

Heterogeneous
Distributed
Cooperative
Problem Solving System

HELIOS

Institute for
New Generation
Computer Technology

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Background

HELIOS -

FGCS project / its Follow-on project

Languages

Quixote, GDCC, KL1, ...

applications

Legal Reasoning,
Genetic Information Processing,
...

Problem: How to solve more complex problems
How to represent problems more efficiently

Motivation

HELIOS -

Biological knowledge

- sequence
- function
- statistics
- ambiguous data
- ...

Legal reasoning

- text
- abstracted rule
- inconsistent knowledge
- negotiation
- algebraic computation
- ...



heterogeneous/cooperative
databases/constraints/systems/...

Motivation of HELIOS

HELIOS -

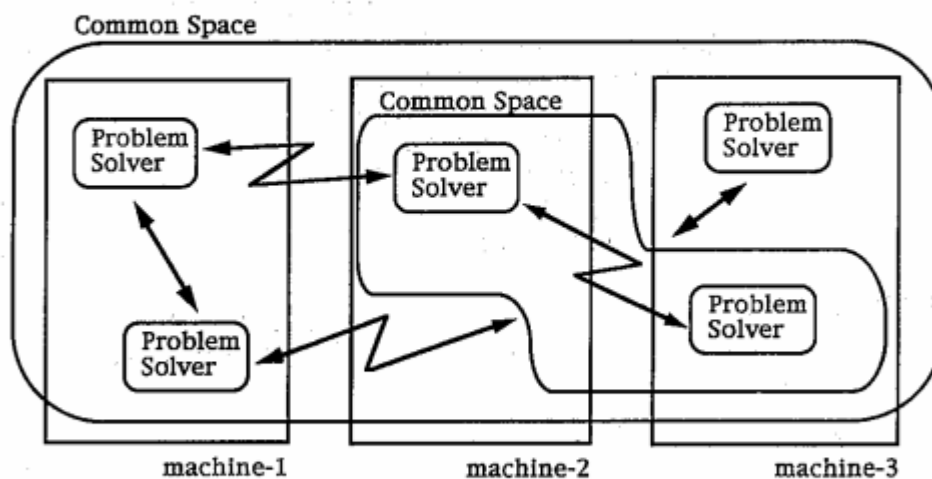
Huge system for
knowledge information processing:

- Three kinds of Heterogeneity
 - Model Heterogeneity
 - Spatial Heterogeneity
 - Temporal Heterogeneity
 - Resource Bound Environment
- ➔ Cooperation

