Authoring Embodied Agents' Behavior through Natural Language and Planning

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PAR System

- Build, interact with, and control *smart avatars* and individualized agents.
- Use natural language for:
  - Giving instructions to virtual agents
  - Generating animations
  - Dynamically authoring agent behaviors
  - Providing an easier and more expressive interface than traditional systems.

Other Systems

- Instructo Soar (Huffman and Laird)
  - Agents can learn from instruction.
  - No user initiated instructions (sub-optimal).
- Steve (Rickel and Johnson)
  - Respond to dynamic events.
  - Discrete environment.

Other Systems (2)

- Sonja (Chapman and Agre)
- NLC (Cavazza and Palmer)
- Homer (Vere and Bickmore)
- ACE (Kallmann and Thalmann)

PAR Attributes

participants: **agent**: *AGENT*; **objects**: *OBJECT list*

start: *TIME*

applicability conditions: *CONDITION boolean-expression*

preparatory specification: **condition**: *CONDITION boolean-expression*; **action:** *PAR*

subactions: *PAR* ***constraint-graph***

execution steps: primitive/complex

complex: *subactions*

core semantics:

- **motion**: *MOTION*
- **force**: *FORCE*
- **path**: *PATH*
- **purpose**: *PURPOSE*
- **termination**: *TERMINATION*
- **duration**: *DURATION*
- **manner**: *MANNER*

postassertions: {assertions}

parent action: *PAR*

previous action: *PAR*

concurrent action: *PAR*

next action: *PAR*

MOTION

- **object:** *OBJECT*
- **caused:** *IPAR*
- **translational:** *BOOLEAN*
- **rotational:** *BOOLEAN*

FORCE

- **object:** *OBJECT*
- **point of contact:** *OBJECT LOCATION*

PATH

- **direction:** *DIRECTION*
- **start:** *LOCATION*
- **end:** *LOCATION*
- **distance:** *LENGTH*

PURPOSE

- **achieve:** *CONDITION* ***boolean-expression***
- **generate:** *PAR*
- **enable:** *PAR*

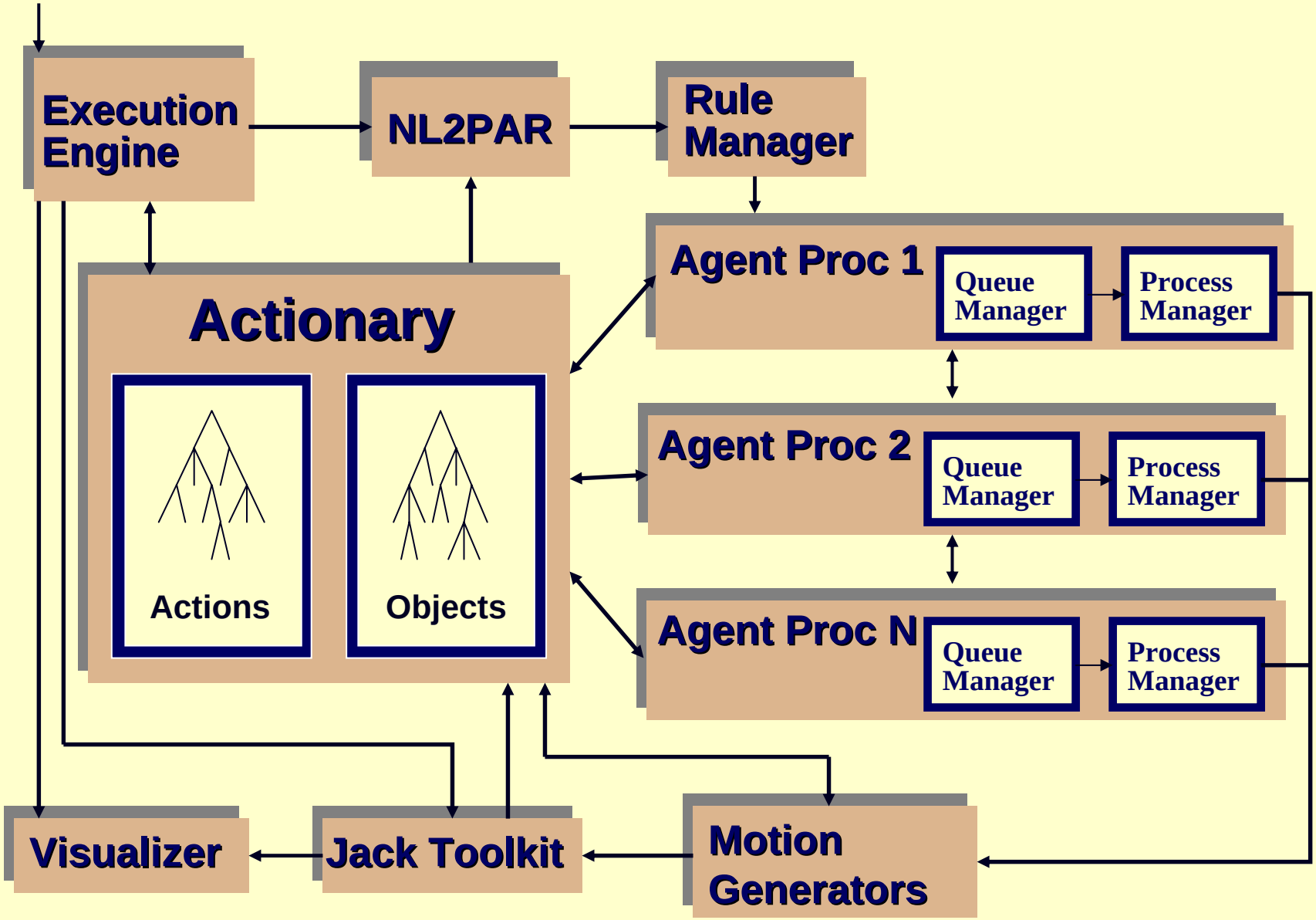
TERMINATION: *CONDITION* ***boolean-expression***

