptop (a Lenovo YOGA 530-14ARR) with a 1920x1080 14-inch screen. In Windows, the scaling setting was set to 125%. The laptop has an HD web camera, but during all

experiments, the resolution recorded was 1280x720 at 30 fps.

The participant’s body temperature was measured using an IR-sensor. The chosen sensor, an *MLX90614ESF-DCI-000-SP-ND*, is specifically constructed for use in medical devices. This IR-sensor has an accuracy of $\pm 0.2^{\circ}C$ in the range of $0^{\circ}C \sim 60^{\circ}C$, and can measure multiple times per second. The sensor was soldered onto a breadboard with a $0.1\mu F$ ceramic capacitor, which is in accordance to the datasheet (*MLX90614 family Datasheet Single and Dual Zone Infra Red Thermometer in TO-39*, 2019). It is then connected to an Espressif ESP32-DevKitC V4 board, which attempts to read the ambient and object temperature 10 times per second. Initially, the experiments would be measuring the temperature from a distance of about 30 cm, with the sensor mounted on top of the laptop screen. This would be technically possible as the sensor has a 5° field of view (fov), however, this eventually proved to be too restrictive, as the participant could not move their head further than a couple of centimetres left and right. The sensor was therefore mounted to the participants head using a headband and wooden stick, which can be seen in Figure 4.



Figure 4. An overview of the experiment setup, with the IR-sensor shown on the participants head. Screenshots of the experimentation text-reader software can be found in Appendix G. Note: this is not the room the experiment took place in.

Experimentation software

The experimentation software is written in C# with .NET Framework 4.8 in Visual Studio. The experiment software both entailed some common parts used by all the project members and some code specific for this paper which mostly entails the post-analysis of the recorded data to generate an ‘attentiveness score’ from the gathered webcam and temperature data. The datasets were run through different ML algorithms using *Weka*, which is a helpful GUI for running multiple ML algorithms on different datasets (Witten et al., 2016).

3 Results

3.1 Circumplex model of affect not applicable

At this point, after some visual inspection of the emotional values as graphs, it became clear that the original hypothesis of linking the emotions to the circumplex model of affect was not possible. There were no significant changes visible which would make a manual mapping possible from the top right quadrant to the bottom left quadrant. This can be clearly seen in Figure 6 in Appendix A, there a section of about 20 seconds is shown. At the right, near the blue vertical bar, a small white dot can be seen in the ‘Inattentive (Messages)’ channel. This is an indication that at that moment the participant deblurred the screen, but this deblur took longer than the found blur discrimination time in experiment 2A, thus the participant was not fully attentive. Comparing this to attentive data to Figure 7 it should become clear that no discernable differences exist. Merely perhaps a larger spread, but this was not always the case. Moreover, the majority of the data indicates a neutral score > 0.7 , which would mean about the middle of the circumplex model of affect. This disproves **hypothesis 2 and 4**. Another approach was chosen, one which would try to train different ML algorithms on the data in the hopes of this detecting small changes based on statistical data of the seven emotions and the participant’s temperature.

3.2 Machine Learning data preparation

To attempt to detect attention and loss of sustained attention, the collected data had to be put through various different ML algorithms. Before the different ML algorithms were selected, first some other definitions had to be made.

Time windows

The data was cut up into smaller time windows, where an entire window is either put into the attentive or inattentive class. All data from experiment 1 is attentive data, therefore it could simply be cut up into pieces of t_w seconds long and then the features could be extracted from every window. Experiment 2B contained not only attentive data, but also inattentive data. The inattentive data could be classified into two classes: ‘inattentive’ and ‘distracted’. Where inattentive is based on the deblur-time and distracted based on the distraction button push, as explained in section 2.3. For both the inattentive and distracted tags, windows of length t_w were extracted. These windows would start t_w seconds before the inattentive or distracted tag in the stream, and end exactly at the tag. Thus in simple terms, whenever someone pushed the button, a window was extracted of length t_w which contained the t_w seconds before the button press.

Determining blur discrimination time

Before the inattentive windows could be extracted, the blur discrimination time needed to be determined. In total, during experiment 2A, 174 deblurring times were gathered. A histogram of these times can be seen in Figure 5. The blur discrimination is set to the 98th-percentile, which is 2902ms, rounded down to **2900ms**.

Therefore, any deblur-time longer than 2900ms during experiment 2B was marked as ‘inattentive’.

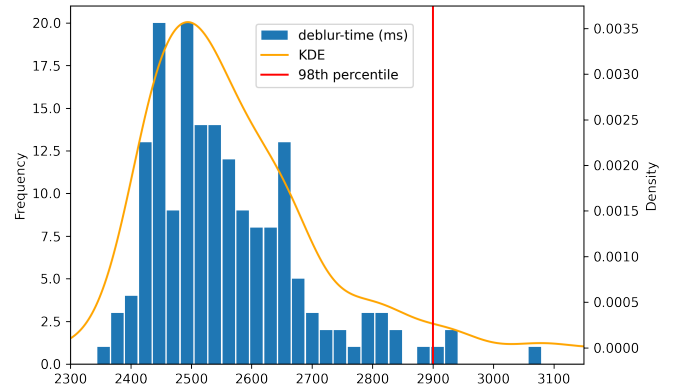


Figure 5. A histogram of all deblurring times gathered during experiment 2A, with KDE and

Features

Three different methods of extracting features were used.

- **Actual value:** In ‘actual value’ extraction mode, all features are extracted based on actual values. Thus the features extracted are: *mean, median, min, max, standard deviation, range (max - min), skewness and kurtosis*, where mean, median, min, max and range are all values based on the actual value of the data inputs from 0 to 1. The total number of features from this mode extracted is $8 * 8 = 64$.
- **Relative value:** In ‘relative value’ extraction mode, only features that say something about the distribution or variability of the data are extracted. Thus: *min, max, standard deviation, range (max - min), skewness and kurtosis*, where min, max and range are relative to the mean of the data points. E.g. if the mean of the dataset is 10 and the highest value is 15, then the feature ‘max’ is $|\text{mean} - \text{max}| = |10 - 15| = 5$. The total number of features extracted from this mode is $8 * 6 = 48$.
- **All 2B Relative:** This extracts the same features as in ‘relative value’ mode, but all the attentive and inattentive windows are extracted from the data recorded in experiment 2B, so no data from experiment 1 is used. Reasoning for this can be found in subsection 4.1. The attentive windows were defined by first gathering all the distraction/inattentive tags, and defining the regions of size t_w before those tags as ‘forbidden regions’ for the attentive data. Everything else outside these forbidden regions could then be extracted as ‘attentive’ windows, and all the ‘forbidden regions’ were extracted as distraction/inattentive windows. The total number of features extracted from this mode is $8 * 6 = 48$.

Apart from varying the window size t_w , three other variations could be introduced, namely what data inputs were fed into the algorithm, which inattentive tags were fed into the algorithm, and lastly which classification algorithm was used.

Datasets

After the features and the inattentive/attentive windows were defined and extracted, the datasets could be created. There were a couple of variables that could be altered between datasets, an overview can be seen in Table 1, and they are explained below:

- (a) Distraction / Inattentive / Combined. This relates to which ‘inattentive’ tags were used from the data stream in Experiment 2B, as described in section 3.2 ‘Time windows’.
- (b) Emotions only / Temperature only / Emotions and Temperature. This relates to the eight data inputs, as described in subsection 2.4.
- (c) 10s / 20s / 30s. This is the window size t_w as explained in section 3.2.

Important to note is the fact that for every dataset, all three variables had to be picked. As all three variables have three options, this resulted in $3 * 3 * 3 = 27$ different datasets which could be input into the ML algorithms. An example dataset could be: ‘*InattentiveFeatures-EmotionsOnly-20s*’.

Var. (a)	Var. (b)	Var. (c)
Distraction	Emotions only	10s
Inattentive	Temperature only	20s
Combined	Emotions and Temperature	30s

Table 1: An overview of variables altered between datasets.

3.3 Machine learning algorithms

The 4 classification algorithms that were used in Weka are *Random Tree (RT)*, *Random Forest (RF)*, *Decision Stump (DS)* and *J48 (C4.5 classifier)*. All models are classification models which use a decision tree (Fürnkranz, 2010) as underlying base model.

The RT algorithm constructs a tree that considers K randomly chosen attributes at each node (Witten et al., 2016). The RF algorithm builds and samples multiple random trees, using tree predictors such that each tree has values that are sampled from a random vector independently and using the same distribution for all the trees in the forest (Sammut & Webb, 2010e; Witten et al., 2016). This sampling from multiple trees and averaging it out makes for a more stable prediction. Similarly, a DS is also a tree model, but in this model the trees are only one level deep, and it only uses a single feature to split the data up into its classes (Sammut & Webb, 2010c; Witten et al., 2016). This model therefore may indicate the single most important feature, and if it has a good score it may also indicate that no other features need to be looked at in future research. J48 is an open-source Java implementation in Weka of the C4.5 classifier (Sammut & Webb, 2010a; Witten et al., 2016). The C4.5 algorithm generates a decision tree that can be used for classification. The algorithm chooses at every node the attribute which most efficiently splits the set into multiple subsets that define one of the classes.

Balancing the datasets

Depending on the window size chosen, either the attentive or inattentive class had more data points than the other. When using an imbalanced dataset in a classifier algorithm, the algorithm may be biased towards the class with more data points (Ling & Sheng, 2010). To prevent this, for every algorithm and dataset combination, the dataset was balanced using the `SpreadSubSample` class from Weka (Witten et al., 2016). This class produces a random subsample of the dataset, with a defined maximum ratio between classes and based on a random user-defined seed. For every algorithm and dataset combination, the `distributionSpread` was set to 1, indicating that the data would be subsampled randomly with a 1:1 ratio between the two classes. Therefore, no bias is introduced due to an imbalanced dataset.

Algorithm variations

The RF algorithm provided some variables which could possibly influence the results of the algorithm. The two variables altered are ‘number of features’ and ‘number of trees in the random forest’. The ‘number of features’ variable sets the size of the subset of random features chosen per node. The recommended value for this is $\text{int}(\log_2(\#\text{attributes}) + 1)$ (Sammut & Webb, 2010e). Thus, for a dataset with 64 features, the number of random features chosen per node is $\text{int}(\log_2(64) + 1) = 7$. Secondly, the ‘number of trees in random forest’ variable controlled just that, the number of trees that would be created in the forest. The default value is 100, so some experimentation was done to see the effects of this. The random forest also allows specifying a seed used for the randomiser to allow reproducibility.

The J48 algorithm allowed specifying a ‘confidence factor’, which controls which nodes will be dropped during the pruning phase where smaller values incur more pruning (Witten et al., 2016).

The RT algorithm, like the RF algorithm allows specifying a value (the K-value) which specifies the size of the subsets of randomly chosen features at every node (Witten et al., 2016). Similarly, the recommended value is $\text{int}(\log_2(\#\text{attributes}) + 1)$.

An overview of all the above-mentioned variations can be seen in Table 3 in Appendix B.

Results of all algorithms and datasets

As three modes of feature extraction were used (see section 3.2 ‘Features’), three different overview tables can be made combining the different datasets and ML models. Every algorithm was run 10 times on every dataset and ML model combination, averaging the result from those 10 runs. An overview of this can be seen in tables 4, 5 and 6 in appendices C, D and E respectively. These tables show the average Matthews Correlation Coefficient (MCC) for every dataset and model combination, thus every cell represents the average result of 10 runs of the model on that dataset. The MCC is a more reliable measure in binary machine learning classification models than the F1 score (Sammut & Webb, 2010d).

Actual value features From Table 4 in Appendix C these main conclusions can be drawn about the models and datasets using ‘actual value’ feature extraction:

1. The first 7 models are all Random Forest classification models, which performed by far the best. This is in line with the findings of Huang et al. (2019).
2. Temperature by itself is not a good indication of loss of sustained attention.
3. Combining temperature and emotions results in a stronger score than temperature or emotions only. This is an indication that there might be a correlation between temperature and emotional values. However, **hypothesis 3** cannot be proven in this paper, due to reasons explained in subsection 4.1.
4. On average, the 10-second windows performed best and the 30-second windows performed worst.
5. There is no significant difference when deviating from the default settings of the machine learning models. Experiments 1-7, 9-10 and 14-18 prove this by not having a significant difference in score between them.
6. The best model has a 0.92 MCC score, indicating the model has a very high accuracy.

The best performing dataset and model combination is:

- A dataset containing window sizes of 10 seconds, emotional and temperature values, and uses windows marked inattentive from both the distraction button and the inattentive indication using the deblur-times.
- A Random Forest model using 8 randomly selected features and 100 trees per forest.

Relative value features From Table 5 in Appendix D these main conclusions can be drawn about the models and datasets using ‘relative value’ feature extraction:

1. The Random Forest classification models still outperform all other models.
2. There is a small difference between 10, 20 and 30-second window sizes.
3. The models performed best on datasets that only contained ‘distraction button’ events as inattentive time windows.
4. The best model has a 0.86 MCC score, indicating the model has a very high accuracy, albeit lower than the best model using ‘actual value’ extraction.

The best performing dataset and model combination is:

- A dataset containing window sizes of 20 seconds, emotional and temperature values, and uses windows marked inattentive only using the distraction button.
- A Random Forest model using $\text{int} \log_2(48) + 1 = 7$ randomly selected features and 100 trees per forest.

All 2B Relative value features From Table 6 in Appendix E these main conclusions can be drawn about the models and datasets using ‘All 2B Relative value’ feature extraction.

1. Most models scored poorly, yet the Random Forest models still performed best.
2. A 30 second window size works significantly better in almost all cases.
3. The highest MCC is only 0.48, which indicates that the model is not very accurate.

The best performing dataset and model combination is:

- A dataset containing window sizes of 30 seconds, emotional and temperature values, and uses windows marked inattentive only using the distraction button.
- A Random Forest model using 4 randomly selected features and 100 trees per forest.

Most significant features

Using the best scoring dataset and model combination, the most significant features could be selected. The most significant features refer to the features most relevant in the decision tree. These features were selected using the `InfoGainAttributeEval Attribute Evaluator` and the `Ranker` search method from Witten et al. (2016). This evaluator ranks every feature based on their entropy and information they gain for selecting the two different classes.

Rank	Feature extraction mode		
	Actual value	Relative value	All 2B relative
1	sad-sd	sad-sd	sad-sd
2	sad-range	sad-max	sad-max
3	neutral-sd	neutral-sd	neutral-sd
4	neutral-range	fear-sd	sad-min
5	sad-max	sad-min	happy-max

Table 2: A ranked overview of the most significant features

As can be seen from Table 2, the top-ranking feature for the best datasets, no matter the feature extraction mode, is the sadness standard deviation. Overall, sadness is the most dominant data input, followed by neutral.

Validating the models

Every model has been evaluated using 10-fold cross-validation (Sammut & Webb, 2010b). k -fold cross-validation is a validation method that splits up the dataset into k training and validation sets of about the same size. The algorithm is then run k times on all subsets except one, which is used as the validation set. The result of these runs is then averaged to deduce the final model. An advantage of k -fold cross-validation is that it uses all the data at least once for training, and it reduces bias. As the datasets had to be collected completely from scratch, which is a lengthy process, the amount of data available was low and the likelihood of a bias was high, hence k -fold cross-validation was the best training and validation method to use in this scenario.

The best model for every mode of feature extraction was saved, resulting in a total of 3 models which could then be validated manually. This was done by applying the model on every frame of the recorded webcam data from experiment 2B. For every frame, a window of size t_w was extracted that started t_w seconds before that frame and ended exactly at it. Thus, for the ‘relative value’ feature extraction mode, windows of size 20s were extracted before every frame, the model applied, and then a value of 0 (attentive) or 1 (inattentive) was saved to a PSI store. This could then be visualised in PSI Studio, to give an indication of the viability of the model.

As can be seen in Figure 8 in Appendix F, which is a

screenshot of one of these visualisations, the model does not perform well. While it does generally report inattentiveness around distraction or inattentive tags, it does so just as much around assumed attentive areas. The most prevalent issue in all models, though, was that it reported most of the frames as inattentive. This leads to the hypothesis that the model has overfitted on the different experimental setups.