Logical Model of HELIOS

HELIOS -

Intuitive Framework

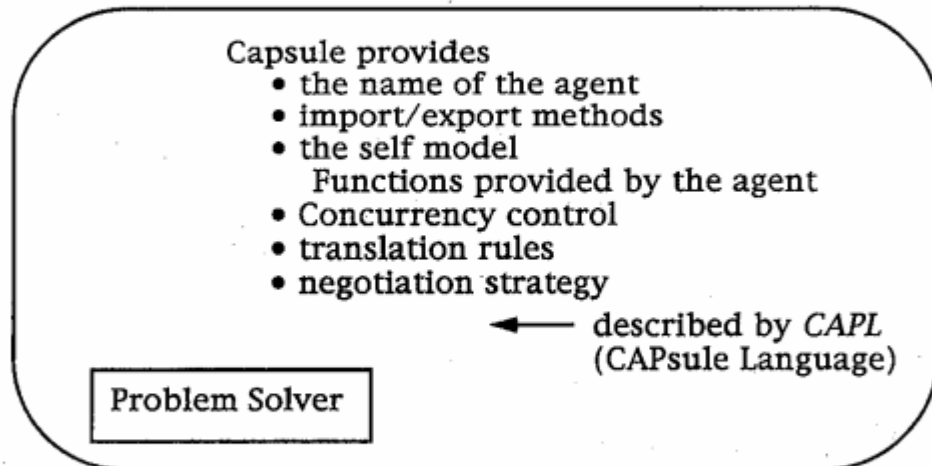


Logical Model of HELIOS

HELIOS ■

Capsule, Agent, and Environment

Agent

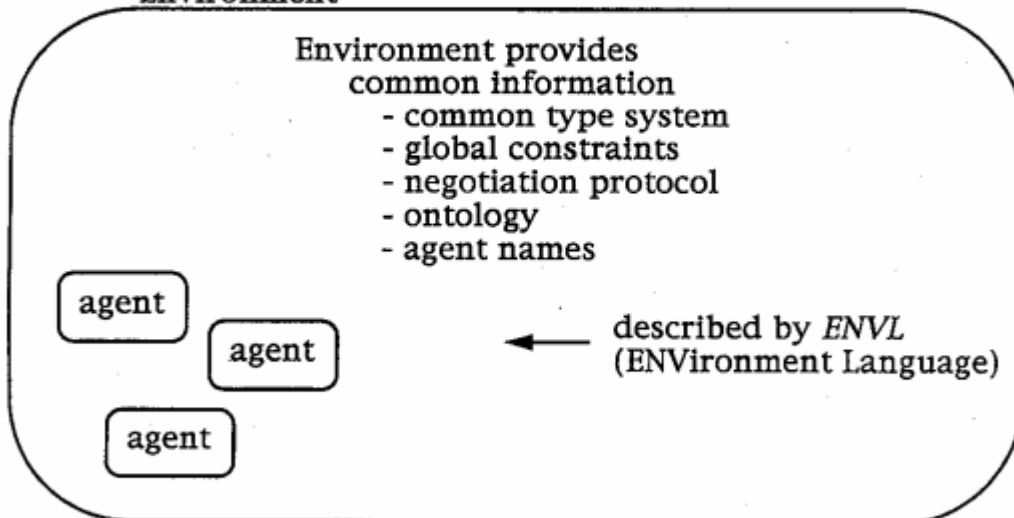


Logical Model of HELIOS

HELIOS ■

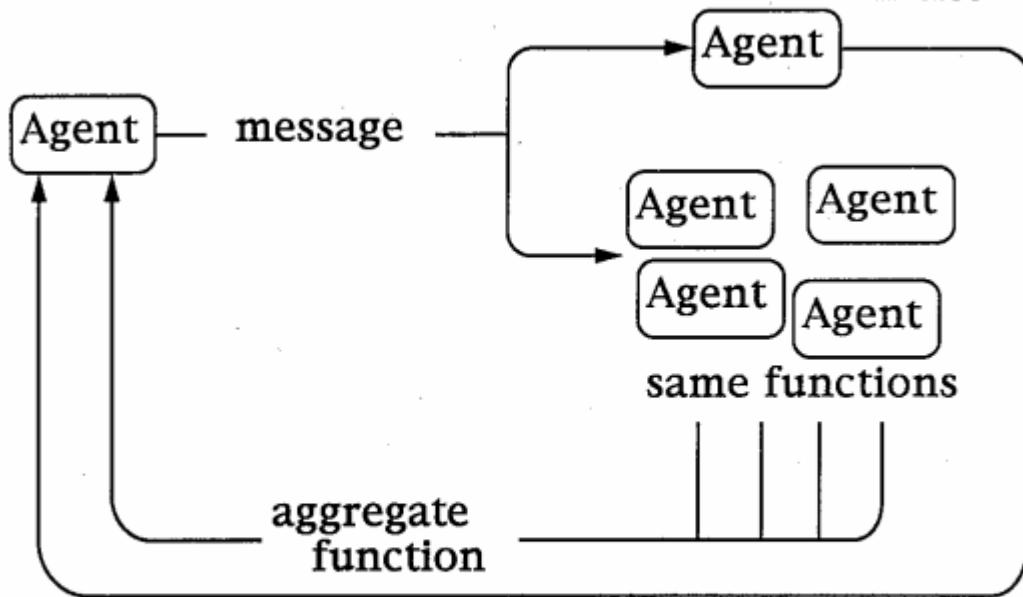
Capsule, Agent and Environment

Environment



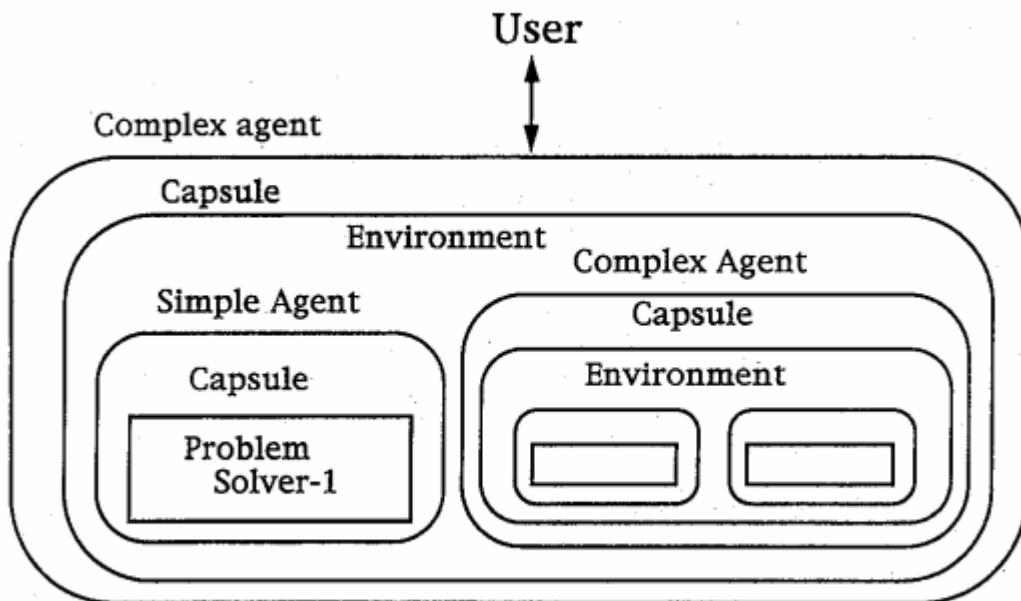
Delivering Messages

