SMART Information Flow Technologies

Applications and Opportunities

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Outline

- 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

Issue of Mathematical Optimization

- 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.

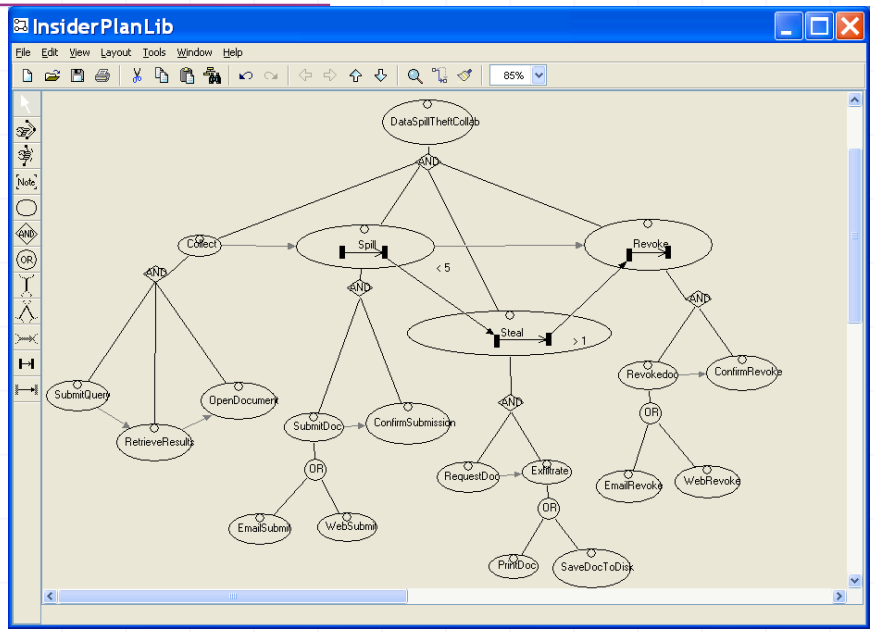
What Do People Want?

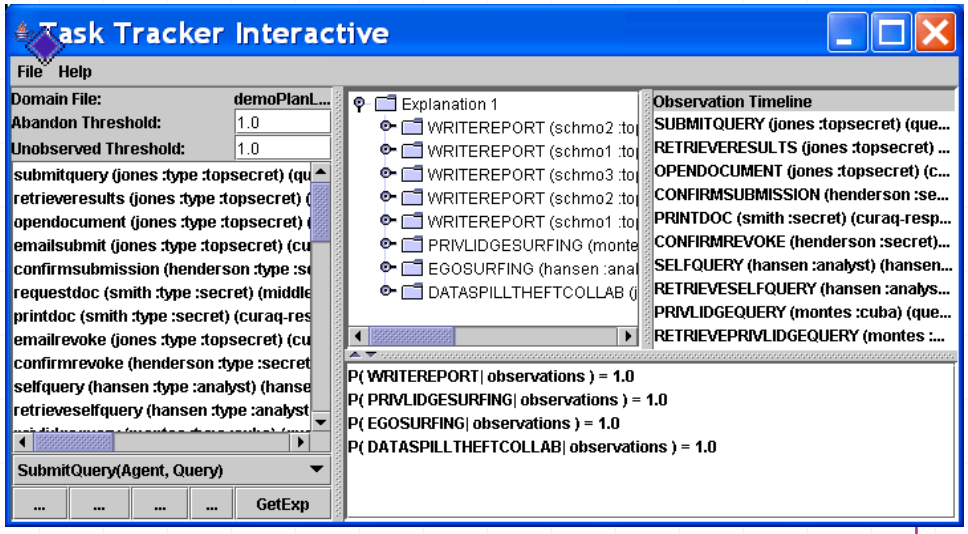
- Autonomous decision-makers?
  - Probably not for military decision support
  - But maybe for autonomous systems (might be relatively invisible to users) :
    - Keep the UAV safe
    - Patrol to find *X*
- Recommendations?
- Situation awareness?
- Critiques?
- Counter-examples?
- Explanations….

- 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?



