Investigating Contextual Variations in Explaining Plausible Narratives of Social Intention in Hospitals

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Abstract

Intelligent systems are being increasingly deployed alongside humans, yet their ability to understand human intentions in order to perform tasks better is far from perfect. In this paper a literature survey will be performed to obtain existing examples of narratives, with and without intelligent systems, that take place in a Hospital - a setting with a variation in situation openness, where a framework of cues, characteristics, classes, internal scripts, external scripts, and memory and associative triggers all play an equally important role in determining an individual's intention. Dimensions were extract from these scenarios and were analysed based on the three roles: Patients, Clinicians, and Family Members. Results and findings were used to develop a new case study involving an intelligent system assisting a doctor with diagnosing a patient and communicating it to them. Variations of contextual cues, amid other dimensions, were made to demonstrate multiple plausible narratives and its effects on intention.

1 Introduction

1.1 Problem Motivation

Intelligent systems are being used at a higher frequency on a daily basis for assisting humans and completing numerous tasks. These systems can consist of machine learning models that are tailored to the problem at hand, and are often meant to either be used by and/or on human beings. Therefore, it can be inferred that any intelligent system performing functions in such a capacity would be able to benefit from being able to understand the intentions of the humans it is working alongside, as it would gain a better understanding of what it needs to do to achieve a desired result. Within this context, intentions refer to what an individual aims or plans to do, even if they have not acted yet, and social intentions would refer to intentions that involve other people. Understanding human intentions however, and making them understandable for intelligent systems, poses a large hurdle for machine learning and artificial intelligence researchers, and while most literature focuses on realised intentions, individuals also have unrealised intentions. These are intentions that a person may have but not act on or complete, and are important to study since they can lead to real emotions, consequences, and further intentions even without having a physical presence themselves. So, there still needs to be a magnitude of research until researchers and intelligent systems can utilise intentions effectively.

Since intention estimation is currently based on reading human body language, there exist multiple methods that can provide a system with the required parameters, ranging from body motion tracking, wearable sensors (Inertial Measurement Units), myographic activity/muscle detection, and eyesight tracking [1]. Yet even after obtaining these base parameters, the method and ways to recognise intention are still not fully understood, and a primary reason for that is because understanding intention recognition in social scenarios is a difficult cognitive task that can consist of multiple decisions, all of which may not be apparent. As described by Belardinelli [1], intentions can be difficult to study since "intentions are hidden, unobservable states, which can be first inferred when translated into motor behaviour", meaning that unrealised intentions that play a part in a situation can remain invisible to observers, yet still affect actions and decisions made within the situation. Furthermore, research carried out by Rawte et al [2] into AI hallucination divides types of hallucinations and errors into eight categories and assigns a severity to them, yet does not address the errors these systems can have in recognising and detailing human intention, proving that this field still requires substantial research to be understood with respect to intelligent systems as well.

Hospitals provide a unique and challenging setting for studying social intentions and the bridge between them and intelligent systems. By balancing high stakes decision making, emotional vulnerability, and protocol driven situations, scenarios set within Hospitals often contain a myriad of intentions, often ambiguous and unrealised, that have emotional and physical consequences. Furthermore, hospitals are an ideal location to deploy intelligent systems that can work alongside humans, since they already rely heavily on technological infrastructure and the collaboration between man and machine. This makes them a suitable setting within which intention estimation research for intteligent systems can be carried out.

1.2 Research Question

This study set out to investigate the following main Research Question:

How do contextual variations of cues affect the intention recognition of intelligent systems within a Hospital?

Furthermore, four sub questions will be addressed and answered:

- "How do intentions vary with respect to an individual's role within a hospital situation?"
- "What is the current use and future potential of intelligent systems within a hospital?"
- "How can script theory be used to translate and develop social scenarios with multiple plausible narratives?"
- "What are the limitations and open challenges of social intention modelling?"

This paper will attempt to answer the aforementioned questions by performing a literature survey to understand the field, and use that knowledge to create case studies of social situations, involving intelligent systems, that can contain multiple plausible narratives. Section 2 will provide required background knowledge for terms and concepts used for intention recognition and situation modelling within the case studies. Section 3 of the paper describes the methodology used to perform the literature survey, and create and analyse the case

studies. Section 4 will detail the results of the literature survey, presenting existing literature regarding intentions within Hospital settings, both with and without intelligent systems. The knowledge obtained from the survey will be applied in Section 5, where case studies will be created to explore how different narratives of a situation can exist. Section 6, Responsible Research, will go into more detail regarding reproducibility and potential ethical concerns that may exist. Lastly, Section 7 will discuss the scenarios and conclusions that have been made, lay out ways to expand and improve upon the findings, and finally provide answers to the research questions mentioned earlier.

2 Background

2.1 Dimensions of Variation

To be able to create and study case studies effectively, it is important to be able to model them using a simple and reproducible framework. The individual components that vary from scenario to scenario, which will be used to represent them, are referred to as the dimensions of variation. One set of dimensions that is used to analyse the scenarios involves Script Theory. As laid out by Fischer et al in *Towards a Script Theory of Guidance*[3], script theory consists of modelling situations using:

- **Internal Scripts**: This constitutes the working model of an individual's understanding of a situation and the actors within it[3]. For example, upon receiving unfortunate news regarding a patient, the family members might interpret the situation differently based on their beliefs about responsibility, their expectations of the medical care and staff, and the level of medical technicality with which they understand the situation.
- **External Scripts**: This constitutes the working model of a normative version of the situation and the actors within it, including but not limited to defined actor roles, and objective rules and tasks that need to be followed[3]. For example, during a surgery within a Hospital, external scripts would dictate the steps needed to prepare a patient for the operation and the medical procedure that must be followed by the surgeons.