HELIOS -



Basic Model for HELIOS

HELIOS -



Implementation of HELIOS

HELIOS -

- Experimental version (Jan. 1994)

Using SICStus Prolog & Expect on UNIX workstation

- Version 1 (July 1994)

Using C language on UNIX workstations

- Version 2 (November 1994)

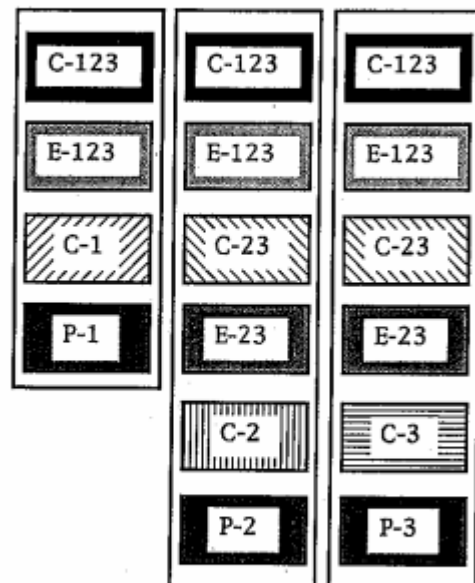
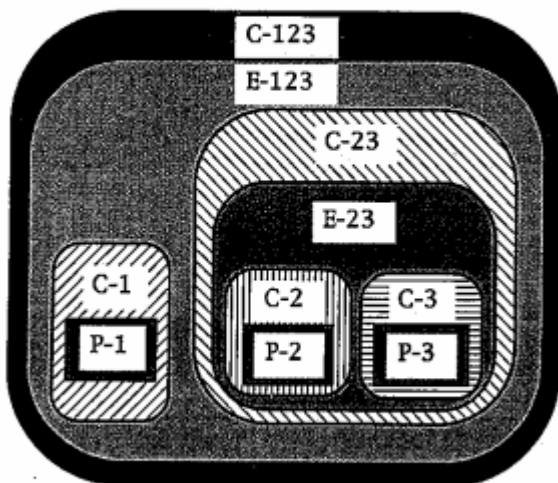
Using C language on UNIX workstations

