AgentSpeak(L) and Jason: Environment & Agent Interaction

Laboratory of Multiagent Systems LM

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Ingegneria Due

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1. Environment
2. Agent Interaction
3. Example: Domestic Robot
4. Exercises
   - Exercise 1
   - Exercise 2
5. Conclusion

Agents are Situated

- Autonomous agents live *situated* in an environment
- In MAS, the environment is shared by multiple agents, so an agent's actions are likely to interfere with those of other agent

→ Having an explicit notion of environment, although not mandatory, is an important aspect in MAS developing

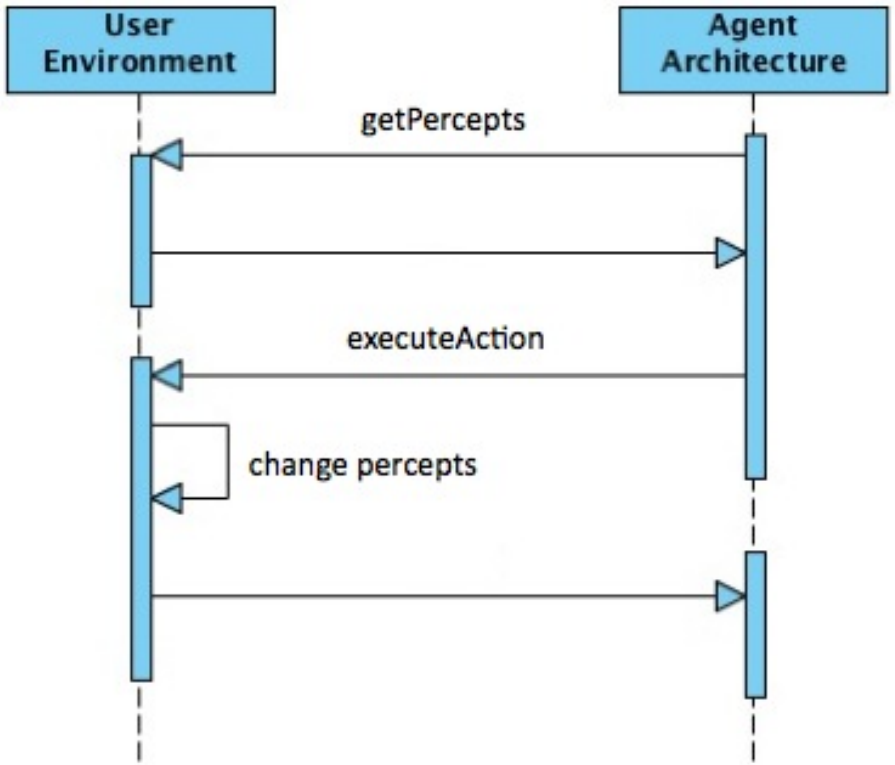
Environment in Jason

- There are two ways to design and implement the MAS environment:
  1. Defining perceptions and actions so to operate on spceific environments
     - This is done defining in Java lower-level mechanisms, and by specializing the Agent Architecture and Agent classes
  2. Creating a 'simulated' environment
     - This is done in Java by extending Jason's Environment class and using methods such as `addPercept(String Agent, Literal Percept)`

Agent-Environment Interaction

Percepts

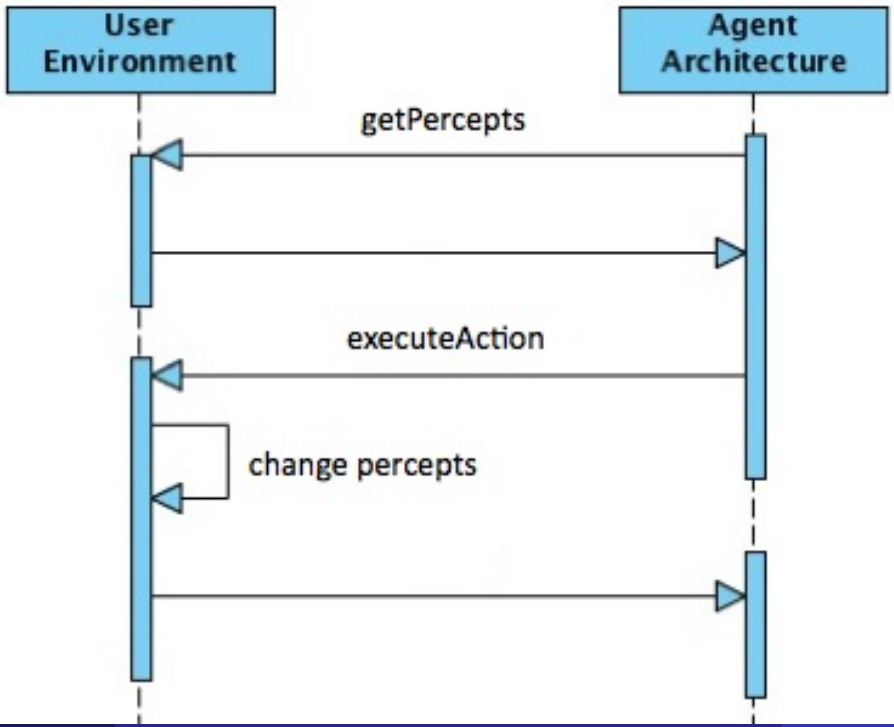
- Existent Agent architecture uses the `getPercepts` method to retrieve, form the simulated environment, the *percepts* to which that particular agent currently has access



