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Querying Social Practices in Hospital Context

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Abstract: Understanding the social contexts in which actions and interactions take place is of utmost importance for planning one's goals and activities. People use social practices as means to make sense of their environment, assessing how that context relates to past, common experiences, culture and capabilities. Social practices can therefore simplify deliberation and planning in complex contexts. In the context of patient-centered planning, hospitals seek means to ensure that patients and their families are at the center of decisions and planning of the healthcare processes. This requires on one hand that patients are aware of the practices being in place at the hospital and on the other hand that hospitals have the means to evaluate and adapt current practices to the needs of the patients. In this paper we apply a framework for formalizing social practices of an organization to an emergency department that carries out patient-centered planning. We indicate how such a formalization can be used to answer operational queries about the expected outcome of operational actions.

1 INTRODUCTION

The importance of developing shared meaning and understandings is one of the main aspects of maintaining an organization. Hospital organizations are no different and tend to develop their own ways of doing things which need to be shared with novices. Moreover, as vision and strategy change, new practices need to be implemented to ensure that medical staff and users are able to function properly in the new model of operation.

In recent years, ensuring patient satisfaction in hospitals is becoming increasingly important, requiring hospitals to develop means to continuously assess and adapt their processes and practices. Patient-centered planning is a way of thinking and doing things that sees the patients in health and social services as equal partners in planning, developing and monitoring care to make sure the treatment meets their needs. The patients and their families are put at the center of decisions and seen as experts in their own condition, working alongside professionals to get the best outcome. Traditional planning technologies are typically designed to produce complete plans that handle all situations given a well defined set of goals. This approach is not suitable for patient-centered planning, which involve human agents, as it leads to a combinatorial explosion if the actions of the human agents are not predictable or limited. Social practices provide a mean to deal with the complexity by considering the social and physical constructs that shape and constrain the interaction.

A hospital can be seen as the embodiment of ongoing social practices of many different forms (including, for example, nursing, diagnosing, operating, office working, drug dispensing). It is also materially bound up in those practices (and their successful performance), and in how these are changing over time. For example, as patient-centered planning (including how it is organized, managed and monitored) becomes the practice in hospital management, existing processes and roles may become less functional and need to adapt in order to stay fit for that purpose [Walker et al., 2014].

This work contributes with frameworks to help with understanding of how patient-centered planning relates to the changing practices of hospital work and understandings of what constitutes a well-working hospital. In particular we consider the emergency department and how the social practices that govern it have consequences across the hospital. In the present paper we propose our approach for applying a frame-

work for formalizing social practices of the emergency department and how such a formalization can be used for answering operational queries about the expected outcome of operational actions. The emergency department is also the focus of [Larsen and Villadsen, 2017] which proposes an approach for modeling it as a multi-agent organization.

2 SOCIAL PRACTICES

Social interactions are the focus of Social Sciences and have also long been discussed in Multi-Agent Systems (MAS) where there are many formalizations and theories that describe specific aspects of interactions [Van Den Broek et al., 2005, Dignum and Dignum, 2011, Köhler, 2007].

Social practices are accepted ways of doing things, contextual and materially mediated, that are shared between actors and routinized over time [Reckwitz, 2002]. They can be seen as patterns that are filled in by a multitude of single and often unique actions. Through (joint) performance, the patterns provided by the practice are filled out and reproduced. Each time a social practice is used, elements of the practice, including know-how, meanings and purposes, are reconfigured and adapted [Shove et al., 2012]. Actors learn from the use of social practices, and the more one uses a social practice with satisfactory results, the more that actor will tend to use that practice. Social practices are shared which means that individuals playing a role in a social practice will know what to do and will expect certain behavior and reactions of the other participants. Success enforces the social practice.