For verifying our Basic Model for HELIOS

Implementation of HELIOS (v.2)

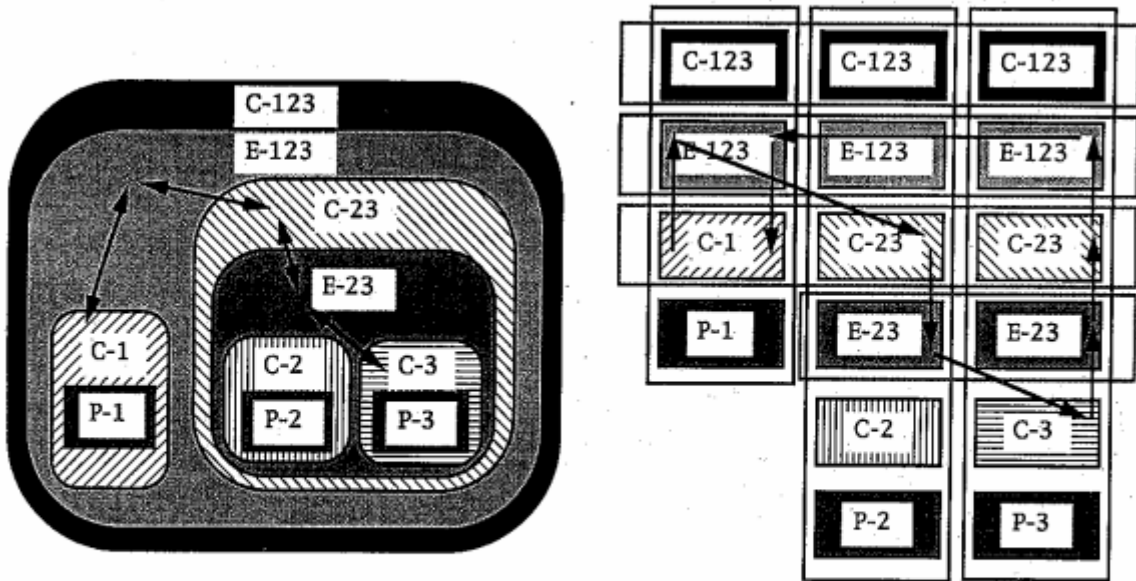
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Process Model



Communication between Agents

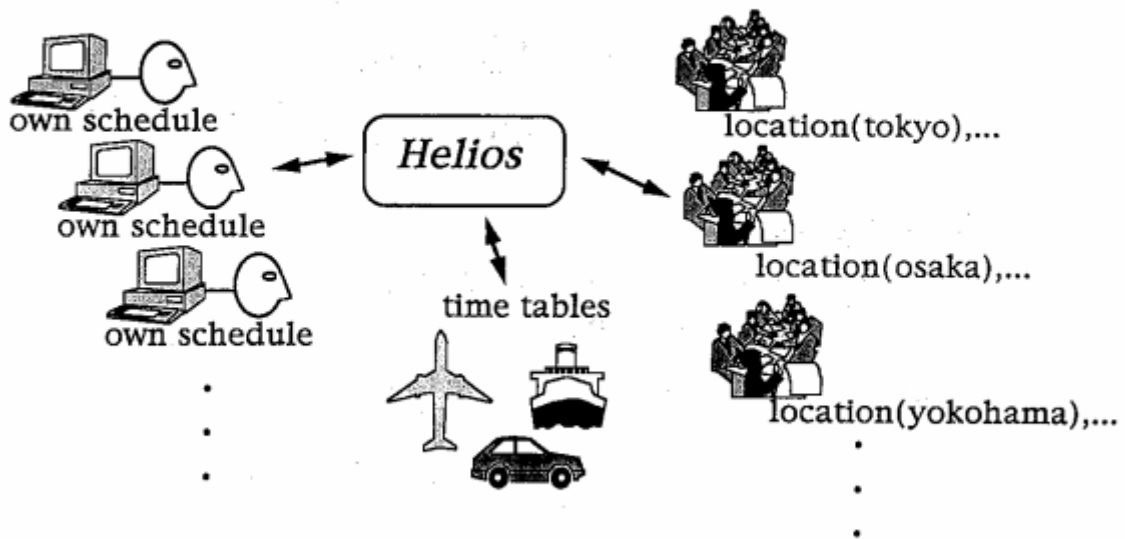
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Meeting Scheduling