These scripts can be applied to the different components of a scenario - the individuals' roles, scripltets (sequences of activities), scenes, and plays (a generalisation of the theme and setting of the scenario)[3].

While script theory provides a good representation of the knowledge possessed by an individual as well as the steps demanded off of them, scenarios also have a large amount of emotional, physical, and psychological attributes that affect the narratives. Firstly, intention relies heavily on emotions, thoughts, and memories, and while Internal Scripts cover an individual's knowledge and understanding, it fails to cover the emotional aspect. Therefore, another dimension of variation that must be introduced and used to examine the case studies is **Memory and associative Triggers**. This involves those memories and thoughts that affect emotion and internal thought processes, and are triggered through external stimuli via hearing, smell, etc. For example, this can include bias due to nostalgia and aversion due to past disgust, and can also be shaped through past intentions and actions [4; 5].

Finally, to better further represent the physical and psychological attributes, the last subset of the dimensions of variations that are examined include the 3Cs structure presented by Rauthmann and Sherman[6], which include cues, characteristics, and classes while modelling social scenarios.

- **Cues**: Cues are the physical and objectively quantifiable elements within a setting, and can include people, objects, events, locations, and times within the situation[6]. These are elements that are observable to all individuals within the scenario, and possess no inherent psychological meaning[6].
- **Characteristics**: Characteristics are an attempt to represent the psychological meanings of situational cues, and therefore "represent inferred qualities or attributions coloring the perceptions of situations"[6]. Specifically, the six following characteristics of a scenario will be examined, as well as the degree of relevance (low, moderate, and high) they hold in said scenarios - *Threat* (how dangerous or risky is the situation), *Stress* (how frustrating and distressing is the situation), *Tasks* (how many tasks jobs or tasks does the situation require), *Processing* (how intellectually engaging is the situation), *Fun* (how enjoyable is the situation), and *Mundaneness* (how repetitive and routine is the situation)[6].
- **Classes**: Classes provides a broad, generalised, and abstracted higher level understanding of what type of scenario is being dealt with[6]. They can shape expectations of actions and intentions within the scenario.

Together, Script Theory, 3Cs, and Memory and Associative Triggers provide the framework that is used in this paper to model scenarios.

2.2 Annotation

In order to understand how intelligent systems are trained to make sense of the world round us, it is necessary to briefly discuss annotation, and its importance in intention estimation for intelligent systems. Whether done manually or automatically, "data annotation is the practice of labelling a set of digital representations of objects"[7], which can then be used by machine learning and artificial intelligence researchers to train intelligent systems. Within the fields of intention recognition and estimation, it is the role of human annotators to recognise and label the intentions of individuals within a scene. However, due to the ambiguity of intention, both realised and unrealised, classifying these can lead to disagreements between annotators, as they all attempt to label the intention from a different perspective[7]. While the methods used to reduce this labelling disparity is not the focus of the paper, it does introduce how different individuals can view and interpret different scenarios and intentions differently, based on relative technical, social, economical, and

political contexts [7]. This helps understand how the case studies developed later in this paper can be viewed differently by different individuals, and how that affects intelligent systems.

3 Methodology

The following sections will lay out the details regarding the setup of the literature survey, the method through which the found case studies were examined, and the creation of the case studies, and help provide a glimpse into how the research questions are answered.

3.1 Literature Survey Setup

In order to gain a sufficient understanding of social situations within Hospitals, it was of utmost importance to complete a thorough literature survey with the intention of obtaining research papers that tackle medical scenarios, describing the individual components of the scenario that help shape them. Such a literature survey also allowed for the understanding of the current state of intelligent systems within Hospitals. An adapted version of a pragmatic literature survey was carried out - scouring available papers to find relevant scenarios rather than exhaustively going through them. In order to identify these papers a search query was obtained through iterative testing with the appropriate changing of search criteria. This was done by checking the relevance of the returned papers to the research. Papers were deemed relevant to the survey if they contained case studies or narratives, and they were relevant to the Hospital setting. An emphasis was put on the latter, in order to obtain narratives that can take place in hospitals over other medical situations and settings. The final obtained search query consists of six different inclusion and exclusion criteria-

1. **Intentions and Narratives**: the first part of the search query addresses terms that are related to human intention, narratives of a situation, and goal inference.
2. **Case studies and Scenario Modelling**: this part of the search query aims to make sure that the obtained papers consist of a case studies and example scenarios that can be used to understand situations in the field. Furthermore, this part also aims to identify papers that make an effort at using the pre established framework of script theory and annotation to represent said case studies.
3. **Hospital and Medicine**: this part consists of keywords that focus on the relevant domain of Hospitals. In order to make sure that the obtained case studies focus solely on Hospital cases as opposed to general medical situations, appropriate keywords were used. Search terms such as hospital, surgery, and patient were opted over more generic terms such as medicine, clinical, and treatment.
4. **Technology and Exploration**: this part aims to identify papers that focus on the involvement of technologies in the field. It is also an attempt at identifying papers that provide an exploration or commentary on any relevant scenarios mentioned.
5. **Non relevant terms**: this exclusion criteria consists of terms that were deemed out of scope for the discussion, such as "husbandry", "animals", and "social media".
6. **Other domain relevant terms**: since the research has been carried out in three other instances for other domains (Aviation, Driving, and Restaurants), it is important to obtain a set of mutually exclusive papers. Therefore, this exclusion criteria contains the domain relevant terms of the other domains.

This search query was used in the advanced search criteria on Scopus and resulted in 398 results. The query can be found in Appendix A in its entirety. To ensure that a manageable selection of papers was acquired from this, the results were sorted based on relevance, and only papers written in English were subject to investigation. Additionally, papers were ignored if completely inaccessible due to paywalls.