DURATION: *LENGTH*

MANNER

- **space:** *REAL*
- **weight:** *REAL*
- **time:** *REAL*
- **flow:** *REAL*

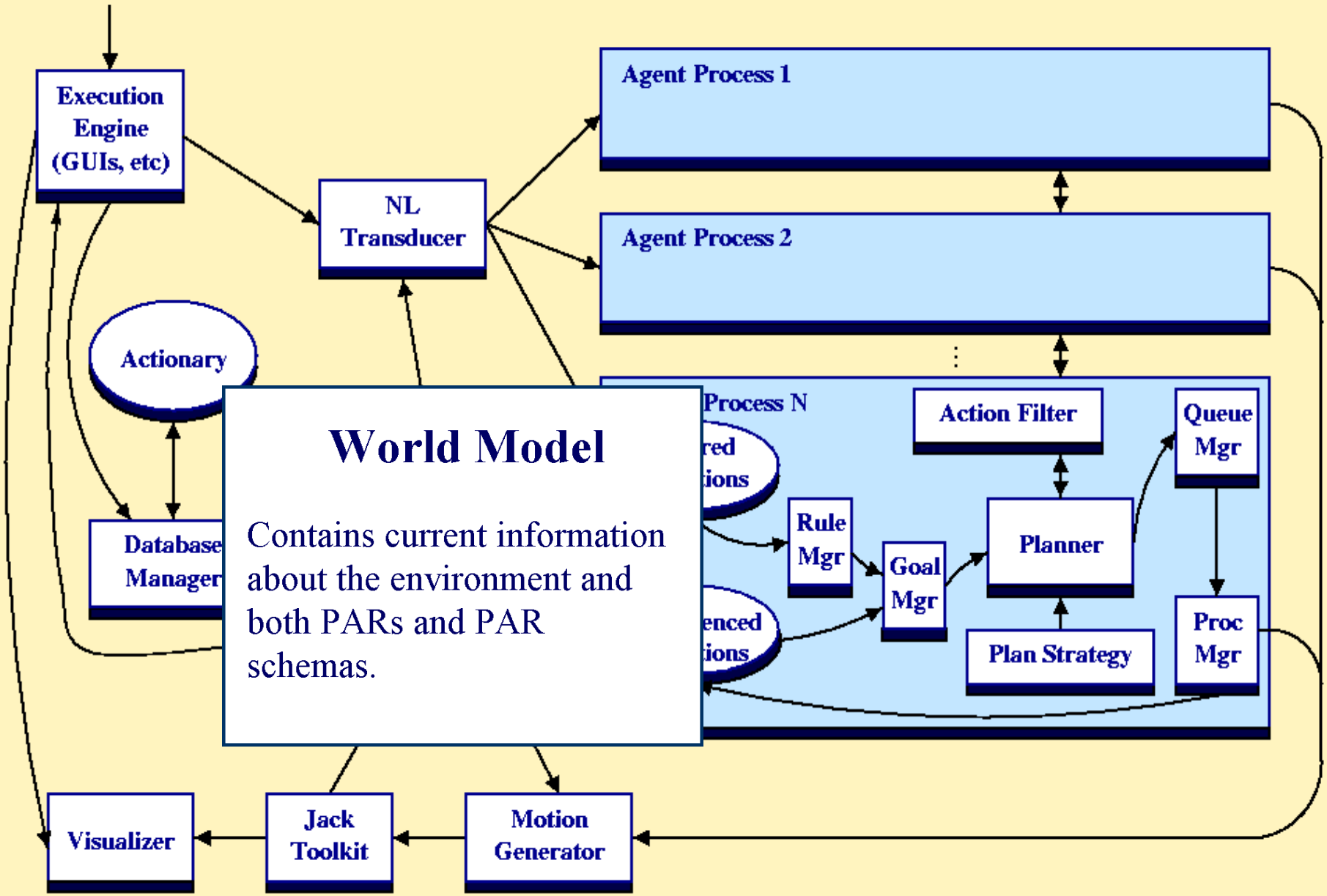
1st Generation PAR System Architecture



Limitations

- Only positive directives.
- Only existential quantifiers.
- Limited complexity and abstraction of the instructions.
- Limited spatial referents.

