



Results of IPC2011

Learning Part

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Motivation for the Learning Part



- ▶ Deterministic Part
 - Planning from scratch (**deductive** inference)
- ▶ Learning Part
 - Planning exploiting past experience (**inductive** inference)

Work in both directions (**deductive/inductive**) is complementary



Format of the Competition

1. Learning Stage @participants
 - ▶ Systems learn **Domain Specific Knowledge (DSK)**
2. Testing Stage @organizers
 - ▶ Evaluation of systems **with** and **without** learned **DSK**



1. Learning Stage

Learning Stage

For each domain, participants are provided with

- ▶ The **domain** definition
- ▶ A problem **generator**
- ▶ The distribution of the **test problems**



1. Learning Stage

Domains

9 domains

- ▶ Represented in the STRIPS fragment of PDDL
- ▶ New domains: Barman, Spanner
- ▶ Domains from previous IPCs: Gripper, Blocksworld, Satellite, Rover, Parking, Depots, TPP



1. Learning Stage

Problem Generator

Participants can implement their own strategies for exploring the domain

- ▶ They can generate their own set of learning examples
- ▶ They can evaluate the learned knowledge



1. Learning Stage

Test problems

Participants do **not know** the set of **test problems** but they **know** the **distribution** of these problems

- ▶ Challenging for IPC2008 state-of-art planners
 - Large problems (from 50 to 100 blocks in the blocksworld)
 - *Relaxing deletes* misses key knowledge
- ▶ Room for learning
 - Accessible when using effective past experience



1. Learning Stage

Format of the Competition

1. Learning Stage @participants [February 1st - March 10th]
 - ▶ Systems learn **Domain Specific Knowledge (DSK)**
2. Testing Stage @organizers
 - ▶ Evaluation of systems **with** and **without** learned DSK



2. Testing Stage

Testing Stage

- ▶ 15 minute time limit per problem
- ▶ Evaluation of two dimensions: **Quality** and **Time**
- ▶ For each dimension
 - **Planning performance** with DSK
 - **Learning performance**



2. Testing Stage

Learning Performance

Which one is the best learner?

Planner	Base performance	DSK performance
A	10	15
B	5	10

- ▶ $\Delta \text{ performance} = (\text{DSK performance} - \text{Base performance})$
- ▶ $\Delta \text{ performance}$ is not enough, $\Delta \text{ performance}(A)=5$ $\Delta \text{ performance}(B)=5$
- ▶ **New metric!!!** *Pareto Ranking*¹ for $(\text{Base performance}, \Delta \text{ performance})$

¹Number of planners by which it is *Pareto dominated*

Outline

Motivation

Competition Format

1. Learning Stage
2. Testing Stage

Results

Awards



Participants

1. OALDAEYASHP

Matyas Brendel, Marc Schoenauer

2. Fast-Downward-Autotune-quality

Chris Fawcett, Malte Helmert, Holger Hoos, Erez Karpas, Gabriele Röger, Jendrik Seipp

3. Fast-Downward-Autotune-speed

Chris Fawcett, Malte Helmert, Holger Hoos, Erez Karpas, Gabriele Röger, Jendrik Seipp

4. Bootstrap-Planner

Shahab Jabbari Arfaee, Robert C. Holte, Sandra Zilles

5. Par-LPG

Mauro Vallati, Chris Fawcett, Alfonso E. Gerevini, Holger H. Hoos, Alessandro Saetti

6. PbP2.quality

Alfonso E. Gerevini, Alessandro Saetti, Mauro Vallati

7. PbP2.speed

Alfonso E. Gerevini, Alessandro Saetti, Mauro Vallati

8. CBL

Bharat Ranjan Kavuluri, R. Anand Kumar



Quality - Planning performance

Planning performance with learned DSK, **metric:** Q^*/Q

planner	rover	blocksworld	satellite	gripper	spanner	barman	tpp	depots	parking	total
PbP2.q	28.00	29.47	29.95	29.93	30.00	30.00	0.00	9.01	4.09	190.45
FD-autotune-speed	24.18	13.09	15.72	28.76	0.00	26.91	25.24	20.00	17.34	171.22
PbP2.s	19.28	20.91	26.46	27.47	30.00	28.36	0.00	11.53	0.00	164.01
parLPG-speed	21.36	21.50	28.52	28.57	30.00	0.00	7.42	8.31	0.00	145.69
lama-2011	24.69	21.83	10.96	0.00	0.00	1.86	19.99	0.00	3.75	83.08
FD-autotune-quality	22.78	13.16	6.67	0.00	0.00	0.00	12.38	0.00	9.00	63.99
BootstrapPlanner	0.00	10.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.83
OALDAEYASHP	0.00	3.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.75
CBL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
total	140.29	134.54	118.28	114.72	90.00	87.13	65.03	48.85	34.18	

