Unsolvability IPC Track

Christian Muise [1]   Nir Lipovetzky [2]

[1]Computer Science and Artificial Intelligence Laboratory
Massachusetts Institute of Technology, USA
cjmuise@mit.edu

[2]Department of Computing and Information Systems,
University of Melbourne, Australia
nir.lipovetzky@unimelb.edu.au

THE UNIVERSITY OF
MELBOURNE

Before we begin...

Before we begin...

- Running an IPC is hard (*now we know!*)

Before we begin...

- Running an IPC is hard (*now we know!*)

- Unsolvability is (thankfully still) hard

Before we begin...

- Running an IPC is hard (*now we know!*)

- Unsolvability is (thankfully still) hard

- Kudos to those who made it easier:
    - Florian Pommerening & Jendrik Seipp (& the Basel cluster admins) for **lab** and server support / consultation
    - Malte Helmert for involved FD diagnosis
    - ICAPS for sponsoring the awards
    - All who submitted planners and domains (to be mentioned below) – many who put up with very long email threads!

Motivation

~~Satisficing is too easy~~ To promote techniques that are dedicated at detecting if a planning problem is unsolvable.

Applications

- System verification / diagnosis
- Planning with avoidable deadends
- Identifying human error in encodings
- Components in cellular automata proofs

Details

Scoring

- Primary focus was coverage on unsolvable instances
- Solver disqualified on a domain for an incorrect result

    Didn't happen once!

Details

Scoring

- Primary focus was coverage on unsolvable instances
- Solver disqualified on a domain for an incorrect result

Didn't happen once!

Ideal Benchmark Properties

1. Mix of solvable and unsolvable instances
2. No syntactic distinction between them
3. At least some solvable problems are hard

Details

Scoring

- Primary focus was coverage on unsolvable instances
- Solver disqualified on a domain for an incorrect result

Didn't happen once!

Ideal Benchmark Properties

1. Mix of solvable and unsolvable instances
2. No syntactic distinction between them
3. At least some solvable problems are hard

Benchmarks

Sourced from deadend states of classical problems, ~~width-based classical encodings~~, oversubscribed problems, new domains, etc.

Submissions

Domains (15)

- 3 from existing set
- 12 newly submitted (or modified) domains

Planners (11+1)

- 14 teams expressed interest
- 11 teams submitted
- 4 labs represented

Reused Unsolvable Domains

- **bottleneck**: Move around a grid; never revisit a spot

- **pegsol**: Classic game – hop a peg, remove the hopped

- **sliding-tiles**: Classic game – slide tiles to open space.
  Reversing two tiles causes the problem to be unsolvable

Over-subscribed Set

Thanks Marcel Steinmetz, Hootan Nakhost,
Jörg Hoffmann, Martin Mueller

Idea Constrains the problem via a set of tunable
parameters. Most importantly for the contest,
"constrainedness" < 1 makes the problem
unsolvable (i.e., 0.999 is very nearly solvable)

Input Domains nomystery, tpp, rovers

Bagged Problems

Thanks   Patricia Riddle and Mike Barley

Idea   Reformulates the problem using a bagged representation

Input Domains   transport, gripper, barman

Documents, Diving, and Diagnostics

- **document-transfer** (*Thanks to Jordan Douglas*): Need to deliver documents, but can also use them to fuel the travel.

- **diving** (*Thanks to Charles Gretton, Nathan Robinson, CM*): Need to photograph certain locations, but air tanks are a precious resource that aren't always there.

- **diagnosis** (*Thanks to Patrik Haslum*): Encodings of diagnosis problems for control of power plans / autonomous helicopters.

Baffling Board Games

- **tetris** (*Thanks to Mauro Vallati*): Moving tetris pieces around until the board is cleared.

- **pegsol-row5** (*Thanks to Florian Pommerening and Malte Helmert*): Must get 5 rows up on a board, but the task is mathematically impossible.

- **chessboard-pebbling** (*Thanks to Florian Pommerening*): Must clear the bottom corner of an infinite chessboard.