Agent-Environment Interaction

Actions

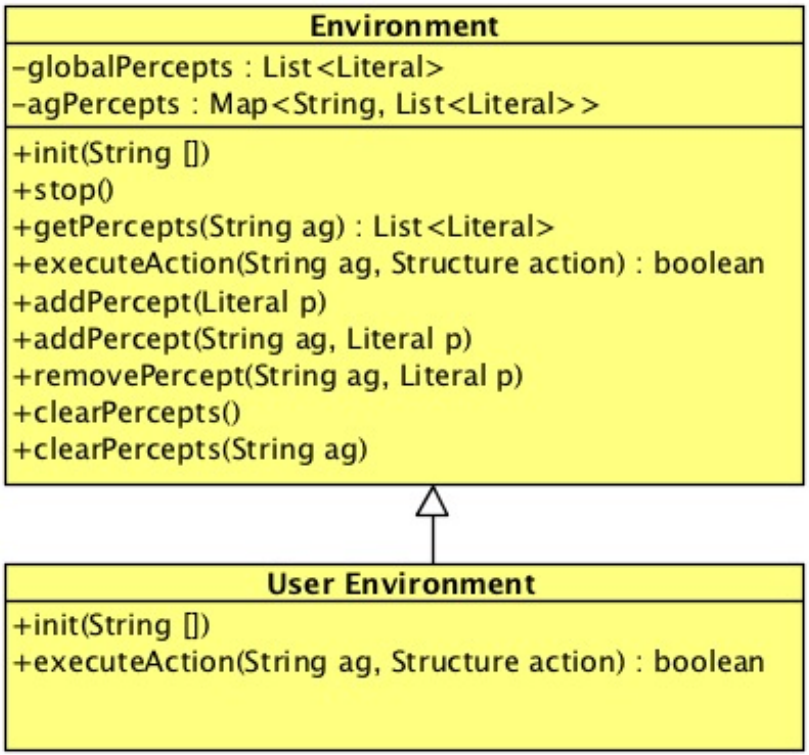
- When an intention is executed and the formula being executed is an environment action
- For each action execution request, the agent architecture invokes the `executeAction` method of the environment, and resumes the respective intention when the method returns (`true` or `false`)



Environment Modelling

User Environment

- In order to implement an environment, programmers need to extend the Environment class and likely to override the `executeAction` and `init` methods



Example of a User Environment

```
import jason.*;
import ...;

public class <EnvironmentName> extends Environment{
// any class members needed...

   @Override
   public void init(String[] args) {
      // setting initial (global) percepts...
      addPercept(Literal.parseLiteral("p(a)"));
      // if this is to be perceived only by agent ag1
      addPercept("ag1", Literal.parseLiteral("p(a)"));
   }

   @Override
   public boolean stop()  {
      // anything else to be done by the environment when
      // the system is stopped...
   }

   ...
```

Example of a User Environment

```
    ...

    @Override
    public boolean executeAction(String ag, Term action)  {
       if (action.equals(...))  {
          addPercept("ag1", Literal.parseLiteral("p(b)");
      }
      ...
      return true;
   }
}
```