4 Discussion

4.1 Overfitting

The disconnect between the very high MCC scores on synthetic validation data and the bad performance of the best models in practice can be largely attributed to the small amount of data that was able to be extracted during the experiments and thus to overfitting. Overfitting is the effect that occurs when an ML model is trained on a relatively small dataset, the model then trains on random noise and variations in the small dataset instead of on the underlying distribution (Webb, 2010). This became very clear once most models started reporting a very large chunk of the frames from experiment 2B as inattentive. Some models reported around 50%, others up to 90%. When testing the models on the attentive data from experiment 1, they almost all reported the data as attentive, within some margin of error. These are all strong indicators of overfitting. It is assumed that the models trained on some slight variations between the two experiments. Three variations between the participants are hypothesised to be the root cause of this.

The first is the slight variations in lighting conditions between experiment 1 and 2B. While not very evident when comparing the two experiments webcam frames side-by-side, it could have had an influence on the detected emotions of the participant, or the participant’s temperature. The experiments were all conducted on the same day, but that still is a timeframe of about 12 hours.

The second is the participant having a different emotional state between the two experiments. For experiment 1 the participant was tasked to reading the text while being fully focused, as the experiment was meant to gather attentive data. This could have led the participant to have a bit more of a stern and focused face compared to experiment 2B, where the participant was told to simply read the text for about an hour and indicate if he/she was distracted. During experiment 2B the participant may have felt a bit more relaxed, which could be showing in their face. For this reason, the ‘relative value’ feature extraction mode was introduced. It was assumed that the participant may have different baseline values for their seven basic emotions. Hence mean and median were taken out, and all other features extracted only indicated the distribution of the data (standard deviation, skewness & kurtosis), or were defined in terms of a relative offset to the mean (min, max & range). This solution did not prove very worthwhile and in fact, only increased the number of frames marked as ‘inattentive’ where this was not expected.

The third and last is the variations in task length between experiment 1 and 2B. Where the intention of exper-

iment 1 was to gather attentive data, it could have accidentally introduced too much variation between it and experiment 2B for the model to be trained properly. Hence the ‘All 2B Relative’ feature extraction mode was introduced. This mode, as explained in section 3.2, extracted only windows from experiment 2B. Therefore, there could be no possible unknown environmental variable influencing the model training and causing overfitting. This has to be stated with a big side-note, however, as it can not be simply assumed that anything outside of the ‘forbidden regions’ of inattentive data is actually attentive data. Using this method, the models improved slightly for one participant, but not for all. The assumption is that this is the most important hypothesis to test in future research.

4.2 Spiking in temperature values

The IR-sensor, while very accurate, suffered from spiking downwards quite often. To counteract this, before the temperature data was fed into the models for training, it was filtered to remove any large spikes downwards. After some testing, it seems that the IR-sensor itself may have been faulty, or damaged during the soldering process, as no specific cause could be found for the spikes.

5 Conclusions and Future Work

This paper set out to investigate methods to detect sustained attention of a learner in the remote learning context, using commonly available data inputs such as a web camera and data inputs that are missing from existing literature such as body temperature. In spite of the limited data available, the experiments and subsequent processing of gathered data have shown that facial emotion recognition and body temperature sensing of a learner in the remote context is a viable solution. The main limitations in this paper were the overfitting of the ML models on the data, causing the models to work exceptionally good in synthetic 10-fold cross-validation, but poorly in practice. As such, no strong conclusions about the practical use of the models could be drawn.

Therefore this study should be repeated in future research, by first trying to solve the issues of overfitting by gathering more data, and secondly by finding a better solution of extracting attentive/inattentive windows of data which does not suffer from the possible variations as were problematic in experiment 1 and 2B in this paper.

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7 Responsible Research

While the technology researched in this paper can be used for many good things, and the paper has been written with the best intentions in mind, some aspects of it could be used in an unethical manner. As always, when technology researches topics regarding facial emotional detection and other bodily vital signs such as temperature, great care must be taken to preserve the privacy of all participants and eventual persons this technology may be used upon.

Great care has been taken to provide an as accurate description as possible of all the experiments and their subsequent data processing. Moreover, all code is open source and published together with all gathered datasets and derived datasets at <https://github.com/MultimodalLearningAnalytics>. Only one data modality is missing from the published datasets, the raw recorded web camera frames, as this is highly personal and identifying data. All other derivations, including the emotional values, are published. Therefore the results of this paper are reproducible except for the detection of facial emotions. The raw web camera data can be shared upon reasonable request.

Last but not least, it must be stated that the user study was conducted on a very specific target group with low variety. All three participants were white males (20-24 years old). Therefore the results of this paper are likely not generalisable to people outside that target group.

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Glossary

COVID-19 Coronavirus disease. 1

DS Decision Stump. 6

FER Facial Emotion Recognition. 4

fov field of view. 4

fps frames per second. 4

IR-sensor Infrared Temperature sensor. 1, 4, 8

MCC Matthews Correlation Coefficient. 6–8

ML Machine Learning. 1, 4–6, 8

PSI Microsoft Platform for Situated Intelligence. 2

RF Random Forest. 6

RT Random Tree. 6

SD Standard Deviation. 3

A PSI-Studio showing attentive and inattentive data

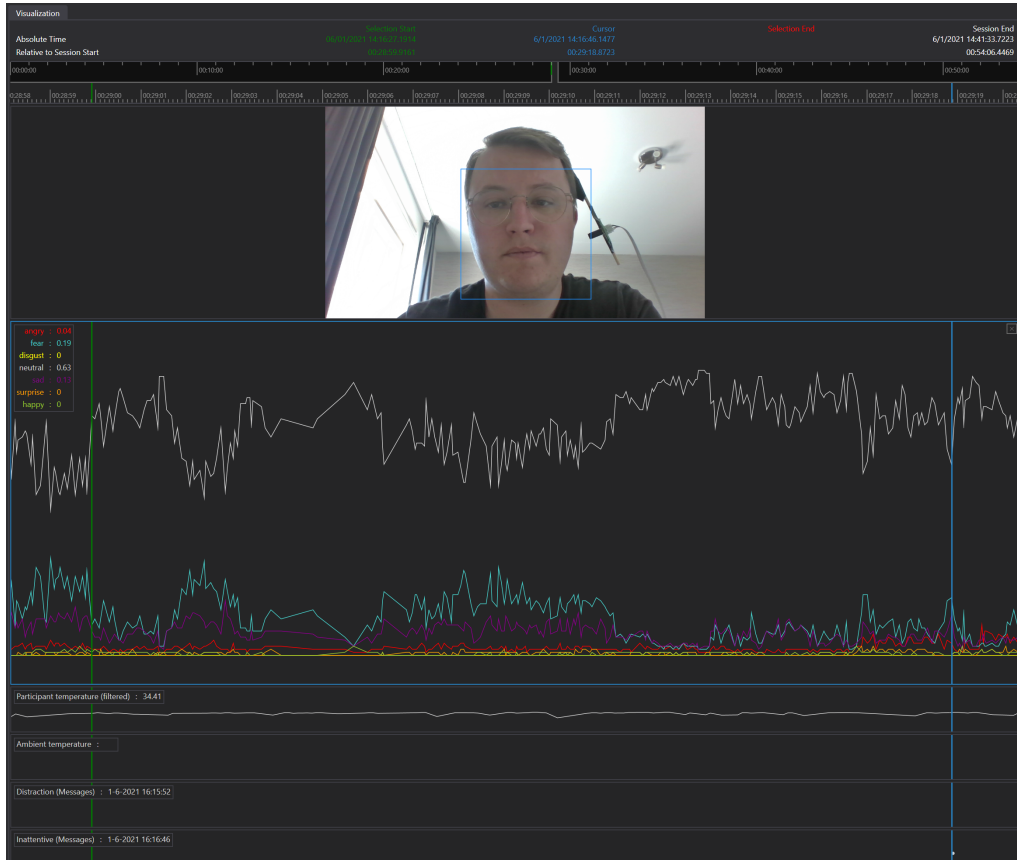


Figure 6. PSI-Studio showing a 20 second long section of data which is labelled as ‘inattentive’, as can be seen by the white dot near the blue vertical bar.

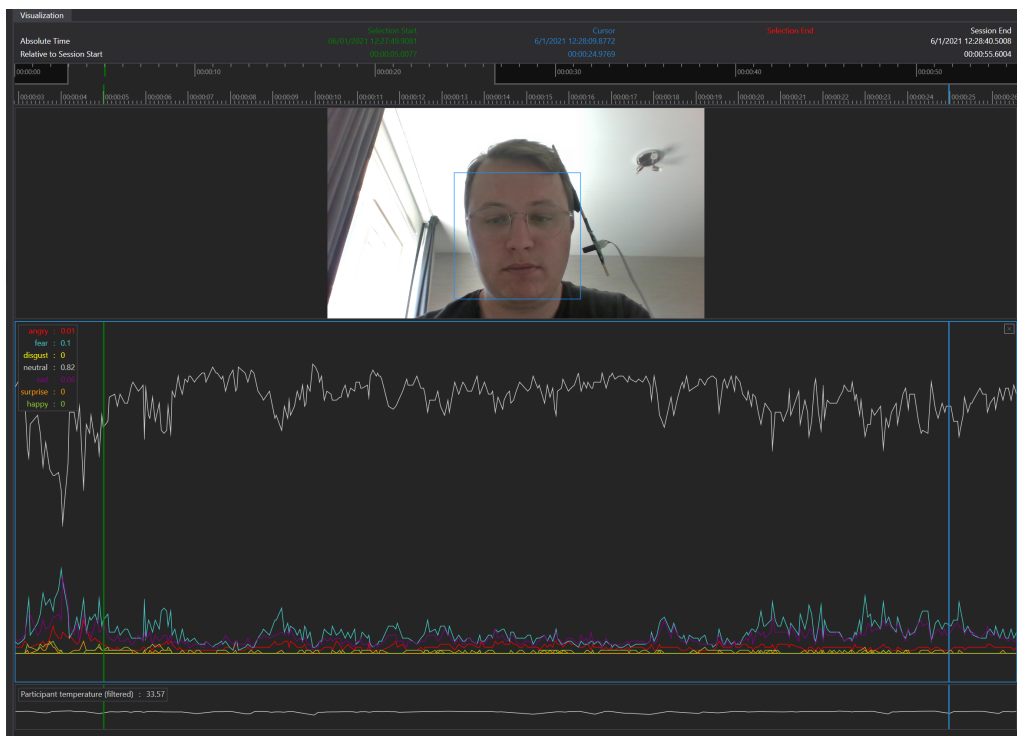


Figure 7. PSI-Studio showing a 20 second long section of data which is labelled as ‘attentive’.

B An overview of different variations in the different Machine Learning models

#	Subsample seed	ML Model	Model seed	RF - #features	RF - #trees in forest	J48 - Confidence factor	RT - K-value
[1]	4727	Random Forest	6625	$\log_2(\#\text{attributes}) + 1$	100		
[2]	4727	Random Forest	6625	4	100		
[3]	4727	Random Forest	6625	8	100		
[4]	4727	Random Forest	6625	16	100		
[5]	4727	Random Forest	6625	$\log_2(\#\text{attributes}) + 1$	50		
[6]	4727	Random Forest	6625	$\log_2(\#\text{attributes}) + 1$	150		
[7]	4727	Random Forest	6625	$\log_2(\#\text{attributes}) + 1$	200		
[8]	4596	Decision Stump	-				
[9]	6678	J48	-			0.1	
[10]	6678	J48	-			0.2	
[11]	6678	J48	-			0.3	
[12]	6678	J48	-			0.4	
[13]	6678	J48	-			0.5	
[14]	9645	Random Tree	1746				$\log_2(\#\text{attributes}) + 1$
[15]	9645	Random Tree	1746				4
[16]	9645	Random Tree	1746				8
[17]	9645	Random Tree	1746				16
[18]	9645	Random Tree	1746				32

Table 3: An overview of different variations in the different Machine Learning models

C Matthews correlation score of all Machine Learning models & datasets using ‘actual value’ extraction

Dataset	Model																		Average
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	
CombinedFeatures-EmotionsAndTemp-10s	0.91	0.91	0.92	0.91	0.91	0.92	0.92	0.62	0.83	0.83	0.82	0.82	0.82	0.76	0.72	0.78	0.78	0.81	0.83
CombinedFeatures-EmotionsAndTemp-20s	0.87	0.88	0.87	0.86	0.87	0.87	0.87	0.63	0.78	0.77	0.77	0.77	0.77	0.69	0.68	0.72	0.75	0.76	0.79
CombinedFeatures-EmotionsAndTemp-30s	0.78	0.8	0.79	0.77	0.77	0.79	0.78	0.62	0.71	0.71	0.71	0.71	0.71	0.63	0.6	0.61	0.63	0.64	0.71
CombinedFeatures-EmotionsOnly-10s	0.79	0.79	0.79	0.8	0.79	0.79	0.79	0.62	0.71	0.7	0.7	0.7	0.7	0.65	0.65	0.66	0.7	0.71	0.72
CombinedFeatures-EmotionsOnly-20s	0.76	0.76	0.76	0.75	0.75	0.76	0.76	0.64	0.68	0.68	0.69	0.69	0.69	0.6	0.57	0.64	0.66	0.67	0.70
CombinedFeatures-EmotionsOnly-30s	0.69	0.68	0.69	0.69	0.68	0.69	0.69	0.62	0.6	0.6	0.58	0.58	0.58	0.54	0.53	0.55	0.57	0.58	0.62
CombinedFeatures-TempOnly-10s	0.47	0.47	0.44	0.44	0.44	0.46	0.46	0.37	0.42	0.43	0.43	0.44	0.43	0.39	0.39	0.43	0.43	0.43	0.43
CombinedFeatures-TempOnly-20s	0.44	0.44	0.44	0.44	0.44	0.45	0.44	0.47	0.38	0.38	0.38	0.38	0.38	0.36	0.36	0.35	0.35	0.35	0.40
CombinedFeatures-TempOnly-30s	0.41	0.41	0.41	0.41	0.41	0.41	0.42	0.46	0.34	0.33	0.34	0.33	0.33	0.34	0.34	0.33	0.33	0.33	0.37
DistractionFeatures-EmotionsAndTemp-10s	0.86	0.87	0.86	0.85	0.87	0.87	0.87	0.75	0.74	0.74	0.74	0.74	0.74	0.72	0.69	0.74	0.74	0.79	0.79
DistractionFeatures-EmotionsAndTemp-20s	0.89	0.91	0.9	0.89	0.9	0.9	0.9	0.71	0.8	0.79	0.78	0.78	0.78	0.76	0.74	0.77	0.82	0.83	0.83
DistractionFeatures-EmotionsAndTemp-30s	0.86	0.86	0.86	0.85	0.86	0.86	0.86	0.75	0.8	0.79	0.79	0.79	0.79	0.7	0.69	0.74	0.73	0.73	0.80
DistractionFeatures-EmotionsOnly-10s	0.84	0.85	0.85	0.85	0.84	0.85	0.85	0.74	0.75	0.75	0.75	0.75	0.75	0.71	0.67	0.73	0.74	0.75	0.78
DistractionFeatures-EmotionsOnly-20s	0.85	0.86	0.86	0.87	0.85	0.85	0.86	0.7	0.8	0.8	0.8	0.8	0.8	0.71	0.69	0.73	0.76	0.79	0.80
DistractionFeatures-EmotionsOnly-30s	0.84	0.85	0.84	0.84	0.83	0.84	0.84	0.74	0.74	0.73	0.73	0.73	0.73	0.67	0.68	0.67	0.76	0.77	0.77
DistractionFeatures-TempOnly-10s	0.5	0.5	0.47	0.47	0.49	0.49	0.5	0.38	0.43	0.43	0.44	0.44	0.44	0.41	0.41	0.43	0.43	0.43	0.45
DistractionFeatures-TempOnly-20s	0.59	0.59	0.56	0.56	0.57	0.6	0.59	0.4	0.39	0.38	0.38	0.38	0.38	0.44	0.44	0.44	0.44	0.44	0.48
DistractionFeatures-TempOnly-30s	0.56	0.56	0.57	0.57	0.56	0.56	0.56	0.44	0.37	0.39	0.4	0.4	0.4	0.42	0.42	0.45	0.45	0.45	0.47
InattentiveFeatures-EmotionsAndTemp-10s	0.84	0.84	0.83	0.83	0.83	0.83	0.84	0.33	0.75	0.74	0.75	0.75	0.75	0.64	0.62	0.62	0.67	0.67	0.73
InattentiveFeatures-EmotionsAndTemp-20s	0.89	0.88	0.91	0.89	0.88	0.89	0.89	0.54	0.73	0.74	0.74	0.74	0.74	0.68	0.62	0.7	0.7	0.7	0.77
InattentiveFeatures-EmotionsAndTemp-30s	0.8	0.82	0.79	0.77	0.79	0.81	0.8	0.58	0.69	0.68	0.68	0.68	0.68	0.63	0.61	0.6	0.61	0.58	0.70
InattentiveFeatures-EmotionsOnly-10s	0.68	0.69	0.68	0.68	0.68	0.68	0.69	0.35	0.56	0.56	0.57	0.57	0.57	0.51	0.47	0.52	0.55	0.53	0.59
InattentiveFeatures-EmotionsOnly-20s	0.73	0.73	0.73	0.71	0.73	0.73	0.74	0.55	0.58	0.57	0.58	0.58	0.58	0.57	0.55	0.59	0.62	0.6	0.64
InattentiveFeatures-EmotionsOnly-30s	0.7	0.7	0.7	0.72	0.69	0.72	0.7	0.53	0.62	0.61	0.59	0.59	0.59	0.49	0.51	0.53	0.59	0.56	0.62
InattentiveFeatures-TempOnly-10s	0.29	0.29	0.28	0.28	0.29	0.29	0.29	0.26	0.26	0.25	0.25	0.24	0.24	0.27	0.27	0.25	0.25	0.25	0.27
InattentiveFeatures-TempOnly-20s	0.36	0.36	0.38	0.38	0.36	0.35	0.35	0.41	0.35	0.34	0.34	0.34	0.34	0.31	0.31	0.33	0.33	0.33	0.35
InattentiveFeatures-TempOnly-30s	0.33	0.33	0.37	0.37	0.32	0.33	0.33	0.48	0.22	0.21	0.21	0.2	0.2	0.28	0.28	0.31	0.31	0.31	0.30
Average	0.69	0.69	0.69	0.68	0.68	0.69	0.69	0.54	0.59	0.59	0.59	0.59	0.59	0.55	0.54	0.56	0.58	0.58	

Table 4: An overview of the results of all the ML models and datasets using ‘actual value’ feature extraction, and their respective Matthews correlation score. The model numbers relate to the models described in Table 3 in Appendix B.

