What's Hot: ICAPS
"Challenges in Planning"

Human-in-the-Loop/Human-Aware Planning and Decision Support

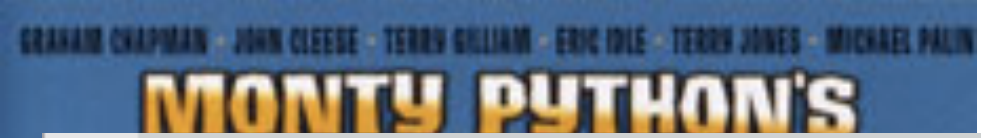
A brief talk on the core & (one) fringe of ICAPS

Subbarao Kambhampati

Arizona State University

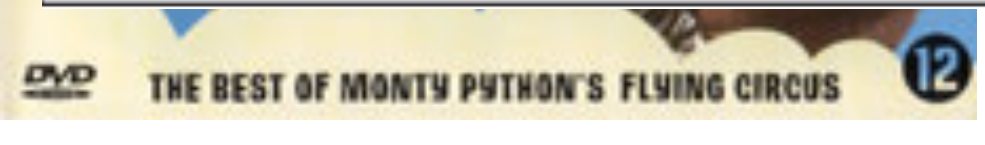
Talk given at AAAI 2014


GRAHAM CHAPMAN · JOHN CLEESE · TERRY GILLIAM · ERIC IDLE · TERRY JONES · MICHAEL PALIN
MONTY PYTHON'S
AND NOW FOR SOMETHING COMPLETELY DIFFERENT
DVD
THE BEST OF MONTY PYTHON'S FLYING CIRCUS
12



10:20– 11:35 AM		**Novel Machine Learning Algorithms** Wormhole Hamiltonian Monte Carlo *Shiwei Lan, Jeffrey Streets, Babak Shahbaba* Learning the Structure of Probabilistic Graphical Models with an Extended Cascading Indian Buffet Process *Patrick Dallaire, Philippe Giguère, Brahim Chaib-Draa* Small-Variance Asymptotics for Dirichlet Process Mixtures of SVMs *Yining Wang, Jun Zhu* Using the Matrix Ridge Approximation to Speedup Determinantal Point Processes Sampling Algorithms *Shusen Wang, Chao Zhang, Hui Qian, Zhihua Zhang* Large-Scale Optimistic Adaptive Submodularity *Victor Gabillon, Branislav Kveton, Zheng Wen, Brian Eriksson, S. Muthukrishnan*	**Planning and Scheduling** Parametrized Families of Hard Planning Problems from Phase Transitions *Eleanor G. Rieffel, Davide Venturelli, Minh Do, Itay Hen, Jeremy Frank* Backdoors to Planning *Martin Kronegger, Sebastian Ordyniak, Andreas Pfandler* Scheduling for Transfers in Pickup and Delivery Problems with Very Large Neighborhood Search *Brian Coltin, Manuela Veloso* A Scheduler for Actions with Iterated Durations *James Paterson, Eric Timmons, Brian C. Williams* *Best Paper Nominee*: Generalized Label Reduction for Merge-and-Shrink Heuristics *Silvan Sievers, Martin Wehrle, Malte Helmert*	**Game Theory and Multiagent Systems** Congestion Games for V2G-Enabled EV Charging *Benny Lutati, Vadim Levit, Tal Grinshpoun, Amnon Meisels* A Game-Theoretic Analysis of Catalog Optimization *Joel Oren, Nina Narodytska, Craig Boutilier* Robust Winners and Winner Determination Policies under Candidate Uncertainty *Craig Boutilier, Jérôme Lang, Joel Oren, Hector Palacios* Theory of Cooperation in Complex Social Networks *Bijan Ranjbar-Sahraei, Haitham Bou Ammar, Daan Bloembergen, Karl Tuyls, Gerhard Weiss* Prices Matter for the Parameterized Complexity of Shift Bribery *Robert Bredereck, Jiehua Chen, Piotr Faliszewski, André Nichterlein, Rolf Niedermeier*
11:35 – 11:50 AM		**What's Hot: ICAPS** Challenges in Planning *Rao Khambampati*	**What's Hot: AAMAS** What's Hot in Autonomous Agents *Noa Agmon*	