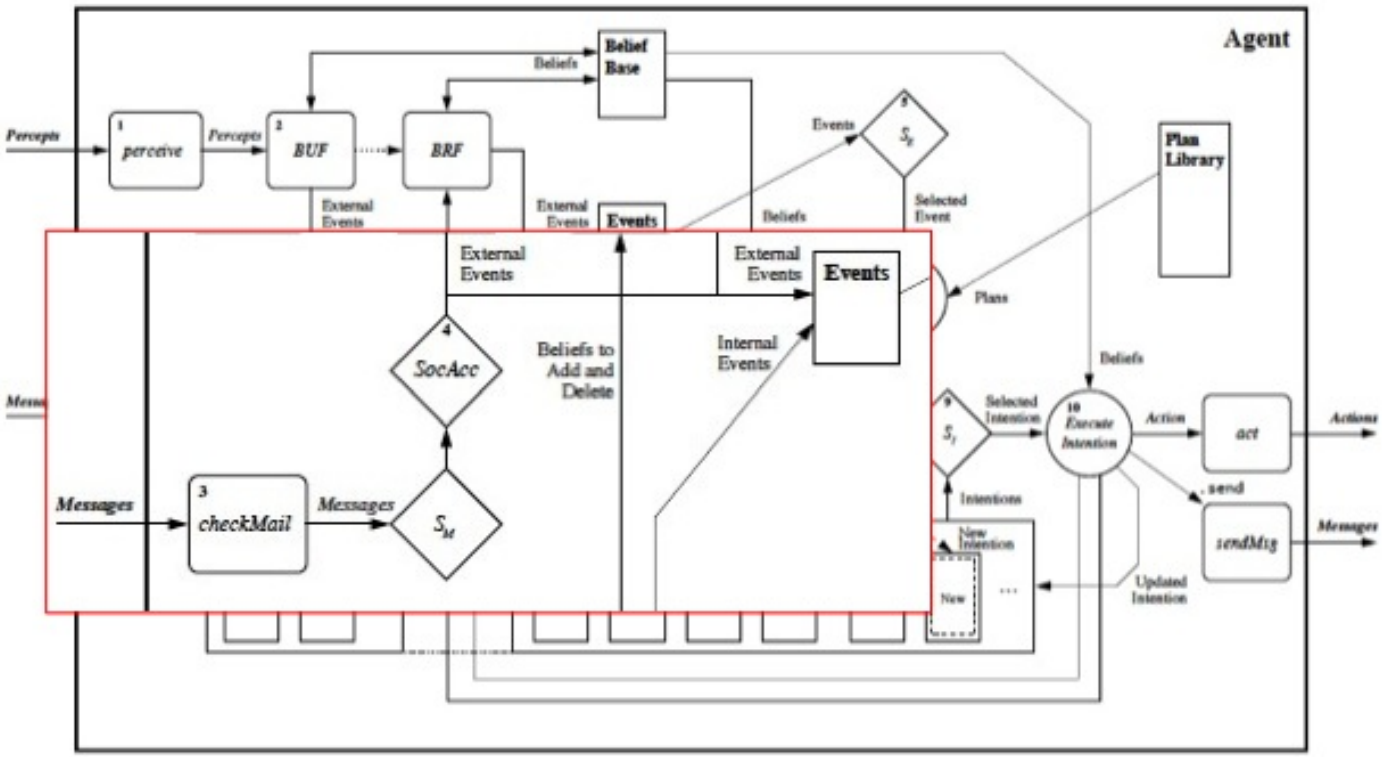
Agents are Social

- Autonomous agents live and interact within agent societies & MAS
- Since agents are autonomous, only data (knowledge, information) crosses agent boundaries

Agent Interaction in Jason

Receiving Messages

- At the beginning of each reasoning cycle, agents check for messages they might have received from other agents
- Any message received by the `checkMail` method has the structure: <*sender*, *illoc_force*, *content*>



Agent Interaction in Jason

Sending Messages

- Messages are sent with the use (in plan bodies) of a special pre-defined internal action
- The general form of such an internal action is:
  `.send(receiver, illocutionary_force, propositional_content)`

Performatives

`tell`	*s* intends *r* to believe *c* to be true
`untell`	*s* intends *r* not to believe *c* to be true
`achieve`	*s* intends *r* to try and achieve *c*
`unachieve`	*s* intends *r* to drop the goal *c*
`askOne`	*s* wants to know if *c* is true for *c*
`askAll`	*s* wants all of *r*'s answers to a question
`tellHow`	*s* informs *r* of a plan
`untellHow`	*s* requests that *r* discard a certain plan
`askHow`	*s* wants all of *r*'s plans that are relevant for the triggering event *c*