D Matthews correlation score of all Machine Learning models & datasets using ‘relative value’ extraction

Dataset	Model																		Average
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	
CombinedFeatures-EmotionsAndTemp-10s	0.76	0.76	0.77	0.77	0.76	0.77	0.77	0.55	0.63	0.63	0.62	0.62	0.62	0.59	0.57	0.6	0.62	0.6	0.67
CombinedFeatures-EmotionsAndTemp-20s	0.76	0.74	0.76	0.75	0.76	0.76	0.76	0.61	0.63	0.63	0.62	0.62	0.62	0.55	0.56	0.57	0.6	0.61	0.66
CombinedFeatures-EmotionsAndTemp-30s	0.73	0.74	0.74	0.74	0.73	0.74	0.74	0.61	0.63	0.63	0.63	0.63	0.63	0.52	0.53	0.54	0.59	0.57	0.65
CombinedFeatures-EmotionsOnly-10s	0.71	0.71	0.71	0.71	0.7	0.71	0.71	0.54	0.59	0.59	0.58	0.58	0.58	0.53	0.53	0.55	0.59	0.57	0.62
CombinedFeatures-EmotionsOnly-20s	0.67	0.67	0.67	0.66	0.67	0.68	0.69	0.63	0.53	0.53	0.53	0.53	0.53	0.51	0.49	0.53	0.53	0.55	0.59
CombinedFeatures-EmotionsOnly-30s	0.67	0.64	0.66	0.67	0.63	0.67	0.66	0.6	0.56	0.56	0.56	0.56	0.56	0.46	0.5	0.52	0.53	0.49	0.58
CombinedFeatures-TempOnly-10s	0.42	0.41	0.4	0.4	0.41	0.42	0.42	0.4	0.41	0.41	0.4	0.4	0.4	0.31	0.33	0.35	0.35	0.35	0.39
CombinedFeatures-TempOnly-20s	0.47	0.47	0.47	0.47	0.47	0.49	0.49	0.42	0.45	0.45	0.45	0.44	0.44	0.4	0.42	0.44	0.44	0.44	0.45
CombinedFeatures-TempOnly-30s	0.48	0.48	0.45	0.45	0.48	0.48	0.48	0.36	0.36	0.36	0.37	0.37	0.37	0.37	0.38	0.36	0.36	0.36	0.41
DistractionFeatures-EmotionsAndTemp-10s	0.84	0.83	0.84	0.83	0.84	0.84	0.84	0.74	0.71	0.71	0.7	0.7	0.7	0.63	0.61	0.65	0.68	0.69	0.74
DistractionFeatures-EmotionsAndTemp-20s	0.86	0.86	0.85	0.85	0.86	0.85	0.85	0.69	0.76	0.75	0.75	0.75	0.75	0.7	0.67	0.67	0.7	0.77	0.77
DistractionFeatures-EmotionsAndTemp-30s	0.84	0.84	0.84	0.83	0.83	0.84	0.84	0.74	0.72	0.72	0.72	0.72	0.72	0.65	0.62	0.7	0.69	0.69	0.75
DistractionFeatures-EmotionsOnly-10s	0.8	0.79	0.81	0.8	0.78	0.8	0.8	0.75	0.69	0.69	0.69	0.69	0.69	0.63	0.6	0.63	0.66	0.67	0.72
DistractionFeatures-EmotionsOnly-20s	0.8	0.81	0.81	0.81	0.8	0.81	0.81	0.7	0.75	0.74	0.74	0.74	0.74	0.62	0.63	0.7	0.72	0.74	0.75
DistractionFeatures-EmotionsOnly-30s	0.83	0.82	0.84	0.82	0.82	0.84	0.82	0.75	0.72	0.71	0.7	0.7	0.7	0.64	0.63	0.65	0.68	0.7	0.74
DistractionFeatures-TempOnly-10s	0.36	0.35	0.34	0.34	0.36	0.36	0.37	0.37	0.38	0.37	0.37	0.37	0.37	0.32	0.33	0.3	0.3	0.3	0.35
DistractionFeatures-TempOnly-20s	0.6	0.6	0.6	0.6	0.58	0.59	0.6	0.33	0.5	0.51	0.51	0.51	0.51	0.46	0.48	0.51	0.51	0.51	0.53
DistractionFeatures-TempOnly-30s	0.62	0.63	0.61	0.61	0.6	0.63	0.63	0.4	0.57	0.56	0.57	0.57	0.57	0.56	0.53	0.56	0.56	0.56	0.57
InattentiveFeatures-EmotionsAndTemp-10s	0.63	0.62	0.63	0.63	0.62	0.63	0.62	0.35	0.48	0.48	0.48	0.48	0.48	0.45	0.41	0.46	0.48	0.48	0.52
InattentiveFeatures-EmotionsAndTemp-20s	0.69	0.68	0.71	0.71	0.69	0.7	0.7	0.48	0.55	0.54	0.53	0.53	0.53	0.49	0.48	0.52	0.53	0.51	0.59
InattentiveFeatures-EmotionsAndTemp-30s	0.69	0.72	0.72	0.73	0.7	0.71	0.71	0.62	0.74	0.73	0.73	0.73	0.73	0.49	0.53	0.55	0.59	0.64	0.67
InattentiveFeatures-EmotionsOnly-10s	0.54	0.53	0.53	0.55	0.54	0.54	0.54	0.32	0.48	0.48	0.48	0.48	0.48	0.42	0.39	0.41	0.43	0.39	0.47
InattentiveFeatures-EmotionsOnly-20s	0.55	0.57	0.56	0.56	0.55	0.55	0.54	0.5	0.4	0.4	0.4	0.4	0.4	0.41	0.4	0.42	0.41	0.39	0.47
InattentiveFeatures-EmotionsOnly-30s	0.62	0.59	0.62	0.65	0.61	0.62	0.62	0.6	0.56	0.57	0.55	0.55	0.55	0.5	0.47	0.51	0.52	0.56	0.57
InattentiveFeatures-TempOnly-10s	0.35	0.35	0.33	0.33	0.35	0.35	0.34	0.25	0.26	0.26	0.26	0.26	0.26	0.27	0.27	0.28	0.28	0.28	0.30
InattentiveFeatures-TempOnly-20s	0.46	0.47	0.46	0.46	0.45	0.45	0.46	0.4	0.39	0.39	0.4	0.39	0.39	0.37	0.34	0.38	0.38	0.38	0.41
InattentiveFeatures-TempOnly-30s	0.47	0.46	0.44	0.44	0.47	0.47	0.47	0.41	0.32	0.31	0.33	0.33	0.33	0.35	0.36	0.35	0.35	0.35	0.39
Average	0.64	0.63	0.64	0.64	0.63	0.64	0.64	0.52	0.55	0.54	0.54	0.54	0.54	0.49	0.48	0.51	0.52	0.52	

Table 5: An overview of the results of all the ML models and datasets using ‘relative’ feature extraction, and their respective Matthews correlation score. The model numbers relate to the models described in Table 3 in Appendix B.

E Matthews correlation score of all Machine Learning models & datasets using ‘all 2B relative’ extraction

Dataset	Model																		Average
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	
AllEx2B-Combined-EmotionsAndTemp-10s	0.26	0.26	0.26	0.27	0.25	0.26	0.26	0.25	0.2	0.19	0.19	0.19	0.19	0.12	0.12	0.12	0.12	0.15	0.20
AllEx2B-Combined-EmotionsAndTemp-20s	0.35	0.36	0.34	0.34	0.35	0.36	0.36	0.23	0.18	0.18	0.18	0.18	0.17	0.14	0.13	0.15	0.15	0.17	0.24
AllEx2B-Combined-EmotionsAndTemp-30s	0.4	0.42	0.4	0.39	0.41	0.41	0.41	0.22	0.23	0.23	0.23	0.23	0.23	0.23	0.19	0.23	0.19	0.21	0.29
AllEx2B-Combined-EmotionsOnly-10s	0.26	0.26	0.25	0.25	0.26	0.26	0.27	0.25	0.18	0.18	0.18	0.18	0.18	0.11	0.1	0.13	0.13	0.13	0.20
AllEx2B-Combined-EmotionsOnly-20s	0.32	0.33	0.32	0.31	0.32	0.33	0.33	0.26	0.14	0.14	0.14	0.14	0.14	0.15	0.13	0.16	0.17	0.16	0.22
AllEx2B-Combined-EmotionsOnly-30s	0.41	0.42	0.41	0.37	0.39	0.42	0.42	0.21	0.27	0.27	0.27	0.27	0.27	0.21	0.2	0.21	0.22	0.21	0.30
AllEx2B-Combined-TempOnly-10s	0.06	0.07	0.07	0.07	0.07	0.06	0.06	0.01	-0.03	-0.03	-0.03	-0.04	-0.04	0.05	0.02	0.05	0.05	0.05	0.03
AllEx2B-Combined-TempOnly-20s	0.2	0.19	0.19	0.19	0.2	0.2	0.2	0.14	0.2	0.19	0.19	0.19	0.19	0.12	0.13	0.12	0.12	0.12	0.17
AllEx2B-Combined-TempOnly-30s	0.16	0.17	0.15	0.15	0.16	0.17	0.17	0.09	0.21	0.2	0.2	0.2	0.2	0.11	0.05	0.07	0.07	0.07	0.14
AllEx2B-Distracton-EmotionsAndTemp-10s	0.31	0.31	0.31	0.3	0.3	0.31	0.31	0.18	0.19	0.19	0.19	0.19	0.19	0.17	0.16	0.18	0.16	0.16	0.23
AllEx2B-Distracton-EmotionsAndTemp-20s	0.43	0.43	0.42	0.41	0.41	0.42	0.42	0.18	0.24	0.24	0.24	0.24	0.24	0.23	0.21	0.21	0.21	0.21	0.30
AllEx2B-Distracton-EmotionsAndTemp-30s	0.46	0.48	0.46	0.44	0.46	0.47	0.46	0.17	0.27	0.27	0.27	0.27	0.27	0.27	0.22	0.25	0.25	0.28	0.33
AllEx2B-Distracton-EmotionsOnly-10s	0.3	0.31	0.3	0.29	0.3	0.31	0.3	0.19	0.2	0.2	0.2	0.2	0.2	0.16	0.15	0.17	0.17	0.18	0.23
AllEx2B-Distracton-EmotionsOnly-20s	0.41	0.42	0.41	0.39	0.38	0.4	0.4	0.17	0.24	0.23	0.23	0.23	0.23	0.23	0.21	0.22	0.22	0.23	0.29
AllEx2B-Distracton-EmotionsOnly-30s	0.43	0.44	0.42	0.42	0.44	0.43	0.43	0.19	0.28	0.28	0.28	0.28	0.28	0.25	0.26	0.24	0.23	0.26	0.32
AllEx2B-Distracton-TempOnly-10s	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.07	0.05	0.05	0.05	0.05	0.05	0.01	0.03	0.02	0.02	0.02	0.04
AllEx2B-Distracton-TempOnly-20s	0.11	0.1	0.11	0.11	0.11	0.12	0.11	0.22	0.2	0.2	0.2	0.2	0.2	0.07	0.08	0.11	0.11	0.11	0.14
AllEx2B-Distracton-TempOnly-30s	0.11	0.1	0.11	0.11	0.11	0.1	0.11	0.19	0.17	0.16	0.16	0.16	0.16	0.02	0.05	0.04	0.04	0.04	0.11
AllEx2B-Inattentive-EmotionsAndTemp-10s	0.11	0.11	0.11	0.12	0.12	0.11	0.12	0.09	0.07	0.07	0.07	0.07	0.07	0.04	0.03	0.06	0.06	0.06	0.08
AllEx2B-Inattentive-EmotionsAndTemp-20s	0.2	0.2	0.19	0.18	0.19	0.2	0.2	0.12	0.07	0.08	0.07	0.07	0.07	0.1	0.07	0.07	0.09	0.1	0.13
AllEx2B-Inattentive-EmotionsAndTemp-30s	0.35	0.35	0.35	0.34	0.35	0.35	0.35	0.27	0.23	0.23	0.22	0.23	0.23	0.16	0.17	0.18	0.14	0.15	0.26
AllEx2B-Inattentive-EmotionsOnly-10s	0.14	0.14	0.14	0.14	0.14	0.13	0.13	0.11	0.07	0.08	0.08	0.08	0.08	0.05	0.05	0.07	0.08	0.08	0.10
AllEx2B-Inattentive-EmotionsOnly-20s	0.2	0.22	0.2	0.19	0.19	0.2	0.2	0.15	0.13	0.12	0.12	0.12	0.12	0.06	0.07	0.07	0.09	0.08	0.14
AllEx2B-Inattentive-EmotionsOnly-30s	0.33	0.33	0.32	0.32	0.32	0.34	0.33	0.27	0.21	0.19	0.19	0.19	0.19	0.15	0.15	0.14	0.16	0.18	0.24
AllEx2B-Inattentive-TempOnly-10s	0.04	0.03	0.04	0.04	0.04	0.04	0.03	0.01	0.03	0.03	0.03	0.03	0.03	0.02	0	0.02	0.02	0.02	0.03
AllEx2B-Inattentive-TempOnly-20s	0.17	0.17	0.16	0.16	0.16	0.17	0.17	0.23	0.19	0.19	0.19	0.19	0.19	0.13	0.1	0.12	0.12	0.12	0.16
AllEx2B-Inattentive-TempOnly-30s	0.23	0.21	0.2	0.2	0.23	0.24	0.23	0.31	0.27	0.27	0.27	0.27	0.27	0.13	0.12	0.11	0.11	0.11	0.21
Average	0.25	0.25	0.25	0.24	0.25	0.25	0.25	0.18	0.17	0.17	0.17	0.17	0.17	0.13	0.12	0.13	0.13	0.14	

Table 6: An overview of the results of all the ML models and datasets using ‘all 2B relative’ feature extraction, and their respective Matthews correlation score. The model numbers relate to the models described in Table 3 in Appendix B.