LUNCH, 11:50 AM– 1:00 PM



GRAHAM CHAPMAN · JOHN CLEESE · TERRY GILLIAM · ERIC IDLE · TERRY JONES · MICHAEL PALIN

MONTY PYTHON'S

10:20– 11:35 AM

Novel Machine Learning Algorithms

Wormhole Hamiltonian Monte Carlo
Shiwei Lan, Jeffrey Streets, Babak Shahbaba

Learning the Structure of Probabilistic Graphical Models with an Extended Cascading Indian Buffet Process
Patrick Dallaire, Philippe Giguère, Brahim Chaib-Draa

Small-Variance Asymptotics for Dirichlet Process Mixtures of SVMs
Yining Wang, Jun Zhu

Using the Matrix Ridge Approximation to Speedup Determinantal Point Processes Sampling Algorithms
Shusen Wang, Chao Zhang, Hui Qian, Zhihua Zhang

Large-Scale Optimistic Adaptive Submodularity
Victor Gabillon, Branislav Kveton, Zheng Wen, Brian Eriksson, S. Muthukrishnan

11:35 – 11:50 AM

What's Hot: ICAPS

Challenges in Planning
Rao Khambampati

LUNCH, 11:5

DVD THE BEST OF MONTY PYTHON'S FLYING CIRCUS 12

What's Hot: ICAPS
"Challenges in Planning"

Human-in-the-Loop/Human-Aware Planning and Decision Support

A brief talk on the core & (one) fringe of ICAPS

Subbarao Kambhampati

Arizona State University

Talk given at AAAI 2014

Portsmouth, USA
June 21-26, 2014

24th International Conference on Automated Planning and Scheduling

Welcome

ICAPS 2014, the 24th International Conference on Automated Planning and Scheduling will take place in Portsmouth, NH, USA, **June 21-26, 2014**. Similar to previous editions, the schedule will consist of the Doctoral Consortium on the first day (June 21), workshops and tutorials on the second and third days (June 22-23), and the last three days (June 24-26) are dedicated to the main program.

ICAPS 2014 is part of the ICAPS conference series. ICAPS is the premier forum for exchanging news and research results on theory and applications of intelligent planning and scheduling technology.

The conference features a pre-conference program of workshops and tutorials on current research topics. The main technical program consists of invited talks by leading scientists working in the area, presentations of technical papers, as well as system demonstrations. For graduate students the pre-conference program includes a Doctoral Consortium.

An advertising flier (PDF) for the conference is available here.

Registration is OPEN

ICAPS'14 Schedule Overview and the **Full Detailed Schedule** are now available

News and Updates

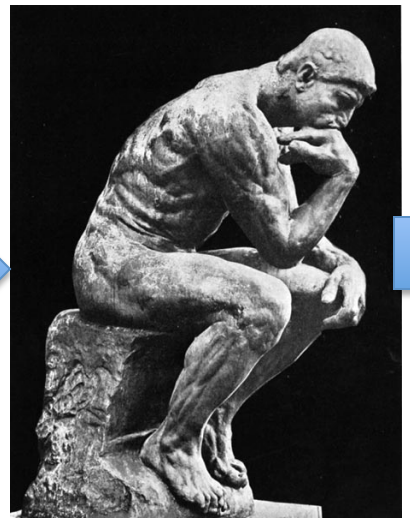
[7 July 2014] ICAPS'14 presentations are now available successively on the ICAPS YouTube Channel. In particular, check out the ICAPS theme song, performed at the ICAPS'14 banquet by the ICAPS Three Band.

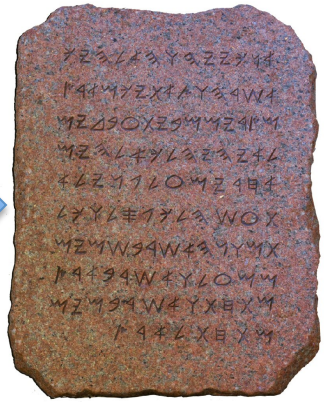
[4 June 2014] Individual papers from the ICAPS'14 proceedings are now available for download.

[4 April 2014] The *Outstanding Papers* (3) and *Honorable Mentions* (3) are now marked in the list of accepted papers.