Domestic Robot Environment

Pattern Model-View-Control

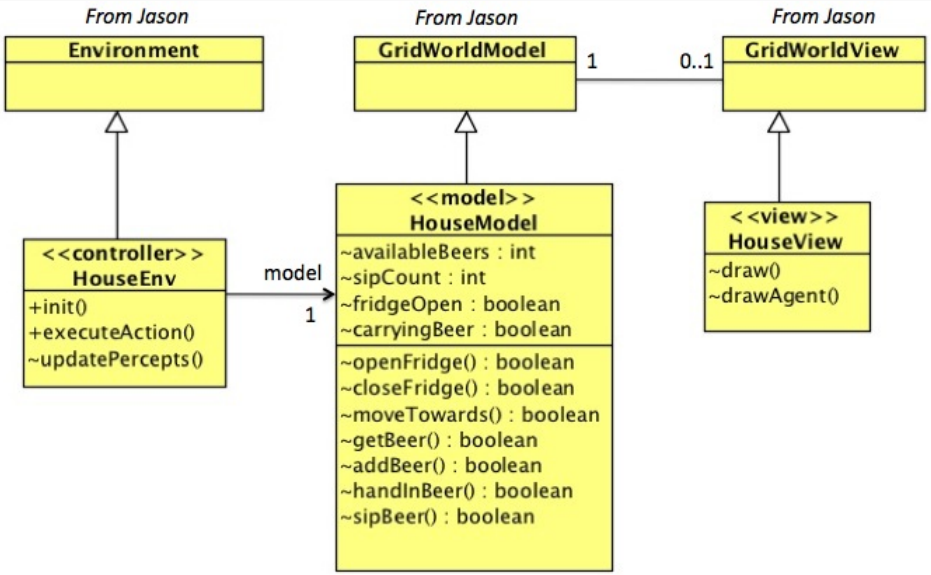
- Its design is based on a common object-oriented design pattern: *Model-View-Control* (MVC)
- The environment design is thus based on the following three components:

model	maintains the information about the environment state and the dynamics of the environment
view	renders the model into a form suitable for visualisation
control	interacts with the agents and invokes changes in the model and perhaps the view

Modelling the Environment

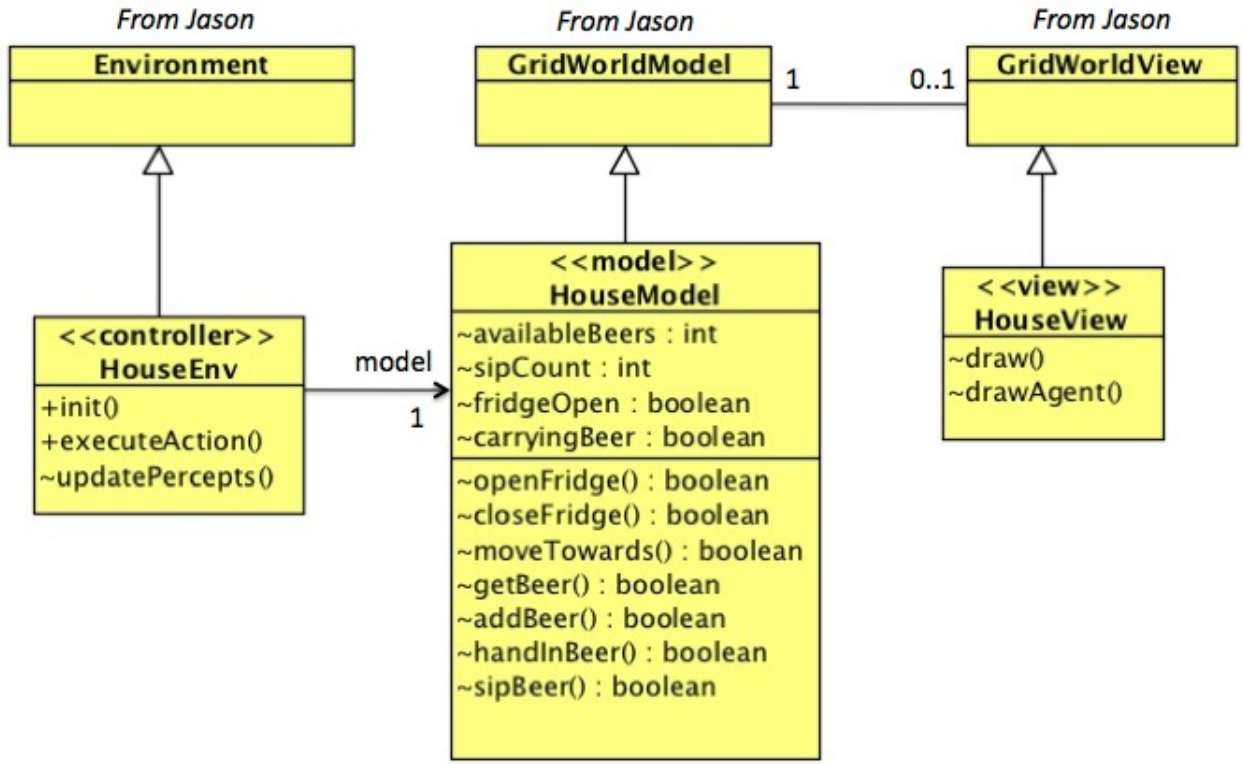
Percepts

- `at(robot, Place)`. Only two places are perceived, `fridge` and `owner`. Thus, depending on its location in the house, the robot will perceive either `at(robot, fridge)` or `at(robot, owner)`
- `stock(beer, N)`. When the fridge is open, the robot will perceive how many beers are stored in the fridge
- `has(owner, beer)`. It si perceived by the robot and the owner when the owner has a (non-empty) bottle of beer