F PSI Studio showing the best model using actual value feature extraction

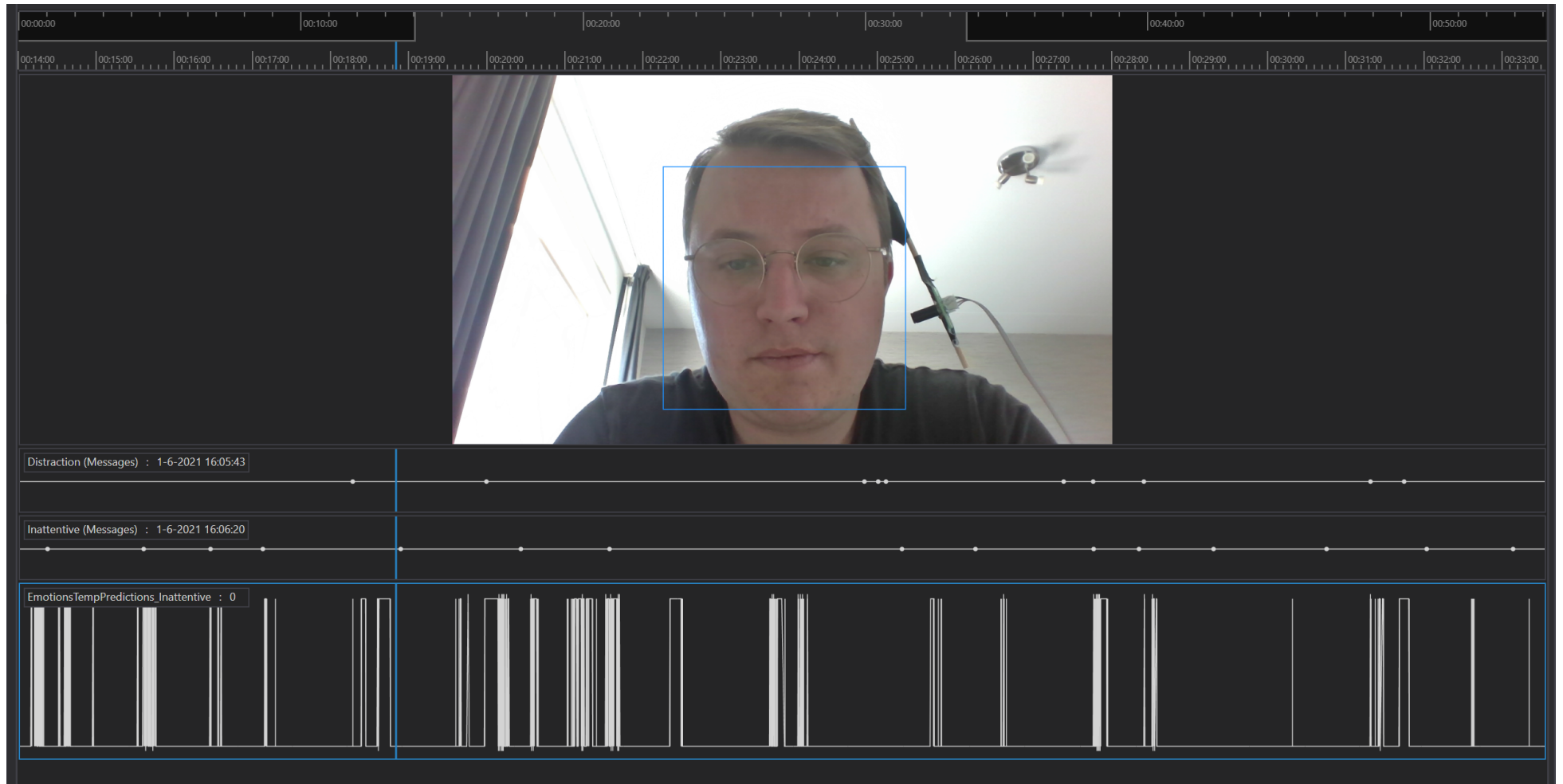
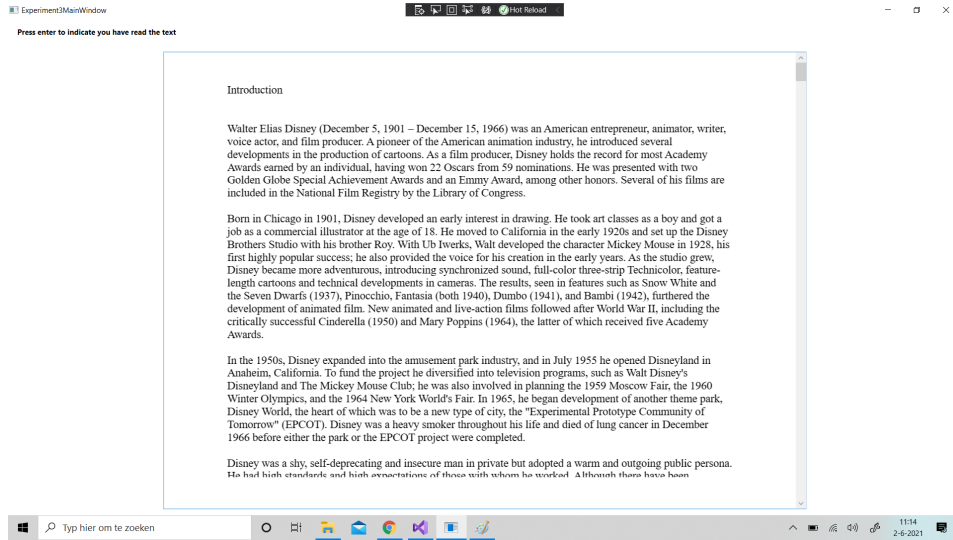
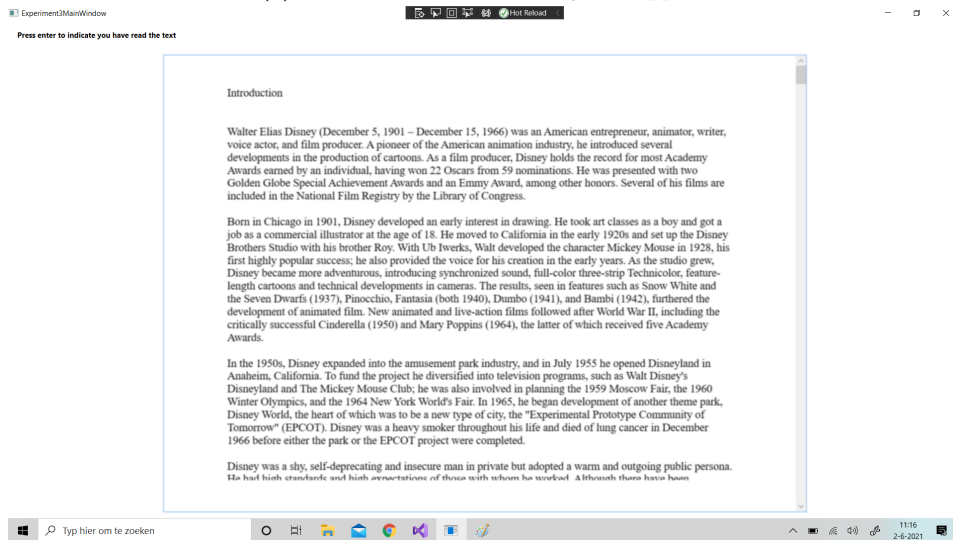


Figure 8. PSI Studio showing the best model using 'actual value' extraction

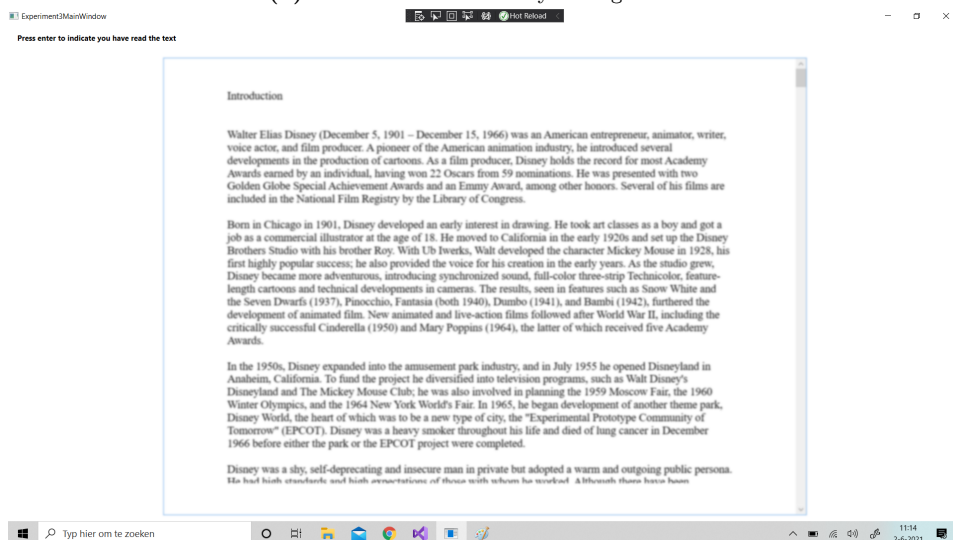
G Screenshots of the text reading software including blurring



(a) The text reader without any blur applied



(b) The text reader halfway through a blur



(c) The text reader fully blurred

Figure 9. Screenshots of the experimentation software

H Experiment 1 short texts

Text	Number of words
1	144
2	247
3	175
4	192
5	256
6	199
7	271
8	224
9	175
10	192
11	227
12	166

Table 7: An overview of the texts and their lengths used in experiment 1

H.1 Text one

Amazon has sealed an \$8.45 billion deal to buy MGM, the company that owns the iconic Hollywood studio known for releasing movies in the James Bond and Rocky franchises. The deal sets a course to amp up Amazon Prime Video with new programming mined from MGM's long history and to bolster Amazon's existing original production arm, Amazon Studios.

Amazon said MGM's goldmine is the intellectual property that it can leverage for making new content – the beloved franchises that Amazon can now tap into to make new material.

"The real financial value behind this deal is the treasure trove of IP in the deep catalog that we plan to reimagine and develop together with MGM's talented team," Mike Hopkins, Amazon's senior vice president of Prime Video and Amazon Studios, said in a release. "It's very exciting and provides so many opportunities for high-quality storytelling."

<https://www.cnet.com/news/amazon-buys-mgm-setting-prime-video-up-for-a-james-bond-rocky-infusion/>

H.2 Text two

Holy floppin' hellfire, Henry! Have you heard? A terrifying new form of Android malware is running amok — stealing passwords, emptying bank accounts, and drinking all the grape soda from the refrigerators of unsuspecting Android phone owners.

We should all be quivering in our rainboots, according to almost all the information I've read on these here internets. Numerous adjective-filled news stories have warned me that the "scary new Android malware" is "spreading quickly," targeting "millions" (millions!) of users, and occasionally even "kicking people square in the groin." (All right, so I made that last part up. But you get the idea.)

BUT WAIT! It gets worse: The malware, known as FluBot (because it wouldn't be Android malware if it didn't have an annoyingly cutesy name), works by showing up on your phone, gaining access to all of your most sensitive data, and then sending your deepest secrets to hooligans who are preemptively cackling over your unavoidable misfortune.

It's enough to make you want to toss your Android phone into the nearest quarry and go into permanent hiding. I get it — who wouldn't react that way? Before you start searching for the nearest bunker, though, there's something you should know about this menacing Android malware. And it's something that, if we're being fully honest, applies to the vast majority of fear-inducing Android security stories we see out in the wild.

Ready? This Android malware should be incredibly scary for you — if, that is, you're a complete and total nitwit.

<https://www.computerworld.com/article/3616703/android-security-warning.html>

H.3 Text three

Any enterprise eager to meet accessibility and diversity targets now has additional reasons to consider Apple's technologies, with Assistive Touch for Apple Watch hinting at a gesture-based future for wearable tech. Accessibility for the rest of us?

Apple made a series of announcements to mark Global Accessibility Awareness Day, which is today. New accessible user interface (UI) enhancements included support for third-party, eye-tracking hardware to control iPads and a very interesting use of machine vision intelligence so your device can identify objects within images when using voice to control the device.

But it's Assistive Touch for Apple Watch that feels most like watching *Minority Report*, because it introduces new gesture controls. These use built-in motion sensors inside the watch, including the gyroscope, accelerometer, optical heart rate sensor, and on-device machine learning to detect subtle differences in muscle movement and tendon activity.

These gestures are then translated into actions, so it's possible to answer a call by clenching your hand as you raise your wrist, or to scroll an on-page app interface by moving your hand.

<https://www.computerworld.com/article/3619889/accessibility-takes-a-magic-leap-with-apple-watch-gesture-control.html>

H.4 Text four

Iran has announced a four-month ban on the energy-consuming mining of cryptocurrencies such as Bitcoin after cities suffered unplanned blackouts.

President Hassan Rouhani told a cabinet meeting the main cause of the blackouts was a drought that had affected hydro-electric power generation.

But he said cryptocurrency mining, 85

An estimated 4.5

According to analytics firm Elliptic, the activity allows the country to bypass sanctions and earn hundreds of millions of dollars in crypto-assets that can be used to purchase imports.

Bitcoin consumes 'more electricity than Argentina'

Iran's banks were cut off from the global financial system and its oil exports plummeted, depriving it of a major source of hard currency and revenue, as a result of sanctions reinstated by the US in 2018 when then President Donald Trump abandoned a landmark nuclear deal.

Bitcoin operates on the blockchain, a digital ledger of transactions. Miners audit Bitcoin transactions in exchange for an opportunity to acquire the digital currency. It requires enormous computing power, which in turn uses huge amounts of electricity.

<https://www.bbc.com/news/world-middle-east-57260829>

H.5 Text five

When Matt LeBlanc and Matthew Perry plop down in side-by-side leather lounge chairs in *Friends: The Reunion* on HBO Max, it is, for a moment, as if no time has passed since their characters reclined in front of their cherished TV set all those years ago.

Yet the actors have lived lifetimes since a young Joey Tribbiani and Chandler Bing shared a New York bachelor pad on the long-running NBC comedy. And in the case of the 51-year-old Perry, who's battled addiction and spent three months in the hospital following gastrointestinal surgery, life hasn't always been funny.

"Aww, Matty, it's good to see you, man," Perry tells the affable LeBlanc, now a 53-year-old teddy bear of a guy who delivers lingering hugs to his former cast mates.

There's a genuine warmth to the exchange between the two actors, and as an old episode flashes back to them in their 20s, sitting in barcaloungers in the exact same spot, it's hard not to feel a bit melancholy. Now they're two middle-aged guys with gray hair and more lived experience, together again and looking back. It's a simple moment, tinged with a poignancy that permeates the whole special.

The highly anticipated reunion, also dubbed *The One Where They Get Back Together*, reunites the six lead actors on the show's original soundstage at the Warner Bros. Studio lot in Burbank, California. It's the first time LeBlanc, Perry, Jennifer Aniston, Courtney Cox, Lisa Kudrow and David Schwimmer have been together in the same room since the finale aired in 2004.

<https://www.cnet.com/news/friends-the-reunion-on-hbo-max-review-drags-in-spots-but-is-mostly-a-poignant-homecoming/>

H.6 Text six

Instagram is offering its users the option to hide the number of likes they receive on posts on the app.

The aim is to “depressurize people’s experience” on the platform, the social media giant said.

Users with the feature enabled will now see the username of a follower who has liked the post, “and others”, instead of a number.

The tool has been tested in several countries since 2019, but it is now being rolled out globally.

“This has taken longer than I had hoped, but I am pretty excited about... giving people more control over the experience,” Instagram’s boss Adam Mosseri told the BBC.

In its testing and research, Instagram said that removing likes had little impact on behaviour or wellbeing - after concerns that using the platform could be linked to insecurity and poor mental health.

Despite this, Mr Mosseri said Instagram - which is owned by Facebook - introduced the feature to make “people feel good about the time they spend” on the platform.

“I do think there’s more to do in this space,” he added. “The more we can give people the ability to shape Instagram and Facebook into what’s good for them, the better.”

<https://www.bbc.com/news/technology-57254488>

H.7 Text seven

Microsoft last week launched a public preview of the APIs (application programming interfaces) that IT admins can call on to control Windows Update for Business Deployment Service, the company’s latest effort to push commercial customers to adopt cloud-only servicing for Windows 10.

"With today’s public preview release, you can use the Windows Update for Business deployment service directly through the Microsoft Graph API and associated SDKs, as well as Azure PowerShell," David Mebane, principal program manager lead with the Windows servicing group, said in an April 28 post. [Related: Troubleshooting Windows 10 with Reliability Monitor]

Although Microsoft trumpeted WUfB Deployment Service at its Ignite developers conference last month, Friday was the unveiling of any actual functionality. Nor were the APIs made available last week the story’s end, as Microsoft will continue to expand on the preview’s functionality over an as-yet-not-nailed-down timeline.