PAR SYSTEM ARCHITECTURE



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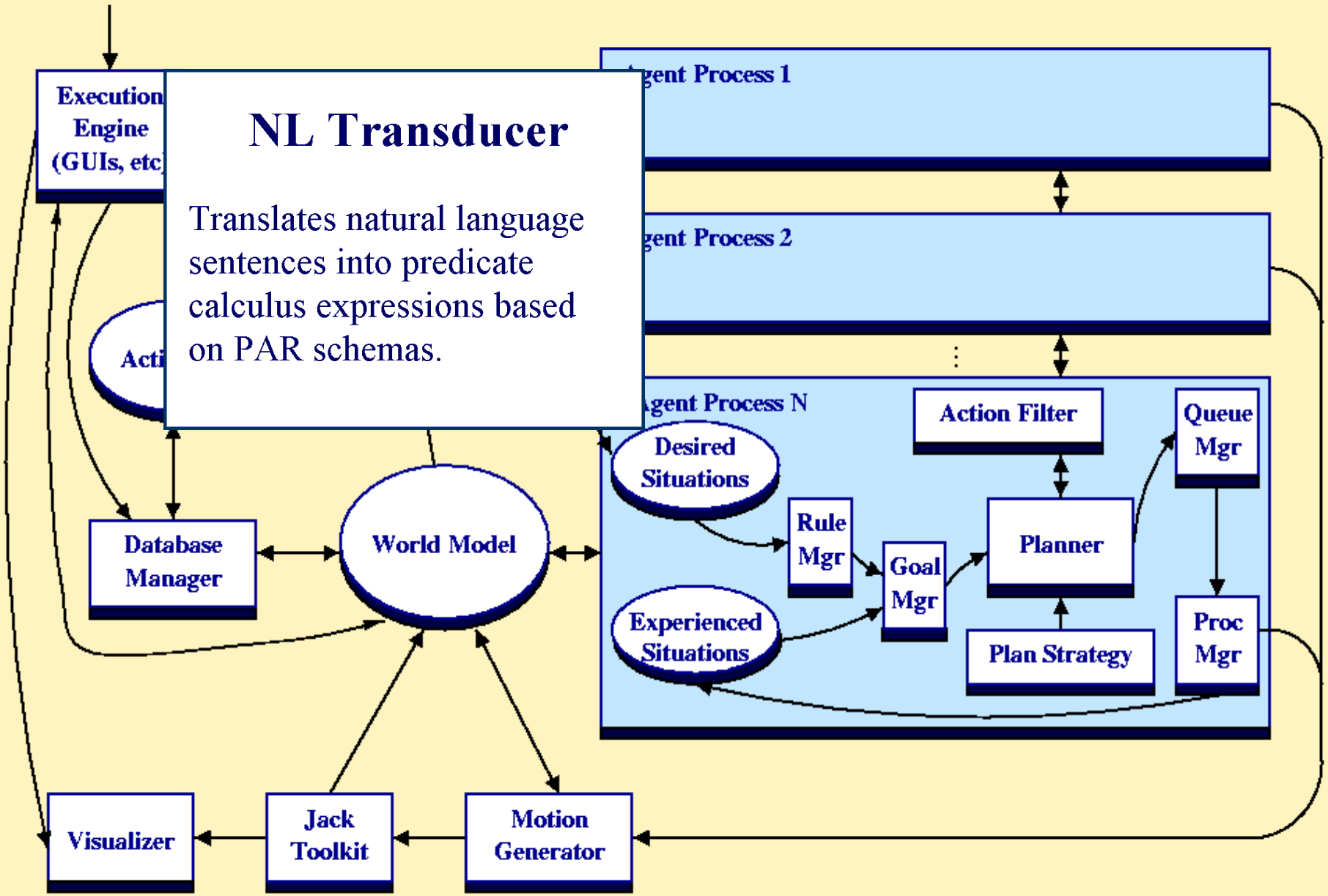
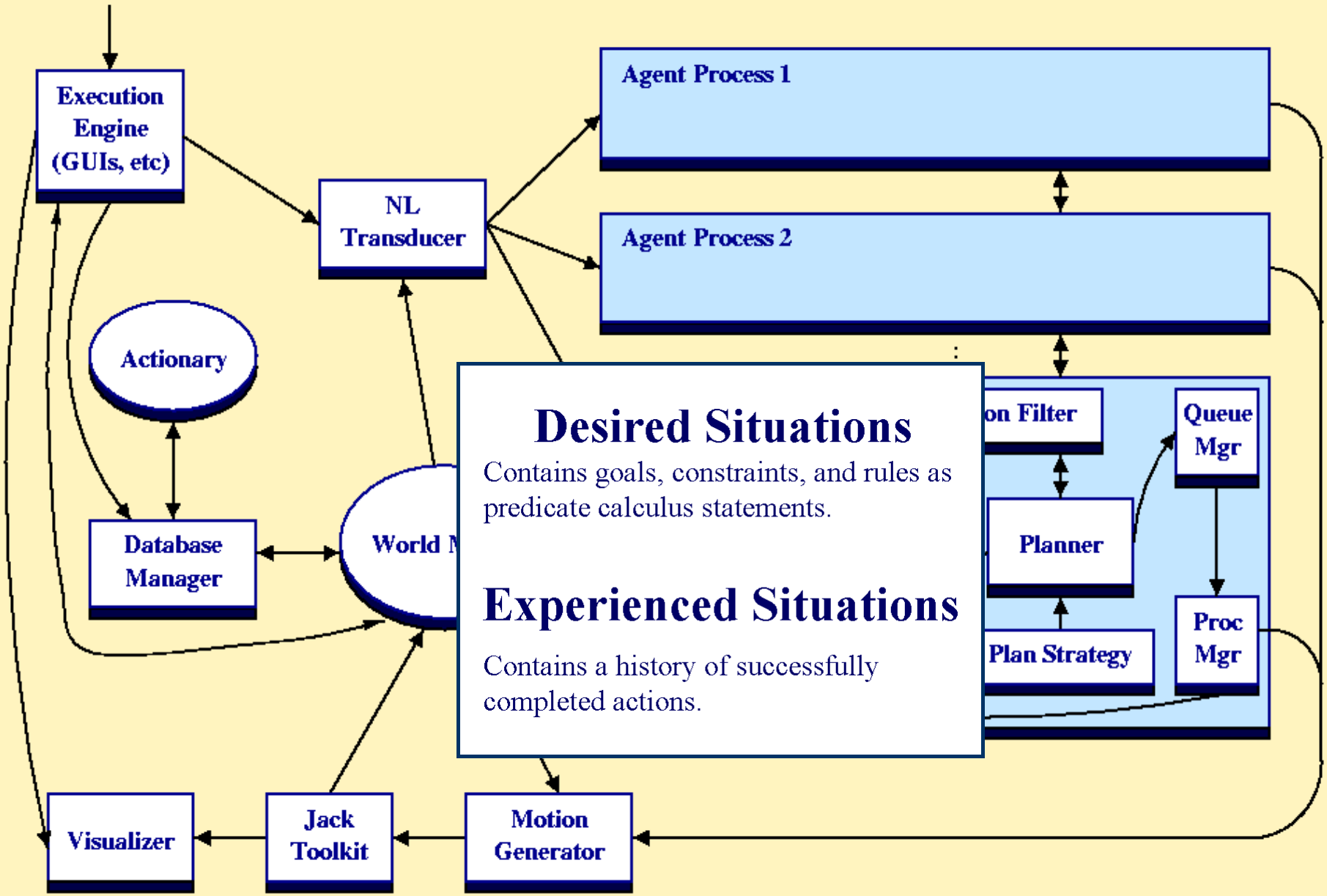