Modelling the Environment

- The model of the Domestic Robot environment should maintain:
  - the number of available beers in the fridge (attribute `availableBeers`)
  - whether the owner currently has a bottle of beer (the percept `has(owner, beer)` is based of the `sipCount` value)
  - the robot's location (the location is maintained through the use of the class GridWorldModel modelling an $n \times m$ grid)



HouseEnv

```
import jason.asSyntax.*;

public class HouseEnv extends Environment
{
    // common literals
    public static final Literal of = Literal.parseLiteral("open(fridge)");
    public static final Literal clf = Literal.parseLiteral("close(fridge)");
    public static final Literal gb = Literal.parseLiteral("get(beer)");
    public static final Literal hb = Literal.parseLiteral("hand_in(beer)");
    public static final Literal sb = Literal.parseLiteral("sip(beer)");
    public static final Literal hob = Literal.parseLiteral("has(owner,beer)");

    public static final Literal af = Literal.parseLiteral("at(robot,fridge)");
    public static final Literal ao = Literal.parseLiteral("at(robot,owner)");

    HouseModel model; // the model of the grid

    @Override
    public void init(String[] args)
    {
        model = new HouseModel();

        if (args.length == 1 && args[0].equals("gui"))
        {
            HouseView view = new HouseView(model);
            model.setView(view);
        }

        updatePercepts();
    }
```

HouseEnv

```
/** creates the agents percepts based on the HouseModel */
void updatePercepts()
{
    // clear the percepts of the agents
    clearPercepts("robot");
    clearPercepts("owner");

    // get the robot location
    Location lRobot = model.getAgPos(0);

    // add agent location to its percepts
    if (lRobot.equals(model.lFridge))
    {
        addPercept("robot", af);
    }
    if (lRobot.equals(model.lOwner))
    {
        addPercept("robot", ao);
    }

    // add beer "status" to the percepts
    if (model.fridgeOpen)
    {
        addPercept("robot", Literal.parseLiteral("stock(beer," + model.availableBeers + ")"));
    }
    if (model.sipCount > 0)
    {
        addPercept("robot", hob);
        addPercept("owner", hob);
    }
}
```

HouseEnv

```
@Override
public boolean executeAction(String ag, Structure action)
{
    System.out.println("[" + ag + "] doing: " + action);
    boolean result = false;

    if (action.equals(of))
    { // of = open(fridge)
        result = model.openFridge();
    }
    else if (action.equals(clf))
    { // clf = close(fridge)
        result = model.closeFridge();

    }
    else if (action.getFunctor().equals("move_towards"))
    {
        String l = action.getTerm(0).toString();
        Location dest = null;
        if (l.equals("fridge"))
        {
            dest = model.lFridge;
        }
        else if (l.equals("owner"))
        {
            dest = model.lOwner;
        }
```

HouseEnv

```
        try
        {
            result = model.moveTowards(dest);
        }
        catch (Exception e)
        {
            e.printStackTrace();
        }
    }
    else if (action.equals(gb))
    {
        result = model.getBeer();
    }
    else if (action.equals(hb))
    {
        result = model.handInBeer();
    }
    else if (action.equals(sb))
    {
        result = model.sipBeer();
    }
```

HouseEnv

```
    else if (action.getFunctor().equals("deliver"))
    {
        // wait 4 seconds to finish "deliver"
        try
        {
            Thread.sleep(4000);
        }
        catch (Exception e)
        {
        }
        result = model.addBeer((int) ((NumberTerm) action.getTerm(1)).solve());
    }
    else
    {
        System.err.println("Failed to execute action " + action);
    }

    if (result)
    {
        updatePercepts();
        try
        {
            Thread.sleep(100);
        }
        catch (Exception e)
        {
        }
    }
    return result;
}
```

