Competition of Distributed and Multiagent Planners (CoDMAP)

http://agents.cz/codmap

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Motivation

Aims

- consolidate the distributed and multi-agent planners in terms of input format and formalism.
- a proof-of-concept of a potential future IPC track on multi-agent planning.
- to bring closer the classical and multi-agent planning communities.

Context

- various forms of multi-agent planning have recently found their way to the ICAPS community (main track, DMAP workshop)
- no IPC track on multi-agent planning so far
- wide variety of actual problems the term multi-agent planning covers (e.g., online planning modeled as Dec-POMDPs)

Focus (CoDMAP TL;DR)

- (Brafman and Domshlak 2008) domain-independent multiagent planning (slightly generalized)
- MA-STRIPS (STRIPS-like model) via MA-PDDL
  - fully observable
  - STRIPS actions (distinct sets for different agents)
  - init & common goals
- cooperative agents (common goals)
- offline planning
- multi-agent planning for the very multi-agent system
  - $\rightsquigarrow$ each agent planning for itself
  - $\rightsquigarrow$ distributed problem solving with distributed execution
  - $\rightsquigarrow$ "IPC multi-core track without shared memory": TCP/IP
- evaluation: coverage, quality (total count, makespan), time

MA-STRIPS

Formalization

Minimal extension of MA-STRIPS toward multi-agent planning:

$$\text{STRIPS } \langle P, A, I, G\rangle \rightsquigarrow \text{MA-STRIPS } \langle P, \{A_i\}_{i=1}^{n}, I, G\rangle$$

- n agents defined by their actions
- STRIPS actions: $a = \langle \mathsf{pre}(a), \mathsf{add}(a), \mathsf{del}(a)\rangle, a \in A_i$
- factorization: n action sets, ag. k can use only actions in A_k
- privacy:
  $p \in P$ is *public*, if $p \in \mathsf{facts}(a_i) \cap \mathsf{facts}(a_j)$ and $a_i \in A_i$, $a_j \in A_j$ and $i \neq j$,
  otherwise p is *private* to agent k s.t. $p \in \mathsf{facts}(a_k)$ for some $a_k \in A_k$.

$$\mathsf{facts}(a) = \mathsf{pre}(a) \cup \mathsf{add}(a) \cup \mathsf{del}(a)$$

Properties

Actions

- non-durative
- deterministic

Privacy

- pragmatics of public/private separation defined weakly
- $\rightsquigarrow$ agents do not know, observe, use foreign private information

MA-PDDL

Variants

Minimal extension of PDDL (3.1) to describe MA-STRIPS problems.

Factored Privacy

- :factored-privacy

Unfactored Privacy

- :unfactored-privacy and :multi-agent

Privacy Semantics

The privacy is semantically defined over grounded facts, based on a set of rules common to both variants:

1. A public predicate definition grounded with public objects/constants is a public fact.
2. A public predicate definition grounded with at least one object/constant private to agent α is a private fact of agent α (grounding a single predicate definition with objects private to different agents is not allowed).
3. A private predicate grounds to a private fact regardless of privacy of the objects used for grounding.

Factored Privacy

- :factored-privacy (privacy extension)
- each agent has its separate domain and problem files
- each containing only the particular agent's factor
  - public predicates (functions, constants)
  - agent's private predicates (functions, constants)
  - agent's actions A_i
- private elements are enclosed in (:private ...)

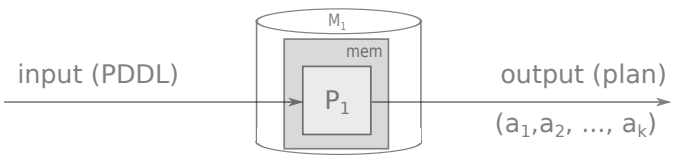
Unfactored Privacy

- :multi-agent (factorization extension)
- :unfactored-privacy (privacy extension)
- single domain and problem file for all agents
- agents are defined as object/constant
- each action is extended by a special parameter defining the agent:
  :agent ?a
- private elements for a particular agent are enclosed in
  (:private <agent> ...)

