ICAPS 2004
International Planning Competition 2004 (IPC-4)
First Probabilistic Track

Organizers:
Michael L. Littman (Rutgers University)
Håkan L. S. Younes (Carnegie Mellon)

Special Thanks

Organizing Group Members (Rutgers)
- John Asmuth
- David Weissman
- Paul Batchis

Sven and Shlomo

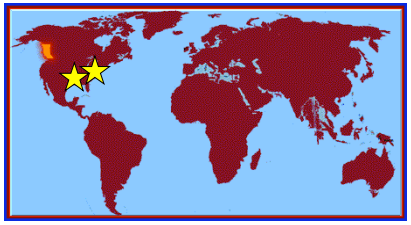
IPC-4 Organizers

NSF

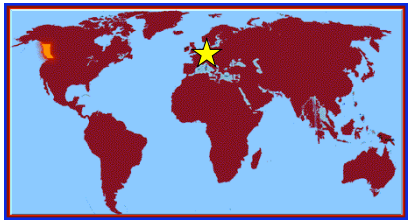
The (very) active participants: ideas, suggestions, hard work

Participants

Group C. UMass
Participants: Zhengzhu Feng (Univ. of Massachusetts)
Eric A. Hansen (Mississippi State Univ.)
Description: Symbolic heuristic search.



Group E. Dresden ("FCPlanner")
Participants: Eldar Karabaev (Dresden Univ. of Tech.)
Olga Skvortsova
Description: First-order value iteration in fluent calculus; domain-specific.



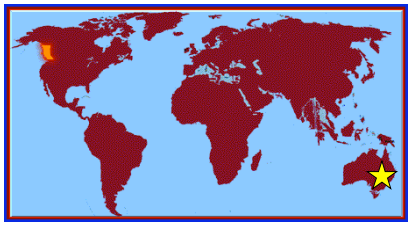
Group G. ANU ("NMRDPP")

Participants: Charles Gretton
David Price (The Australian National U.)
Sylvie Thiébaux

Descriptions:

G1: Planner that exploits non-Markovian rewards.

G2: NMRDPP augmented with control knowledge.



Group J. Purdue

Participants: SungWook Yoon (Purdue University)
Alan Fern
Robert Givan

Descriptions:

J1: Human-written policy in Classy's policy language ("Purdue-Humans").

J2: Offline policy iteration by reduction to classification, automatically acquiring a domain-specific policy ("Classy").

J3: Deterministic replanner using FF ("FF-rePlan").

Group P. Simón Bolívar ("mGPT")

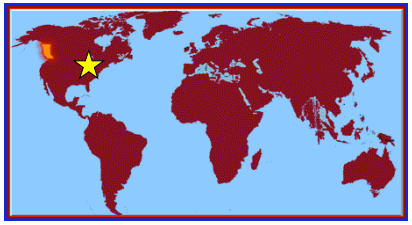
Participants: Blai Bonet (Universidad Simón Bolívar)
Héctor Geffner (Univ. Pompeu Fabra)

Description: Labeled RTDP with lower bounds extracted from the problem description.

Q. Michigan Tech ("Probapop")

Participants: Nilufer Onder (Michigan Tech. Univ.)
Garrett C. Whelan
Li Li

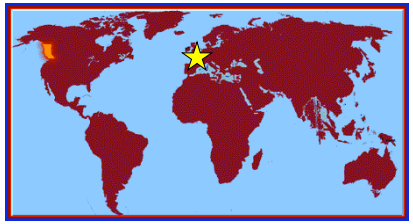
Description: POP-style planner (no sensing).



R. CERT

Participants: Florent Teichteil-Königsbuch
Patrick Fabiani

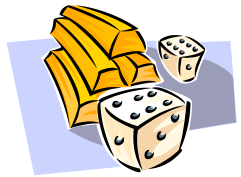
Description: Explicit state enumeration and DBNs, producing value functions.



Probabilistic Features

Main differences from the classical track:

- Actions can have uncertain effects.
- Even optimal plan may sometimes fail.
- Value is action cost plus goal reward.
- No durative actions, derived predicates or functions.
- No separate "optimal".
- Didn't separate plan/execution.
- No unified execution environment.



PPDDL Example

```
(define (domain bomb-and-toilet)
    (:requirements :conditional-effects :probabilistic-effects)
    (:predicates (bomb-in-package ?pkg) (toilet-clogged) (bomb-defused))
    (:action dunk-package
          :parameters (?pkg)
          :effect (and (when (bomb-in-package ?pkg) (bomb-defused))
                       (probabilistic 0.05 (toilet-clogged)))))
(define (problem bomb-and-toilet)
    (:domain bomb-and-toilet)
    (:requirements :negative-preconditions)
    (:objects package1 package2)
    (:init (probabilistic 0.5 (bomb-in-package package1)
                          0.5 (bomb-in-package package2)))
    (:goal (and (bomb-defused) (not (toilet-clogged)))))
```

Evaluation

Participants were presented with twenty problems in PPDDL format.

To evaluate each problem:

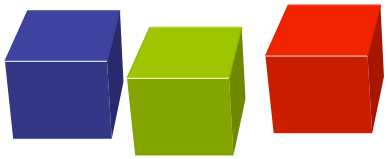
- Connect to server (at CMU or Rutgers).
- Get initial state, provide action.
- Iterate until goal or quit.
- Value: Action costs (if any) & 500 for goal.
- Repeat 30 times in 15 minutes and average.