3.2 Scenario Open-Endedness

For the literature survey, only papers that contain and describe social situations within Hospitals were chosen. The open-endedness of these social situations differ from paper to paper. For this research, open-endedness refers to the number of possible actions someone can, but does not have to, take in a given situation. Two different sets of papers, and therefore two different sets of scenarios, will be obtained and clustered based on their level of open-endedness. These two sets include:

- **Scenarios describing the domain**: these scenarios will be used to better grasp an understanding of social scenarios that can exist in Hospitals, and the multiple parts within them that affect narratives and intentions. These scenarios do not necessarily need to involve intelligent systems, as long as they assist with understanding the nature of social scenarios within Hospitals. These scenarios are considered more open-ended due to the high variability that can exist in terms of delivering and perceiving intention, as well as the large number of and variations within these intentions.
- **Scenarios integrating intelligent systems**: these scenarios will be used for inspiring the creation and examination of scenarios later in the paper. Therefore, these social scenarios need to involve intelligent systems playing either an active or passive role in the situation alongside one or more humans. These scenarios also will not discriminate between scenarios where intelligent systems are intervening in real time to the situation versus those systems that perceive and intervene post-hoc. These scenarios are less open-ended due to the involvement of intelligent systems in them, as well as the requirement for the intelligent systems to be working alongside humans. While the previously obtained papers also contain scenarios that fall in this group, higher relevance was placed on papers obtained by applying an additional filter to the aforementioned query. This limited the returned papers on Scopus to those that also fall under the Computer Science Subject Area, returning 40 papers.

3.3 Dimension Extraction

Using social scenarios found via the literature survey, core concepts and behaviours in a Hospital scenario are identified, and framework described in Section 2 is applied to the found social scenarios to represent them in terms of Script Theory, the 3Cs, and memory and Associative Triggers. This process will be referred to as Dimension Extraction, and involves mapping the described physical, emotional, and psychological elements to various components of the framework. Extracting the dimensions of scenarios from the literature survey should provide a sufficient basis upon which case studies can later be fabricated and developed to study scenarios involving intelligent systems that can have multiple plausible narratives. Since this allows for studying scenarios by their working components, it should allow for investigation into how variations within these dimensions can affect the scenario and in turn the intentions present within it.

4 Literature Survey Results

This section will elaborate on the findings of the performed literature survey, and attempt to list out the dimensions of variation for some of these scenarios. As described in section 3, the found papers and scenarios have varying levels of open-endedness and integration with intelligent systems, which is what will be used to separate the papers into different clusters. Within each cluster, scenarios found in the literature were also sub categorised into three subgroups: Patients, Clinicians, and Family members, as these are the three primary roles that were repeatedly found to be present in social scenarios, and so provide three different lenses through which the same scenario can be viewed. The extracted dimensions of an individual scenario for each cluster is then presented.

4.1 Cluster 1: Domain specific cases

Cluster 1 includes papers and narratives that help provide an understanding of general social scenarios within Hospitals and do not include intelligent systems. A few classes of scenarios were found to be common across the literature, and at a very top down level they include a *diagnosis or prognosis session* where a patient is informed of a condition for the first time[8] and are informed on what they can do about it [9], an *information or consultation session* where an update on a situation is given and which might require further decisions to be made[10], and *treatments* which include steps being taken to cure a patient.

Patients

In a hospital, the Patient role includes those individuals who are the subject of examinations, tests, surgeries, treatments, and diagnoses. Usually, these individuals may have issues or display symptoms of bigger problems that they wish to be informed about or cured. Therefore, the primary goal of these individuals is to see themselves cured of their ailments, and so they will therefore comply and cooperate to see it be done. To ensure that this primary objective is kept throughout the narrative, a decision was made to not focus on scenarios with mentally ill patients that did not want their condition cured[11]. Patients can be in emotionally and psychologically vulnerable states, as they remain worried regarding what could be affecting them and want reassurance while reducing uncertainty regarding their conditions[10]. Translating these emotions to characteristics gives us moderate to high Stress, low Fun, and moderate Processing. Stress itself can depend on factors such as patient age and their familiarity with the surroundings[12]. The actual severity of the condition affects the Threat characteristic and the Mundaneness (how routinely they are subject to tasks examinations, treatments, and consultations). Tasks can range from low to moderate.

Depending on the scenario class, patients may also be in possession of medical documents and records, such as previous test results regarding their conditions and hospital discharge letters[10], which can be included in the cues present in the situation. Cues also include the symptoms they demonstrate, and the age and sex of the patient.

Patients will usually also have a number of memory and associative triggers that are guiding their intentions and actions. For example, this could include their past negative experiences with an ailment[9], whether it was they themselves that had it or another loved one,. This includes hereditary illnesses, contagious diseases, and resurfacing problems. This could determine the method they choose to deal with it and their choices regarding bodily control and autonomy[13]. A similar effect can also be observed from positive memories and triggers, such as through memories and emotions for family members and friends, which can dictate the responsibility they feel they bear towards others. This can influence their willingness to seek treatment and show more positive responses[14], or prioritise the the needs of their loved ones over their own[13]. These beliefs and expectations from the patients can also be represented via internal scripts.