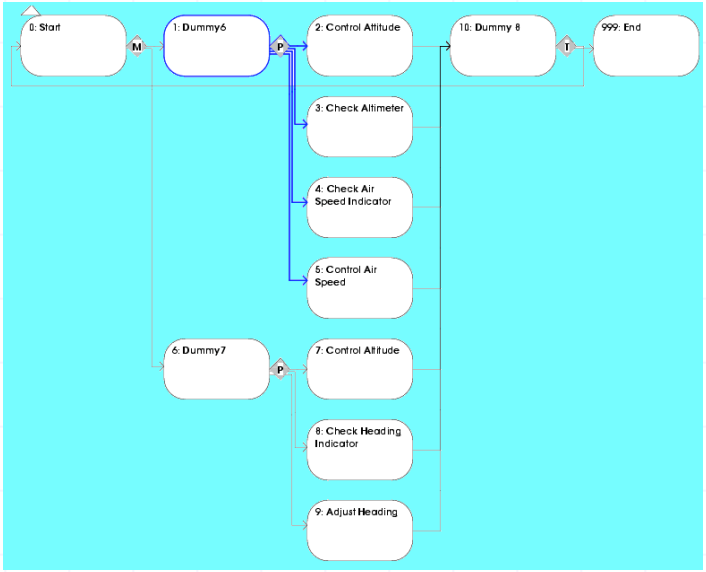


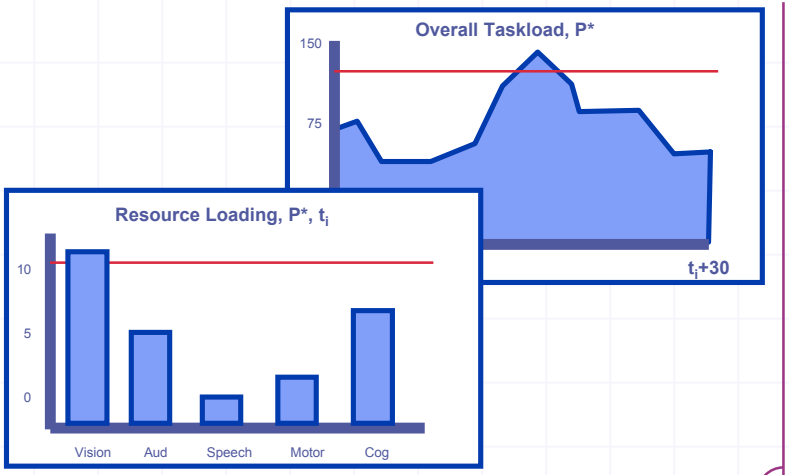
SMART Information Flow Technologies

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 "believabi-lity" of social interactions based on observ-able 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.

Tactical Language Tutor– CARTE, USC.

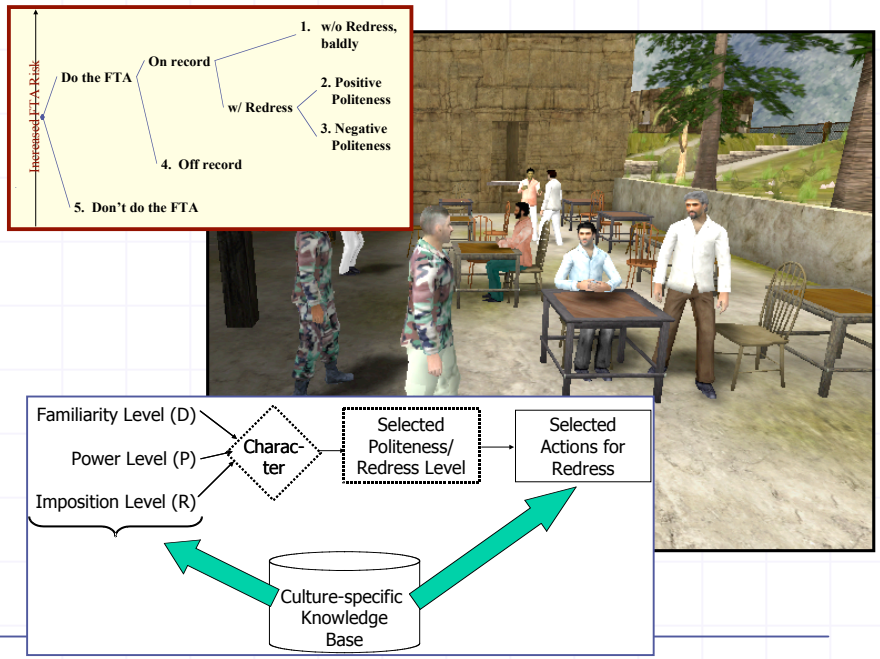
Carmen's Bright Ideas– CARTE, USC.

