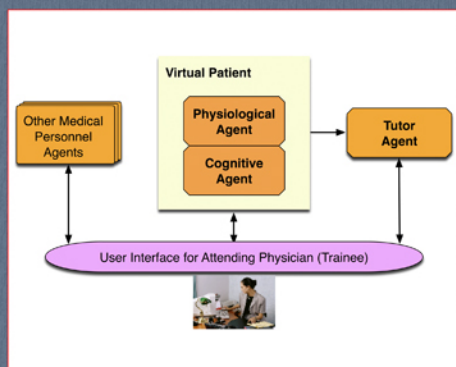


# The Cross-Cutting Semantics of Maryland Virtual Patient (MVP)

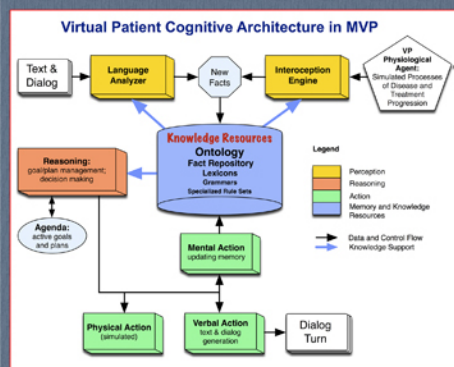
Sergei Nirenburg, Marjorie McShane, Stephen Beale (University of Maryland Baltimore County)

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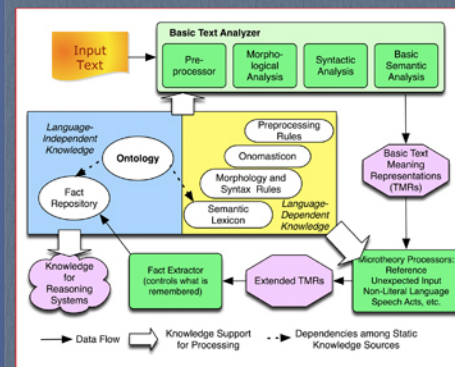


MVP is a simulation and tutoring environment developed to support training in clinical medicine.

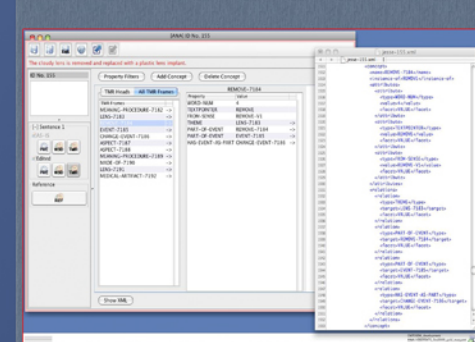
- It is implemented as a network of human and software agents.
- The human user plays the role attending physician who, with the optional support of a tutor, uses an open-ended natural language interaction to diagnose and treat virtual patients (VPs) over time.
- Each VP is a "double agent" composed of a realistically functioning, semantically simulated physiological agent and a semantics-based reasoning cognitive agent capable of communicating in natural language.



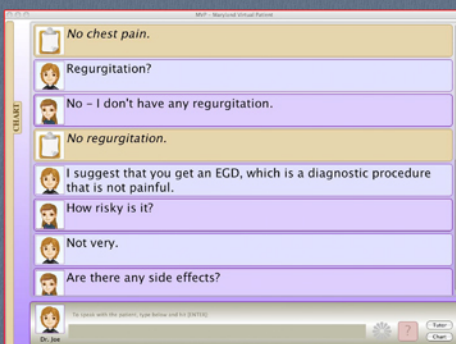
The cognitive side of the VP permits it to consciously experience and reason about its disease state, make decisions and learn about its lifestyle and medical treatments and discuss all of these in natural language with its attending physician.