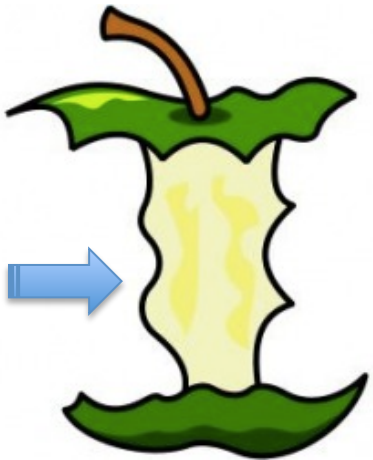
Planning: The Canonical View

A fully specified problem
--Initial state
--Goals
(each non-negotiable)
--Complete Action Model





The Plan



The IPC 2014 Competition tracks

Four different tracks were announced, but only three took place:

- Sequential
  - Features: action costs, negative preconditions, conditional effects
  - Objective: minimise action cost (sum of action costs)
- Agile
  - Features: action costs, negative preconditions, conditional effects
  - Objective: minimise CPU time
- Temporal
  - Features: durative actions, metric quantities
  - Objective: minimise total time (makespan)

A satisficing, optimal and multi-core subtrack were arranged for the Sequential track.

Planners

- Sequential satisficing: 43 registered, 21 submitted, 1 withdrawn
- Sequential optimal: 34 registered, 17 submitted
- Sequential multi-core: 17 registered, 9 submitted
- Agile: 21 registered, 15 submitted
- Temporal satisficing: 9 registered, 6 submitted
- Temporal optimal: 6 registered, 1 submitted, cancelled
- Preferences satisficing: 5 registered, 2 submitted, cancelled
- Preferences optimisation: 4 registered, 0 submitted, cancelled

67 planners in total from 66 people from 15 countries. Australia, Canada, Czech Republic, Finland, France, Germany, Iran, Israel, New Zealand, Spain, Switzerland, United Kingdom, Venezuela, USA.

Sequential Satisficing track: Results

20 planners. Showing the top FIVE

IBaCoP2	166.21/280	**1st**
IBaCoP	162.73/280	**1st**
Mercury	153.04/280	**2nd**
MIPlan	150.00/280	3rd
Jasper	144.89/280	4th
FD-Uniform	143.25/280	5th

Winner

IBaCoP2: Isabel Cenamor, Tomás de la Rosa, Fernando Fernández

[IPC 2014 slides from Chrpa, Vallati & McCluskey]

How far have we got?

How planners from past IPCs would have performed in IPC-8?

- In Sequential Satisficing track, LAMA-11 (winner of Sequential Satisficing track of IPC-7) would have been **12th** out of 21.
- In Agile track, LPG and FF would have been, respectively, **13th** and **17th** out of 17.

The take-home messsage

- A large number of high-performance planners is available, mainly because of the availability of well documented and supported platforms (FD, FF, ..)
  - 29 planners out of 67 built on top of FD.
- Portfolio-based systems are now a concrete reality.
  - 29 portfolios in IPC-8; 3 awarded.

On the other hand...

Portfolio planners use a set of base planners and select the planner to use based on the problem features

→ Typically the selection policy learned in terms of problem features

So why the continued fascination with classical planning?

- ..of course, the myriad applications for classical STRIPS planning ☺
- But more seriously, because classical planners have become a customized substrate for "compiling down" other more expressive planning problems
  - Effective approaches exist for leveraging classical planners to do partial satisfaction planning, conformant planning, conditional planning, stochastic planning etc.

Compilation Substrates for Planning

SAT

- First of the substrates
  - Kautz&Selman got the classic paper award honorable mention
- Continued work on fast SAT solvers
- Limited to bounded length planning
- (Not great for metric constraints)

IP/LP

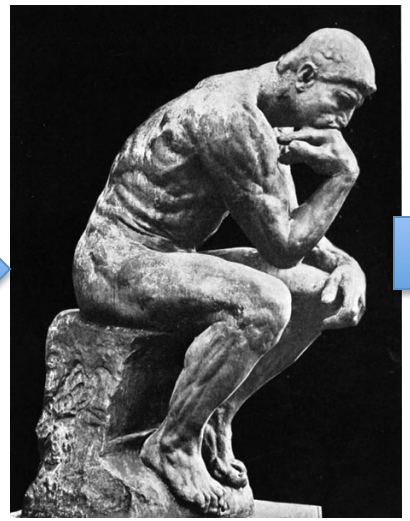
- Followed closely on the heels of SAT
- Can go beyond bounded length planning
  - Allows LP Relaxation
  - (Has become the basis for powerful admissible heuristics)
- IP solvers evolve much slower..