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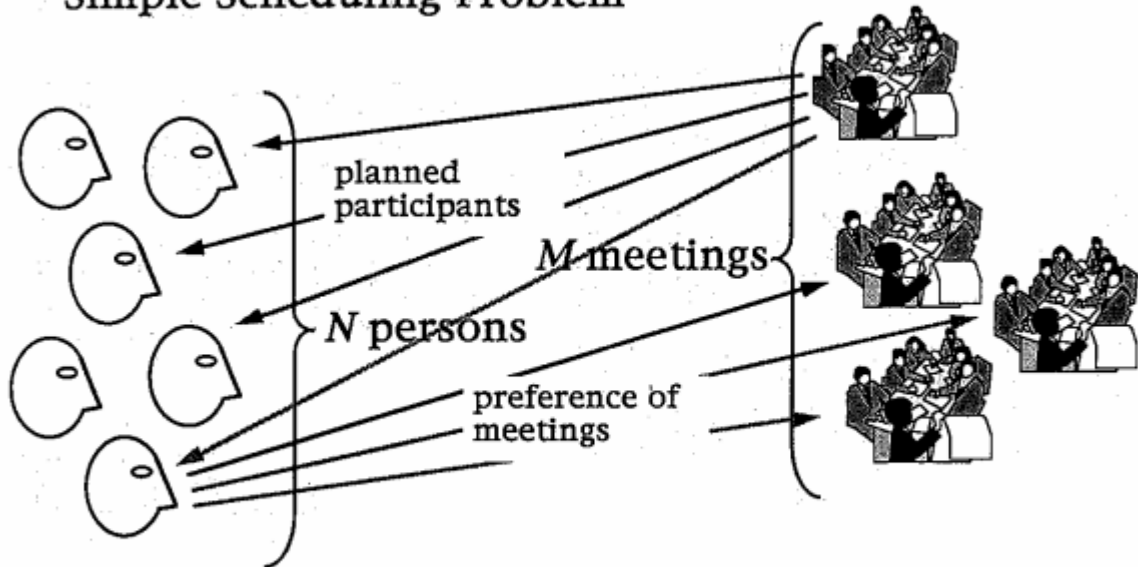
Meeting scheduling is a complicated problem



Example: Meeting Scheduling

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Simple Scheduling Problem



Agents


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- Member Agent



preference on meetings:

ex.  2 points

 1 points


...

