Approaches and Architectures:

Bottom-Up vs. Top-Down

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Seminar: Normative Reasoning and Machine Ethics (Prof. Benzmüller, FU Berlin WiSe 19/20)

Structure

1. What is Machine Ethics?

2. Categories of Approaches

3. Comparison: Advantages and Disadvantages

4. Examples:
   ○ Bottom-Up: CIRL
   ○ Top-Down: LOGIKEY

5. Discussion

What is Machine Ethics?

1. What is Machine Ethics?

Landscape of research field

- machine ethics is branch of AI ethics
- AI ethics: minimize ethical harms by AI
- machine ethics: create ethical machines

Ethical agencies

1. ethical impact agents
2. implicit ethical agents
3. explicit ethical agents
4. full ethical agents

Categories of Approaches

2. Categories of Approaches

Bottom-Up Approach

- engineering sense:
  - use performance measure
- ethical sense:
  - treat normative values as being implicit in activity of agents
  - not explicitly articulated (or even articulable)
- merged sense:
  - create agents with accurate understanding of own and other’s morality

2. Categories of Approaches

Top-Down Approach

- engineering sense:
  - decompose task into subtasks
- ethical sense:
  - take general ethical theory
  - derive consequences for particular cases
- merged sense:
  - take ethical theory
  - analyze requirements
  - design subsystems to implement that theory

2. Categories of Approaches

Hybrid Approach

- merge bottom-up and top-down
  - bottom-up for socialization
  - top-down for basic norms

Different Approaches for specific skills

supervised learning:	deontological rules
reinforcement learning:	socialization
applied game theory:	multiple-party interests
probabilistic programming:	uncertainty management
scenario rendering:	modelling interactions
inverse reinforcement learning:	modelling intent

Comparison:

Advantages and Disadvantages

3. Comparison:

Advantages and Disadvantages

Bottom-Up

- advantages:
    - assembling components to achieve goal
    - no explicit rules are needed
    - step-by-step learning
- disadvantages:
    - not transparent
    - bias-prone
    - insufficient artificial environments for training
- problems:
    - does morality emerge from assembly?
    - how to verify morality?

3. Comparison:

Advantages and Disadvantages

Top-Down

- advantages:
  - transparent
  - easy fitting to new contexts by adding rules
- disadvantages:
  - how to formulate adequate universal rules that include unknown scenarios?
  - trade-off between vagueness and inflexibility
- problems:
  - which rules to choose?
    - consequentialist
    - deontology
    - virtue ethics
  - what to decide when several rules conflict?
  - when to terminate calculation of best action?

Bottom-Up Example:

CIRL

4.1 Bottom-Up Example:

CIRL

Cooperative **I**nverse **R**einforcement **L**earning

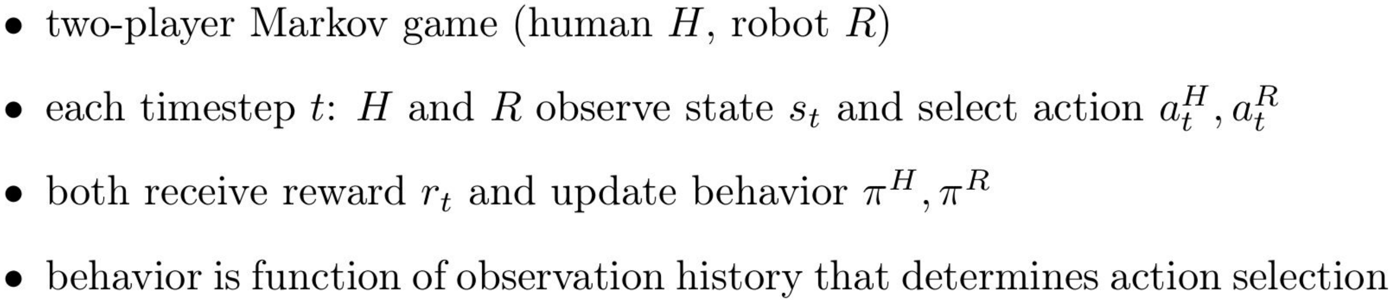
- *implicit ethical agent*
- robot observes human
- estimates human’s intent to act accordingly