Related research on work practices and cognitive architectures are the closest to our proposal. Work practice research recognizes the inherent difference between the work flows as described and prescribed by the organization and employee behavior. The work practice model Brahms enables to define the behavior of entities by means of activities and workframes, amongst others [Sierhuis et al., 2009] but lacks learning capabilities to adjust priorities, and means to distinguish between context and action preconditions. Cognitive architectures [Sun, 2009] use drives as basis to dynamically derive goals during agent interactions. As such, it can capture the motivational complexity of the human mind [Newell, 1994], but it takes an agent perspective rather than a societal one, such as the one we propose. Our approach with social practices also shows some resemblance to agent organizations (see e.g. [Dignum, 2004]) as they both provide structure to the interactions between the agents. However, the structure provided by social practices arises from the bottom up from components that define expected behavior in a given context rather than being an imposed (top-down) organizational structure.

In [Dignum and Dignum, 2015] an initial formal representation of social practices is presented that allows for its incorporation in agent deliberation architectures. It is based on modal logic and extends work on agent organizations and landmarks. In particular, it extends work on the Logic for Agent Organizations (LAO) [Dignum and Dignum, 2011] which formalizes notions of capability, stit [Pörn, 1974], attempt and responsibility. For the purpose of this paper, we suffice with the informal definitions of the symbols in table 1 and the components of a social practice as follows:

- ***Context***
  - *Roles* describe the competencies and expectations about a certain type of actors [Sunstein, 1996]. Thus a lecturer is expected to deliver the presentation.
  - *Actors* are all people and autonomous systems involved, that have capability to reason and (inter)act. This indicates the other agents that are expected to fulfill a part in the practice.
  - *Resources* are objects that are used by the actions in the practice such as — in case of a lecture — seats, projector, screen, etc. So, they are assumed to be available both for standard actions and for the planning within the practice.
  - *Affordances* are the properties of a resource, a place or a context that indicate the action possibilities that are readily perceivable by an actor. E.g. any flat surface at approximately knee-length can afford the action *'sit'*. Affordances permit social actions and depend on the match between context conditions and actor characteristics [Gaver, 1996].
  - *Places* indicate where all objects and actors are usually located relatively to each other, in space or time.
- ***Meaning***
  - *Purpose* determines the social interpretation of actions and of certain physical situations.
  - *Promotes* indicate the values that are promoted (or demoted, by promoting the opposite) by the social practice.
  - *Counts-as* are rules of the type "X counts as Y in C" linking brute facts (X) and institutional facts (Y) in the context (C) [Searle, 1995]. E.g., in a voting place, filling out a ballot counts as a vote.

- ***Expectations***
  - *Plan patterns* describe usual patterns of actions [Bresciani et al., 2004] defined by the landmarks that are expected to occur.
  - *Norms* describe the rules of (expected) behavior within the practice, using the ADICO grammar proposed by Ostrom [Crawford and Ostrom, 1995]. ADICO statements are formed using five components: ***A****ttribute* (or Acting entity), ***D****eontic*, *a**I**m* (or Intention), ***C****ondition*, and ***O****r else* (or sanction). *Norms* are statements that include the acting entity, deontic, intention, and condition (ADIC) and possibly also a sanction (ADICO).
  - *Strategies* indicate the possible activities that are expected within the practice. Not all activities need to be performed! They are meant as potential courses of action. Strategies are specified as AIC statements in ADICO.
  - *Start condition*, or trigger, indicating how the social practice starts.
  - *Duration*, or End condition, indicating how the social practice ends.
- ***Activities***
  - *Possible actions* describe the expected actions by actors in the social practice.
  - *Requirements* indicate the type of capabilities or competences that actors are expected to have in order to enact roles and perform activities within the social practice.

It is also important to note that social practices can be described at different levels of abstraction. Abstract practices are generic and do not give much details on the specifics of a context. Concrete social practices apply to more specific domains, roles or actors and typically provide more details about the possible plans. E.g. an abstract social practice *'greeting'* just indicates when a greeting gesture is expected, but given a more specific context or actors it also describes how it should be performed; for example, by *'bowing'* if context is Japan, or *'hugging'* if actors are good friends.

Finally, social practices relate to each other and to the current situation. Depending on the features of a situation individuals will choose (a set of) social practices to explore. Moreover, social practices can be composed or contain other social practices. E.g. a handshake can be the start of a meeting. So it forms part of the meeting social practice. On the other hand the handshake is one type of greeting. So, handshake is a specialization of greeting and a part of a meeting. In fact, most classification relations that apply to processes (specialization, part-of, is-a, ...) can also be applied to social practices.