HouseModel

```
import jason.environment.grid.GridWorldModel;

/** class that implements the Model of Domestic Robot application */
public class HouseModel extends GridWorldModel
{
    // constants for the grid objects
    public static final int FRIDGE = 16;
    public static final int OWNER = 32;

    // the grid size
    public static final int GSize = 7;

    boolean fridgeOpen = false; // whether the fridge is open
    boolean carryingBeer = false; // whether the robot is carrying beer
    int sipCount = 0; // how many sip the owner did
    int availableBeers = 2; // how many beers are available

    Location lFridge = new Location(0, 0);
    Location lOwner = new Location(GSize - 1, GSize - 1);
```

HouseModel

```
public HouseModel()
{
    // create a 7x7 grid with one mobile agent
    super(GSize, GSize, 1);

    // initial location of robot (column 3, line 3)
    // ag code 0 means the robot
    setAgPos(0, GSize / 2, GSize / 2);

    // initial location of fridge and owner
    add(FRIDGE, lFridge);
    add(OWNER, lOwner);
}

boolean openFridge()
{
    if (!fridgeOpen)
    {
        fridgeOpen = true;
        return true;
    }
    else
    {
        return false;
    }
}
```

HouseModel

```
boolean closeFridge()
{
    if (fridgeOpen)
    {
        fridgeOpen = false;
        return true;
    }
    else
    {
        return false;
    }
}

boolean moveTowards(Location dest)
{
    Location r1 = getAgPos(0);
    if (r1.x < dest.x)
        r1.x++;
    else if (r1.x > dest.x)
        r1.x--;
    if (r1.y < dest.y)
        r1.y++;
    else if (r1.y > dest.y)
        r1.y--;
    setAgPos(0, r1); // move the robot in the grid

    // repaint the fridge and owner locations
    view.update(lFridge.x, lFridge.y);
    view.update(lOwner.x, lOwner.y);
    return true;
}
```

HouseModel

```
boolean getBeer()
{
    if (fridgeOpen && availableBeers > 0 && !carryingBeer)
    {
        availableBeers--;
        carryingBeer = true;
        view.update(lFridge.x, lFridge.y);
        return true;
    }
    else
    {
        return false;
    }
}

boolean addBeer(int n)
{
    availableBeers += n;
    view.update(lFridge.x, lFridge.y);
    return true;
}
```

HouseModel

```
boolean handInBeer()
{
    if (carryingBeer)
    {
        sipCount = 10;
        carryingBeer = false;
        view.update(lOwner.x, lOwner.y);
        return true;
    }
    else
    {
        return false;
    }
}

boolean sipBeer()
{
    if (sipCount > 0)
    {
        sipCount--;
        view.update(lOwner.x, lOwner.y);
        return true;
    }
    else
    {
        return false;
    }
}
```

HouseView

```
import jason.environment.grid.*;

/** class that implements the View of Domestic Robot application */
@SuppressWarnings("serial")
public class HouseView extends GridWorldView
{
    HouseModel hmodel;

    public HouseView(HouseModel model)
    {
        super(model, "Domestic Robot", 700);
        hmodel = model;
        defaultFont = new Font("Arial", Font.BOLD, 16); // change default font
        setVisible(true);
        repaint();
    }
```

HouseView

```
/** draw application objects */
@Override
public void draw(Graphics g, int x, int y, int object)
{
    Location lRobot = hmodel.getAgPos(0);
    super.drawAgent(g, x, y, Color.lightGray, -1);
    switch (object)
    {
        case HouseModel.FRIDGE:
            if (lRobot.equals(hmodel.lFridge))
            {
                super.drawAgent(g, x, y, Color.yellow, -1);
            }
            g.setColor(Color.black);
            drawString(g, x, y, defaultFont, "Fridge (" + hmodel.availableBeers + ")");
            break;
        case HouseModel.OWNER:
            if (lRobot.equals(hmodel.lOwner))
            {
                super.drawAgent(g, x, y, Color.yellow, -1);
            }
            String o = "Owner";
            if (hmodel.sipCount > 0)
            {
                o += " (" + hmodel.sipCount + ")";
            }
            g.setColor(Color.black);
            drawString(g, x, y, defaultFont, o);
            break;
    }
}
```

HouseView

```
@Override
public void drawAgent(Graphics g, int x, int y, Color c, int id)
{
    Location lRobot = hmodel.getAgPos(0);
    if (!lRobot.equals(hmodel.lOwner) && !lRobot.equals(hmodel.lFridge))
    {
        c = Color.yellow;
        if (hmodel.carryingBeer)
            c = Color.orange;
        super.drawAgent(g, x, y, c, -1);
        g.setColor(Color.black);
        super.drawString(g, x, y, defaultFont, "Robot");
    }
}
```