Problems

- robot should not copy all behaviors
  - constraint reward function to optimize reward for human
- observing actions is inefficient
  - actively teach and ask instead

4.1 Bottom-Up Example: CIRL

Definition (simplified)



- two-player Markov game (human H, robot R)
- each timestep t: H and R observe state s_t and select action a_t^H, a_t^R
- both receive reward r_t and update behavior π^H, π^R
- behavior is function of observation history that determines action selection

Top-down Example:

LogiKEy

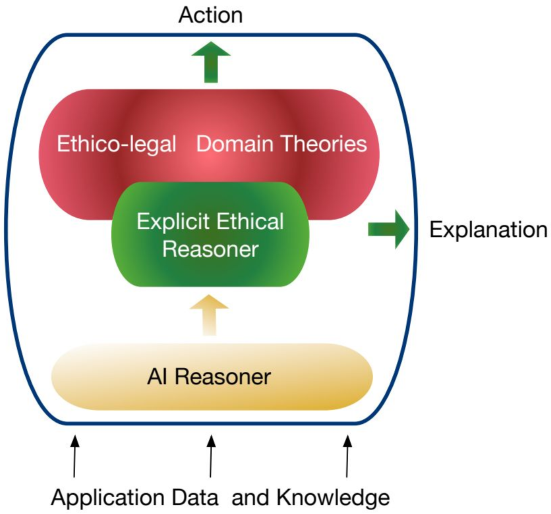
4.2 Top-Down Example:

LOGIKEY

Logic and **K**nowledge **E**ngineering Framework and Methodolog**y**

- (part of) *explicit ethical agent*
- framework for normative reasoning tools
- uses higher order logic (HOL)

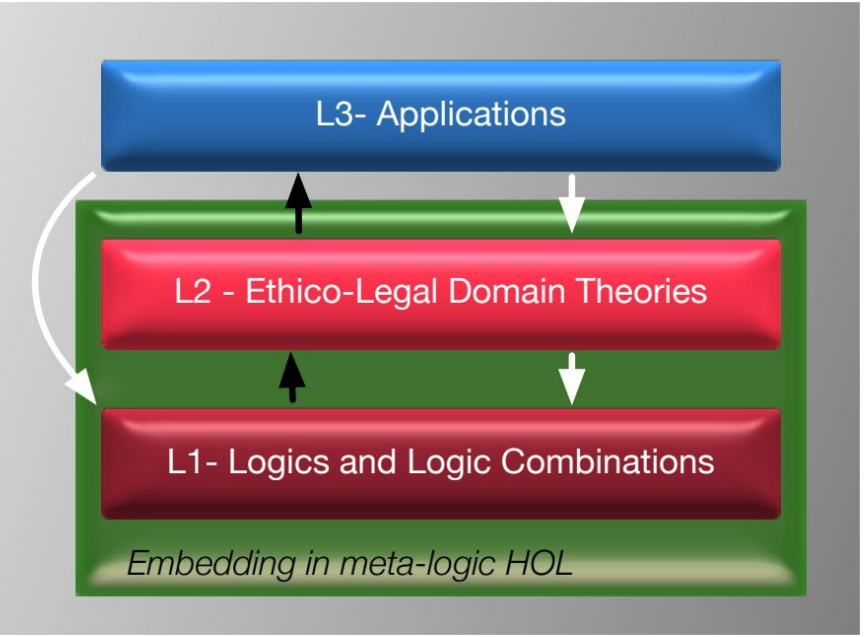
Scheme



4.2 Top-Down Example: LOGIKEY

- LOGIKEY comprises 3 layers
- in each layer the concrete content is interchangeable

- L1: deontic logic paradigms
  - modal logic
  - norm-based
- L2: theories
  - standard deontic logic (SDL)
  - dyadic deontic logic (DDL)
  - input/output (I/O) logic
- L3: examples
  - General Data Protection Regulation (GDPR)
  - Gewirth's Principle of Generic Consistency


L3- Applications
L2 - Ethico-Legal Domain Theories
L1- Logics and Logic Combinations
Embedding in meta-logic HOL

Discussion

5. Discussion

1. What skills are needed for *full ethical agents*?

2. How to approach them?

References

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