Blocksworld

Objects: Table and blocks.
Actions: Pick up and put down blocks.
Goal: Make a predetermined stack.
Noise: Blocks may slip onto table when moved.
Costs: Goal version (none) or unit per action.
Notes: Generator provided in advance.
Problems: 5, 8, 11, 15, 18, 21 blocks & goal version.
Policy: Unstack & stack, repeating failed acts.

Colored Blocksworld

Objects: Table and blocks with colors.
Actions: Pick up and put down blocks.
Goal: Make a stack described by color sequence.
Noise: Blocks may slip onto table when moved.
Costs: Goal version (none) or unit per action.
Notes: Generator provided in advance.
Problems: 5, 8 & 11 blocks & goal version in 3 colors.
Policy: Unstack & stack, repeating failed acts.



Boxworld

Objects: Packages and cities (graph).
Actions: Drive or fly, depending on edge.
Goal: Transfer packages to their destinations.
Noise: Get lost driving and go to wrong neighbor.
Costs: Goal version (none) and unit per action.
Notes: Generator provided in advance.
Problems: 10 boxes, 5/10/15 cities (reward, goal).
Policy: Standard, repeating failed acts.

Exploding Blocksworld

Objects: Table and blocks.
Actions: Pick up and put down blocks.
Goal: Make a predetermined stack.
Noise: First put down may trigger explosion,
irretrievably destroying object it was placed on.
Costs: Goal, may become unreachable.
Notes: Must plan ahead to avoid dead end.
Problem: 11 blocks.
Policy: Use "sacrificial" blocks to preserve stack.

File World

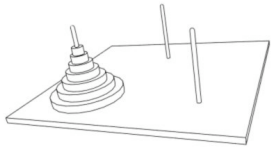
Objects: Folders and files.
Actions: Check destination, get/put folder, put in file.
Goal: Put all files in proper folders.
Noise: Destination chosen randomly when checked.
Costs: Getting folder expensive, filing cheap.
Notes: Reason about the need to gain information.
Problem: 5 folders, 30 files.
Policy: Get folder, put in all appropriate files.

Tire World

Objects: Cities and spare tires.
Actions: Drive, replace flat, pick up spare.
Goal: Reach destination.
Noise: Tire may go flat, requiring replacement.
Costs: Unit costs, high cost for "call AAA".
Notes: Must construct contingent plan to do well.
Problem: 30 cities, reward & goal version (get stuck).
Policy: Drive on longer route, always get a spare!

Towers of Hanoise

Objects: Disks and rods.
Actions: Single, double disk moves.
Goal: Move all disks to Rod 3 from Rod 1.
Noise: Disk may slip and be lost; for doubles, slip probability depends on location of Disk 5.
Costs: Goal, with dead ends.
Notes: Weigh success probability of different paths.
Problem: 5 disks.
Policy: Singles, then doubles after largest disk moved.



Zenotravel

Objects: Plane and cities.
Actions: Fly, zoom.
Goal: Reach destination.
Noise: Different geometric distributions for actions.
Costs: Goal only.
Notes: Adapted from IPC-3, a simple variant.
Problem: 2 cities.
Policy: Repeating any flying action until successful.

Evaluation Tracks: Overall

- Used goal-reward versions of all domains (goal only counted as 500).
- Domains: Blocksworld (7), Colored Blocksworld (2), Boxworld (5), Exploding Blocksworld, File World, Tire World (2), Towers of Hanoise, Zenotravel

Goal-based Domains

- For planners that did not use reward, ignored action costs (maximize probability of reaching goal) with same domains as Overall track.
- Domains: Blocksworld (7), Colored Blocksworld (2), Boxworld (5), Exploding Blocksworld, File World, Tire World (2), Towers of Hanoise, Zenotravel

Overall, Non-Blocks/Box

- Blocksworld and Boxworld dominated the full set and we wanted to see how subtler problems were handled.
- Domains: Exploding Blocksworld, File World, Tire World (2), Towers of Hanoise, Zenotravel

Domain-specific

- "Domain-specific" allowed human tuned rules; "Domain-specific, No Tuning" did not.
- Generated domains: Blocksworld (8), Colored Blocksworld (6), Boxworld (5)

"Blind" Planner

- Planners must produce straightline plans.
- Domains: Blocksworld (7), Colored Blocksworld (2), Boxworld (5), Exploding Blocksworld, File World, Tire World (2), Towers of Hanoise, Zenotravel

Analysis

Some participants only produced results on a subset of problems (due to problem size, language features):

But don't count the other ones as failures, count them as valiant efforts met with less success then they otherwise might have been :)

Encourage sharing: handling of language features.

Wishlist: Next Time?

- Better security, logging on server.
- More focus on interesting domains (simply adding noisy action failures to a deterministic domain not enough); would like to see successful planners in non-Blocksworld domains.
- Natural source of problems—"winner" quite different depending on mix.

Awards/Certificates

Eldar Karabaev and Olga Skvortsova
- Group E. Dresden ("FCPlanner")
- Participation

Charles Gretton, David Price and Sylvie Thiébaux
- Group G1. ANU ("NMRDPP")
- 2nd Place, Overall, Non-Blocks/Box
- Group G2. ANU ("NMRDPP + control knowledge")
- 2nd Place, Domain-specific

Group C. UMass
- Zhengzhu Feng and Eric A. Hansen
- 1st Place, Overall, Non-Blocks/Box

SungWook Yoon, Alan Fern and Robert Givan