DomesticRobot.mas2j

```
MAS domestic_robot {

    environment: HouseEnv(gui)

    agents: robot;
            owner;
            supermarket agentArchClass SupermarketArch;
}
```

Outline

1 Environment

2 Agent Interaction

3 Example: Domestic Robot

4 Exercises
- Exercise 1
- Exercise 2

5 Conclusion

Thermostat Agent with the Environment

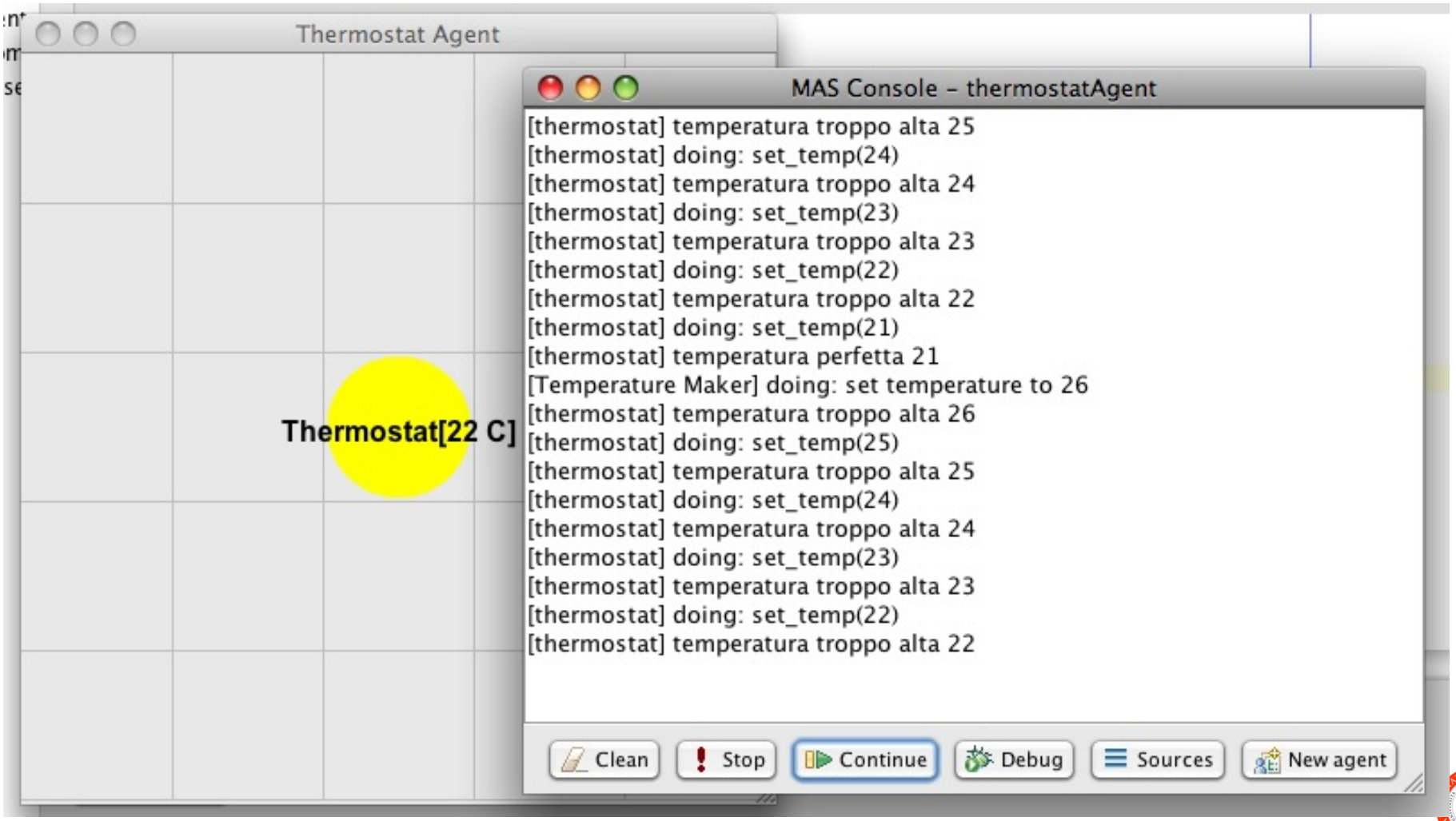
Requirements

- Check the environment temperature T.
- Until T is not: > 18 and < 22:
  - Decrease T of one unit if the temperature is 22
  - Increase T of one unit if the temperature is 18