Out the gate, IT administrators can:

Approve and schedule feature upgrade deployments such as last fall’s 20H2. Admins can also instruct the service not to distribute an upgrade, useful for skipping one that’s available.

Stage deployments over a period of time by defining delivery date, desired feature upgrade, and number of machines affected.

Sidestep existing policies to immediately deploy a security update, say, when Microsoft issues an emergency fix for a vulnerability currently being widely exploited by attackers.

Customers with licenses to a number of Microsoft’s subscription plans can use the APIs immediately, according to Mebane, including:

Windows 10 Enterprise E3 or E5, or Windows 10 Education A3 or A5

Windows Virtual Desktop Access E3 or E5

Microsoft 365 Business Premium (a subscription that supports Windows 10 Pro)

<https://www.computerworld.com/article/3617301/microsoft-previews-new-windows-servicing-apis-for-enterprises.html>

H.8 Text eight

British subscription site OnlyFans is failing to prevent underage users from selling and appearing in explicit videos, a BBC investigation has found.

Under-18s have used fake identification to set up accounts, and police say a 14-year-old used a grandmother's passport. The UK's most senior police officer for child protection also says children are being "exploited" on the platform. OnlyFans says its age verification systems go over and above regulatory requirements.

The platform has more than a million "creators" who share video clips, photos and messages directly with subscribers for a monthly fee.

In return for hosting the material, OnlyFans takes a 20

Warning: Story contains adult themes and language

There is a range of content on the site but it is best known for pornography, and requires users to be over 18.

OnlyFans was a big winner during the pandemic, exploding in popularity as much of the world was housebound. The social media platform has grown nearly 10-fold since 2019, and now has more than 120 million users.

Some creators have become millionaires from their accounts, yet for most it has been a lifeline or a second income during the pandemic.

But BBC News has investigated concerns that under-18s are selling explicit videos on the site, despite it being illegal for individuals to post or share indecent images of children.

<https://www.bbc.com/news/uk-57255983>

H.9 Text nine

Royal Mail has announced its first delivery office to have an all-electric fleet of collection and delivery vehicles.

Bristol East Central Delivery Office's 23 diesel vehicles have been replaced by fully-electric ones.

Royal Mail said Bristol was selected because of its plans to introduce a Clean Air Zone (CAZ) later this year.

Chief executive Simon Thompson described the move as a "really positive step".

Six electric charging posts have also been installed on the site, with electricity for powering the office and charging the vehicles coming from renewable sources.

Mr Thompson said the move would allow them to assess the impact of the changes on customers and staff, and consider changes to other delivery offices.

"It's clear to me that customers increasingly want less environmentally impacting deliveries," he said.

"We are delighted to transform Bristol East Central into the very first Royal Mail 'all-electric' delivery office."

The electric vans have a bigger load space than the vehicles they have replaced, giving them additional capacity to deal with growing parcel volumes, and have lower maintenance requirements.

<https://www.bbc.com/news/uk-england-bristol-57256872>

H.10 Text ten

Russia has been the main source of disinformation on Facebook since 2017, the social network said in a report Wednesday. The company uncovered disinformation campaigns in more than 50 countries in that period and shut down 150 networks of fake accounts.

Aside from Russia, the top sources of fake news have been Iran, Myanmar, the US and Ukraine. The US, Ukraine, Britain, Libya and Sudan have been the most frequent targets.

Read more: Permanently delete your Facebook account, loose ends and all

"Influence operations are not new, but over the past several years they have burst into global public consciousness," Facebook wrote in the report. "These campaigns attempt to undermine trust in civic institutions and corrupt public debate by exploiting the same digital tools that have diversified the online public square and empowered critical discussions from Me Too to the Black Lives Matter movements."

The 2016 US presidential election was a "watershed moment" for disinformation, the report noted, but the techniques used then "are now harder to pull off, more expensive and less likely to succeed." However, the people responsible for disinformation have found more subtle approaches like co-opting legitimate Facebook users.

<https://www.cnet.com/news/russia-remains-the-biggest-source-of-disinformation-facebook-says/>

H.11 Text eleven

WhatsApp is suing the Indian government over new digital rules that will force the messaging service to violate privacy protections.

It said rules that require tracing the origin of chats were the equivalent of keeping a "fingerprint of every single message sent on the service".

In February, the government introduced new guidelines to regulate content on social media and streaming platforms.

India is WhatsApp's largest market with about 400 million users.

The government's rules for social media said that messaging platforms would need to make provisions for the "identification of the first originator of the information".

Whatsapp filed a plea in the high court in Delhi asking it to declare the new rule unconstitutional.

In a statement, a WhatsApp spokesperson said that the rules "would break end-to-end encryption and fundamentally undermine people's right to privacy".

"We have consistently joined civil society and experts around the world in opposing requirements that would violate the privacy of our users. In the meantime, we will also continue to engage with the government of India on practical solutions aimed at keeping people safe, including responding to valid legal requests for the information available to us," WhatsApp said.

According to the messaging service, traceability of texts would force private companies to collect and store billions of messages sent each day for the sole purpose of turning it over to law enforcement agencies.

<https://www.bbc.com/news/world-asia-india-57251612>

H.12 Text twelve

Microsoft CEO Satya Nadella said his company is planning "one of the most significant updates of Windows of the past decade," its software that powers more than 1.3 billion people's devices. Although he didn't offer details, Nadella said Microsoft plans to unveil the new version "very soon."

"I've been using it over the past several months and I'm incredibly excited about the next generation of Windows," he said.

We don't know much about the next generation of Windows software, other than Nadella's earlier promise that the company would "double down" on Windows and PCs. Rumors about the new version, code-named Cobalt, point to updates for the user interface (known as Sun Valley), meant to "reinvigorate" and modernize its look. The last time Microsoft meaningfully changed its look was with Windows 10, which was first released in 2015, following Windows 8.1. Microsoft hasn't said when its new Windows update will be released, but CNET sister site ZDNet said it's targeted for the second half of this year.

<https://www.cnet.com/news/microsoft-ceo-satya-nadella-teases-next-version-of-windows-very-soon/>

I Experiment 2A short texts

Text	Number of words
1	175
2	158
3	171
4	151
5	137
6	143
7	192
8	179
9	132
10	90
11	135
12	159

Table 8: An overview of the texts and their lengths used in experiment 2A

I.1 Text one

President Joe Biden was filmed taking Ford’s all-electric new Lightning pickup truck for what looked like a high-speed run down a stretch of pavement during a visit to Ford’s Rouge factory in Dearborn, Michigan on Tuesday.

While Biden is known as a bit of a Corvette fiend, he seems to be enjoying himself behind the wheel of a vehicle with enough torque to make even a big block C2 quake in its boots. Even better, the Lightning looks quick enough that even the Secret Service was forced to scramble to keep up, in a video clip posted to Twitter by C-SPAN.

What was the presidential verdict after taking the Lightning for a spin? "This sucker’s quick!" he exclaimed, adding that he’d buy one. A reporter asked how quick it was, and Biden said it did 0-60 mph in 4.3 or 4.4 seconds, looking to a Ford employee for clarification, who quickly declined to comment. The president then did a hard launch from a stop right in front of the press pool, accelerating to 80 mph.

<https://www.cnet.com/roadshow/news/biden-test-drives-ford-f150-lightning-electric-pickup/>

I.2 Text two

Google is making it easier for people to evaluate information and check the sources for results that show up on its massive search platform, the company said during the Google I/O developer’s conference keynote on Tuesday.

When you search for something on Google, a new feature called About this Result will appear under a given website in your results list. This will show you how the site describes itself, what other sites say about it, and its Wikipedia page, so you can make a more informed decision about which sites to trust. About this Result will begin rolling out over time.

An update to Google Lens, the AR-powered camera recognition feature that helps you identify plants and animals or translate text on a printed page, will add new capabilities to help you quickly search, copy or listen to text you’ve just translated. The update will launch globally this month on Android devices, and later this summer on iOS.

<https://www.cnet.com/news/google-tackles-fake-news-in-search-update-heres-how-it-works/>

I.3 Text three

The vigilante crime app Citizen falsely accused a California man of starting a wildfire, offering a \$30,000 reward to track him down before retracting the post the next day, in a move that has been condemned by criminal justice experts.

The app – which gives users local crime information via police scanners and other sources – shared an alert on Saturday about an alleged arsonist behind a large brush fire that broke out in Los Angeles over the weekend.

The suspect, who is homeless, was briefly detained by officials who ultimately found there was not enough evidence to tie him to the crime, the Los Angeles fire department confirmed to the Guardian. A different suspect has since been arrested.

But that was not before the falsely accused man had his name and image widely shared. The alert sent by Citizen

contained a photo and was seen by more than 861,000 people. It read: "Citizen is offering a \$30,000 reward to anyone who provides information that leads to the arrest of the arson suspect."

<https://www.theguardian.com/technology/2021/may/18/citizen-app-palisades-fire-wrongly-accused-man>

I.4 Text four

The UK's cybersecurity agency has taken down more scams in the last year than in the previous three years combined, with coronavirus and NHS-themed cybercrime fuelling the increase.

Experts oversaw a 15-fold rise in the removal of online campaigns compared with 2019, according to the National Cyber Security Centre (NCSC).

There was a jump in the number of phishing attacks using NHS branding to dupe victims, with the Covid-19 vaccine rollout used as a lure via email and text message to harvest people's personal information for fraud.

Forty-three fake NHS Covid-19 apps hosted outside of official app stores were also pulled.

"The big increase in Covid-19-related scams, fake vaccine shops, fake PPE shops, show – to me anyway – that criminals have no bounds on what they will abuse and the fear that they engender to try and harm and defraud people," Dr Ian Levy, the technical director of the NCSC told reporters.

<https://www.theguardian.com/technology/2021/may/10/uk-covid-related-cybercrime-fuels-15-fold-rise-in-scam-takedowns>

I.5 Text five

YouTuber Jake Paul is being investigated after posting a video on social media apparently showing him driving around a protected beach in Puerto Rico.

Driving is illegal on some of the island's beaches, as turtles nest in the sand.

The local Department of Natural and Environmental Resources said it would investigate whether the law had been broken.

Paul has been contacted for comment. Protected species

The Instagram video showed Paul and a group of people driving around in two vehicles on a beach. The post now been removed.

Turtle nesting and hatching season is between February and August in Puerto Rico and its beaches attract several protected species, including the endangered leatherback.

The video was widely shared online and many criticised the Youtuber-turned-boxer for putting the reptiles at risk, saying eggs could be crushed by the vehicles.

<https://www.bbc.com/news/technology-57148214>

I.6 Text six

A number of UK universities are preparing to keep lectures online into the autumn term.

It raises the prospect of Covid disrupting another academic year - and will prompt more questions about fee refunds.

Students have called plans for another term of online lectures "unacceptable".

"Online teaching is in no way a substitute for in-person learning," says a petition launched by University of Leeds students.

About half of students in England have only been able to return to face-to-face teaching this week, not long before the term ends - having been taught online since Christmas. 'Pre-recorded video'

But a growing number of universities seem to be anticipating carrying on with a mix of online and in-person teaching into the autumn term.

The University of Liverpool says it wants as "much face-to-face teaching as possible", but is expecting a blend of online and in-person.

<https://www.bbc.com/news/education-57150071>

I.7 Text seven

"Ouch, Charlie bit me! That really hurt, Charlie!"

If you were online in 2007, you're likely one of the 880 million people who have seen the iconic video of Charlie biting his brother Harry's finger.

In the days when viral videos were few and far between, this one was etched into everyone's memories.

Now, the Davis-Carr family are removing their video from YouTube and auctioning it as an NFT, or non-fungible token. line

The video was uploaded it to YouTube by Harry and Charlie's dad, Howard, in 2007, because he couldn't email it to their godparents in America.

The family website says the clip was filmed as "a part of catching random moments as the boys were growing up", and that it "unintentionally went viral".

What are NFTs and why are some worth millions? Watch: 'Memes should be archived in a museum' Are NFTs a new opportunity for digital artists?

The boys, who are now 17 and 15, are "soon entering adulthood" so it's the right time to "embrace the next iteration of the internet", the site adds.

"This is not the end of the beloved video, but rather a new beginning."

<https://www.bbc.com/news/newsbeat-57168631>

I.8 Text eight

Amazon is reportedly in talks to buy the historic MGM Studios for \$9bn (£6.35bn).

MGM is one of Hollywood's most famous studios, with its Leo the Lion logo and an almost century-long history.

The sale would give the technology giant's Prime streaming service access to a vast back catalogue of iconic content.

Amazon and MGM Studios told the BBC that they did not comment on rumours or speculation.

The reports come just hours after telecoms giant AT&T agreed to combine its WarnerMedia unit with Discovery in a deal to create a new streaming giant.

MGM Holdings, the parent company of MGM Studios, has reportedly been exploring a sale since the end of last year, according to media reports.

The purchase by Amazon of MGM Studios would mark a major step for its Prime streaming service.

MGM Studios has a huge catalogue of films and television shows covering the last ten decades, through the Golden Age of Hollywood to the present day.

In more recent times it has produced the James Bond movie franchise and The Handmaid's Tale TV series.

<https://www.bbc.com/news/business-57153680>

I.9 Text nine

For nine years, Chris Hughes has fought a battle very few people ever see.

He oversees a team of 21 analysts in Cambridge who locate, identify and remove child sexual abuse material (CSAM) from the internet.

The Internet Watch Foundation (IWF) is funded by the global tech industry.

It manually reviews online reports of suspected criminal content sent in by the public. Mr Hughes sees upsetting material every day.

When content is verified, analysts create unique "digital fingerprints" of each photo or video, then send it to law enforcement and tech firms. They also search for material online.

Occasionally, there are harrowing situations racing to track down victims from live streaming video.

Reports jumped during the pandemic, he says: "Over the recent May bank holiday weekend, we had more than 2,000 reports."

<https://www.bbc.com/news/business-57050689>

I.10 Text ten

A self-driving taxi has blocked a road in Arizona after becoming confused by a lane closed off with traffic cones.

The Waymo vehicle repeatedly drove away from roadside assistance, dispatched within minutes of the car becoming stuck.

Passenger Joel Johnson documented the experience on his YouTube channel.

The Alphabet-owned company said it was an "unusual situation" and the taxi had operated safely throughout the journey.

Waymo is the first fully self-driving taxi service legally allowed to operate.

For now, it is available in the East Valley district of Phoenix only.

<https://www.bbc.com/news/technology-57144755>

I.11 Text eleven

Mozilla on Tuesday announced that a years-long effort to harden Firefox's defenses can now be previewed in the browser's Nightly and Beta builds.

Debuting as "Project Fission" in February 2019, the project was also linked to the more descriptive "site isolation," a defensive technology in which a browser devotes separate processes to each domain or even each website, and in some cases, assigns different processes to site components, such as iframes, so they are rendered separately from the process handling the overall site.

The idea is to isolate malicious sites and components — and the attack code they harbor — so one site cannot exploit an unknown vulnerability or one still unpatched, then plunder the browser, or the device, or a device's memory of crucial information. That information could include authentication credentials, confidential data, and encryption keys.

<https://www.computerworld.com/article/3619064/firefox-previews-site-isolation-tech-in-move-to-catch-up-to-chrome.html>

I.12 Text twelve

Providing secure access to vital applications has been a key challenge for businesses forced to adapt to remote working during the pandemic. And with many businesses set to continue to support a distributed workforce even after offices reopen, it will remain a priority for IT for some time.

With this in mind, VMware has unveiled a suite of security and endpoint management tools to support remote workers. VMware Anywhere Workspace, announced on Tuesday, combines VMware's Workspace One, a "digital workspace platform" that delivers applications across a range of devices, with its Carbon Black Cloud endpoint security tools and SASE, which provides secure network access for distributed teams.

"By combining these three things we can deliver value to the stakeholders that include employees, the CIO, CISO, lines of business and HR," said Shankar Iyer, SVP and general manager, end user computing at VMware. "This results in highly engaged employees, a broader and more effective security model, reduced cost and overhead."

<https://www.computerworld.com/article/3615593/vmware-targets-remote-work-security-with-anywhere-workspace.html>

J Experiment 2b long text

Introduction

Walter Elias Disney (December 5, 1901 – December 15, 1966) was an American entrepreneur, animator, writer, voice actor, and film producer. A pioneer of the American animation industry, he introduced several developments in the production of cartoons. As a film producer, Disney holds the record for most Academy Awards earned by an individual, having won 22 Oscars from 59 nominations. He was presented with two Golden Globe Special Achievement Awards and an Emmy Award, among other honors. Several of his films are included in the National Film Registry by the Library of Congress.