Detailed results available at the competition website



Quality - Learning performance

Learning performance, **metric**: accumulated Pareto rankings

planner	barman	blocksworld	depots	gripper	parking	rover	satellite	spanner	ttp	total
PbP2.q	0	0	35	1	18	2	0	0	10	66
parLPG-speed	69	16	25	10	33	15	12	0	3	183
PbP2.s	26	21	27	18	27	43	13	0	17	192
FD-autotune-speed	4	62	9	0	5	24	23	90	0	217
FD-autotune-quality	69	49	54	119	10	28	54	90	2	475
OALDAEYASHP	69	113	54	119	33	90	65	90	11	644
BootstrapPlanner	69	80	54	119	33	110	80	90	28	663
CBL	69	132	54	119	33	110	80	90	28	715
total	375	473	312	505	192	422	327	450	99	

Detailed results available at the competition website



Time - Planning performance

Planning performance with learned DSK, **old metric:** T^*/T

✗ If big differences between T^* and $T \rightarrow$ many scores become closer to 0

planner	barman	tpp	rover	spanner	gripper	blocksworld	satellite	parking	depots	total
PbP2.s	28.50	0.00	24.00	30.00	29.00	29.00	28.00	0.00	21.00	189.50
FD-autotune-speed	2.52	27.00	3.37	0.00	0.07	0.25	0.09	20.00	4.00	57.31
parLPG-speed	0.00	11.05	3.95	0.48	1.33	1.00	2.07	0.00	0.12	20.00
PbP2.q	15.34	0.00	0.28	0.00	0.02	0.00	0.13	1.99	0.00	17.77
FD-autotune-quality	0.00	1.45	1.58	0.00	0.00	0.02	0.02	2.53	0.00	5.60
lama-2011	0.00	2.81	0.91	0.00	0.00	0.06	0.01	0.90	0.00	4.69
BootstrapPlanner	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
OALDAEYASHP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CBL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
total	46.36	42.31	34.10	30.48	30.43	30.34	30.32	25.42	25.12	

Detailed results available at the competition website



Time - Planning performance

Planning performance with learned DSK, **metric:** $\frac{1}{(1+\log_{10}(T/T^*))}$

planner	blocksworld	rover	satellite	barman	gripper	tpp	spanner	depots	parking	total
PbP2.s	29.00	24.00	28.00	28.77	29.00	0.00	30.00	21.00	0.00	189.77
FD-autotune-speed	12.55	13.53	6.77	14.30	9.35	28.57	0.00	10.57	20.00	115.63
parLPG-speed	17.13	16.82	17.59	0.00	15.82	13.16	15.95	8.62	0.00	105.09
PbP2.q	7.88	8.18	10.30	22.89	7.96	0.00	7.59	3.05	3.46	71.31
lama-2011	10.56	10.04	3.51	0.52	0.00	10.58	0.00	0.00	2.77	38.00
FD-autotune-quality	8.14	11.25	1.92	0.00	0.00	6.81	0.00	0.00	5.72	33.84
OALDAEYASHP	5.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.70
BootstrapPlanner	3.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.28
CBL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
total	94.23	83.83	68.09	66.48	62.13	59.13	53.54	43.24	31.95	

Detailed results available at the competition website



Time - Learning performance

Learning performance, **metric**: accumulated Pareto rankings

planner	barman	blocksworld	depots	gripper	parking	rover	satellite	spanner	tpp	total
FD-autotune-speed	4	9	11	0	0	13	15	40	0	92
parLPG-speed	89	0	14	0	32	6	0	0	19	160
PbP2.q	2	41	28	30	18	34	13	24	20	210
PbP2.s	1	69	40	32	27	58	30	30	50	337
FD-autotune-quality	89	27	47	64	12	8	53	40	30	370
OALDAEYASHP	89	66	47	64	32	74	66	40	57	535
BootstrapPlanner	89	64	47	64	32	96	69	40	70	571
CBL	89	102	47	64	32	96	69	40	70	609
total	452	378	281	318	185	385	315	254	316	