Clinicians

Within a hospital setting, the Clinician role includes Doctors, Surgeons, Nurses, and other relevant medical staff that are present at the hospital and assigned to treat, diagnose, and take care of sick individuals. Clinicians tend to have high levels of authority within Hospitals, and are usually in charge of multiple regular cases and responsibilities. While addressing an individual case, it is the main goal of Clinicians to assist patients with their problems to the best possible degree, since the Clinicians themselves are the primary contributors to the solution. However, they must aim to relieve the patient of their pains both ethically and professionally [13; 15], sticking to what is demanded by them from external scripts like professional codes of conduct and hospital rules, and internal scripts like their ethical code. These professionals also go through proper medical education and/or competency training, which includes familiarisation with the usage and care of medical equipment [16]. This knowledge gets integrated into the external script they are expected to follow, in the form of standardised medical guidelines. However, the external script may not always be adhered to [16], which could arise due to the routineness of certain tasks like measuring a patient's blood pressure. The Mundaneness characteristic for these tasks can be moderate and in turn affect the clinician's intentions, making them less likely to do it correctly

with the proper method and care. Furthermore, this deviation from external scripts may also rarely be seen when clinicians rely heavily on the medical knowledge and experience they possess, letting their internal scripts guide them instead.

Since they are the main source of information and news, both good and bad, it is important for them to adapt the method used to deliver updates and details based on its severity and emotionality[8], since they might be wanting to reassure patients and mitigate their worries [10]. There is usually a degree of uncertainty when it comes to making medical decisions [10], and due to internal scripts regarding a Clinician's role and authority in a hospital, they should also balance "being candid about uncertainty against risking their authority and credibility" [10]. Thus, their intentions while delivering news can vary.

While the degree of importance for characteristics in general depend from class to class, such as surgical treatments being more stressful than a consultation, some trends can be observed. Similar to characteristics described for the patients, the Threat and Mundaneness depends on the ailment severity level. The Fun characteristic is once again low, but Stress, Tasks, and Processing are all moderate to high. The cues demonstrated in these scenarios include medical tools such as blood pressure measuring devices[16] and apparel such as professional uniforms[17]. Another key difference between the Clinician role and the Patient role is that Memory and Associative Triggers play a less important with shaping their intention. Clinicians are expected to rely primarily on the established scripts and protocols, often prioritising those over make emotion driven responses.

Family Members

This role includes the loved one of the patients being treated or diagnosed at the Hospital, and can include Parents, Guardians, Children, Spouses, etc. Often, these individuals bear significant emotional attachment to the Patients, and so are more prone to having and displaying severe emotional impacts based on news, updates, and diagnoses regarding the patients. This response is not only driven by emotional attachment and memories, but can also depend on factors such as their overall medical knowledge and internal interpretation of the news, with diagnoses that are more misunderstood and socially complex often being met with a stronger emotional outcry [8; 18]. This understanding of the situation can be represented via internal scripts. Furthermore, they can also be made more or less receptive based on the method used to inform them [8]. Often, emotions can also make it difficult for family members to choose between respecting the patient's bodily autonomy, or protecting and caring for the patient regardless of the cost [13], thus varying their intention. The characteristics exhibited by this role are low to moderate Stress, Tasks, and Processing. Fun is once again low, and threat depends on the ailment severity and their bond with the patient. This time the main difference is the lack of influence they may have over the situation, which can means Mundaneness falls between moderate and high.

Dimension Extraction for research by Turowetz and Maynard[8]

The scenario presented focuses on a simple diagnosis - A psychiatric doctor is informing the parents of a young child that the child is on the autism spectrum. This case can include individuals of all three roles, and extracting the dimensions from it, based on what is given in the situation and what can be generalised from other hospital scenarios, gives us the following from the perspective of the doctor:

- Cues: There are up to seven individuals present in the clinician's office, a special education clinician, a speech and language pathologist, an occupational therapist, a psychiatrist, a caseworker, and the parents of the child, and while all the medical experts are not required to be present together in the room at the same time, at least one is expected to be with the parents at all times during the diagnosis. The child itself is not currently present. Activities involve informing the parents of the diagnosis and what it entails for them and their child. This could be done with the assistance of reports or infographics. There is no immediate time pressure involved in this scenario.
- Characteristics: Low Threat, Moderate Stress, Moderate Tasks, Moderate Processing, Low Fun, Moderate Mundaneness.
- Class: The paediatric psychiatric diagnosis guardians.
- Memory and Associative Triggers: Could include past experiences with similar diagnoses.
- External Scripts: the job descriptions of the clinicians, the hospital rules, and medical guidelines dictate how the diagnosis should be communicated and what the parents should be informed about.
- Internal Scripts: the clinicians' ethical responsibilities and morals that also push them to inform the parents while being sensitive to their emotions, as well as their personal beliefs about neurodevelopmental conditions.

This scenario and its extracted dimensions provide a good representation of how a narrative can be modelled by the dimensions of variation. The clinician's intention in the above situation involves letting the parents know about the diagnosis in a manner that meets the least resistance from them. The clinician is also aiming to be helpful and deliver all the sufficient knowledge the parents will need to take care of their child.

4.2 Cluster 2: Intelligent System Integration

Cluster 2 helps identify the current use of the intelligent systems within hospitals, which can also help extrapolate to the future use cases of intelligent systems in the field. Similar to Cluster 1, papers and narratives identified as a part of this cluster can further be sub categorised based on whose intentions the intelligent systems are observing and estimating. With that in mind, it is important to note that while some of these scenarios may focus on the intentions of a single role, integrating intelligent systems to social scenarios with multiple roles could mean the intention estimation of multiple actors, increasing the complexity and importance of this task.