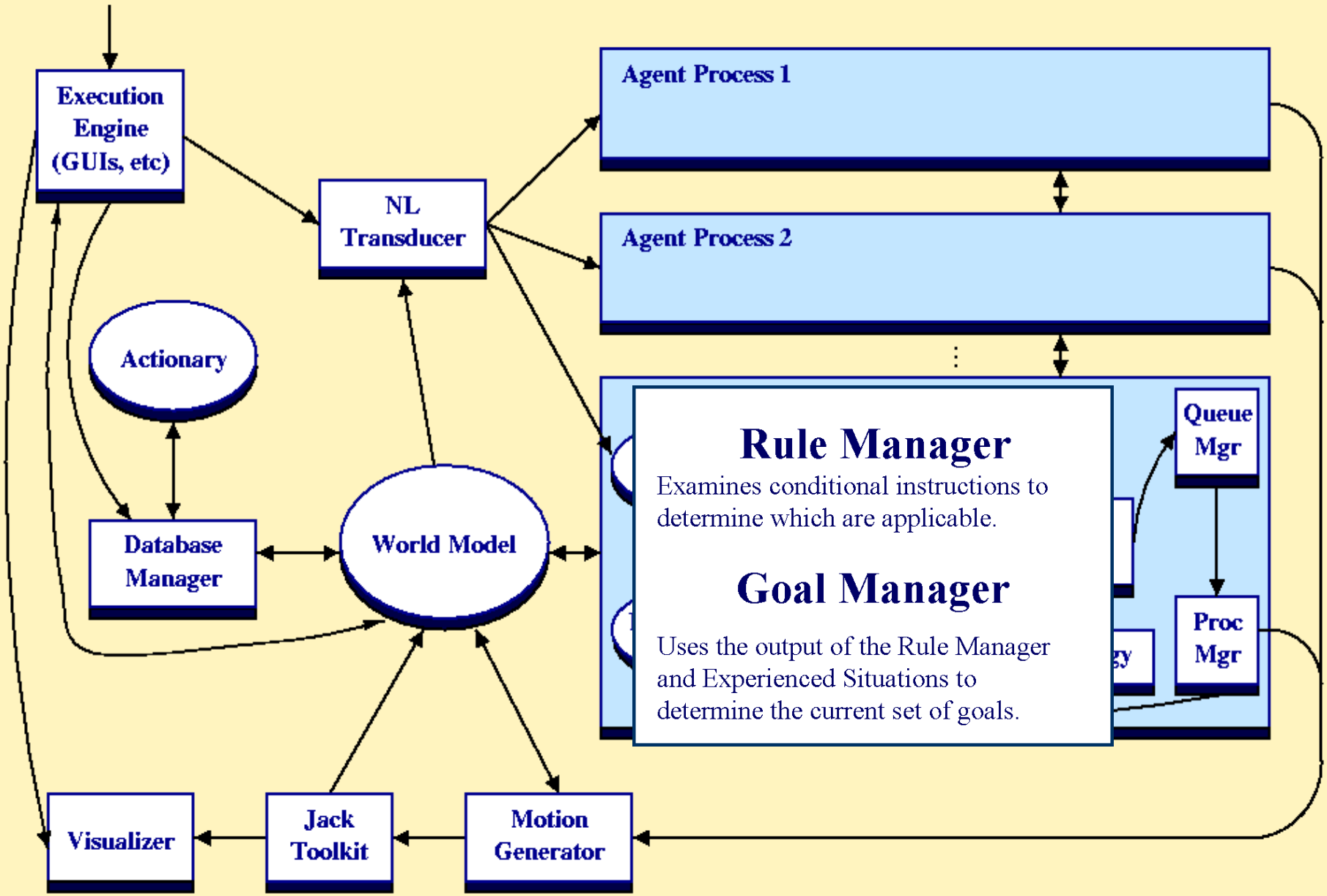
NL Transducer

Translates natural language sentences into predicate calculus expressions based on PAR schemas.