3 PATIENT-CENTERED PLANNING

Advance care planning is a process "whereby a patient, in consultation with health care providers, family members and important others, makes decisions about his or her future health care, should he or she become incapable of participating in medical treatment decisions" [Singer et al., 1996]. The process of advance care planning informs and empowers patients to have a say about their current and future treatment.

Patient-centered planning is a process in which the hospital plans are made with needs of the patient in center. A social practice approach to modeling patient-centered planning can accommodate societal requirements of patient-centered planning, including:

- respecting patients values and putting patients at the center of planning.
- taking into account patients preferences and expressed needs.
- coordinating and integrating care planning.
- working together to ensure good communication, information and education.

Social practices have both a social and a functional purpose, which determines how they are used by the different actors. To regard patient care as a social practice puts an appropriate emphasis on the reasons why people take part in it and how they choose to interpret the various expectations. Young doctors value the hospital regulations and formal workflows because they assume it serves efficiency and patient care. Experienced doctors care for patients but often less for formalisms. Phoning a specialist directly is seen by senior doctors as a good social practice, because they know that the reaction of the specialist is direct and will result in a quick treatment of the patient. Delays caused for other patients are not considered, because the overall hospital perspective is less important for experienced doctors. Identifying and understanding these differences in perceiving hospital policy is important for hospital managers and can be used to redefine processes and policies. In this project, we will develop simulation models that enable hospital managers to analyze the consequences of different social practices from the perspective of patients and medical staff.

In the remainder of this section, we first introduce a simple scenario and then illustrate the use of so-

Table 1: Symbols of the social practice formal representation where O(γ) and F(γ) have standard dynamic deontic logic semantics.

	Symbol	Meaning
Activities		
Basic actions	$\{\alpha_1, ..., \alpha_n\}$	A finite number n of basic actions in the social practice. Entails notion of a complex action γ.
Actors	$\{a_1, ..., a_m\}$	A finite number m of actors in the social practice.
Context	$\{c_1, ..., c_n\}$	A finite number n of special context constants. A subset of these are social practice identifiers SP.
Capabilities	$Capability(a)$	A function that returns the set of actions that actor a is capable of performing.
	$Cap(a, \alpha)$	True iff actor a is capable of performing action a i.e. $Cap(a, \alpha) \equiv \alpha \in Capability(a)$.
	$DO(a, \alpha)$	Actor a performs action α next. Additionally assumes that $DO(a, \alpha) \rightarrow Cap(a, \alpha)$
Beliefs and Assumptions		
	$purpose(a, \alpha, c) = \phi \equiv CB_{A_c}(Salient(a, \alpha, c) \wedge DO(a, \alpha) \rightarrow Goal(a, \phi) \wedge B_a([\alpha(a)]\phi)$	It is common belief among the agents in context c that if actor a performs action α in context c then ϕ is a goal of a and a believes it can achieve it by performing α.
Meanings		
	$play(a, r)$	Indicates that actor a enacts role r.
	$promote(sp, \alpha(a), v)$	Indicates that in the social practice sp, the action $\alpha(a)$ performed by actor a promote value v. For a more formal characterization of the promotes relation see [Weide, 2011].
Expectations		
	$O(r, \phi, \gamma)$	$O(r, \phi, \gamma) \equiv \forall a : play(a, r) \wedge B_a(\phi) \rightarrow O(\gamma(a))$.
	$F(r, \phi, \gamma)$	$O(r, \phi, \gamma) \equiv \forall a : play(a, r) \wedge B_a(\phi) \rightarrow F(\gamma(a))$.
	$strategy(\phi, DO(B, \gamma), sp)$	Indicates that if all actors (involved in the social practice sp) believe that B believes the condition ϕ then they all believe that all actors in B will perform their part of γ next.

cial practices modeling to represent the situation described in the scenario.