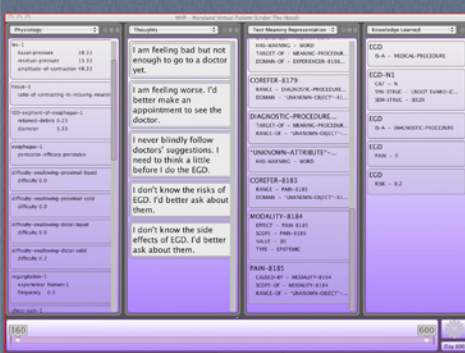
All intelligent functioning in MVP – physiological simulation, language understanding, decision-making, memory management, verbal actions and learning rests on a **uniform semantic substrate**; it relies on creation, modification and use of meaning representations formulated in the metalanguage of OntoSem ontology.



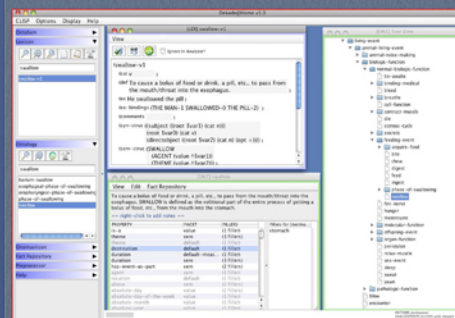
Here are excerpts of the text meaning representation (TMR) of the sentence *The cloudy lens is removed and replaced with a plastic lens implant*. To the left is a view of our custom presentation and editing interface and to the right is an excerpt of the same TMR in the XML format. The XML structure for this sentence is over 2000 lines long and reflects the results of all stages of text processing, from preprocessing to semantic analysis.



This is a view of the User-VP interaction screen.



A (selective) trace of system processing up to the point in the dialogue shown in picture 6 is shown here. The leftmost panel shows how physiological properties change during the simulation run. The second panel shows what thoughts of the VP as it is making decisions. The third panel shows text meaning representations created by the VP's language processor. And the rightmost panel shows lexical and ontological knowledge that is being learned by the patient during the interaction with the clinician.



Here are views of the verb swallow and the concept SWALLOW in the OntoSem lexicon and ontology.

- The ontology, which is language-independent and unambiguous, includes not only simple descriptions of types of objects, events and the properties that link them but also detailed scripts of complex events (e.g. disease progression), knowledge of best clinical practices, clinically relevant population-level medical knowledge, and so on.
- Each intelligent agent has its own version of the ontology, reflecting different inventories of world knowledge, opinions, etc.
- Connected to each agent's ontology are its own ontological semantic lexicon, which permits semantically-oriented language processing, and its own fact repository, or memory of object and event instances.
- Over the course of an MVP run, the VP learns new medical terminology (lexicon), facts about diseases, etc. (ontology), and facts about its own disease, its physician etc. (fact repository) and the tutor learns facts about the specific VP and the specific user/physician (fact repository).

The screenshot shows the patient creation interface. It includes a table for 'Physiological Properties' and a table for 'Symptoms'.

Physiological Properties	Start	W	M	T	F	S	Sa	W
Rate of reduction of the lower esophageal sphincter (LES)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rate of reduction of the upper esophageal sphincter (UES)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rate of reduction of the pyloric sphincter (PS)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rate of reduction of the ileocecal junction (ICJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rate of reduction of the sigmoid colon (SC)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rate of reduction of the rectum (R)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rate of reduction of the sigmoid colon (SC)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rate of reduction of the rectum (R)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rate of reduction of the sigmoid colon (SC)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rate of reduction of the rectum (R)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Symptoms	Start	W	M	T	F	S	Sa	W
Chest pain	0	0	0	0	0	0	0	0
Regurgitation	0	0	0	0	0	0	0	0
Difficulty swallowing	0	0	0	0	0	0	0	0
Difficulty swallowing (dry)	0	0	0	0	0	0	0	0
Difficulty swallowing (wet)	0	0	0	0	0	0	0	0

The patient creation interface has the following functions:

- It permits specialists to be able to quickly create a society of VPs showing clinically relevant differences;
- It key certain aspects of the VP model to specialists for review, evaluation, etc.; and
- It can serve as a pedagogical tool in itself, compiling clinical knowledge in a "snapshot" not found in available materials.