Applications and Opportunities

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Remarks on previous discussions, in the light of applications

Thoughts on possible areas of application

Informed by planning work in non-adversarial settings.
What is Planning?

Adversarial Planning: Detailed thinking about the interaction between different players.
- Simple dynamics, “complex” interactions.

Conventional Planning: Detailed thinking about complex dynamics
- “A set of attributes that we can’t enumerate.”
- Possibly just complex deterministic dynamics (so called “classical” planning)
  - UAV missions
  - Large-scale military deployment
- McDermott argues that plan management is more appealing than plan synthesis in applications
- Games against nature
  - MDP planning
  - Game-theoretic controller synthesis
Do We See Syntheses?

- Complex dynamics with interactions…
- RoboCup, Capture the Flag
- Computer games and simulations
Experience from talking to designers and users of optimization systems for chemical plants…

- Engineers using multidimensional optimizers would turn them into one-dimensional constrained optimization.
- Engineers will often reverse-engineer objective functions from desired behaviors

What about stability of solutions?

Can the factorized representations help?

*This argument doesn’t apply to decision support tools producing insights.*
What Do People Want?

Autonomous decision-makers?
- Probably not for military decision support
- But maybe for autonomous systems (might be relatively invisible to users):
  - Keep the UAV safe
  - Patrol to find X

Recommendations?
Situation awareness?
Critiques?
Counter-examples?
Explanations….

If we don’t have an autonomous system applying policy, can we compress and regularize policies to make them comprehensible?
Plan Recognition

- Given a set of possible plans or goals for an agent, and an observation trace, attempt to identify the agent’s active plan(s) or goal(s).
- Often used to provide assistance to users.
  - Software apps. E.g., Microsoft Lumiere project.
  - Adaptive tutoring systems.
- Rarely has incorporated deception or adversarial components.
- Now typically Bayesian.
- If adversarial reasoning could be incorporated, could plan recognizers provide useful decision support?
- Can we integrate game-theoretic reasoning into the Bayesian approaches?

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Some Possible Areas for Application
Evaluating Task/Function Allocation

Problem:
- Designing human-machine system to perform a task or suite (stochastic?) of tasks.
- Have information about the human workload requirements for tasks, and duration distributions.
- Look for problematic scenarios to critique proposed designs
  - By search
  - By simulation

Typically these approaches assume canonical agents
- Possibly varying for fatigue or other factors
- Do not take cultural features into account
- Do not take into account individual goals, etc. into account.

Potentially could be extended to automatically choosing optimal function allocation.
“Etiquette for Avatars”

**NUGGET:** A predictive model of “believability” of social interactions based on observable etiquette dimensions: familiarity, power, intrusiveness and character.

**APPLICATION:**
- Interactive simulations to support training for etiquette
  - Military
  - Medical—esp. elder care

**STATUS:**
- Ongoing work covers
  - Manipulating perceptions about dimensions
  - “Culture modules”

*SIFT and USC ISI and ICT.*
Cultural Modules for Rapid Creation of Training Simulations

**SIFT, LLC– Dr. Chris Miller**
**USC/ISI– Dr. Lewis Johnson**

**Main Objectives**
- **Phase I**—Develop algorithm for dynamic, culture-specific social interactions based on an abstract model of “face threats”
- **Out Phases**—
  - Make model interactive with users
  - Investigate methods for embedding culture modules
  - Demo portability in militarily-relevant game/simulation environment

**Key Innovations**
- Abstract, modular approach to social interaction “etiquette” knowledge
  - Supported by theory and 20 years of empirical observation
- Embedding in gaming/sim technology
  - Rapid generation of diverse Non-Player Characters (NPCs) that behave like culture-specific individuals
    - Take offense realistically for their culture
    - Offer redress realistically

**Expected Impact**
- 10x improvement in ability to generate NPC behaviors
- Improvements in game generation speed and cultural interaction
  - Accurate depiction of cultural norms
- More playable games ➔ 100 to 10,000x improvement in distribution of Cross-Cultural Training for soldiers
  - Saves resources, time, dollars and lives

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Objective: Provide high-level control for complex systems allowing intuitive tasking.
- E.g., Watch location Alpha for 30 minutes starting by 20 minutes from now…
- Insulate users from details of control systems, platforms.

Technique: Use hierarchical task network (HTN) planning to generate plans to actualize user task requests.
- Enhanced version of UMD SHOP2 planner.
- HTNs permit following standard operating procedures, make planner results more understandable.

Opportunity: take into account adversarial aspects of problem.
Simulating Computer Intrusions

Application to:
- Training security personnel
- Evaluating security strategies
- Experimental test beds for security systems (e.g., Intrusion Detection Systems)

Critical issue is to model adversaries that vary on (at least)
- Goals
- Levels of competence

Need to cope with constant attacks and probes by “ankle-biters.”
- We care about non-optimal attacks, a lot. Including mis-targeted attacks and accidental damage.
- We also care about optimal attacks.

Incomplete information characterizes the domain.
- Poor sensors.

Attacks are multiple-stage, overlapping (share components), and the “physics” are important, so very difficult to enumerate the attacks.

Level of abstraction is a critical issue

[Goldman, 2002; Boddy, et al., 2005]
Controller synthesis framework for non-stochastic system: force a win for any opponent move. Similar to bilevel programming, but discrete.

Controller synthesis for controls; AI people likely to call it “contingent planning.”

Typically played against nature.

Can be done, somewhat efficiently, for domains where time matters, and threats must be preempted.

- E.g., to break a radar lock, you must begin evasive maneuvers within time $t$ of sensing threat, assuming you check for threats every $t'$ seconds...
- Can find time parameters from descriptions of processes and actions

Game theory leveraged to play against nature: can we go back and play the game against an intelligent adversary? [Tripakis & Altisen; Goldman, Musliner & Pelican]