Patients

Majority of intention estimation research and use currently within hospitals focuses on the intent recognition of patients. For patients with limited mobility, due to strokes and other accidents, rehabilitation robots [19; 20; 21] primarily require understanding a patient's human body movement intent in order to assist them. Rehabilitation therapy is also an interesting setting for deployment of intent estimating intelligent systems due to the presence of unrealised intentions in the form of movements that are unable to be made. Thus, research by Adeola Bello et al.[19] suggests that such systems would work optimally if a therapist is present during the rehabilitation, and the robot is understanding their intention alongside the patient's, providing the best ways to assist the patient with recovery. In order to ensure effective recovery, the intelligent system is also used alongside more conventional equipment such as elastic bands, exercise balls, and foam rollers, which contribute to the cues present in the scene. Similar applications can be seen in prosthetic limbs, where the intelligent system operating the limb needs to accurately estimate the patient's gesture intention in real time using electromyography (EMG)[22] and speech recognition therapy[23]. Chen et al. [22] also describes how the physical limitations of such technologies can stem from external cues such as the technical specifications of the device used, and how advancements in technology can help mitigate these limitations. This helps sets up an external script regarding optimal device use and care during operation.

Bodily movement intent aside, current intention recognition systems can also be Gaze based[24], which rely on a language that can be taught to patients which involves how open their eyes are, winks, and their general direction of looking. Used by patients with paralysis and other neural conditions which may leave them unable to communicate otherwise, this allows them to not only gain some control over their surroundings in the ward[24], but can also be used to communicate to medical staff or others present. For such use cases, understanding a patient's intention is important to be able to guarantee that what has been communicated to the clinicians and family members is accurate, yet it too can have its own hurdles stemming from difficulty in identifying the external cues that help shape the gaze based language. For example, confusing a patient checking information around them with them attempting to communicate.

Lastly, there are a number of intention estimation systems that can be deployed to monitor on and check patients, ensuring that any deviations from expected behaviour or any unmet needs can be detected and informed to Clinicians. For example, this can be done through the use of pressure and moisture sensors imbued in the mattress of a bedridden patient[25]. In these situations, the systems are facilitating the social element of the scenario by brining together the patients and the clinicians, yet do so in scenarios that have a moderate to high Stress characteristic.

Clinicians

Given that the diagnosis and prognosis classes exist, a natural extension of the use of intelligent systems leads to Clinical Decision Support Systems (CDSSs), which are systems that assist clinicians with complex medical decision making during a diagnosis and prognosis session [26]. These systems are able to use the patient's medical data as an input and check it against the Knowledge Graphs (KGs) that "amalgamate expert medical knowledge and clinical treatment guidelines"[26]. Research carried out by Gershov et al.[26] incorporates the clinician's verbal thought process and communication into the decision making process of these systems. This means that it would be beneficial for systems to be able to understand the clinician's intentions, even those that are unrealised, as they contribute directly to patient outcomes. This also demonstrates a gap in the existing systems. Diagnoses usually also rely heavily on patient input[10], yet intelligent systems in the field currently primarily rely on recognising the clinician's intent over the patient's.

Family Members

A lack of intelligent systems targeting family members was found in the literature, indicating that they are currently not being used and deployed within situations in hospitals requiring emotional sensitivity and nuanced social interaction. This gap in the field applies to systems that are actively taking part in a scenario and those that aim to assist post-hoc.

Dimension Extraction for research by Adeola Bello et al.[19]

The scenario presented focuses on the upper limb rehabilitation therapy a patient is undergoing after suffering from a stroke which leaves parts of their upper body, such as the arms, immobile. They are being assisted by a therapist guiding them, and an upper body exoskeleton used to facilitate movement. Extracting the dimensions, based on what is given in the situation and what can be generalised from other hospital scenarios with and without intelligent systems, gives us the following from the perspective of the patient:

- Cues: The patient, the therapist, and the exoskeleton system are present in the rehabilitation room. Required rehabilitation equipment such as elastic bands, exercise balls, and foam rollers are also present, as well as medical bed for the patients to sit down at, take a break, and relax. Due to the high demand for therapist and exoskeletons for recovery, this is likely a scenario with hard time limits that must be adhered to. During it, the therapist will be assigning the patient with movements to perform while evaluating the patient's progress. The patient is attempting to perform these bodily movements to the best of their capacity.
- Characteristics: Low Threat, Moderate to High Stress, Moderate Tasks, Moderate Processing, Low Fun, Low Mundaneness.
- Class: Upper limb rehabilitation therapy treatment using an assistive robotic technology.
- Memory and Associative Triggers: Positive memories associated with full movement prior to stroke. Prior rehabilitation sessions with the therapist and exoskeleton can cloud emotion (progress made, or lack thereof, can lead to varying levels of frustration with their own inability). Pain and discomfort triggered from the exoskeleton.

- External Scripts: Medical records, therapist instructions, therapy protocols, and the way the exoskeleton operates can define what the patient is expected to and can do in this therapy session.
- Internal Scripts: The patient's beliefs about the progress of their recovery and the usefulness of the chosen method, their trust in the therapist and exoskeleton robot, and their expectations of themselves can shape how they interact with the therapy session. For example, by making them more or less likely to continue to pursue therapy and attempt to cure their ailments.

Within this scenario, there are a number of patient intentions that must be recognised by both the therapist and intelligent system. This includes their intent to move which could also be an unrealised intention due to lack of movement, and their desire to push themselves past their limits in order to see themselves get cured, even if it means suppressing intents to communicate pain and discomfort.

5 Results - The creation of scenarios

Having identified possible social narratives within a Hospitable and the dimensions that can be used to model the scenarios, an attempt will now be made to create a detailed case study. This case study will be based on the existing scenarios with intelligent systems, as well as natural extensions of scenarios that previously lacked intelligent systems. It will demonstrate how machine learning and artificial intelligence researchers can create multiple plausible narratives with differing intent by altering dimensions.