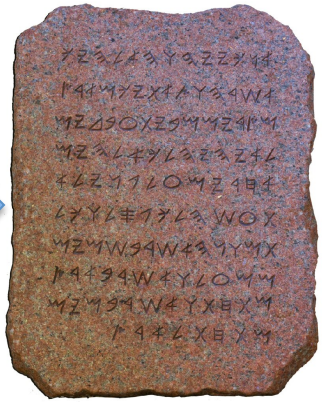
(Classical) Planning

- Tremendous progress on heuristic search approaches to classical planning
- A currently popular approach is to compile expressive planning problems to classical planning
  - Conformant planning, conditional planning
  - (even plan recognition)

Planning: The Canonical View

A fully specified problem
--Initial state
--Goals
(each non-negotiable)
--Complete Action Model



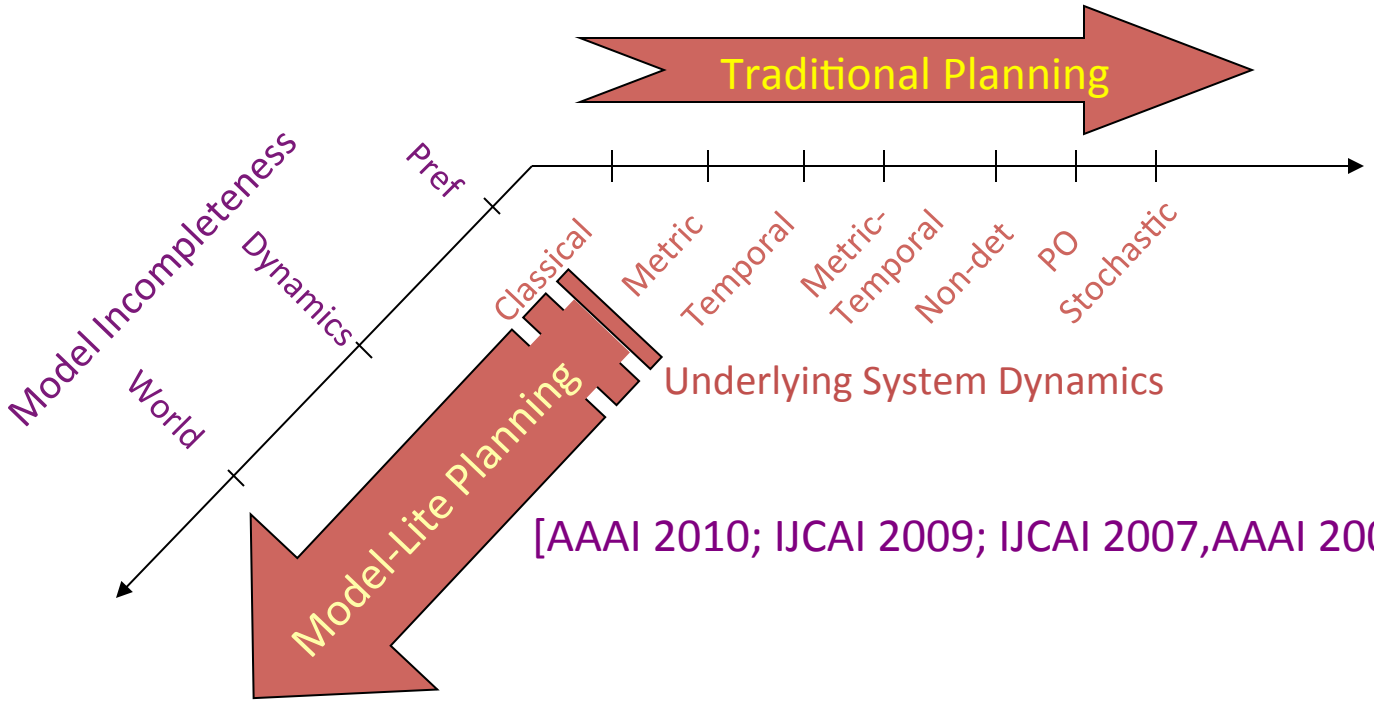


The Plan

Violated Assumptions:
- →~~Complete~~ Action Descriptions (fallible domain writers)
- →~~Fully Specified~~ Preferences (uncertain users)
- →~~Packaged~~ planning problem (Plan Recognition)
- →~~One-shot~~ planning (continual revision)

Planning is no longer a pure inference problem ☹

☹ But humans in the loop can ruin a really a perfect day ☹

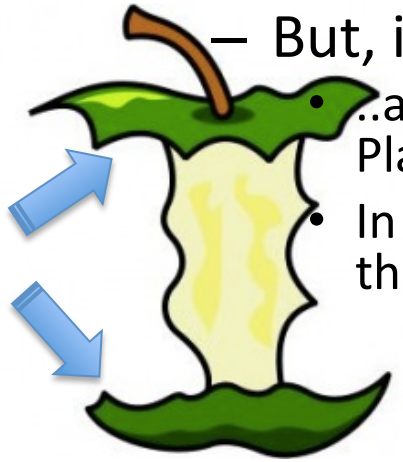


[AAAI 2010; IJCAI 2009; IJCAI 2007,AAAI 2007]