PAR SYSTEM ARCHITECTURE



PAR SYSTEM ARCHITECTURE



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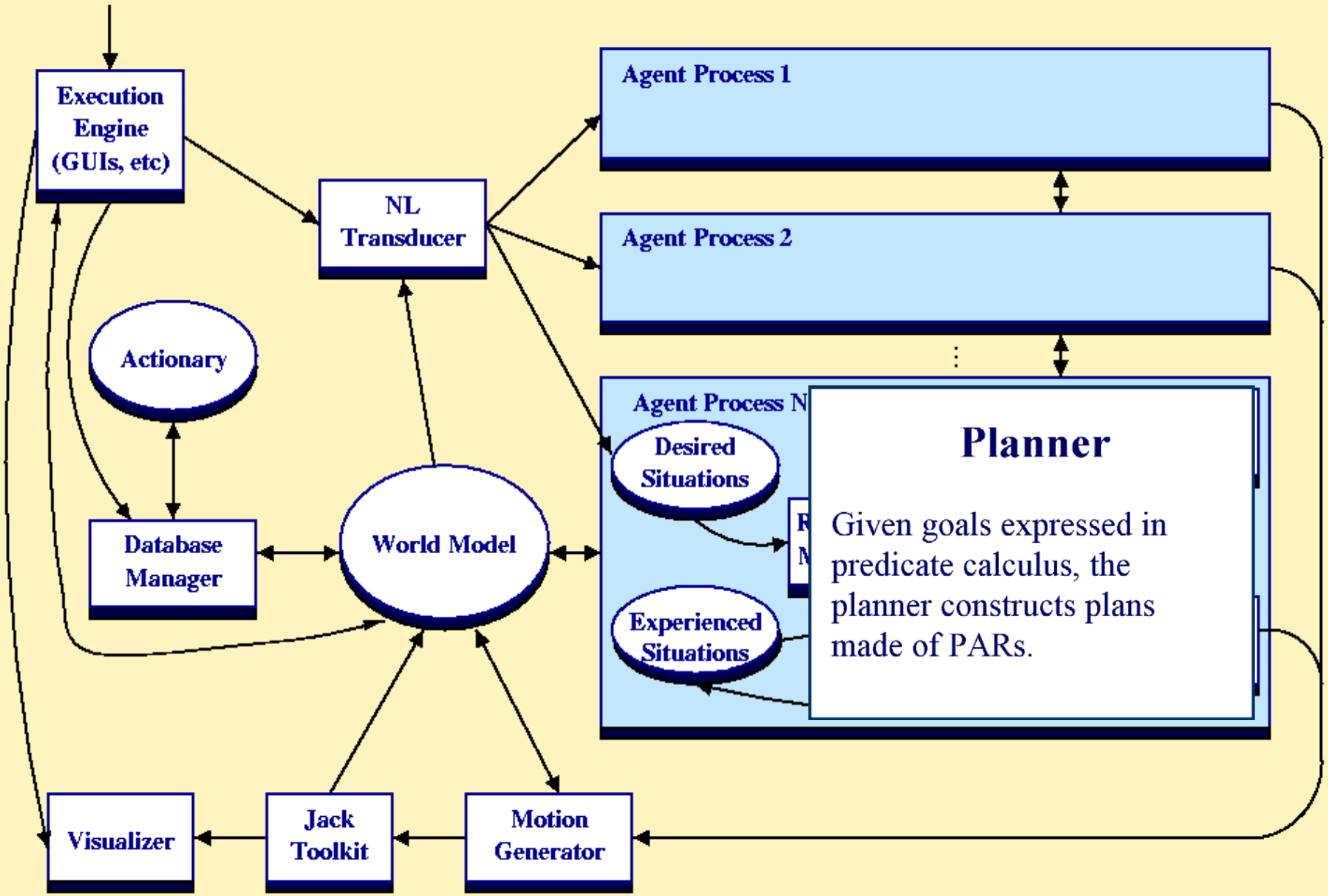

