Modeling the Function of Narrative in Expertise

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Abstract

The use of narrative is ubiquitous in the development, exercise, and communication of expertise. Expertise and narrative, as complex cognitive capacities, have each been investigated quite deeply, but little attention has been paid to their interdependence. We offer here the position that treating these two domains together can fruitfully inform the modeling of expert cognition and behavior, and present the framework we have been using to develop this approach, the SGOMS macro-cognitive architecture. Finally, we briefly explore the role of narrative in an SGOMS model of cooperative video game playing.

1998 ACM Subject Classification H.1.0 Models and Principles: General, I.2.0 Artificial Intelligence: Cognitive simulation, I.2.8 Problem Solving, Control Methods, and Search: Plan execution, formation, and generation, I.2.11 Distributed artificial intelligence: Multiagent systems, I.6.5 Model Development: Modeling methodologies

Keywords and phrases expertise, narrative, cognitive modeling, distributed cognition, macro cognition, multiagent systems

Digital Object Identifier 10.4230/OASIcs.CMN.2014.116

1 Narratives and expertise

The creation and use of narratives is a crucial component of many forms of expertise, particularly those forms involving multiple actors or which are knowledge-based (e.g., science, medicine, or education). In this context, narratives highlight the most important elements of a situation and package them in a coherent way. This serves four principal functions. First, it allows an individual to form a coherent and tractable representation of a situation in order to act. The most common form of this is the creation of plans according to goals, capacities, and environmental elements. Second, narratives facilitate rapid and precise communication between experts through shared vocabularies (jargon), assumptions, and conceptual frameworks. These shared elements support the establishment of common ground between agents [1] which facilitates the integration of efforts. Third, it allows experts to communicate effectively with the public or non-experts (i.e., those lacking the particular expertise in question) by simplifying complex bodies of information. This communicative function also encompasses the use of narratives in teaching, or translating and transferring expertise. Fourth, narratives are used to position the expert in society and define the relationship between expert and public. Note that the first and second function are closely linked, as are the third and fourth.

To illustrate the first three functions, consider the activities of a medical doctor engaged in treating a patient. In the first stages, the doctor must gather information and integrate this into existing knowledge, develop a hypothesis about what is wrong, and from that

5th Workshop on Computational Models of Narrative (CMN'14).
Editors: Mark A. Finlayson, Jan Christoph Meister, and Emile G. Bruneau; pp. 116–120
OpenAccess Series in Informatics
OASICS Schloss Dagstuhl – Leibniz-Zentrum für Informatik, Dagstuhl Publishing, Germany

understanding create a treatment plan (function 1). Following this, the doctor may have to co-ordinate specialist physicians, nurses, pharmacists, and technologists, and this process will be greatly expedited by the group's shared knowledge and vocabulary (function 2). And finally, in order for the physician to communicate important aspects of the problem and proposed treatment to the patient, the doctor will (typically) need to simplify the narrative to make it comprehensible to the patient (function 3). Limitations of space prevent examination of function 4, but see [2] for an excellent treatment of the changing function of the expert narrative within the mental health professions in the 20th century.

In order to understand how expertise is exercised by individuals and coordinated within groups, we must develop a deeper understanding of the intersection of expert knowledge and narratives. To this end, we are working to test two related hypotheses. First, that expertise is structured in consistent ways across both individuals and domains, and second, that these consistencies are reflected in regular patterns of narrative creation and deployment when experts work together. In other words, narratives support a set of functions common to different forms of expertise. This approach is predicated on the idea that the diversity of forms of expertise is largely a function of the different and complex environments in which expertise manifests, while the underlying structure of the expertise is often quite consistent. This is an adaptation of Herbert Simon's "ant on the beach" metaphor [3], in which he argues that the apparent complexity of an ant's behavior as it moves in a convoluted path across a beach is largely attributable to the complexity of the environment, and not to any sophisticated scheming or strategizing by the ant.

2 Integrated cognitive modeling frameworks

In Newell's landmark paper You can't play 20 questions with nature and win [4], he argued for efforts toward theoretical unification. Without these efforts, he claimed, the fields of psychology and cognitive modeling would continue to accumulate experimental data, which could be used to inform theorizing about isolated phenomena and cognitive capacities, but little (if any) progress would be made toward understanding cognitive systems as integrated wholes. Part of the solution Newell proposed was to create cognitive architectures that could be used to model tasks across a variety of domains. An architecture could then be iteratively tested and refined through experimentation in different areas, so that over time it becomes capable of accounting for an ever-broader range of abilities and phenomena.

The framework we have been using is called socio-technical GOMS (SGOMS; [5, 6]), an extension of the GOMS modeling framework [7]. This is an attempt to implement the approach championed by Newell, with a focus on modeling cognition and behavior in complex, multi-agent scenarios. The principal extension is the incorporation of the macro-architecture hypothesis [8], which claims, inter-alia, that there are consistencies in the ways that experts decompose different types of tasks, and that we should use these consistencies in developing systematic methods for the creation of cognitive models. It is a methodological approach aimed at limiting the proliferation of unrelated models and theories. Here, we are primarily concerned with two things: first, how the abilities and limitations of a cognitive system lead to consistencies in the way that tasks are decomposed, both across individuals and across domains, and second, the importance of narrative structures in complex and/or multi-agent task performance.