Born in Chicago in 1901, Disney developed an early interest in drawing. He took art classes as a boy and got a job as a commercial illustrator at the age of 18. He moved to California in the early 1920s and set up the Disney Brothers Studio with his brother Roy. With Ub Iwerks, Walt developed the character Mickey Mouse in 1928, his first highly popular success; he also provided the voice for his creation in the early years. As the studio grew, Disney became more adventurous, introducing synchronized sound, full-color three-strip Technicolor, feature-length cartoons and technical developments in cameras. The results, seen in features such as *Snow White and the Seven Dwarfs* (1937), *Pinocchio*, *Fantasia* (both 1940), *Dumbo* (1941), and *Bambi* (1942), furthered the development of animated film. New animated and live-action films followed after World War II, including the critically successful *Cinderella* (1950) and *Mary Poppins* (1964), the latter of which received five Academy Awards.

In the 1950s, Disney expanded into the amusement park industry, and in July 1955 he opened Disneyland in Anaheim, California. To fund the project he diversified into television programs, such as Walt Disney's *Disneyland* and *The Mickey Mouse Club*; he was also involved in planning the 1959 Moscow Fair, the 1960 Winter Olympics, and the 1964 New York World's Fair. In 1965, he began development of another theme park, Disney World, the heart of which was to be a new type of city, the "Experimental Prototype Community of Tomorrow" (EPCOT). Disney was a heavy smoker throughout his life and died of lung cancer in December 1966 before either the park or the EPCOT project were completed.

Disney was a shy, self-deprecating and insecure man in private but adopted a warm and outgoing public persona. He had high standards and high expectations of those with whom he worked. Although there have been accusations that he was racist or anti-Semitic, they have been contradicted by many who knew him. His reputation changed in the years after his death, from a purveyor of homely patriotic values to a representative of American imperialism. He nevertheless remains an important figure in the history of animation and in the cultural history of the United States, where he is considered a national cultural icon. His film work continues to be shown and adapted; his namesake studio and company maintains high standards in its production of popular entertainment, and the Disney amusement parks have grown in size and number to attract visitors in several countries.

Early life: 1901–1920

Walt Disney was born on December 5, 1901, at 1249 Tripp Avenue, in Chicago's Hermosa neighborhood. He was the fourth son of Elias Disney—born in the Province of Canada, to Irish parents—and Flora (née Call), an American of German and English descent. Aside from Walt, Elias and Flora's sons were Herbert, Raymond and Roy; the couple had a fifth child, Ruth, in December 1903. In 1906, when Disney was four, the family moved to a farm in Marceline, Missouri, where his uncle Robert had just purchased land. In Marceline, Disney developed his interest in drawing when he was paid to draw the horse of a retired neighborhood doctor. Elias was a subscriber to the *Appeal to Reason* newspaper, and Disney practiced drawing by copying the front-page cartoons of Ryan Walker. Disney also began to develop an ability to work with watercolors and crayons. He lived near the Atchison, Topeka and Santa Fe Railway line and became enamored with trains. He and his younger sister Ruth started school at the same time at the Park School in Marceline in late 1909.

In 1911, the Disneys moved to Kansas City, Missouri. There, Disney attended the Benton Grammar School, where he met fellow-student Walter Pfeiffer, who came from a family of theatre fans and introduced Disney to the world of vaudeville and motion pictures. Before long, he was spending more time at the Pfeiffers' house than at home. Elias had purchased a newspaper delivery route for *The Kansas City Star* and *Kansas City Times*. Disney and his brother Roy woke up at 4:30 every morning to deliver the *Times* before school and repeated the round for the evening *Star* after school. The schedule was exhausting, and Disney often received poor grades after falling asleep in class, but he continued his paper route for more than six years. He attended Saturday courses at the Kansas City Art Institute and also took a correspondence course in cartooning.

In 1917, Elias bought stock in a Chicago jelly producer, the O-Zell Company, and moved back to the city with his family. Disney enrolled at McKinley High School and became the cartoonist of the school newspaper, drawing patriotic

pictures about World War I; he also took night courses at the Chicago Academy of Fine Arts. In mid-1918, Disney attempted to join the United States Army to fight against the Germans, but he was rejected for being too young. After forging the date of birth on his birth certificate, he joined the Red Cross in September 1918 as an ambulance driver. He was shipped to France but arrived in November, after the armistice. He drew cartoons on the side of his ambulance for decoration and had some of his work published in the army newspaper *Stars and Stripes*. Disney returned to Kansas City in October 1919, where he worked as an apprentice artist at the Pesmen-Rubin Commercial Art Studio. There, he drew commercial illustrations for advertising, theater programs and catalogs. He also befriended fellow artist Ub Iwerks.

Early career: 1920–1928

In January 1920, as Pesmen-Rubin's revenue declined after Christmas, Disney, aged 18, and Iwerks were laid off. They started their own business, the short-lived Iwerks-Disney Commercial Artists. Failing to attract many customers, Disney and Iwerks agreed that Disney should leave temporarily to earn money at the Kansas City Film Ad Company, run by A. V. Cauger; the following month Iwerks, who was not able to run their business alone, also joined. The company produced commercials using the cutout animation technique. Disney became interested in animation, although he preferred drawn cartoons such as Mutt and Jeff and Koko the Clown. With the assistance of a borrowed book on animation and a camera, he began experimenting at home. He came to the conclusion that cel animation was more promising than the cutout method. Unable to persuade Cauger to try cel animation at the company, Disney opened a new business with a co-worker from the Film Ad Co, Fred Harman. Their main client was the local Newman Theater, and the short cartoons they produced were sold as "Newman's Laugh-O-Grams". Disney studied Paul Terry's Aesop's Fables as a model, and the first six "Laugh-O-Grams" were modernized fairy tales.

In May 1921, the success of the "Laugh-O-Grams" led to the establishment of Laugh-O-Gram Studio, for which he hired more animators, including Fred Harman's brother Hugh, Rudolf Ising and Iwerks. The Laugh-O-Grams cartoons did not provide enough income to keep the company solvent, so Disney started production of *Alice's Wonderland*—based on *Alice's Adventures in Wonderland*—which combined live action with animation; he cast Virginia Davis in the title role. The result, a 12-and-a-half-minute, one-reel film, was completed too late to save Laugh-O-Gram Studio, which went into bankruptcy in 1923.

Disney moved to Hollywood in July 1923 at 21 years old. Although New York was the center of the cartoon industry, he was attracted to Los Angeles because his brother Roy was convalescing from tuberculosis there, and he hoped to become a live-action film director. Disney's efforts to sell *Alice's Wonderland* were in vain until he heard from New York film distributor Margaret J. Winkler. She was losing the rights to both the *Out of the Inkwell* and *Felix the Cat* cartoons, and needed a new series. In October, they signed a contract for six Alice comedies, with an option for two further series of six episodes each. Disney and his brother Roy formed the Disney Brothers Studio—which later became The Walt Disney Company—to produce the films; they persuaded Davis and her family to relocate to Hollywood to continue production, with Davis on contract at \$100 a month. In July 1924, Disney also hired Iwerks, persuading him to relocate to Hollywood from Kansas City.

Early in 1925, Disney hired an ink artist, Lillian Bounds. They married in July of that year, at her brother's house in her hometown of Lewiston, Idaho. The marriage was generally happy, according to Lillian, although according to Disney's biographer Neal Gabler she did not "accept Walt's decisions meekly or his status unquestionably, and she admitted that he was always telling people 'how henpecked he is'." Lillian had little interest in films or the Hollywood social scene and she was, in the words of the historian Steven Watts, "content with household management and providing support for her husband". Their marriage produced two daughters, Diane (born December 1933) and Sharon (adopted in December 1936, born six weeks previously). Within the family, neither Disney nor his wife hid the fact Sharon had been adopted, although they became annoyed if people outside the family raised the point. The Disneys were careful to keep their daughters out of the public eye as much as possible, particularly in the light of the Lindbergh kidnapping; Disney took steps to ensure his daughters were not photographed by the press.

By 1926 Winkler's role in the distribution of the Alice series had been handed over to her husband, the film producer Charles Mintz, although the relationship between him and Disney was sometimes strained. The series ran until July 1927, by which time Disney had begun to tire of it and wanted to move away from the mixed format to all animation. After Mintz requested new material to distribute through Universal Pictures, Disney and Iwerks created *Oswald the Lucky Rabbit*, a character Disney wanted to be "peppy, alert, saucy and venturesome, keeping him also neat and trim".

In February 1928, Disney hoped to negotiate a larger fee for producing the Oswald series, but found Mintz wanting to reduce the payments. Mintz had also persuaded many of the artists involved to work directly for him, including Harman, Ising, Carman Maxwell and Friz Freleng. Disney also found out that Universal owned the intellectual property rights to Oswald. Mintz threatened to start his own studio and produce the series himself if Disney refused to accept

the reductions. Disney declined Mintz's ultimatum and lost most of his animation staff, except Iwerks, who chose to remain with him.

Creation of Mickey Mouse to the first Academy Awards: 1928–1933

To replace Oswald, Disney and Iwerks developed Mickey Mouse, possibly inspired by a pet mouse that Disney had adopted while working in his Laugh-O-Gram studio, although the origins of the character are unclear. Disney's original choice of name was Mortimer Mouse, but Lillian thought it too pompous, and suggested Mickey instead. Iwerks revised Disney's provisional sketches to make the character easier to animate. Disney, who had begun to distance himself from the animation process, provided Mickey's voice until 1947. In the words of one Disney employee, "Ub designed Mickey's physical appearance, but Walt gave him his soul."

Mickey Mouse first appeared in May 1928 as a single test screening of the short *Plane Crazy*, but it, and the second feature, *The Gallopin' Gaucho*, failed to find a distributor. Following the 1927 sensation *The Jazz Singer*, Disney used synchronized sound on the third short, *Steamboat Willie*, to create the first post-produced sound cartoon. After the animation was complete, Disney signed a contract with the former executive of Universal Pictures, Pat Powers, to use the "Powers Cinephone" recording system; Cinephone became the new distributor for Disney's early sound cartoons, which soon became popular.

To improve the quality of the music, Disney hired the professional composer and arranger Carl Stalling, on whose suggestion the *Silly Symphony* series was developed, providing stories through the use of music; the first in the series, *The Skeleton Dance* (1929), was drawn and animated entirely by Iwerks. Also hired at this time were several local artists, some of whom stayed with the company as core animators; the group later became known as the *Nine Old Men*. Both the *Mickey Mouse* and *Silly Symphonies* series were successful, but Disney and his brother felt they were not receiving their rightful share of profits from Powers. In 1930, Disney tried to trim costs from the process by urging Iwerks to abandon the practice of animating every separate cel in favor of the more efficient technique of drawing key poses and letting lower-paid assistants sketch the inbetween poses. Disney asked Powers for an increase in payments for the cartoons. Powers refused and signed Iwerks to work for him; Stalling resigned shortly afterwards, thinking that without Iwerks, the Disney Studio would close. Disney had a nervous breakdown in October 1931—which he blamed on the machinations of Powers and his own overwork—so he and Lillian took an extended holiday to Cuba and a cruise to Panama to recover.

With the loss of Powers as distributor, Disney studios signed a contract with Columbia Pictures to distribute the *Mickey Mouse* cartoons, which became increasingly popular, including internationally. Disney, always keen to embrace new technology, filmed *Flowers and Trees* (1932) in full-color three-strip Technicolor; he was also able to negotiate a deal giving him the sole right to use the three-strip process until August 31, 1935. All subsequent *Silly Symphony* cartoons were in color. *Flowers and Trees* was popular with audiences and won the Academy Award for best Short Subject (Cartoon) at the 1932 ceremony. Disney had been nominated for another film in that category, *Mickey's Orphans*, and received an Honorary Award "for the creation of Mickey Mouse".

In 1933, Disney produced *The Three Little Pigs*, a film described by the media historian Adrian Danks as "the most successful short animation of all time". The film won Disney another Academy Award in the Short Subject (Cartoon) category. The film's success led to a further increase in the studio's staff, which numbered nearly 200 by the end of the year. Disney realized the importance of telling emotionally gripping stories that would interest the audience, and he invested in a "story department" separate from the animators, with storyboard artists who would detail the plots of Disney's films.

Golden age of animation: 1934–1941

By 1934, Disney had become dissatisfied with producing formulaic cartoon shorts, and believed a feature-length cartoon would be more profitable. The studio began the four-year production of *Snow White and the Seven Dwarfs*, based on the fairy tale. When news leaked out about the project, many in the film industry predicted it would bankrupt the company; industry insiders nicknamed it "Disney's Folly". The film, which was the first animated feature made in full color and sound, cost \$1.5 million to produce—three times over budget. To ensure the animation was as realistic as possible, Disney sent his animators on courses at the Chouinard Art Institute; he brought animals into the studio and hired actors so that the animators could study realistic movement. To portray the changing perspective of the background as a camera moved through a scene, Disney's animators developed a multiplane camera which allowed drawings on pieces of glass to be set at various distances from the camera, creating an illusion of depth. The glass could be moved to create the impression of a camera passing through the scene. The first work created on the camera—a *Silly Symphony* called *The Old Mill* (1937)—won the Academy Award for Animated Short Film because of its impressive visual power. Although *Snow White* had been largely finished by the time the multiplane camera had been completed, Disney ordered some scenes be re-drawn to use the new effects.

Snow White premiered in December 1937 to high praise from critics and audiences. The film became the most successful motion picture of 1938 and by May 1939 its total gross of \$6.5 million made it the most successful sound film made to that date. Disney won another Honorary Academy Award, which consisted of one full-sized and seven miniature Oscar statuettes. The success of Snow White heralded one of the most productive eras for the studio; the Walt Disney Family Museum calls the following years "the 'Golden Age of Animation'". With work on Snow White finished, the studio began producing Pinocchio in early 1938 and Fantasia in November of the same year. Both films were released in 1940, and neither performed well at the box office—partly because revenues from Europe had dropped following the start of World War II in 1939. The studio made a loss on both pictures and was deeply in debt by the end of February 1941.

In response to the financial crisis, Disney and his brother Roy started the company's first public stock offering in 1940, and implemented heavy salary cuts. The latter measure, and Disney's sometimes high-handed and insensitive manner of dealing with staff, led to a 1941 animators' strike which lasted five weeks. While a federal mediator from the National Labor Relations Board negotiated with the two sides, Disney accepted an offer from the Office of the Coordinator of Inter-American Affairs to make a goodwill trip to South America, ensuring he was absent during a resolution he knew would be unfavorable to the studio. As a result of the strike—and the financial state of the company—several animators left the studio, and Disney's relationship with other members of staff was permanently strained as a result. The strike temporarily interrupted the studio's next production, Dumbo (1941), which Disney produced in a simple and inexpensive manner; the film received a positive reaction from audiences and critics alike.

World War II and beyond: 1941–1950

Shortly after the release of Dumbo in October 1941, the U.S. entered World War II. Disney formed the Walt Disney Training Films Unit within the company to produce instruction films for the military such as Four Methods of Flush Riveting and Aircraft Production Methods. Disney also met with Henry Morgenthau Jr., the Secretary of the Treasury, and agreed to produce short Donald Duck cartoons to promote war bonds. Disney also produced several propaganda productions, including shorts such as Der Fuehrer's Face—which won an Academy Award—and the 1943 feature film Victory Through Air Power.

The military films generated only enough revenue to cover costs, and the feature film Bambi—which had been in production since 1937—underperformed on its release in April 1942, and lost \$200,000 at the box office. On top of the low earnings from Pinocchio and Fantasia, the company had debts of \$4 million with the Bank of America in 1944. At a meeting with Bank of America executives to discuss the future of the company, the bank's chairman and founder, Amadeo Giannini, told his executives, "I've been watching the Disneys' pictures quite closely because I knew we were lending them money far above the financial risk. ... They're good this year, they're good next year, and they're good the year after. ... You have to relax and give them time to market their product." Disney's production of short films decreased in the late 1940s, coinciding with increasing competition in the animation market from Warner Bros. and Metro-Goldwyn-Mayer. Roy Disney, for financial reasons, suggested more combined animation and live-action productions. In 1948, Disney initiated a series of popular live-action nature films, titled True-Life Adventures, with Seal Island the first; the film won the Academy Award in the Best Short Subject (Two-Reel) category.