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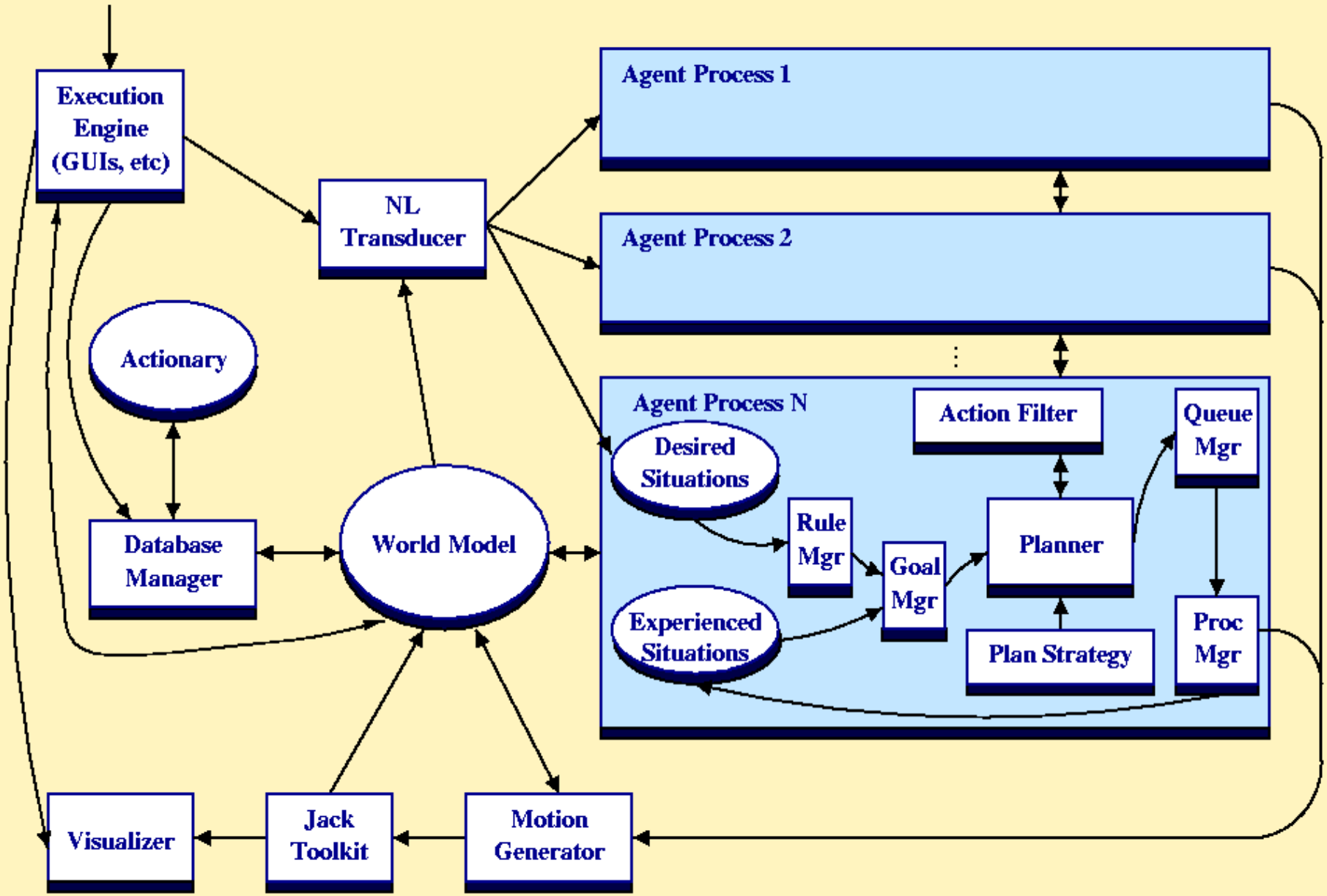

Conclusions

- Both positive and negative directives
  - Predicate Calculus and Planner
- Quantifiers
  - Desired Situation and Goal Manager
- More complex and abstract instructions
  - PAR Schemas and Planner
- Spatial referents and Adverbs
  - NL Transducer and PAR Schemas

The End