Constraint

- Only one agent: thermostat.asl
- Environment modelled with the MVC pattern: RoomModel, RoomView and RoomEnv classes
- RoomModel has to contain the class TempMaker extending the class Thread that changes the environment temperature with a random value

Thermostat Agent with the Environment



Outline

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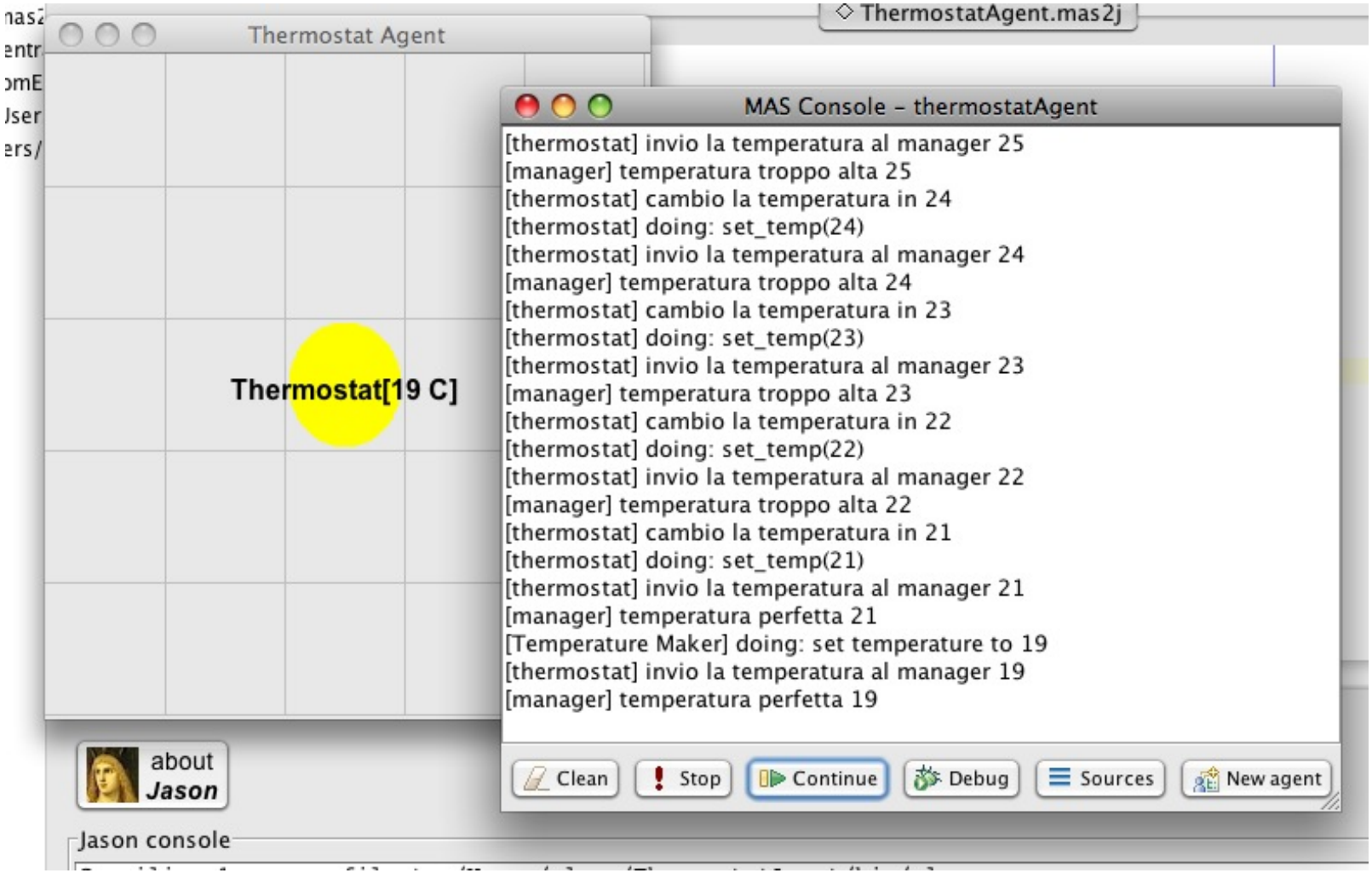
Thermostat Agent with Agent Interaction

A New Constraint

- Two interacting agents: thermostat.asl and manager.asl
  - thermostat senses the temperature and sends the temperature to manager and sets the new temperature when it is received from manager
  - manager checks the temperature and sends the new temperature to set to thermostat

Thermostat Agent with Agent Interaction



Conclusion

Questions

- Centralised or distributed Agents?
- Non-simulated Environment?

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