Planners (1/3)
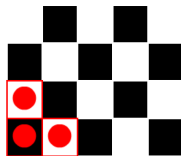
- **ReachLunch** (*Tomas Balyo, Martin Suda*)
  6min DFS phase, followed by Property Directed Reachability

- **iProverPlan** (*Konstantin Korovin, Martin Suda*)
  Theorem prover for a lifted (1st-order) SAT-as-planning encoding

- **SymPA** (*Alvaro Torralba, Jörg Hoffmann*)
  Symbolic search using PDBs and perimeters
    - **irr** variant removes irrelevant operators found with M&S

- **M+S** (*Alvaro Torralba, Jörg Hoffmann*)
  M&S with linear merges and perfect shrinking (optionally **irr**)

Planners (2/3)

- **SimDominance** (*Alvaro Torralba, Jörg Hoffmann*)
  M&S with multiple merge strategies. A* with h^1 / dominance pruning

- **DECS** (*Daniel Gnad, Jörg Hoffmann*)
  Decoupled search with an X-shape topology using A* and h^{max}

- **Django** (*Daniel Gnad, Jörg Hoffmann*)
  Performs incremental red-black search using A* and h^{max}.

- **CLone** (*Marcel Steinmetz, Jörg Hoffmann*)
  DFS using Critical-Path Driven Clause Learning

Planners (3/3)

- **Aidos** (*Jendrik Seipp, Florian Pommerening, Silvan Sievers Martin Wehrle, Chris Fawcett, Yusra Alkhazraji*)
  Portfolio using stubborn sets and combination of (1) DE PDBs (2) LP with potentials (3) projected "depletable resources"
  - **v1** distributes time according to experiments; **v2** distributes uniformly; and **v3** distributes to maximize coverage / time

- **h^{++}** (*Patrik Haslum*)
  Incrementally improves lower bounds until h$^+$ is unsolvable

- **DE-PDB** (*Florian Pommerening, Jendrik Seipp*)
  $\frac{1}{2}$ time spent on building DE PDB and $\frac{1}{2}$ spent on DFS with pruning

- **blind**
  Eager blind search using the latest FD

Results (out of 340 problems)

Runner Up

Winner

Results (out of 340 problems)

Runner Up – **SymPA**

irr	239	Alvaro Torralba
base	227	Jörg Hoffmann

Winner

Results (out of 340 problems)