- Meeting Agent



Planned participants
with points:

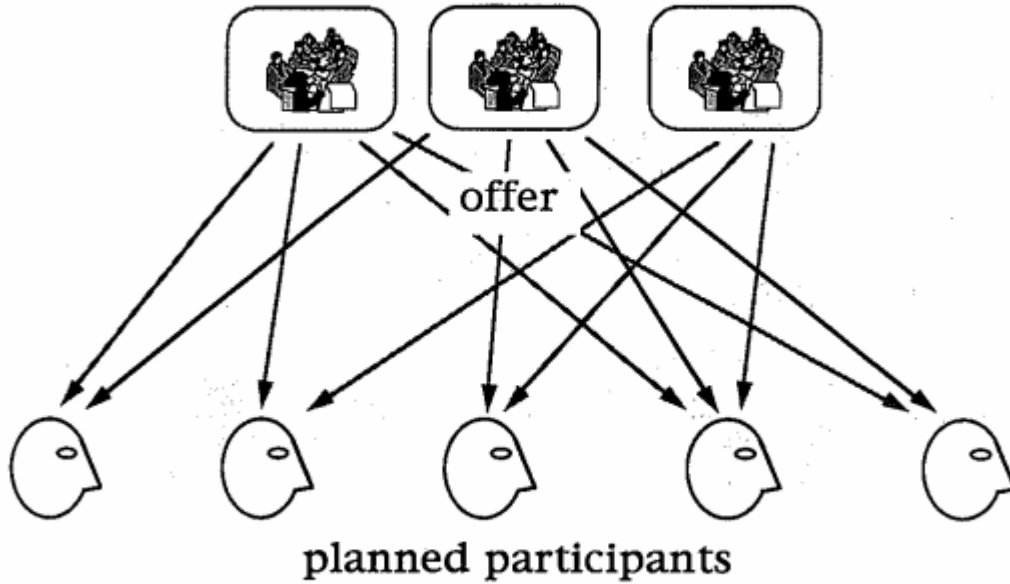
ex.  5 points

 3 points

...

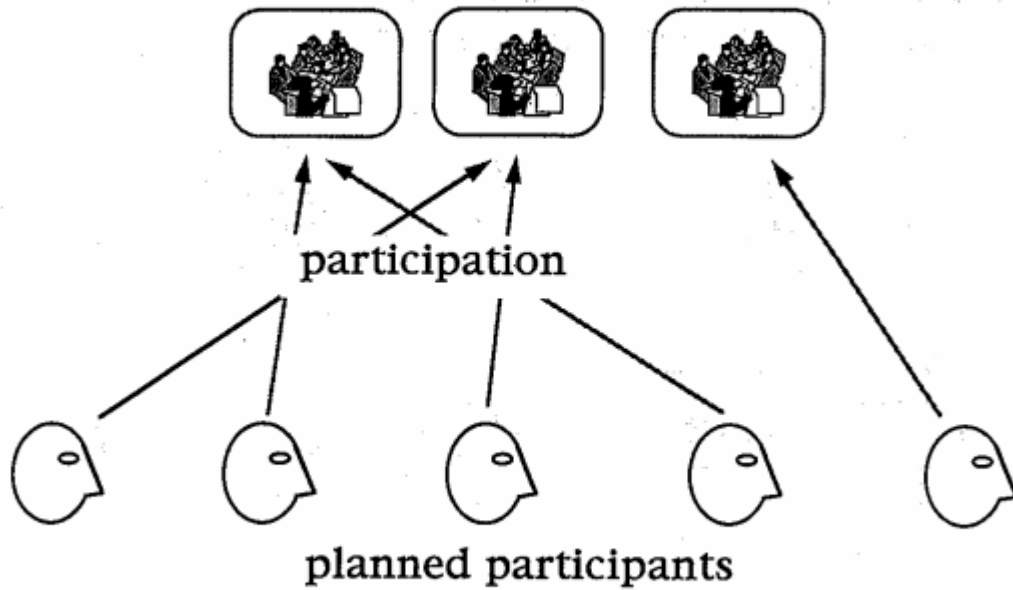
Problem Solving in HELIOS (1)

HELIOS -



Problem Solving in HELIOS (2)