3.1 Scenario: Specialist Consults

In this paper, we consider the case of scheduling specialist consults for emergency ward patients. These patients arrive at the hospital unscheduled and the attending doctor may decide that a specialist opinion is needed. However, these specialists follow a regular consult plan and emergency patients will need to be placed in between the regular patients. Several strategies can be used for this, depending on the severity of the case, the knowledge the emergency doctor has about hospital procedures and informal strategies or workarounds, and the overall culture of the hospital location.

In particular, we will consider the following scenario: A man arrives at the emergency ward with very bad headache. The patient is not critically ill but the doctor fears that his condition can deteriorate and needs a second opinion from a specialist. Depending on the seniority and expertise of the attending doctor, two different plans will be followed:

- A junior doctor, not aware of the hospital's informal processes and networks, will file a request for a specialist consult through the formal channels and wait for the specialist to make the time to attend to this patient.
- A senior doctor, knowing how things work, will directly call a specialist who will directly attend to this request, delaying her consult with a scheduled regular patient.

These two different practices lead to different results. In the first case, the acute patient will need to wait, which depending on his condition may have serious health consequences. On the latter case, the scheduled patients will need to wait longer than their appointed times, leading to irritation and possibly

complaints to the hospital administration.

As both of the situations above illustrate, the decisions that the emergency ward doctors make depend a lot on their experience with "how things work" in the hospital. The junior doctor looks for an available specialist whereas the experienced doctor finds a specialist who is scheduled for a checkup that they agree can wait. The experienced doctor can do this as they know that there is usually a specialist who has an appointment with a patient who is otherwise doing fine. The experienced doctor is aware of how the patient depends on the specialist; the junior doctor is not. There is no clear cut "best" outcome as there are both satisfied and dissatisfied patients in both cases but it is clear that the interaction between the acute doctors and the specialists influence the outcomes.

Overseeing the entire operation, the hospital management people are tasked with ensuring that there is a balance between taking care of the scheduled patients and the acute patients. They are capable of executing *operational actions* that have either an immediate effect during operation or long term actions with effects in future operations.

Depending on the local culture and social expectations, delays to regular consults may require the hospital to reschedule all patients to another day or offer some kind of compensation, rather than expect those regular patients to wait patiently to their consult. Depending on the frequency and number of emergency ward patients, long term adaptation of existing protocols may be required which demands well informed management, as discussed in the next section.

3.2 Scenario as Social Practice

As described in Section 2, social practices can be described at several levels of abstraction, resulting in a graph structure that represents differentiation in terms of context specialization, inclusion and salience. In the case of the Specialist Consults scenario, practices vary for senior and junior doctors and also for the societal expectations on how to deal with delays. Figure 1 gives an overview of these relations between social practices.

We provide a basic formal representation of the scenario as an abstract social practice as follows.

- ***Context***
  - *Roles* are identified from the actors that are mentioned in the scenario: the junior doctor, the senior doctor, the regular patient, and the acute patient. We consider each actor as a role. We also consider both the acute patient and the regular patient as a patient role:

    $$jd, sd, d, rp, ap, p : ap, rp \in p \wedge jd, sd \in d$$

  - *Actors* are defined by the *play*-predicate. We use it to state that four people have the roles above:

    $$play(j, jd), play(s, sd), play(r, rp), play(a, ap)$$

  - *Resources* include the room in which the doctor diagnoses the patient, the scheduling system, and other objects that we leave vague on purpose for this abstract social practice:

    $$o_1, ..., o_m$$

  - *Places* are the three main areas of the scenario: the hospital as a whole, an MRI room (where the specialists carry out their diagnosis), and the emergency ward:

    hospital, MRI-room, ER

- ***Meaning***
  - *Purpose* is defined by *purpose*-predicate. We use it to state that the purpose of the *consult* action for acute patient a is to get a diagnosis, and for a junior doctor j is to learn and gain experience:

    $$purpose(a, consult, sp) = diagnosis(a)$$
    $$purpose(j, consult, sp) = learn(j)$$

  - *Promoted Values* are defined by the *promote*-predicate. We use it to state that for the junior doctor, tending patients *promotes* learning. We also state that for the patient, getting a treatment *promotes* awareness about their condition and staying long in the ER *demotes* timeliness:

    $$promote(sp, tendPatient(j), Learning)$$
    $$\forall p : promote(sp, diagnosis(p), Awareness)$$
    $$\forall p : promote(sp, longStay(p), \neg Timeliness)$$