Runner Up – SymPA

irr	239	Alvaro Torralba
base	227	Jörg Hoffmann

Winner – **Aidos**

		Jendrik Seipp
v1	262	Florian Pommerening
v2	259	Silvan Sievers
v3	250	Martin Wehrle
		Chris Fawcett
		Yusra Alkhazraji
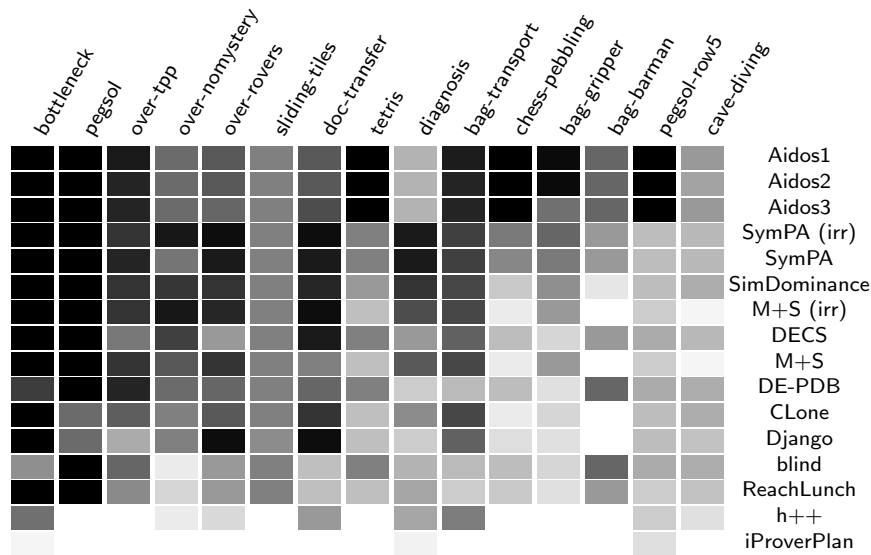
Results
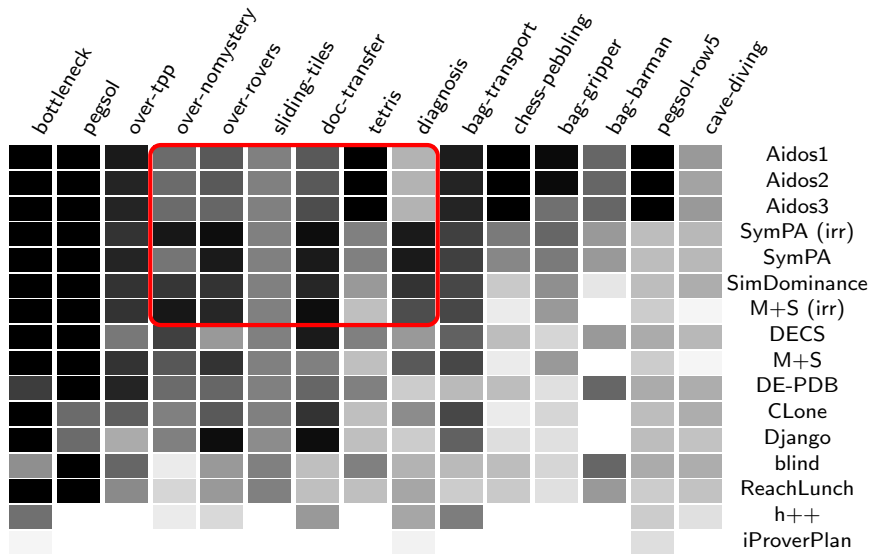
Results
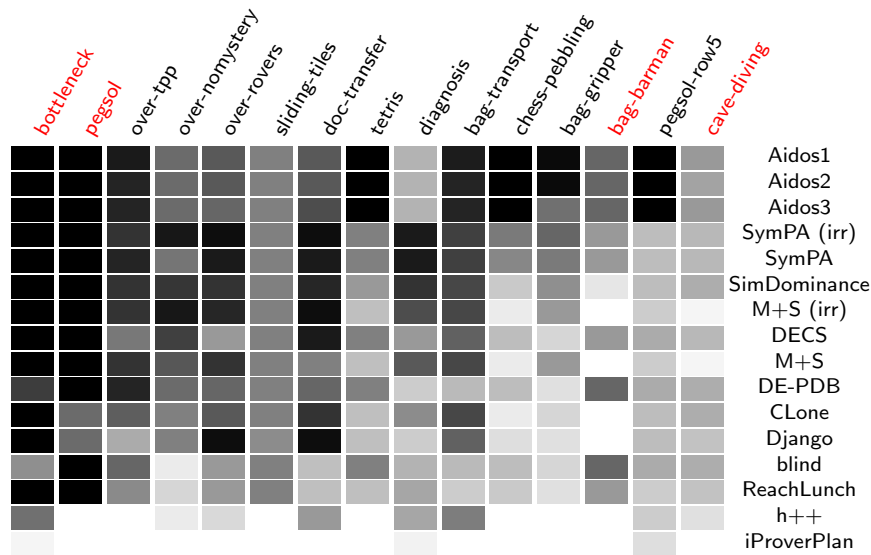
Unknown Known Results

Domain Team	SymPA (irr)	SimDominance	SymPA	CLone	DECS
document-transfer	5	1	0	0	0
diagnosis	2	3	3	2	2
TOTAL:	7	4	3	2	2

Table: Unknowns solved (Part 1)

Domain Team	Aidos3	Aidos2	Aidos1	Django	M+S (irr)
document-transfer	0	0	0	0	1
diagnosis	1	1	1	1	0
TOTAL:	1	1	1	1	1

Table: Unknowns solved (Part 2)

Next Steps

To be released on `unsolve-ipc.eng.unimelb.edu.au`

- Git repo of solvers / domains / eval setup / etc

- DataJoy project of all the statistics / analysis

- Planner descriptions (extended abstracts)

Next Steps

To be released on `unsolve-ipc.eng.unimelb.edu.au`

- Git repo of solvers / domains / eval setup / etc

- DataJoy project of all the statistics / analysis

- Planner descriptions (extended abstracts)

UNSOLVE-IPC-2018

Any takers?

Thanks again to all who participated, submitted domains, provided server support, played devil's advocate[1], encouraged the endeavour, etc.

---

[1] if LAMA doesn't solve in 30min; return "unsolvable"