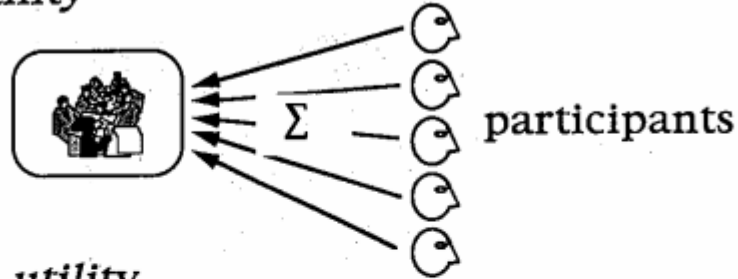
HELIOS -



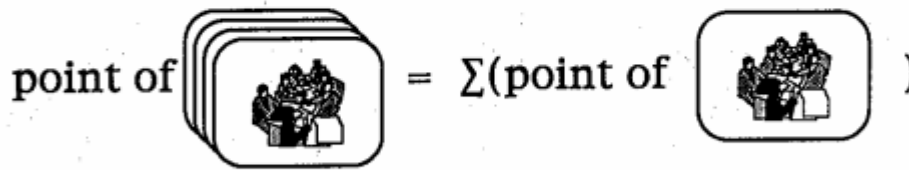
Problem Solving in HELIOS (3)

HELIOS -

Local utility



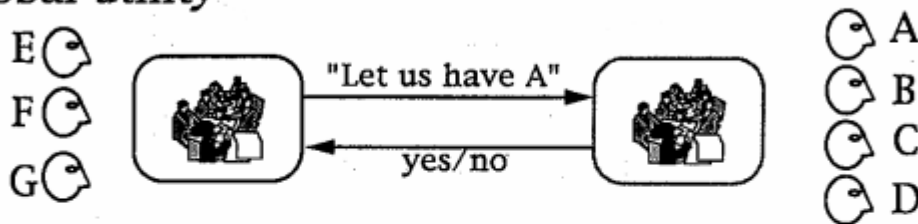
Global utility



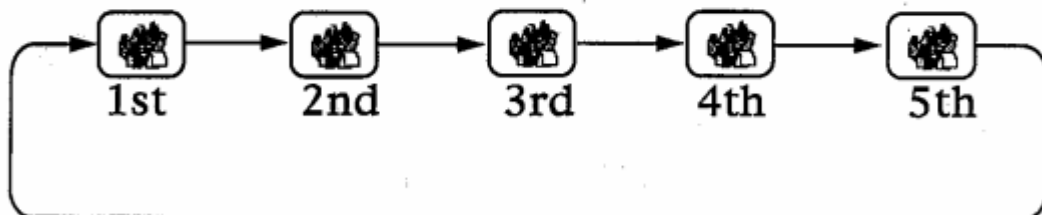
Problem Solving in HELIOS (4)