Effective ways to handle the more expressive planning problems by exploiting the deterministic planning technology

Need for Human-in-the-Loop/Human-Aware Planning &Decision Support

- Planners are increasingly embedded in systems that include both humans and machines
  - Human Robot Teaming
    - Petrick et al, Veloso et al, Williams et al, Shah et al, Kambhampati et al
  - Decision support systems; Crowd-planning systems; Tutorial planning systems
    - Allen et al, Kambhampati et al; L
- Necessitates Human-in-the-Loop Planning
  - But, isn't it just "Mixed-Initiative Planning"?
    - ..a lot of old MIP systems had the "Humans in the land of Planners" paradigm (the humans help planners)
    - In effective human-aware planning, planners realize they inhabit the land of humans..



Human-Robot Teaming

- Search and report (rescue)
- Goals incoming on the go
- World is evolving
- Model is changing

- Infer instructions from Natural Language
- Determine goal formulation through clarifications and questions

Crowd-Sourced Planning

TourPlanner Instructions

TOUR REQUEST

Going to New York City for only a day in about a month. Where is a must to eat at that I can make reservations at? With so little time, I don't exactly want to spend it waiting for hours to get seated/get food. Also, what are the must things I should do and see in NYC? Off the beaten path things are preferred! :) I've been to NYC before, so perhaps new speakasies, restaurants and night life recommendations would be awesome.

manhattan_gettingto

- st
- #museum
- ecture
- Have a quick light lunch. Budget is 30$. #lunch
- Do some shopping for a maximum of 2 hours. I can spend upto 300$ on shopping. #shop
- Take a walk in some touristy place. #walk #touristy
- Have dinner and drinks at a good local restaurant. I want to spend a maximum time of 3 hours here. #dinner

TO DO Tags:

manhattan_gettingto

Getting to manhattan

museum

lunch

Existing Activities:

Macys: Awesome clothes and the head quarters (10:00 hrs) (1 hours) #shop

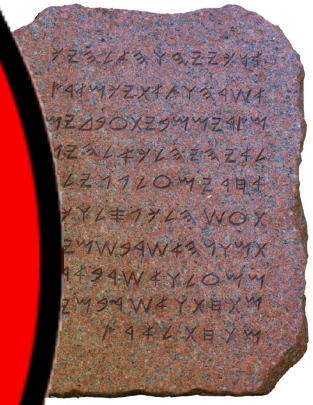
Manhattan: Walk near the NY public library and the charging bull (14:00 hrs) #walk

Add new activity »

Critique existing activity »

Planning: The Canonical View

A fully specified problem
--Initial state
--Goals
(each non-nego
--Complete Action



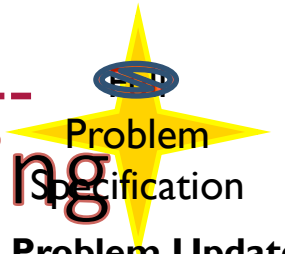
he Plan

Challenges in Human-in-the-Loop/Human-Aware Planning & Decision Support

- Interpret what humans are doing
  - Plan/goal/intent recognition
- Plan with incomplete domain models
  - Robust planning with "lite" models
  - (Learn to improve domain models)
- Continual planning/Replanning
  - Commitment sensitive to ensure coherent interaction
- Explanations/Excuses
  - Excuse generation can be modeled as the (conjugate of) planning problem
- Asking for help/elaboration
  - Reason about the information value

Eigen Slide

Planning for Human-Robot Teaming



Open World Goals
[IROS09, AAAI10, TIST10]

Action Model Information
[HRI12]

Handle Human Instructions
[ACS13, IROS14]

Communicate with Human in the Loop

PLANNER
Sapa Replan

Fully Specified
Action Model

Fully Specified
Goals

Completely Known
(Initial) World State

Problem Updates
[TIST10]