Disney grew more politically conservative as he got older. A Democratic Party supporter until the 1940 presidential election, when he switched allegiance to the Republican Party, he became a generous donor to Thomas E. Dewey's 1944 bid for the presidency. In 1946, he was a founding member of the Motion Picture Alliance for the Preservation of American Ideals, an organization who stated they "believe in, and like, the American Way of Life ... we find ourselves in sharp revolt against a rising tide of Communism, Fascism and kindred beliefs, that seek by subversive means to undermine and change this way of life". In 1947, during the Second Red Scare, Disney testified before the House Un-American Activities Committee (HUAC), where he branded Herbert Sorrell, David Hilberman and William Pomerance, former animators and labor union organizers, as communist agitators; Disney stated that the 1941 strike led by them was part of an organized communist effort to gain influence in Hollywood. It was alleged by The New York Times in 1993 that Disney had been passing secret information to the FBI from 1940 until his death in 1966. In return for this information, J. Edgar Hoover allowed Disney to film in FBI headquarters in Washington. Disney was made a "full Special Agent in Charge Contact" in 1954.

In 1949, Disney and his family moved to a new home in the Holmby Hills district of Los Angeles. With the help of his friends Ward and Betty Kimball, who already had their own backyard railroad, Disney developed blueprints and immediately set to work on creating a miniature live steam railroad for his backyard. The name of the railroad, Carolwood Pacific Railroad, came from his home's location on Carolwood Drive. The miniature working steam locomotive was built by Disney Studios engineer Roger E. Broggie, and Disney named it Lilly Belle after his wife; after three years Disney ordered it into storage due to a series of accidents involving his guests.

Theme parks, television and other interests: 1950–1966

In early 1950, Disney produced *Cinderella*, his studio's first animated feature in eight years. It was popular with critics and theater audiences. Costing \$2.2 million to produce, it earned nearly \$8 million in its first year. Disney was less involved than he had been with previous pictures because of his involvement in his first entirely live-action feature, *Treasure Island* (1950), which was shot in Britain, as was *The Story of Robin Hood and His Merrie Men* (1952). Other all-live-action features followed, many of which had patriotic themes. He continued to produce full-length animated features too, including *Alice in Wonderland* (1951, which he could finally create, having plans to create it going back to the beginning of his career) and *Peter Pan* (1953). From the early to mid-1950s, Disney began to devote less attention to the animation department, entrusting most of its operations to his key animators, the Nine Old Men, although he was always present at story meetings. Instead, he started concentrating on other ventures.

For several years Disney had been considering building a theme park. When he visited Griffith Park in Los Angeles with his daughters, he wanted to be in a clean, unspoiled park, where both children and their parents could have fun. The story goes that he came up with the idea for Disneyland while sitting on a bench in Griffith Park, watching his children riding the merry-go-round. The bench he set at and the merry-go-round still exist to this day and both have become a favorite location to visit for both Disney and Disney park fans around the world. He visited the Tivoli Gardens in Copenhagen, Denmark, and was heavily influenced by the cleanliness and layout of the park. For a long time people believed Walt also visited the Efteling to get inspiration for Disneyland, but this story has since been debunked. Former PR-employee Reinoud van Assendelft de Coningh said about this: "As a PR-employee, I were responsible for the story of Walt Disney visiting the Efteling. I once told a couple of journalists that it could be possible that Walt Disney once visited the Efteling. It was known that for his plans to build a amusement park in the US, he came to Europe to get inspiration. He has been to Denmark, that is for sure, but nobody knows if he actually visited the Efteling. There are no witnesses, nor pictures. After I told my story to the journalists, I sad in an airplan and read in the paper of the aircompany that Walt Disney has visited the Efteling for inspiration. The 'maybe' was scraped from the story. From there on the story went on the lead its own live. Even the vice-president of Disney, Ted Crowell, believed the story to be true. He said at the Applause Award in 1992 that it is not weird that the Efteling received the highest decoration, because it had to be a fantastic park because Walt went there to get inspiration for his own parks"

In March 1952 Walt received zoning permission to build a theme park in Burbank, near the Disney studios. This site proved too small, and a larger plot in Anaheim, 35 miles (56 km) south of the studio, was purchased. To distance the project from the studio—which might attract the criticism of shareholders—Disney formed WED Enterprises (now Walt Disney Imagineering) and used his own money to fund a group of designers and animators to work on the plans; those involved became known as "Imagineers". The employees at WED were encouraged to come up with inovative ideas and let there imagination run free. After obtaining bank funding he invited other stockholders, American Broadcasting-Paramount Theatres—part of American Broadcasting Company (ABC)—and Western Printing and Lithographing Company. In mid-1954, Disney sent his Imagineers to every amusement park in the U.S. to analyze what worked and what pitfalls or problems there were in the various locations and incorporated their findings into his design. Construction work started in July 1954, and Disneyland opened in July 1955; the opening ceremony was broadcast on ABC, which reached 70 million viewers. The park was designed as a series of themed lands, linked by the central Main Street, U.S.A.—a replica of the main street in his hometown of Marceline. The connected themed areas were Adventureland, Frontierland, Fantasyland and Tomorrowland. The park also contained the narrow gauge Disneyland Railroad that linked the lands; around the outside of the park was a high berm to separate the park from the outside world. An editorial in *The New York Times* considered that Disney had "tastefully combined some of the pleasant things of yesterday with fantasy and dreams of tomorrow". Although there were early minor problems with the park, it was a success, and after a month's operation, Disneyland was receiving over 20,000 visitors a day; by the end of its first year, it attracted 3.6 million guests.

The money from ABC was contingent on Disney television programs. The studio had been involved in a successful television special on Christmas Day 1950 about the making of *Alice in Wonderland*. Roy believed the program added millions to the box office takings. In a March 1951 letter to shareholders, he wrote that "television can be a most powerful selling aid for us, as well as a source of revenue. It will probably be on this premise that we enter television when we do". In 1954, after the Disneyland funding had been agreed, ABC broadcast Walt Disney's *Disneyland*, an anthology consisting of animated cartoons, live-action features and other material from the studio's library. The show was successful in terms of ratings and profits, earning an audience share of over 50%. In April 1955, *Newsweek* called the series an "American institution". ABC was pleased with the ratings, leading to Disney's first daily television program, *The Mickey Mouse Club*, a variety show catering specifically to children. The program was accompanied by merchandising through various companies (Western Printing, for example, had been producing coloring books and comics for over 20 years, and produced several items connected to the show). One of the segments of *Disneyland* consisted of the five-part miniseries *Davy Crockett* which, according to Gabler, "became an overnight sensation". The show's theme song, "The Ballad of Davy Crockett", became internationally popular, and ten million records were sold. As a result, Disney formed his own record production and distribution entity, Disneyland Records.

As well as the construction of Disneyland, Disney worked on other projects away from the studio. He was consultant to the 1959 American National Exhibition in Moscow; Disney Studios' contribution was *America the Beautiful*, a 19-minute film in the 360-degree Circarama theater that was one of the most popular attractions. The following year he acted as the chairman of the Pageantry Committee for the 1960 Winter Olympics in Squaw Valley, California, where he designed the opening, closing and medal ceremonies.

Despite the demands wrought by non-studio projects, Disney continued to work on film and television projects. In 1955, he was involved in "Man in Space", an episode of the Disneyland series, which was made in collaboration with NASA rocket designer Wernher von Braun. Disney also oversaw aspects of the full-length features *Lady and the Tramp* (the first animated film in CinemaScope) in 1955, *Sleeping Beauty* (the first animated film in Technirama 70 mm film) in 1959, *One Hundred and One Dalmatians* (the first animated feature film to use Xerox cels) in 1961, and *The Sword in the Stone* in 1963.

In 1964, Disney produced *Mary Poppins*, based on the book series by P. L. Travers; he had been trying to acquire the rights to the story since the 1940s. It became the most successful Disney film of the 1960s, although Travers disliked the film intensely and regretted having sold the rights. The same year he also became involved in plans to expand the California Institute of the Arts (colloquially called CalArts), and had an architect draw up blueprints for a new building.

Disney provided four exhibits for the 1964 New York World's Fair, for which he obtained funding from selected corporate sponsors. For PepsiCo, who planned a tribute to UNICEF, Disney developed *It's a Small World*, a boat ride with audio-animatronic dolls depicting children of the world; *Great Moments with Mr. Lincoln* contained an animatronic Abraham Lincoln giving excerpts from his speeches; *Carousel of Progress* promoted the importance of electricity; and *Ford's Magic Skyway* portrayed the progress of mankind. Elements of all four exhibits—principally concepts and technology—were re-installed in Disneyland, although *It's a Small World* is the ride that most closely resembles the original.

The *Ford's Magic Skyway* had been reworked into the peplemover which took park guests for a trip around the tomorrowland section of Disneyland. The peplemover was later transformed into *Rocket Rods* providing a faster and more thrilling ride. Unfortunately the foundation of the peplemover was not build for the forces delivered by the *Rocket Rods*, so after only two years of operation, the ride had to be closed permanently. Because the track of the *Peplemover* goes around the entirety of tomorrowland and goes over most main walkways, to repair or dismantel the track, the tomorrowland section of the park has to be completly closed. Therefore the track still sits abandoned in the park till this day reminding fans of what ones was a fan favorite ride.

The other rides of the World's fair still operate to this day. The only change that has happend is that the *Carousel of Progress* has been moved to the *Magic Kingdom* in Orlando, Florida.

During the early to mid-1960s, Disney developed plans for a ski resort in Mineral King, a glacial valley in California's Sierra Nevada. He hired experts such as the renowned Olympic ski coach and ski-area designer Willy Schaeffler. With income from Disneyland accounting for an increasing proportion of the studio's income, Disney continued to look for venues for other attractions. In late 1965, he announced plans to develop another theme park to be called "Disney World" (now Walt Disney World), a few miles southwest of Orlando, Florida. Disney World was to include the "Magic Kingdom"—a larger and more elaborate version of Disneyland—plus golf courses and resort hotels. The heart of Disney World was to be the "Experimental Prototype Community of Tomorrow" (EPCOT), which he described as:

an experimental prototype community of tomorrow that will take its cue from the new ideas and new technologies that are now emerging from the creative centers of American industry. It will be a community of tomorrow that will never be completed, but will always be introducing and testing and demonstrating new materials and systems. And EPCOT will always be a showcase to the world for the ingenuity and imagination of American free enterprise.

During 1966, Disney cultivated businesses willing to sponsor EPCOT. He increased his involvement in the studio's films, and was heavily involved in the story development of *The Jungle Book*, the live-action musical feature *The Happiest Millionaire* (both 1967) and the animated short *Winnie the Pooh and the Blustery Day* (1968).

Illness, death and aftermath

Disney had been a heavy smoker since World War I. He did not use cigarettes with filters and had smoked a pipe as a young man. In early November 1966, he was diagnosed with lung cancer and was treated with cobalt therapy. On November 30, he felt unwell and was taken by ambulance from his home to St. Joseph Hospital where, on December 15, 1966 ten days after his 65th birthday, he died of circulatory collapse caused by the cancer. His remains were cremated two days later and his ashes interred at the Forest Lawn Memorial Park in Glendale, California.

The release of *The Jungle Book* and *The Happiest Millionaire* in 1967 raised the total number of feature films that Disney had been involved in to 81. When *Winnie the Pooh and the Blustery Day* was released in 1968, it earned Disney an Academy Award in the Short Subject (Cartoon) category, awarded posthumously. After Disney's death, his studios continued to produce live-action films prolifically but largely abandoned animation until the late 1980s, after which there was what *The New York Times* describes as the "Disney Renaissance" that began with *The Little Mermaid* (1989). Disney's companies continue to produce successful film, television and stage entertainment.

Disney's plans for the futuristic city of EPCOT did not come to fruition. After Disney's death, his brother Roy deferred his retirement to take full control of the Disney companies. He changed the focus of the project from a town to an attraction. At the inauguration in 1971, Roy dedicated Walt Disney World to his brother. Walt Disney World expanded with the opening of Epcot Center in 1982; Walt Disney's vision of a functional city was replaced by a park more akin to a permanent world's fair. The park is split up into two parts: future showcase and world showcase. The future showcase part features rides focuses on future technology. The world showcase features pavilions sponsored by different countries around the world. All the pavilions are designed to resemble architecture famous to the specific country. The shops and restaurants in the pavilions sell products that are specific to the country. For example, the Japan pavilion sells sushi and features a famous Japanese wholesale store, the England pavilion sells famous English tea, etcetera. Disney employs people from the countries at the world showcase to work at the pavilion of their home country as part of the Disney College Program. The nice thing about this, is that if you go to, for example, the Germany pavilion, chances are that if you speak German to the employee, the employee can also respond in German.

Although Walt's original ideas for EPCOT never came to fruition, a remnant of his plans can still be found inside the parks. When the Magic Kingdom was built, a copy of Disney's Tomorrowland was built and with it a copy of the Peppercorn, originally built for the New York World's Fair. When envisioning EPCOT, Walt built a detailed maquette of his ideas. This maquette has been preserved and a part of this can still be seen in one of the darkride sections of the Peppercorn in the Magic Kingdom.

In 2009, the Walt Disney Family Museum, designed by Disney's daughter Diane and her son Walter E. D. Miller, opened in the Presidio of San Francisco. Thousands of artifacts from Disney's life and career are on display, including numerous awards that he received. In 2014, the Disney theme parks around the world hosted approximately 134 million visitors.

Disney has been portrayed numerous times in fictional works. H. G. Wells references Disney in his 1938 novel *The Holy Terror*, in which World Dictator Rud fears that Donald Duck is meant to lampoon the dictator. Disney was portrayed by Len Cariou in the 1995 made-for-TV film *A Dream Is a Wish Your Heart Makes: The Annette Funicello Story*, and by Tom Hanks in the 2013 film *Saving Mr. Banks*. In 2001, the German author Peter Stephan Jungk published *Der König von Amerika* (trans: *The King of America*), a fictional work of Disney's later years that re-imagines him as a power-hungry racist. The composer Philip Glass later adapted the book into the opera *The Perfect American* (2013).

Additional information

Disneyland was partially Walt Disney's personal playground. Disney was a big fan of trains and he could often be found riding the train at the park, wearing a train-riders-cap and with a big smile on his head! This was mostly the reason Disneyland featured a train bringing guests around the park. This later became an iconic part of amusement parks around the world.

When Disneyland opened, the opening was far from perfect. The park quickly reached capacity which meant the entrance gates had to be closed. Many guests who did not manage to get into the park before capacity had been reached grabbed ladders and sneaked over the fences of the park. Some even went so far to rent their ladder to other people wanting to enter the parks. Because the construction was rushed in the end, the tarmac was not fully dried yet. Because of this and because of the high heat at opening day, the tarmac started to melt, making people's shoes stick to the road.

Many people were complaining about the rides in the park. The main complaint was that the main characters of the rides like Snow White, Peter Pan and Mr. Toad were nowhere to be seen in the rides. The rides were created with the idea that the rider is the main character, but people did not get this and complained about the absence of the characters. On top of that, the Snow White ride was made scary, but unknowing parents did not expect this, bringing their small children expecting a nice light-hearted ride, but getting out with terrified children.

From the beginning of Disneyland, it has been a "dry" park. No alcoholic beverages could be found in the park. This was because Walt did not want adults getting drunk and rowdy. To make sure he and other VIPs could still enjoy a drink, he created Club 33. This is an exclusive club where only VIPs can come to eat and drink and this is the only part in Disneyland where alcohol is served.

Walt Disney used to have an appartement inside the park. The appartement can be found above the Firedepartment in Main Street USA with a window looking over the park. When Walt was at his appartement, a light in the window overlooking town square would be turned on to show that Walt was present in his appartement. After Walt passed away, the light has always been kept turned on as a memorial. The light now symbolizes Walt Disney's spirit and presence at Disneyland. The light is only turned off when his daughters visit out of respect for the family.

Disneyland Paris

Following the success of Disneyland in California, top to the plans to build a similar theme park in Europe emerged in 1966 with sites in Frankfurt, Paris, London or Milan under consideration. Under the leadership of E. Cardon Walker, Tokyo Disneyland opened in 1983 in Japan with instant success, forming a catalyst for international expansion. In late 1984 the heads of Disney's theme park division, Dick Nunis and Jim Cora, presented a list of approximately 1,200 possible European locations for the park. Britain, France, Italy and Spain were all considered. However, Britain and Italy were dropped from the list due to both lacking a suitable expanse of flat land. By March 1985, the number of possible locations for the park had been reduced to four; two in France and two in Spain. Both nations saw the potential economic advantages of a Disney theme park and offered competing financing deals to Disney.