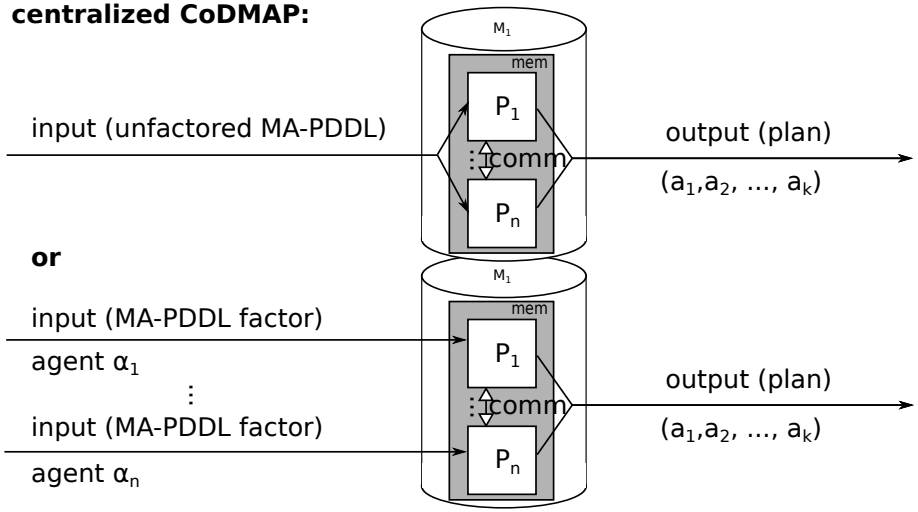
Competition

Competition Tracks

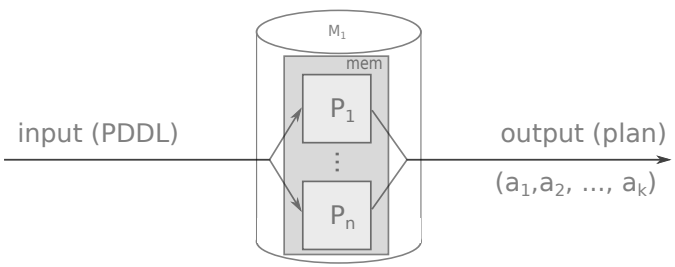
classical IPC:



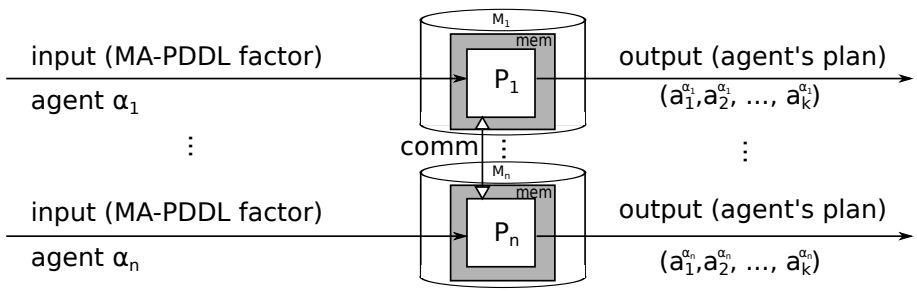
centralized CoDMAP:



multi-core IPC:



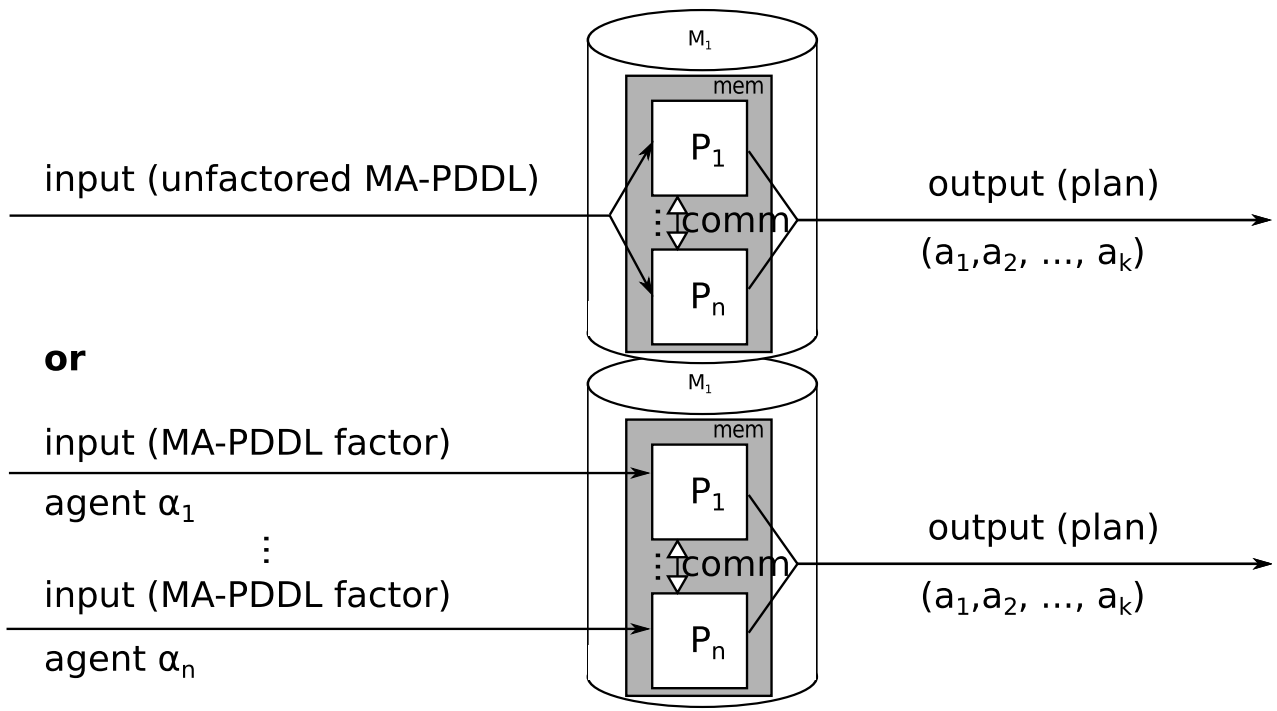
distributed CoDMAP:



Centralized "Transitional" Track

Aiming for maximal compatibility with IPC and existing planners.