HELIOS -

Negotiation between agents for maximizing global utility



Order of negotiation

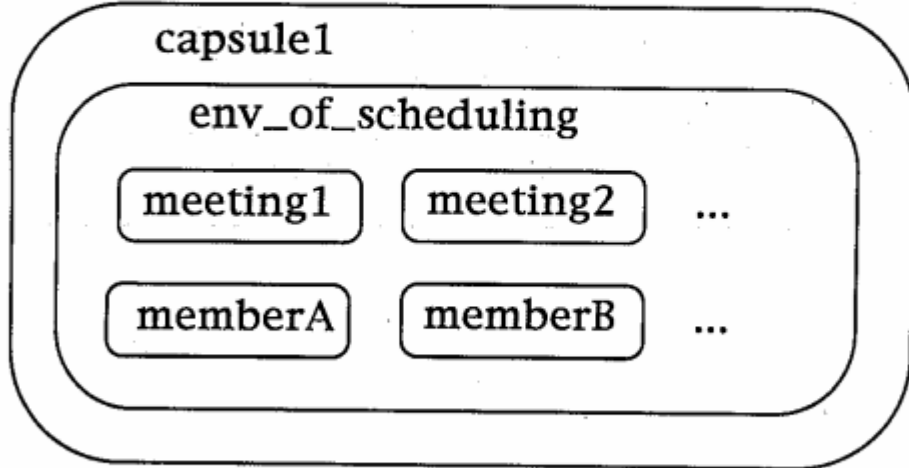


Environments and Agents

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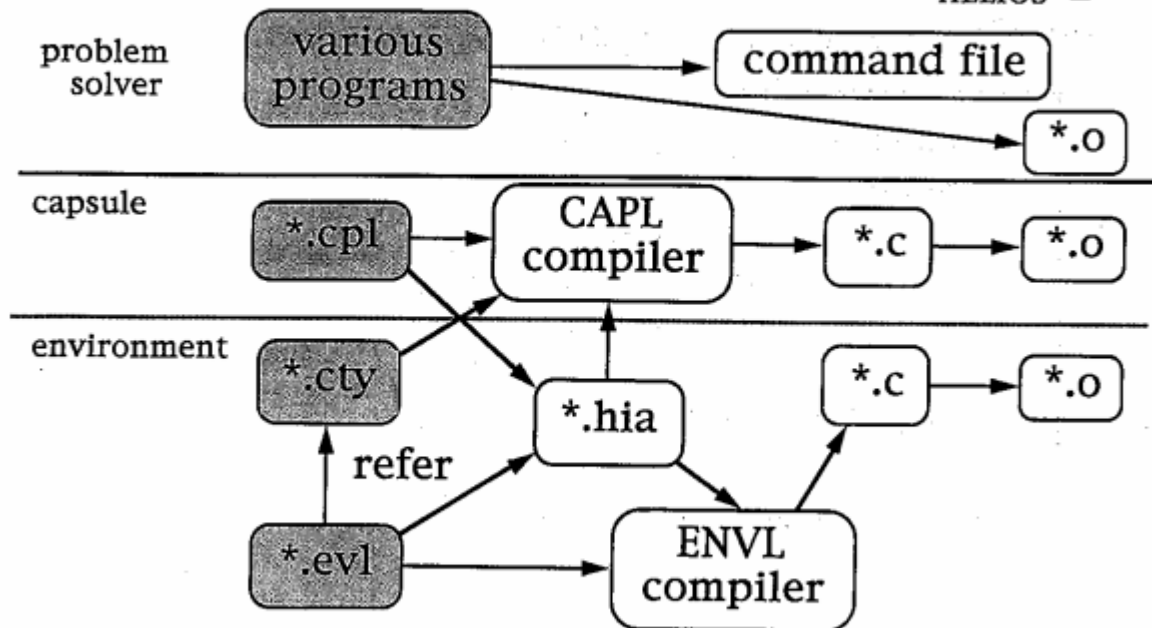
Environment and agents for solving scheduling problem

meeting



File Configuration of HELIOS

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Description of ENVL

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```
&environment env_of_scheduling;
  &common_type scheduling.cty
  &agent_dir   meeting1, meeting2, ...
              memberA, memberB, ...
```

Description of cty-file

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cty file is a file for common type system

```
meeting ::= string;
member  ::= string;
date    ::= <month=int,
            date=int,
            start=time,
            finish=time>;
time    ::= <hour=int,
            minute=int>;
```

Description of CAPL

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CAPL for capsule1

```
&type complex;
&agent meeting;
&inside env_of_scheduling meeting.evl
&import_method
    scheduling #1:[meeting] ->
        [<meeting=#2:meeting,
         date=#3:date,
         member=#4:[member]>]
=> all, bag_of ! schedule #1:[meeting] ->
    <#2:meeting,
     #3:date,
     #4:[member]>;
```

Concluding Remarks

HELIOS ■

- We provided a comprehensive testbed for heterogeneous distributed cooperative problem solving
- future works
 - separation of negotiation protocol from negotiation strategy
 - ontology
 - generation of methods translation
 - establishing computation model
- applications
 - Heterogeneous natural language processing
- Released as ICOT Free Software by March 1995