Detailed results available at the competition website



Runner-up

FD-autotune-speed

Chris Fawcett, Malte Helmert, Holger Hoos, Erez Karpas, Gabriele Röger, Jendrik Seipp



Winner

PbP2.quality

Alfonso E. Gerevini, Alessandro Saetti and Mauro Vallati



Coverage

planner with DSK	blocksworld	rover	satellite	gripper	barman	spanner	tpp	depots	parking	total
FD-autotune-speed	29.00	30.00	19.00	30.00	30.00	0.00	30.00	20.00	20.00	208.00
PbP2.q	30.00	28.00	30.00	30.00	30.00	30.00	0.00	10.00	5.00	193.00
PbP2.s	29.00	24.00	28.00	29.00	29.00	30.00	0.00	21.00	0.00	190.00
parLPG-speed	30.00	27.00	30.00	30.00	0.00	30.00	15.00	17.00	0.00	179.00
lama-2011	29.00	30.00	13.00	0.00	2.00	0.00	20.00	0.00	5.00	99.00
FD-autotune-quality	27.00	30.00	7.00	0.00	0.00	0.00	14.00	0.00	9.00	87.00
OALDAEYASHP	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.00
BootstrapPlanner	11.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.00
CBL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
total	205.00	169.00	127.00	119.00	91.00	90.00	79.00	68.00	39.00	

planner	rover	blocksworld	satellite	tpp	gripper	spanner	barman	parking	depots	total
PbP2.s	22.00	22.00	29.00	14.00	30.00	25.00	28.00	4.00	6.00	180.00
PbP2.q	19.00	23.00	29.00	15.00	29.00	22.00	28.00	5.00	4.00	174.00
parLPG-speed	28.00	24.00	30.00	1.00	30.00	30.00	0.00	0.00	11.00	154.00
lama-2011	30.00	29.00	13.00	20.00	0.00	0.00	2.00	5.00	0.00	99.00
FD-autotune-speed	30.00	22.00	4.00	30.00	0.00	0.00	0.00	5.00	0.00	91.00
OALDAEYASHP	29.00	21.00	11.00	10.00	0.00	0.00	0.00	0.00	0.00	71.00
FD-autotune-quality	13.00	10.00	10.00	12.00	0.00	0.00	0.00	4.00	0.00	49.00
BootstrapPlanner	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CBL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
total	171.00	151.00	126.00	102.00	89.00	77.00	58.00	23.00	21.00	

Detailed results available at the competition website





Conclusions

- ✓ New metric for evaluating learning performance
- ✓ Refined metric for evaluating planning time performance
- ✓ Learned DSK improved coverage in 7 out of 9 domains and in 6 out of 8 systems
- ✓ 4 Learning systems outperformed coverage of the winner of the deterministic part¹
- ✗ Robustness is still an issue, learning still damages base performance

¹Results obtained with a time limit of 15 minutes



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Runner-up



XXI ICAPS Conference
11–16th June, 2011 · Freiburg, Germany

Runner-up of the Seventh International Planning Competition Award

The IPC Council and the Chairs of the Learning Part
proudly present the award for

Runner-up of the *Learning Part* to: **Fast-Downward-Autotune-speed**

Chris Fawcett Malte Helmert Holger Hoos
Erez Karpas Gabriele Röger Jendrik Seipp

Derek Long
Head of the IPC Council

Sergio Jiménez Celorrio
Co-chair of Learning Part IPC 2011

Amanda Coles
Co-chair of Learning Part IPC 2011

Andrew Coles
Co-chair of Learning Part IPC 2011



Winner



XXI ICAPS Conference
11–16th June, 2011 · Freiburg, Germany

Winner of the Seventh International Planning Competition Award

The IPC Council and the Chairs of the Learning Part
proudly present the award for

Winner of the *Learning Part* to: **PbP2.quality**

Alfonso E. Gerevini Alessandro Saetti Mauro Vallati

Derek Long
Head of the IPC Council

Sergio Jiménez Celorrio
Co-chair of Learning Part IPC 2011

Amanda Coles
Co-chair of Learning Part IPC 2011

Andrew Coles
Co-chair of Learning Part IPC 2011



Results of IPC2011

Learning Part

Organizers: Sergio Jiménez Celorrio, Amanda Coles and Andrew Coles

June, 2011