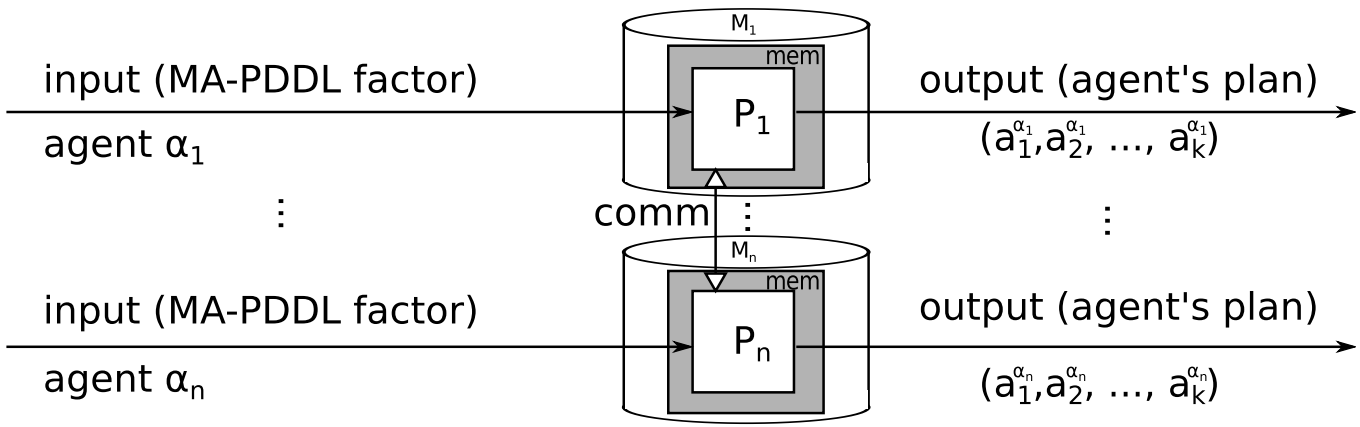
- both factored or unfactored privacy input
- any communication (incl. shared memory)
- any factorization allowed, one output plan



Distributed "Experimental" Track

Aiming for a proper multi-agent setting.

- only factored privacy input
- only TCP/IP communication
- defined factorization & output (coordinated) plans



Evaluation

- 12 benchmark domains (two unknown to the participants)
- each domain with 20 problems
- max 10 agents per problem
- 30 minutes, 8GB memory limit and 4 cores per machine

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Metrics

- coverage over all domains and problems (max 240)
- IPC score over the plan quality Q (sum over all problems Q^*/Q, where Q^* is the cost of optimal plan or of the best plan found by any of the planners)
- IPC score over the planning time T
- in *the distributed track*: total cost (sum of costs of all used actions) and makespan (the maximum timestep of the plan if executed in parallel)

Results (cvg)

- Centralized: 8 teams, 12 planners, 17 configurations
- Distributed: 3 teams, 3 planners, 6 configurations

Centralized		PSM-VRD [6]	171
ADP-legacy [8]	222	MADLA [1]	154
ADP [8]	218	PMR [2]	149
SIW→BFS [7]	216	MAPR-p [2]	140
CMAP-t [2]	210	PSM-VR [6]	113
DFS+ [7]	208	MH-FMAP [4]	102
Anyt-LAPKT [7]	207	MAPlan/LMc [5]	79*
CMAP-q [2]	204	MAPlan/maLMc [5]	71*
MAPlan [5]	191	MARC [9]	1

Distributed	
PSM-VRD [6]	180
MAPlan [5]	174
MH-FMAP [4]	107
PSM-VR [6]	99
MAPlan/LMc [5]	75*
MAPlan/maLMc [5]	52*

* optimal

Interactive results will be available at the competition webpage:

http://agents.cz/codmap

CoDMAP as a Future IPC Track

- towards a new multi-agent track for the next IPC
- ideally the format of the CoDMAP Distributed Track
- new multi-agent specific domains & problems
- extensions: joint actions, private goals, pair-wise privacy, etc.
- enhancements and modifications according to the experience with the current competition and feedback we received

We would like to thank to all participants.
Thank you!

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