2.1 Task decomposition: unit tasks and planning units

It is common practice in cognitive modeling to first construct a unit-task model of a task, which is a high-level conceptual model of how an agent divides a task into parts. A single unit-task is a set of operations or actions that can be executed as a unit to achieve some goal. In the GOMS modeling framework, the task is partitioned into unit-tasks such that they help the agent to avoid downtime and overload [8]. With SGOMS, we have added the constraint that unit-tasks should be unlikely to be interrupted, and added an additional, higher-level control structure called planning units, which is typically a set of unit tasks, the sequential execution of which is intended to achieve some higher-level objective. The motivation for these additions is that we wish to model experts in chaotic, multi-agent, real-world scenarios in which interruptions may be frequent and costly, and GOMS models often have difficulty with such scenarios [9]. We believe that experts develop strategies to minimize the impacts of interruptions and to adapt to unexpected events, particularly in situations involving multiple agents and chaotic environments. In such environments, one of the principle functions of a planning unit co-ordination, allowing each individual to react locally without the need to re-convene and create a new global plan. Another function is to allow individuals to efficiently pass information back and forth. And finally, planning units allow for interruption and resumption.

2.2 Cooperative experts and narratives

In recent work [10], we have found that, through cooperative activity, experts quickly develop shared planning units and create names for them. These then become the principal unit of communication by which the experts coordinate their efforts. We consider individual planning units to be "micro-narratives," while the chaining together of multiple planning units forms the overall "expert narrative" that guides each expert's behavior and helps groups of experts to coordinate their efforts. Our conception of narratives owes much to Todorov's idea that narratives consist of passage from one equilibrium to another due to some disturbing force [14]. A planning unit comprises the initial environmental conditions under which its application is appropriate, a final desired state, and a sequence of actions by which the final state may be achieved. This structure fits naturally with production system modeling frameworks, such as the one we are using: Python ACT-R [8]. We turn now to the process of building these models.

2.3 Data collection and modeling procedure

Constructing SGOMS models involves three steps. First, experts in the domain of interest must be observed or recorded performing the activities of interest. By communicating with the expert during this process and taking notes about their behavior, we can sketch an outline of the elements of the task. Second, once this initial sketch has been made, we construct a paper-and-pen process model of the planning units and unit tasks that make up the task. We compare this early model against collected data of expert behavior, which is primarily in the form of video recordings and protocol analysis. We iteratively change and compare the model to incorporate all observed environmental conditions and agent actions. Once we have a model that is capable of accounting for all "reasonable next actions", i.e., experts do not deviate from the action options of the model, we implement the model in Python ACT-R. This third and final step is accomplished via a graphical modeling interface which we have developed. The interface allows a user to create a "virtual paper-and-pen" SGOMS model, while the back-end of the interface can compiles this model Python ACT-R code [10].

2.4 Example model: cooperative video game playing

We have developed a model of two people cooperatively playing a first-person shooter video game, Gears of War 3. This is a very fast, chaotic game, and was chosen because of the high frequency of interruptions and the cooperative mode of play. We do not present the details of the model here, but see [8, 10] for more. The model is presented here to illustrate the usefulness of narrative constructs in modeling expert cooperation.

Our data revealed players using two distinct forms of communication while playing the video game. We have called these “command” and “coordinate”. “Command” exchanges were one or two word utterances, such as “left side”, “he’s charging”, or “run”. This was predominant when there was a lot of action on the screen. In the second form, “coordinate”, the players exchanged longer utterances, such as “set up a cross fire at the opening”. These were strategic adjustments or negotiations, and occurred when there was a lull in the action.

These shifts in communication style were interesting for two reasons. First, the shift from one style to the other was quite marked, and mapped onto clear changes in the action of the game. Second, and more importantly, the utterances made when players were in the “command” style mapped directly onto unit tasks, whereas the utterances made in the “coordinate” style mapped directly onto planning units. Thus we interpreted the cycling between communication styles as players first creating shared planning units (which involved establishing a common narrative for where they were, where they wanted to go, and how to they planned to get there), and then continually updating each other about the current situation. Note that the difference in the function and form of these two communication styles maps quite nicely onto narrative functions one and two, above: “command” represents rapid communication, and ”coordinate” represents plan formation.

A final point of interest is that when we used an “expert-substitution” method, replacing one of the highly skilled players with a novice, we often observed the remaining expert instructing the novice using modified versions of the planning units just mentioned. This effectively “scaffolded” the abilities of the novice, improving the play of the novice quite rapidly. This reflects the third narrative function mentioned above, communication with non-experts.

3 Conclusion

The work presented here has, thus far, been largely exploratory. We have been investigating the intersections and interdependencies of narrative and expertise through cognitive modeling, and have had promising initial results. We have found that the functions of narrative in facilitating the use and transfer of expertise are captured quite nicely by the SGOMS macro-architecture, and are currently developing new models to examine how robust these findings are across domains. Future work will examine both lower-level instantiations of our models (in SGOMS:ACT-R, [10]) as well as higher-level investigations, in models of many-agent models of distributed cognition.

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