- ***Expectations***
  - *Plan Patterns* are the sequences of abstract actions that models the general procedure as described in the scenario. We use α_i for the abstract actions in the sequences. The sequence models the two different approaches for the abstract social practice to take place depending on which of the two doctors take care of the acute patient, as described in the scenario:

    $$\alpha_1(arrive); \alpha_2(checkup); (\alpha_5(get2Op) +$$
    $$(\alpha_3(plan2op); \alpha_4(wait); \alpha_5(get2Op)))$$

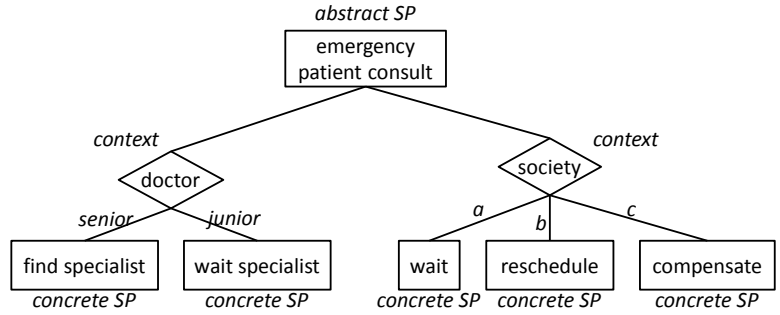

Figure 1: Contextual variations on social practices.

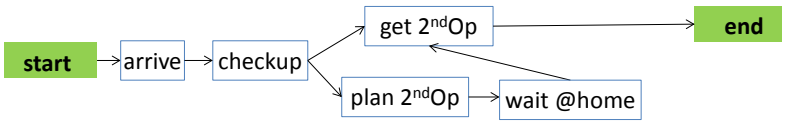

Figure 2: Plan pattern.

– *Norms* are stated as deontic logic predicates. We state that junior doctors are *obliged* to treat acute patients first, and that junior doctors are *forbidden* from giving a diagnosis:

$$O(jd, plays(a, ap), prioritize(jd, a))$$
$$F(jd, plays(a, ap), diagnose(jd, a))$$

– *Strategies* are defined by the *strategy*-predicate. We use strategies to state that the patient waits, that a senior doctor calls for help from a specialist by phone, and that a junior doctor waits for help from a specialist:

$$strategy(\top, DO(p, wait), sp)$$
$$strategy(diagnose(d, p), DO(senior(d), phone), sp)$$
$$strategy(diagnose(d, p), DO(junior(d), wait), sp)$$

– *Start Condition & Duration/End* are respectively that the acute patient arrives and that the acute patient has a treatment plan. As we only consider this particular abstract social practice we do not state them explicitly.

- ***Activities***
  – *Possible Actions* includes waiting, calling on phone, and stating a diagnosis, among others:

$$wait(), phone(), diagnose(X, p), \ldots$$

  – *Requirements* are stated with formulas using the *cap*-predicate. We use it to state that the doctors have medical expertise, and that patients wait:

$$\forall a_i, play(a_i, d) : cap(a_i, medicalexpertise)$$
$$\forall a_i, play(a_i, p) : cap(a_i, wait)$$

In Table 2 we provide a summary of the above. We provide a more detailed description of the *play*-, *purpose*-, *promote*-, *strategy*-, and *cap*-predicates. We are working on the full specification of the patient-centered scenario as a validation of this formal representation language.

4 OPERATIONAL QUERIES

Operational actions are generally considered risky in the sense that they can have far reaching effects and that it can be difficult to estimate the consequences. Immediate actions compromise the schedule greatly and can turn up much more expensive than first thought. Long term actions that change the protocols may lead to immediate dissatisfaction among staff but can be beneficial in the long run. As an example in the Specialist Consults scenario, the management may choose to have the specialists prioritize acute patients over regular patients so that the junior doctors will have an easier time finding an available specialist. Such a change can cause dissatisfaction in the specialized wards and it is unclear if it would actually be beneficial in the long run. For that reason they need insight into the expected outcome of the current situation, and insight into how an operational action can change the expected outcome. We consider an approach for giving such insight by the way of operational queries that can answer questions such as:

- How many acute patients do we expect in the near future?
- How long will the average waiting time be for acute patients?