5.1 Case Study - An intelligent system assists with a diagnosis session

A house doctor/general practitioner is conducting a session with a patient presenting symptoms. A Clinical Decision Support System (CDSS) is present in the room that listens to the conversation between the doctor and the patient, and uses real time video footage to capture the patient's facial expressions, gaze, and body language, to infer their emotional states. This allows such a system to assist the doctor not only with the medical diagnosis but also with tailoring communication strategies to deal with the patient personally. This scenario is a natural extension of the current state of the art since it integrates existing technologies to applications that are lacking sufficient research. The dimension extraction of the scenario gives us the following from the perspective of the Doctor:

- Cues: The patient's symptoms, facial expressions, body language, and input to the diagnosis. The doctor asking questions. The hardware used by the intelligent system to capture audio and video and present the Doctor with results. Any medical records, symptom descriptions, and test results. The clinical environment/office. There is a lack of hard time limits.
- Characteristics: Low to moderate Threat, Moderate Stress, Moderate Tasks, Moderate Processing, Low Fun, Low to Moderate Mundaneness.
- Class: Clinical diagnostic session supported by an emotion aware intelligent system
- Memory and Associative Triggers: Personal experiences with misdiagnosis or undiagnosed conditions, and past interactions with similar intelligent systems.
- External Scripts: Medical guidelines, professional responsibilities dictated by the role, hospital's rules, patient's medical records, and the operational constraints of the CDSS dictate how the diagnosis is made, as well as how it is communicated to the patient while addressing their worries and emotion states.
- Internal Scripts: The ethical responsibilities they understand they have, the trust the doctor places in the medical and emotional observations of the CDSS, and the beliefs the doctor possesses about professionalism, their own role, and the power dynamic between themselves and the patient, can dictate tones and intents while talking to the patient.

From the perspective of the patient, the cues and class remain the same, but other dimensions can change:

- Characteristics: Low to moderate Threat, Moderate Stress, Low Tasks, Low Processing, Low Fun, Low Mundaneness.
- Memory and Associative Triggers: Past experiences with illnesses and the negative bias that might be associated with them, past experiences with treatments at this hospital and with this doctor that might be associated with a positive bias. Pain or discomfort being felt at the time of the diagnosis can also affect their urgency and emotional state, which in turn affects the cues they exhibit via facial expressions, gaze, and body language.
- External Script: Prompts and follow up questions given by the doctor to explain problems and symptoms, as well as the power dynamic and vulnerability of the patient, require the patient to be transparent and engage in the diagnostic discussion.
- Internal Script: The patient's understanding of the roles within the hospital and how they play into it, their preconceived notions regarding their ailments, and the expectations they set on the doctor and the intelligent system can affect how they communicate symptoms, and engage and comply with the discussion. Their worry for themselves also prompts further curiosity.

In this scenario, the doctor intends to spend ample time diagnosing the patient, making sure to properly understand their problem, correctly identifying the issue and its solutions, and then communicating this clearly to the patient to soothe their worries and maintain their comfort. The Patient intends to comply with any questions and requests the doctor may have to help them diagnose the problem, seek reassurance about the condition, and minimise personal worry and discomfort. Upcoming variations will all be made upon this base case scenario.

5.2 Variation 1 - Change in time constraints

An extra constraint in the cues can be added, which involves a large crowd waiting in the waiting room right outside the

office for their chance to meet the doctor. This means that while there is no hard imposed time limit, the doctor could intend to speed up the diagnosis as they would like to speed up processes in order to see everyone present, which can also increase the relevance of the Processing characteristic. This results in a shift in the intention of the doctor, making them more likely to prioritise efficiency over empathy. The intelligent system should be able to pick on this shift in intention through the doctor's verbal cues, and adapt based on its programmed guidelines. This can range from supporting the change in the doctor's diagnoses and providing a greater emphasis on the diagnosis, to attempting to reiterate and remind the doctor to emotionally soothe the patient's worries regardless of the change in cues. If patients feel that they are not being given enough time, their behaviour could become even more compliant and quiet, as they wish to stick to the established roles. Their need for obtaining a diagnosis can get pushed to the background and become unrealised unless it is voiced. If they become more vocal, this is not unrealised and either the doctor or the CDSS is made aware of their need to see themselves better. This variation provides a good example of how researchers can use variations that reduce open-endedness and make the situation more constrained.

5.3 Variation 2 - Uncertainty in diagnosis

This variation attempts to make the situation more open-ended by adapting the cues to make the patient's symptoms more ambiguous and the internal scripting to decrease the trust the doctor places in the intelligent system. This makes reaching a diagnosis harder, which means the doctor attempts to probe for more information from the patient and perform more complex reasoning to identify the issue. This increases the Processing and Tasks characteristic demonstrated by the doctor. In terms of a diagnosis, this situation now becomes more open and exploratory for both the Doctor and Intelligent System. Upon recognising the doctor's intention to put less weight on the CDSS's suggestion, it can switch to a strategy where it provides the doctor with more likely problems rather than hypotheticals. As found in the literature review, diagnostic uncertainty can lead to a shift in the doctor's intention mid diagnosis to present this uncertainty without risking their authority and credibility in the situation. This variations also means that the patient's worries remain for longer, which can extend to a change in their intention, making them more likely to ask questions, seek reassurance, or provide additional contextual information. Once again, upon recognising this change in the patient, the CDSS's suggestion strategy can oscillate between probabilistic suggestions and clear-cut recommendations for the doctor. This variation demonstrates how variations can affect the intents of multiple actors in the scenario, which in turn can help decide upon different strategies to employ.