Both Spanish sites were located near the Mediterranean and offered a subtropical climate similar to Disney's parks in California and Florida. Disney had asked each site to provide average temperatures for every month for the previous 40 years, which proved a complicated endeavour as none of the records were computerised and were registered on paper. The site in Pego, Alicante became the front-runner, but the location was controversial as it would have meant the destruction of Marjal de Pego-Oliva marshlands, a site of natural beauty and one of the last homes of the almost extinct Samaruc or Valencia Tothcarp, so there was some local outcry among environmentalists. Disney had also shown interest in a site near Toulon in southern France, not far from Marseille. The pleasing landscape of that region, as well as its climate, made the location a top competitor for what would be called Euro Disneyland. However, shallow bedrock was encountered beneath the site, which would have rendered construction too difficult. Finally, a site in the rural town of Marne-la-Vallée was chosen because of its proximity to Paris and its central location in Western Europe. This location was estimated to be no more than a four-hour drive for 68 million people and no more than a two-hour flight for a further 300 million.

Michael Eisner, Disney's CEO at the time, signed the first letter of agreement with the French government for the 20-square-kilometre (4,940-acre) site on 18 December 1985, and the first financial contracts were drawn up during the following spring. The final contract was signed by the leaders of the Walt Disney Company and the French government and territorial collectivities on 24 March 1987. Construction began in August 1988, and in December 1990, an information centre named "Espace Euro Disney" was opened to show the public what was being constructed. Plans for a theme park next to Euro Disneyland based on the entertainment industry, Disney-MGM Studios Europe, quickly went into development, scheduled to open in 1996 with a construction budget of US\$2.3 billion. The construction manager was Bovis.

In order to provide lodging to patrons, it was decided that 5,200 Disney-owned hotel rooms would be built within the complex. In March 1988, Disney and a council of architects (Frank Gehry, Michael Graves, Robert A.M. Stern, Stanley Tigerman, and Robert Venturi) decided on an exclusively American theme in which each hotel would depict a region of the United States. At the time of the opening in April 1992, seven hotels collectively housing 5,800 rooms had been built.

An entertainment, shopping, and dining complex based on Walt Disney World's Downtown Disney was designed by Frank Gehry.

With its towers of oxidised silver and bronze-coloured stainless steel under a canopy of lights, it opened as Festival Disney. For a projected daily attendance of 55,000, Euro Disney planned to serve an estimated 14,000 people per hour inside the Euro Disneyland park. In order to accomplish this, 29 restaurants were built inside the park (with a further 11 restaurants built at the Euro Disney resort hotels and five at Festival Disney). Menus and prices were varied with an American flavour predominant and Disney's precedent of not serving alcoholic beverages was continued in the park.

2,300 patio seats (30% of park seating) were installed to satisfy Europeans' expected preference of eating outdoors in good weather. In test kitchens at Walt Disney World, recipes were adapted for European tastes. Walter Meyer, executive chef for menu development at Euro Disney and executive chef of food projects development at Walt Disney World noted, "A few things we did need to change, but most of the time people kept telling us, 'Do your own thing. Do what's American'."

Unlike Disney's American theme parks, Euro Disney aimed for permanent employees (an estimated requirement of 12,000 for the theme park itself), as opposed to seasonal and temporary part-time employees. Casting centres were

set up in Paris, London, and Amsterdam. However, it was understood by the French government and Disney that "a concentrated effort would be made to tap into the local French labour market". Disney sought workers with sufficient communication skills, who spoke two European languages (French and one other), and were socially outgoing. Following precedent, Euro Disney set up its own Disney University to train workers. 24,000 people had applied by November 1991.

The prospect of a Disney park in France was a subject of debate and controversy. Critics, who included prominent French intellectuals, denounced what they considered to be the cultural imperialism of Euro Disney and felt it would encourage an unhealthy American type of consumerism in France. On 28 June 1992, a group of French farmers blockaded Euro Disney in protest of farm policies supported at the time by the United States.

A journalist at the centre-right French newspaper *Le Figaro* wrote, "I wish with all my heart that the rebels would set fire to Disneyland." Ariane Mnouchkine, a Parisian stage director, named the concept a "cultural Chernobyl", a phrase which would be echoed in the media during Euro Disney's initial years.

In response, French philosopher Michel Serres noted, "It is not America that is invading us. It is we who adore it, who adopt its fashions and above all, its words." Euro Disney S.C.A.'s then-chairman Robert Fitzpatrick responded, "We didn't come in and say O.K., we're going to put a beret and a baguette on Mickey Mouse. We are who we are."

Topics of controversy also included Disney's American managers requiring English to be spoken at all meetings and Disney's appearance code for members of staff, which listed regulations and limitations for the use of makeup, facial hair, tattoos, jewellery, and more.

French labour unions mounted protests against the appearance code, which they saw as "an attack on individual liberty". Others criticised Disney as being insensitive to French culture, individualism, and privacy, because restrictions on individual or collective liberties were illegal under French law, unless it could be demonstrated that the restrictions are requisite to the job and do not exceed what is necessary.

Disney countered by saying that a ruling that barred them from imposing such an employment standard could threaten the image and long-term success of the park. "For us, the appearance code has a great effect from a product identification standpoint," said Thor Degelmann, Euro Disney's personnel director. "Without it we couldn't be presenting the Disney product that people would be expecting."

Euro Disney opened for employee preview and testing in March 1992. During this time visitors were mostly park employees and their family members, who tested facilities and operations. The press was able to visit the day before the park's opening day on 12 April 1992.

On 12 April 1992, Euro Disney Resort and its theme park, Euro Disneyland, officially opened (on the same date that Mediaset's La Cinq TV channel closed permanently). Visitors were warned of chaos on the roads. A government survey indicated that half a million people carried by 90,000 cars might attempt to enter the complex. French radio warned traffic to avoid the area. By midday, the car park was approximately half full, suggesting an attendance level below 25,000. Explanations of the lower-than-expected turnout included speculation that people heeded the advice to stay away and that the one-day strike that cut the direct RER railway connection to Euro Disney from the centre of Paris made the park inaccessible. Due to the European recession that August, the park faced financial difficulties as there were a lack of things to do and an overabundance of hotels, leading to underperformance.

Just like in the American parks, no alcohol was served in Disneyland Paris. The French people found this to be an attack on their culture since they were not able to drink wine at dinner, something that is part of French culture. Another problem mistake the Americans made is the assumption that travel distances work the same as in America. Because of the size of the cities and the distance between cities, Americans are used to driving longer distances to get to a destination. They assumed this would also be the case in Europe, making people from all countries of Europe come to Disneyland. The problem is that Europeans are not used to this, so the majority of the guests came from France, rather than from every country.

A new Indiana Jones roller-coaster ride was opened at Euro Disney in 1993. A few weeks after the ride opened there were problems with the emergency brakes which resulted in guest injuries.

In 1994, the company was still having financial difficulties. There were rumours that Euro Disney was getting close to having to file for bankruptcy. The banks and the backers had meetings to work out some of the financial problems facing Euro Disney. In March 1994 Team Disney went into negotiations with the banks so that they could get some help for their debt. As a last resort, the Walt Disney Company threatened to close the Disneyland Paris park, leaving the banks with the land.

In May 1992, entertainment magazine The Hollywood Reporter reported that about 25% of Euro Disney's workforce – approximately 3,000 people – had resigned from their jobs because of unacceptable working conditions. It also reported that the park's attendance was far behind expectations. The disappointing attendance can be at least partly explained by the recession and increased unemployment, which was affecting France and most of the rest of the developed world at this time; when construction of the resort began, the economy was still on an upswing.

Euro Disney S.C.A. responded in an interview with The Wall Street Journal, in which Robert Fitzpatrick claimed only 1,000 people had left their jobs. In response to the financial situation, Fitzpatrick ordered that the Disney-MGM Studios Europe project would be put on halt until a further decision could be made. Prices at the hotels were reduced.

Despite these efforts in May 1992, park attendance was around 25,000 (some reports give a figure of 30,000) instead of the predicted 60,000. The Euro Disney Company stock price spiraled downwards and on 23 July 1992, Euro Disney announced an expected net loss in its first year of operation of approximately 300 million French francs. During Euro Disney's first winter, hotel occupancy was so low that it was decided to close the Newport Bay Club hotel during the season.

Initial hopes were that each visitor would spend around US\$33 per day, but near the end of 1992, analysts found spending to be around 12% lower. Efforts to improve attendance included serving alcoholic beverages with meals inside the Euro Disneyland park, in response to a presumed European demand, which began 12 June 1993.

By the summer of 1994, Euro Disney was burdened with \$3 billion worth of debt. Disney CFO Richard Nanula and Wall Street financier Steve Norris worked with Alwaleed's business advisor Mustafa Al Hejailan to rescue the overleveraged company. In that deal, the Walt Disney Corporation's 49 percent stake was reduced to 39 percent, the banks agreed to forego interest payments until 1997, Disney wrote off royalties and fees until 1999, and Alwaleed agreed to pay \$345 million for a 24 percent stake in Euro Disney.

On October 1, 1994, Euro Disney changed its name to Disneyland Paris. On 31 May 1995, a new attraction opened at the theme park. Space Mountain: De la Terre à la Lune had been planned since the inception of Disneyland Paris under the name Discovery Mountain, but was reserved for a revival of public interest. With a redesign of the attraction (which had premiered as Space Mountain at the Walt Disney World Resort's Magic Kingdom in 1975) including a "cannon launch" system, inversions, and an on-ride soundtrack, the US\$100 million attraction was dedicated in a ceremony attended by celebrities such as Elton John, Claudia Schiffer, and Buzz Aldrin. The ride was themed after the Jule Verne story "to the moon and back". The idea behind this was to overcome the "tomorrowland issue". By giving the ride a steam-punk, alternate futuristic look, it would not become "old" after time. The problem with the tomorrowlands in America is that it tries to showcase a realistic future, but after 10 years or so, this future becomes reality making everything look old and outdated. Space Mountain was designed by the now legendary Disney Imagineer Tony Baxter, who was responsible for the design of Disneyland Paris. Space Mountain saved Disneyland Paris from going under.

On 25 July 1995, Disneyland Paris reported its first quarterly profit of US\$35.3 million. On 15 November 1995, the results for the fiscal year ending 30 September 1995, were released; in one year the theme park's attendance had climbed from 8.8 million to 10.7 million – an increase of 21%. Hotel occupancy had also climbed from 60 to 68.5%. After debt payments, Disneyland Paris ended the year with a net profit of US\$22.8 million.

In March of 2002, the second gate "Walt Disney Studios Park" opened at Disneyland Resort Paris (further called WDSP). Because of the agreement Disney had with the French government, they were obligated to build a second gate before a certain amount of years of opening. The problem Disney faced was that Disneyland did not make a huge profit and because of this did not have a huge budget to create the second gate. The result: WDSP, a park with too few rides, made as cheap as possible!

As of March 2002, Disneyland Paris underwent a second name change to Disneyland Resort Paris. In 2002, Euro Disney S.C.A. and the Walt Disney Company announced another annual profit for Disneyland Paris. However, it then incurred a net loss in the three years following. By March 2004, the Walt Disney Company had agreed to write off all debt that Euro Disney S.C.A. owed to the Walt Disney Company. On 1 December 2003, Euro Disney S.C.A. launched the 'Need Magic' campaign, which lasted until March 2006 to bring new, first-time European visitors to the resort. And by 2005, having been open fewer than fifteen years, Disneyland Paris had become the number one tourist destination for Europe, outselling the Louvre and the Eiffel Tower.

In March 2006, Disneyland Resort Paris launched the advertising campaign, "believe in your dreams" and paired with the TGV East European Line to encourage European family attendance to the resort. Shortly after announcing a 12% increase in revenues for the fiscal year of 2007, Euro Disney S.C.A. implemented a "reverse split" consolidation of shares of 100 to 1. August 2008 brought the resort's 200 millionth visitor, and made for the third consecutive year

of growth in revenues for the resort as well as record a record of 15.3 million visitors in attendance.

In 2009, the resort demonstrated dedication to the recruitment of new employment positions, especially for the Christmas and summer seasons, which continued in 2010 and 2011 when 2,000 and 3,000 employment contracts being offered, respectively. The 2009 fiscal year saw a decrease in revenues by 7% and a net loss of 63 million followed by stable revenues at 1.2 billion in fiscal 2010. Euro Disney S.C.A. refinanced their debt to Walt Disney Company again for 1.3 billion euros in September 2012.

A study done by the Inter-ministerial Delegation reviewing Disneyland Paris' contribution to the French economy was released in time for the Resort's 20th anniversary in March 2012. It found that despite the resort's financial hardships, it has generated "37 billion euros in tourism-related revenues over twenty years", supports on average 55,000 jobs in France annually, and that one job at Disneyland Paris generates nearly three jobs elsewhere in France.

For the first time in the resort's history, both the Disneyland Park and Walt Disney Studios Park closed from 14 to 17 November 2015, as part of France's national days of mourning following the November 2015 Paris attacks.

On 19 June 2017, the resort's operating company, Euro Disney S.C.A, was acquired by The Walt Disney Company, in the process, giving them full control of the resort. In December 2018, Natacha Rafalski took over as CEO. On 1 September 2017 the resort's second nature resort opened as Les Villages Nature Paris.

On 27 February 2018, Walt Disney Company CEO Bob Iger announced that company would invest €2 billion into the Disneyland Paris resort. The Walt Disney Studios Park will be expanded with three new areas based upon Marvel, Frozen and Star Wars. In addition to the three new areas, the expansion includes a new lake, which will be the focal point for entertainment experiences and will also connect each of the new park areas. The first phase of the expansion will be completed in 2021. Part of this expansion also include a retheme of the Studio Tramtour into a Cars ride. Because the tramtour was located in the center of the park, it had to go to accommodate the new expansions. The problem is that the studios park already suffers from a lack of capacity, completely removing a ride would not be possible. Therefore the ride is rethemed and the station is relocated. Only the right half of the track will remain and only one scene of the ride (catastrophy canyon) still remains. This scene is rethemed to the Cars IP. The ride is set to reopen this year. (Personal note from Jeffrey to make this text a little bit longer because I already had to put together two hugh wikipedia pages and it is still not enough :-): The retheme seems to be really cheaply done. I expect that this retheme is only done because it would really hurt the capacity of the park if this ride would be removed, especially if you consider that this ride has a scarily large capacity. Something had to happen because the road that leads to the new lake would have to go straight through the old tram tour station. Therefore they opted to remove the left part of the track, creating more place for the new/rethemed Marvel section, and kept the unused part on the ride to keep the tram tours capacity. I think that when the expansion of the park with the three new lands is done, the tram tour will be next on the list to be removed. This will created a nice plot of land to create a new ride, maybe with an expansion of the Toy Story or France land. But sorry for the interruption, I will not keep you waiting any longer and let you continue with the nice story you have been reading which should not take too long to complete from here on. And yes, I am still trying to expand the amount on non-sense in this section to make the text longer. I am going to continue making the questionnaire now! BYEEEEEEEE) In April 2019, the location hosted a Dota 2 esports tournament.

In March 2018, a Disney Parks West regional division was formed with Disneyland Resort in California, Walt Disney World in Florida, and Disneyland Paris under Catherine Powell, outgoing Disneyland Paris president. This mirrors the Disney Parks East regional division consisting of Shanghai Disney Resort, Hong Kong Disneyland and Walt Disney Attractions Japan and headed by Michael Colglazier. Natacha Rafalski was promoted from chief financial officer to president for Disneyland Paris in December 2018. In September 2019, Powell exited her post as president of the park west division with division dissolving and Disneyland Paris transferred to Disney Parks International, East region reverting to its prior name.

On 1 June 2019, Disneyland Paris sponsored the Magical Pride Party, an LGBTQ celebration. Previous similar events have taken place at the park since 2014, but were not officially sponsored by Disney.

On 15 March 2020, in line with other Disney parks and resorts, Disneyland Paris was shut down due to the worldwide COVID-19 pandemic. Disneyland Park and Walt Disney Studios Park reopened to the public on 15 July with the rest of the resort. On 29 October 2020, the resort closed again due a second nationwide lockdown. In May 2021, Disneyland Paris announced that it will re-open on June 17. The park is currently not opened.

Sources: https://nl.wikipedia.org/wiki/Walt_Disney and https://en.wikipedia.org/wiki/Disneyland_Paris