Assimilate Sensor Information

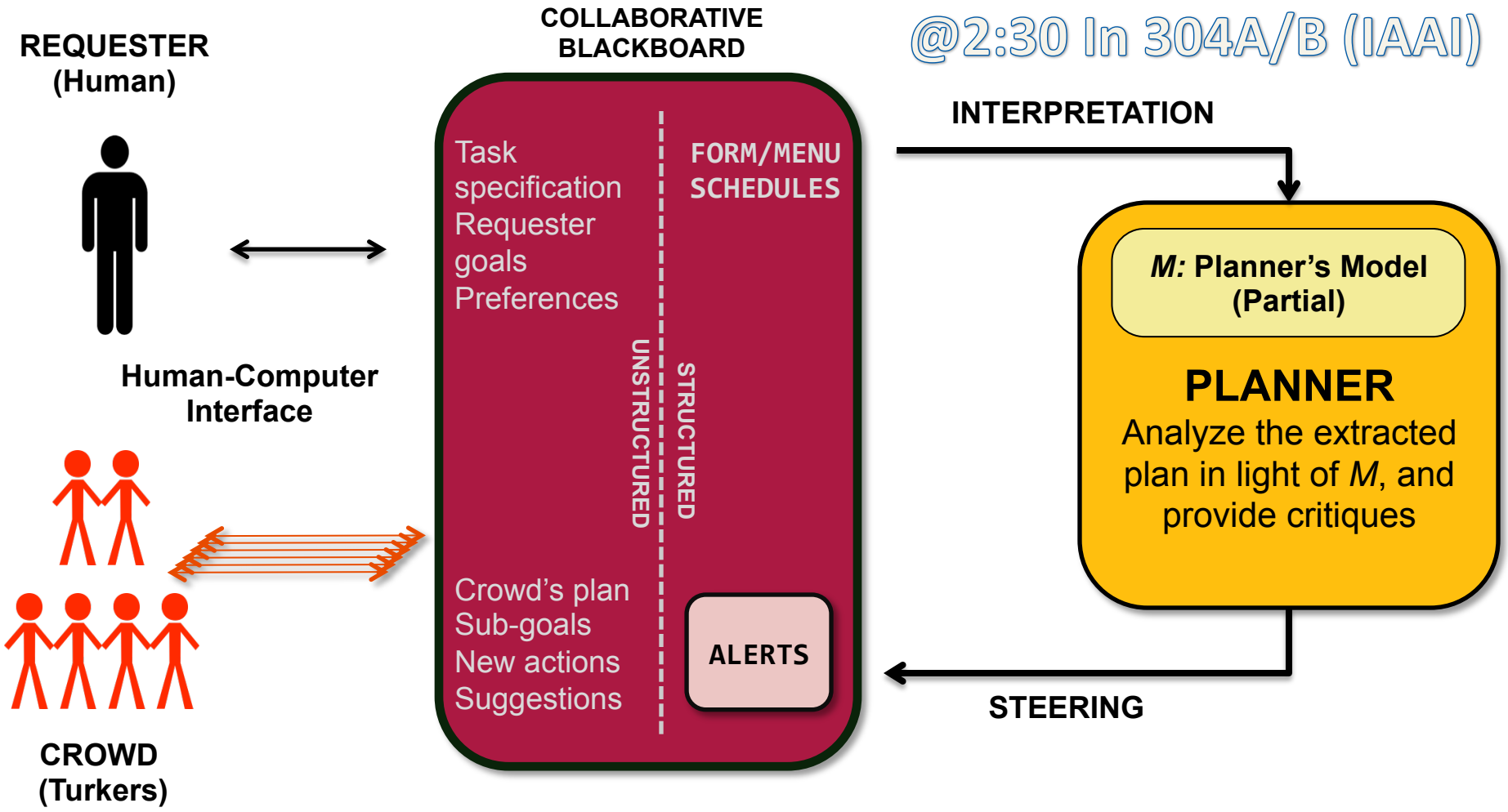
Replan for the Robot
[AAAI10, DMAP13]

Planning for Human-Robot Teaming

Coordinate with Humans
[IROS14]

AI-MIX: System Schematic

Talk this afternoon
@2:30 In 304A/B (IAAI)



Human-in-the-Loop Planning is making inroads at ICAPS..

- Several papers that handle these challenges of Human-Aware Planning have been presented at the recent ICAPS (and AAAI and IJCAI)
  - Significant help from applications track, robotics track and demonstration track
  - Several planning-related papers in non-ICAPS venues (e.g. AAMAS and even CHI) have more in common with the challenges of Human-aware planning
- ..so consider it for your embedded planning applications

AI-MIX: System Schematic

Talk this afternoon
@2:30 In 304A/B (IAAI)