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

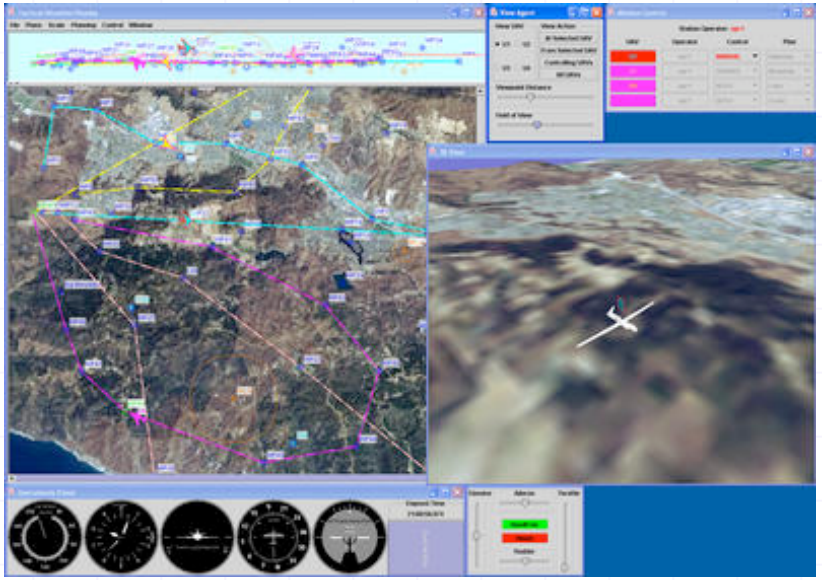
- Abstract, modular approach to social interaction "etiquette" knowledge
  - Supported by theory and 20 years of empirical observation
- Embedding in gaming/sim technology
  - Rapid generation of diverse Non-Player Characters (NPCs) that behave like culture-specific individuals
    - Take offense realistically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

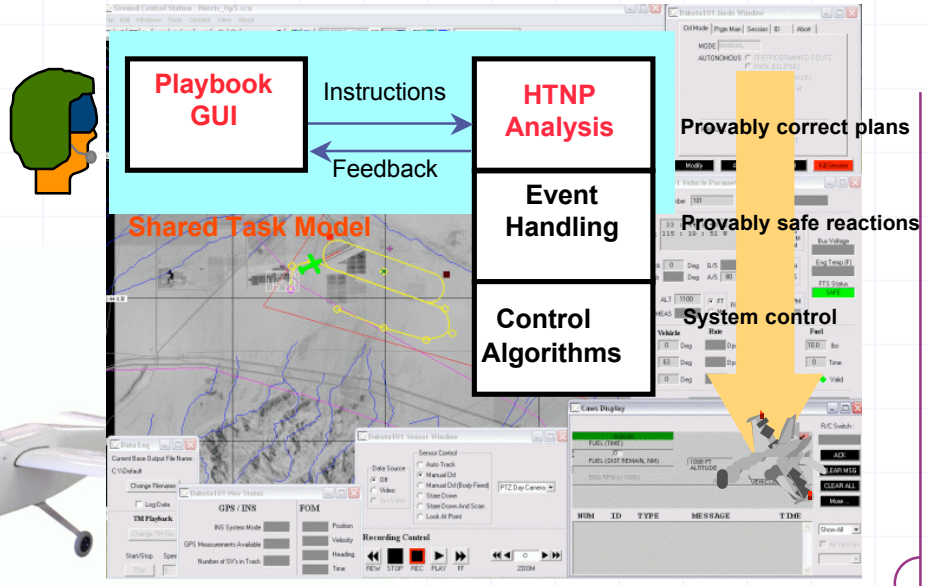
Expected Impact

- 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

Playbook™ for UAVs

- 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]

Real-time Controller Synthesis

- 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]