ALLEGRO $\doteq$ Belief-based Programming

(Joint with H. Levesque; IJCAI-15)

+

HYPE $\doteq$ Probabilistic Programming

(Joint with D. Nitti, L. De Raedt; ECML-15)

Vaishak Belle

Poster: Only-knowing + common knowledge + announcement = deductive solution to muddy children!

Key features

- **logic + probability**: modeling power, e.g. medical data of patients i.i.d. independent of relations, programs, etc.

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- strong formal foundations $\doteq$ semantics
- intuitive implementations realizing machinery
- tested on <u>realistic</u> robotic specifications

High-Level Agent Programming

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$$\begin{aligned}\textbf{loop}: \quad & \textbf{if } \neg Empty(queue) \\ & \quad \textbf{then } (\pi p)\, selectRequest(p); \\ & \quad\quad pickupCoffee;\ bringCoffee(p) \\ & \quad \textbf{else } wait\end{aligned}$$

- lots of success, e.g., **diagnosis, cognitive robotics** (museum robot)

Criticism

Major criticism: action & knowledge specification very unrealistic for actual robots!

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Need to rethink GOLOG, both at specification and implementation level

Foundations

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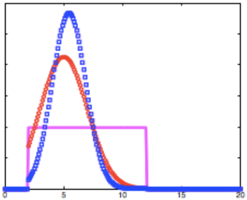
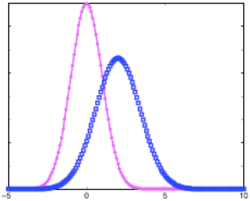
- **UAI-13**: regression, **KR-14**: progression
- **IJCAI-15**: program model wrt basic action theory (w. initial beliefs, noise models, etc.)

ALLEGRO

$$
\begin{array}{l}
\textbf{until}(\textbf{Bel}(h \geq 3 \wedge h \leq 5) > \theta) \\
\qquad \textbf{until}(\textbf{Bel}(|\, h - \hbar \,| \leq \beta) > \eta)\ \textit{sonar}\ \textbf{endUntil}; \\
\qquad \textit{nfwd}(\hbar - 4) \\
\textbf{endUntil}
\end{array}
$$





Nested belief terms, **loops,** etc. (For semantics, cf. paper)

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Theorem: $BAT \models Bel(\phi, do(\sigma, S_0)) = u$ iff $\lim_{n \to \infty} INTERPRETER[(\texttt{bel}\ \phi), PROG, BAT_0] = u$.

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HYPE

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A modeling problem: place robot at the center of **this room**: describe its position to an unknown number of participants

Model

(view of the robot)

$$\mathtt{n} \sim \mathtt{poisson}(6).$$
$$\mathtt{pos(P)} \sim \mathtt{uniform}(1, 10) \leftarrow \mathtt{between}(1, \simeq\!(\mathtt{n}), \mathtt{P}).$$

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- **Semantics**: distributions on Herbrand interps.
- HYPE = planning on such clauses
- task and motion planning, including tracking

Conclusions

- ALLEGRO = belief-based programs
- HYPE = planning via probabilistic programs

Motivation: bring **epistemic reasoning** and **probabilistic techniques** closer, both from specification and implementation perspective.

- modeling power, rich control structures, etc. for novel tasks and applications