Table 2: A social practice application.

Social Practice	A: Hospital SP (informal)	B: Hospital SP (formal)
Context		
Roles	junior doc, senior doc, regular patient, acute patient, patient	$jd, sd, d, rp, ap, p : ap, rp \in p \wedge jd, sd \in d$
Actors	j, s, r, a	$play(j, jd)$,$play(s, sd)$, $play(r, rp)$,$play(a, ap)$
Resources	rooms, scheduling system...	$o_1, ..., o_m$
Places	hospital, MRI-room, ER...	*hospital, MRI-room, ER*
Meaning		
Purpose	diagnosis of patient	$purpose(a, consult, sp) = diagnosis(a)$
	teach junior doctor	$purpose(j, consult, sp) = learn(j)$
Promoted Values	tending patients *promotes* learning	$promote(sp, tendPatient(j), Learning)$
	getting a diagnosis promotes awareness	$\forall p : promote(sp, diagnosis(p), Awareness)$
	a long stay demotes timeliness	$\forall p : promote(sp, longStay(p), \neg Timeliness)$
Expectations		
Plan Patterns	the plan pattern graph in figure 2.	$\alpha_1(arrive); \alpha_2(checkup); (\alpha_5(get2Op) + (\alpha_3(plan2op); \alpha_4(wait); \alpha_5(get2Op)))$
Norms	acute patients must be prioritized	$O(jd, plays(a, ap), prioritize(jd, a))$
	junior doctors cannot give diagnosis	$F(jd, plays(a, ap), diagnose(jd, a))$
Strategies	patients wait	$strategy(\top, DO(p, wait), sp)$
	senior doctors find available specialist	$strategy(diagnose(d, p), DO(senior(d), phone), sp)$
	junior doctors wait for available specialist	$strategy(diagnose(d, p), DO(junior(d), wait), sp)$
Start Condition	acute patient arrives	
Duration/End	patient has plan	
Activities		
Possible Actions	wait, phone, diagnosis, ...	$wait(), phone(), diagnose(X, p), ...$
Requirements	doctor: medical expertise	$\forall a_i, play(a_i, d) : cap(a_i, medicalexpertise)$
	patient: wait	$\forall a_i, play(a_i, p)$: $cap(a_i, wait)$

- What are the expected behavior of the senior doctors?
- What are the expected behavior of the junior doctors?

These queries are hard to answer analytically, but by simulating the situation with artificial agents that act according to our formalization of the social practices, we can provide sufficiently accurate answers about the expected outcome. For the simulation we consider having the agents include their knowledge about social practices when they decide on an action. The operational query is then answered by simulating the actions of the agents within the immediate future, returning a list of pairs of outcomes together with their expectancy. In this way, operational queries and simulation can provide insight into how decisions and changes to hospital work practices influence expected developments and potential bottlenecks.

5 CONCLUSION AND FUTURE WORK

The social practice approach shows promise as a way to augment agents with social reasoning. The hospital context provides a good scenario for validating this approach. The social practice approach supports decision making. In the scenario we considered, the operational queries can trigger long term operational actions that change the protocols. If social context is known then protocols can be designed to be in line with social expectations.

In the future we would like to investigate to which extent operational queries can trigger short term operational actions with an immediate effect. Our next step towards an evaluation is to implement the formal representation in an agent simulation framework that shows how changes to the social practice model

influence agent decisions. Furthermore, we intend to investigate the work in the recent PhD thesis by Christian Michel Sørup on a generic performance measurement model for an emergency department [Sørup, 2015]. We consider that work highly relevant as it investigates performance measurement and decision support in the emergency department scenario and was done in close collaboration with the emergency department at one of the hospitals in the Danish capital region. We hope that our approach using social practices can add to that work.

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