5.4 Variation 3 - The presence of a Family Member

This variation makes the situation more social by adding a new actor with a new role to the scene. The family member provides support to the patient, yet is worried themselves and seeks to understand the diagnosis. This variations makes the situation much more open, as the doctor and CDSS must take input from two different emotionally vulnerable individuals, one of which is suffering, and provide the doctor with communication strategies that can be used to soothe the worries of both. The doctor's intent must now switch from communication effectively with one individual to two. This becomes a more difficult line to tread as the patient and the family member may not respond similarly to different communication styles. Such a scenario demonstrates how variation in roles can lead to more open-endedness and variation with regards to intent.

5.5 Variation 4 - Annotators used by Researchers

As found and supported in Section 4, the results of the literature survey, the role an individual has in a scenario affects the characteristics of the scene for them, as well as the external and internal scripts guiding their actions. Therefore, when training the intelligent CDSS on this scenario using annotators, researchers will find variation in labelled intention based on the demographic chosen to play this role of annotators, leading to changes with the way the intelligent system perceives and handles intentions. In this scenario, using a larger proportion of clinicians as annotators can lead to the system focusing more on objective medical reasoning and adherence to professional protocols. For example, emotions the patient might possess such as anxiety are more likely to be viewed as a problem or symptoms for a problem rather than a product of their worry and emotionally vulnerable state. Similarly, using a larger proportion of patients could do the reverse and attribute heightened emotions to worry regarding the diagnosis rather than symptoms. This provides an insight into how annotations can be used by researchers to adjust intnetion estimation.

6 Responsible Research

This section will detail some ethical aspects of the research, including reproducibility, and potential moral and privacy concerns that may exist.

6.1 Reproducibility

Since this paper aims to assist in helping machine learning and AI researchers with scenario creation of multiple narratives for intelligent systems, it is very important for it to be reproducible. This would allow others to truly use the research in the most effective way as they are able to pull from it and make it their own, applying it to their required studies. Steps that have been taken in this research have been detailed. The setup of the literature survey, including the survey type, the query setup, and the dimensions used to process the scenarios have been documents, which should allow for adequate reproducibility. The detailed use of established frameworks such as Script Theory and the 3Cs should further ensure that it is possible to reproduce the steps taken to analyse the dimensions of a situation. By demonstrating how the presented knowledge can be used for creating case studies that can be researched, machine learning and artificial intelligence researchers can produce similar case studies with similar results. This contributes directly to the reproducible development of intelligent systems for social intention estimation.

6.2 Moral and privacy concerns

Ethical concerns behind such a project can be twofold. Firstly, it is possible for an individual's intent to be considered a private matter, and any attempts to study it in certain situations can be concerning and intrusive for said individuals. In order to prevent this risk, scenarios analysed and dealt with in this paper have been obtained from other research papers where either said scenarios have been given permission by individuals to be shared, or they have been fabricated based on the authors' accumulated knowledge. Simultaneously, the scenarios that have been introduced and discussed in this paper are purely imaginary based on the performed research, so they too do not raise such concerns.

The second similar responsibility stems from the nature of the domain of the study. Hospitals are, by nature, environments with vulnerable individuals who may either not want to disclose any details regarding their situation or not be in the right physical or mental state to do so. Furthermore, a power dynamic between the doctors, the medical staff, the patients, and the family members can influence the way that intentions are perceived and reacted to. This could have multiple ramifications, such as more vulnerable stakeholders like patients and family members having their intentions misinterpreted or overly simplified. By studying in this paper how the roles of actors within a situation can affect intention estimation, an attempt is made to highlight the responsibility of researchers while creating scenarios rather than taking the importance of these roles for granted.

7 Discussion and Future Work

7.1 Discussion

The literature survey and consequent case study development illustrate how frameworks can be used to model and analyse social scenarios involving intelligent systems in hospital. By systematically altering annotator groups and dimensions such as cues and scripts, it is possible to observe how changes can affect the motivations, intentions, and actions of different roles in a scenario, including clinicians, patients, and family members. The literature survey helped understand the factors that influence the intentions of the three identified roles in a hospital, as well as determine the current and future use case for intelligent systems within the field. Overall, this paper should provide sufficient background knowledge for machine learning and artificial intelligence researchers to model their own social situations in order to determine how variations in intent can affect intelligent systems being developed.

7.2 Future work and improvements

The research carried out does have important limitations that affect the findings of the literature survey and the creation of the case studies. Firstly, the literature survey itself can be improved upon. While a pragmatic literature survey may have been suited for the time available for research, it does mean that there can exist certain biases within the results of the survey. For example, the literature studied was missing non English sources, which can introduce a cultural bias towards English speaking countries. Such a survey could have also missed recent developments and emergences in medical technologies or intention modelling frameworks that were not yet well represented in the selected literature. Therefore, the presented results should give an indication for general patterns and trends, but does not cover everything that can exists in the domain.

Furthermore, limitations and open challenges exist when attempting to model social intentions in narratives. As demonstrated, social intentions are context dependent, subjective, and can often be unrealised. The dimensions of variation used to obtain the individual components of the scenarios are an attempt to simplify complex processes, both mental and social. While the use of existing frameworks like Script Theory and the 3Cs are an attempt to use studied methods to reduce this problem, abstractions cannot fully capture ever changing dynamics within a situation. Therefore, the case study developed to explore intentions should be viewed as faithful mediums to explore and further research intention variation, rather than an absolute representation of real world behaviour.

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A Literature survey query

The following search query was used to perform the literature survey:

(TITLE-ABS-KEY("social intention*") OR
TITLE-ABS-KEY("intent* recognition") OR
TITLE-ABS-KEY("intent* estimat*") OR
TITLE-ABS-KEY("intent detection") OR
TITLE-ABS-KEY("intent* predict*") OR
TITLE-ABS-KEY("behavio*r interpret*") OR
TITLE-ABS-KEY("action understanding") OR
TITLE-ABS-KEY("social percept*") OR
TITLE-ABS-KEY("action prediction") OR
TITLE-ABS-KEY("goal inference") OR

TITLE-ABS-KEY(”narrative expl*”) OR
TITLE-ABS-KEY(”plausible narrative*”) OR
TITLE-ABS-KEY(“intent* inferenc*”) OR
TITLE-ABS-KEY(“goal recogn*”) OR
TITLE-ABS-KEY(“goal estimat*”) OR
TITLE-ABS-KEY(“goal inferenc*”) OR
TITLE-ABS-KEY(“behavio*r recogn*”) OR
TITLE-ABS-KEY(“behavio*r estimat*”) OR
TITLE-ABS-KEY(“behavio*r inferenc*”) OR
TITLE-ABS-KEY(“behavio*r understand*”))

AND

(TITLE-ABS-KEY(”subjective annotation”) OR
TITLE-ABS-KEY(”plausible narrative*”) OR
TITLE-ABS-KEY(”alternative narrative*”) OR
TITLE-ABS-KEY(”script theory”) OR
TITLE-ABS-KEY(”social norm*”) OR
TITLE-ABS-KEY(”contextual variation”) OR
TITLE-ABS-KEY(”human factors”) OR
TITLE-ABS-KEY(”subjectivity”) OR
TITLE-ABS-KEY(”perspectiv*”) OR
TITLE-ABS-KEY(”multi-perspective”) OR
TITLE-ABS-KEY(”ambigu*”) OR
TITLE-ABS-KEY(”uncertainty”) OR
TITLE-ABS-KEY(”context model*”) OR
TITLE-ABS-KEY(”situation awareness”) OR
TITLE-ABS-KEY(”script theory”) OR
TITLE-ABS-KEY(”external script*”) OR
TITLE-ABS-KEY(”internal script*”) OR
TITLE-ABS-KEY(”multiple annotator perspective*”) OR
TITLE-ABS-KEY(”multi-perspective”) OR
TITLE-ABS-KEY(”situational script*”) OR
TITLE-ABS-KEY(”commonsense script*”) OR
TITLE-ABS-KEY(”situation*”) OR
TITLE-ABS-KEY(”scenario*”) OR
TITLE-ABS-KEY(”case?stud*”))

AND

(TITLE-ABS-KEY(”hospital”) OR
TITLE-ABS-KEY(”patient*”) OR
TITLE-ABS-KEY(”doctor*”) OR
TITLE-ABS-KEY(”surgeon*”) OR
TITLE-ABS-KEY(”surger*”))

AND

(TITLE-ABS-KEY(”tech*”) OR
TITLE-ABS-KEY(”appl*”) OR
TITLE-ABS-KEY(”innovat*”) OR
TITLE-ABS-KEY(”integrat*”) OR
TITLE-ABS-KEY(”modern*”) OR
TITLE-ABS-KEY(”commentary”) OR
TITLE-ABS-KEY(”explor*”))

AND NOT

(TITLE-ABS-KEY(”social media”) OR
TITLE-ABS-KEY(”twitter”) OR
TITLE-ABS-KEY(”facebook”) OR
TITLE-ABS-KEY(”animal*”) OR
TITLE-ABS-KEY(”husbandry”))

AND NOT

(TITLE-ABS-KEY(”social network”) OR
TITLE-ABS-KEY (networking) OR
TITLE-ABS-KEY (”networking strategies”) OR
TITLE-ABS-KEY (”networking events”) OR
TITLE-ABS-KEY (mingling) OR
TITLE-ABS-KEY (talking) OR
TITLE-ABS-KEY (”hang* out”) OR
TITLE-ABS-KEY (meetup*) OR
TITLE-ABS-KEY(”face-to-face”) OR
TITLE-ABS-KEY(driving) OR
TITLE-ABS-KEY(driver) OR
TITLE-ABS-KEY(vehicle*) OR
TITLE-ABS-KEY(automotive) OR
TITLE-ABS-KEY(”autonomous car”) OR
TITLE-ABS-KEY(traffic) OR
TITLE-ABS-KEY(road) OR
TITLE-ABS-KEY(pedestrian) OR
TITLE-ABS-KEY(ADAS) OR
TITLE-ABS-KEY(”intelligent transport*”) OR
TITLE-ABS-KEY(aviation) OR
TITLE-ABS-KEY(aircraft) OR
TITLE-ABS-KEY(”flight deck”) OR
TITLE-ABS-KEY(”cockpit”) OR
TITLE-ABS-KEY(”pilot*”) OR
TITLE-ABS-KEY(”flight simulation”) OR
TITLE-ABS-KEY(”aviation simulation”) OR
TITLE-ABS-KEY(”flight scenario*”) OR
TITLE-ABS-KEY(”restaurant*”) OR
TITLE-ABS-KEY(”diner*”) OR
TITLE-ABS-KEY(”dining”) OR
TITLE-ABS-KEY(”eatery”) OR
TITLE-ABS-KEY(”tavern*”) OR
TITLE-ABS-KEY(”cafe*”) OR
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TITLE-ABS-KEY(”pizzeria*”) OR
TITLE-ABS-KEY(”canteen*”) OR
TITLE-ABS-KEY(”drive-in*”) OR
TITLE-ABS-KEY(”doughtnut shop*”) OR
TITLE-ABS-KEY(”hamburger stand*”) OR
TITLE-ABS-KEY(”hotdog stand*”) OR
TITLE-ABS-KEY(”waiter*”) OR
TITLE-ABS-KEY(”waitstaff*”))