



Towards Distributed Agent Environments for Pervasive Healthcare

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Outline

- Gestational Diabetes Mellitus
 - Current Drawbacks of the Treatment
 - Possible Improvements
- Objectives Of the Platform
- GOLEM Platform for Pervasive Healthcare
 - Rules Of the Environment
 - Body Area Network
 - Cognitive Model
- Future Works
- Conclusions

Gestational diabetes mellitus (GDM)

- Occurs during pregnancy (4%) due to increased resistance to insulin.

Precise mechanisms unknown.

- Current approach:

- ▶ planned diet, exercise and self-blood glucose monitoring tests
- ▶ Individual **treatment adjustment**

- If hyperglycemia last for more than one day, this may cause **macrosomia** (excessive growth of the baby):

- ▶ Important to act as fast as possible to prevent any serious complication to the mother and the baby, by normalizing the blood pressure and glucose levels.



Main drawbacks of current GDM treatments

1. Current treatment practices usually see patient 2-3 times a week. In case of hyperglycemia, the patient may **arrive too late** to the dietician or doctor.
2. At each patient visit, the doctor sees the glucose levels and blood pressure at the very moment of the consultancy, and **not the evolution** of the values.
3. Furthermore *white coat effect* during consultancy.

Possible improvements of GDM care

1. **Automatic alerts** to Doctors about the condition of the patient
2. Constant **monitoring and recording** of glucose and blood pressure values, in order to use history to ease **treatment adjustment** (key issue)



Our Objectives (I)

■ Goal:

Develop a **pervasive healthcare infrastructure (PHI)** to achievement those 2 improvements:

- ▶ alert Doctors
- ▶ Collect historical values.

■ Technology:

- ▶ **Wearable sensors** currently used in Hospitals to monitor glucose level and blood pressure.
- ▶ **Pervasive and ubiquitous multi agent system** deployed in the environment and accessible through smart phones.
- ▶ **Abductive Logic Programmed Agents** that work as mobile expert systems and are capable to monitor the physiological signals of the patients.

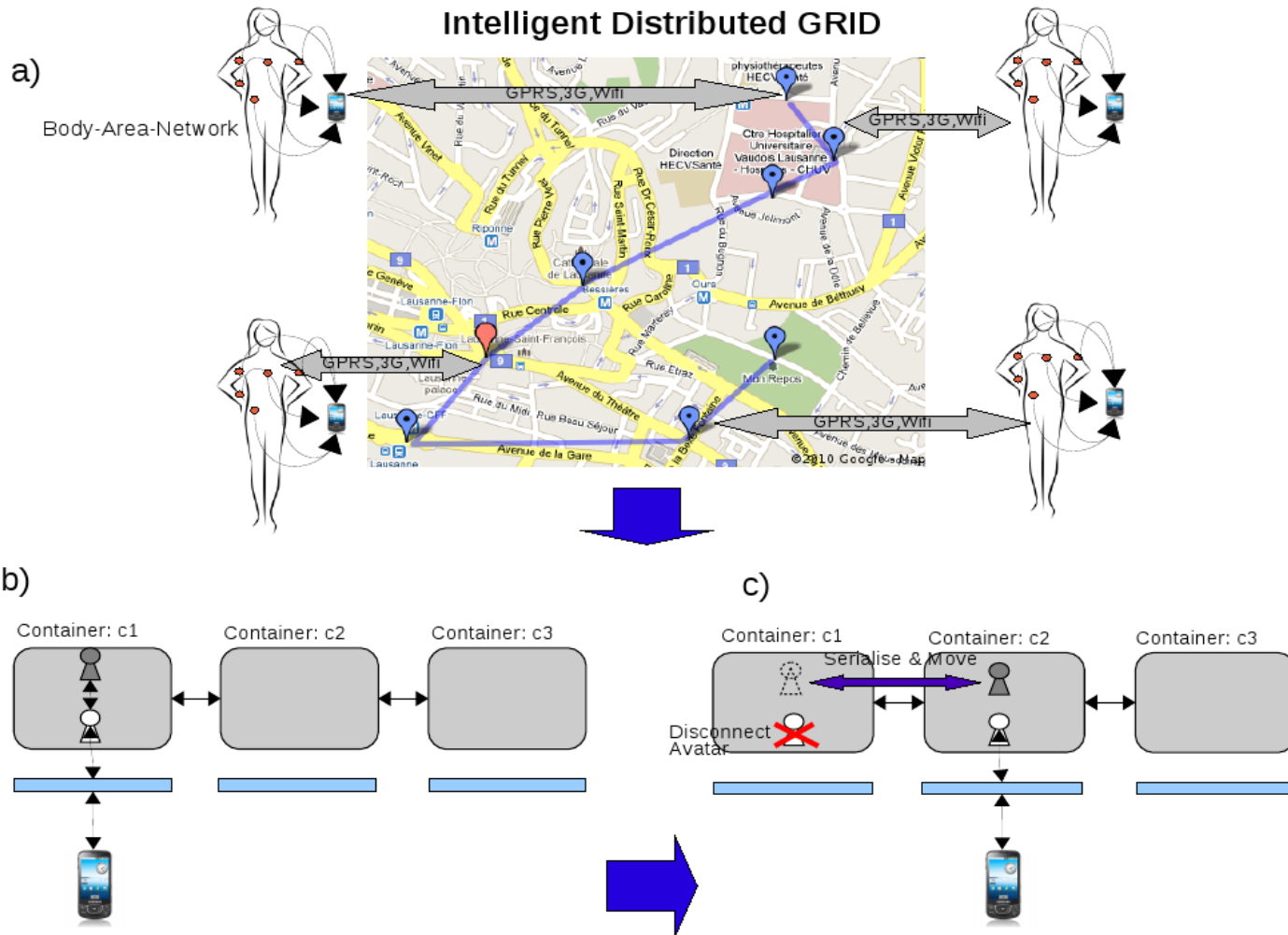
Our Objectives (II)

- We want to focus mainly on the current conditions happening in GDM:
 - **Macrosomia**
 - Excessive growth of the fetus
 - **Preeclampsia**
 - Hypertension + Proteinuria
 - **Hypoglycemia**
 - **Pregnancy Induced Hypertension (PIH)**
 - Hypertension without Proteinuria

The GOLEM PLATFORM Components

- Project based on the GOLEM platform
- GOLEM is based on the concepts of
 - Agents
 - Cognitive and Reasoning Entities
 - Objects
 - Passive Entities used as resources
 - Containers
 - Distributed Nodes containing the agents/objects/avatars
 - Avatars
 - Embodiment of the users in the agent environment
- In GOLEM the interaction between the entities is constantly mediated by declarative rules
 - Defined in the terms of the Ambient Event Calculus (dialect of the EC).
 - That works in distributed setting.

THE GOLEM platform for Pervasive Healthcare



Mobility Rules For the Agent Environment

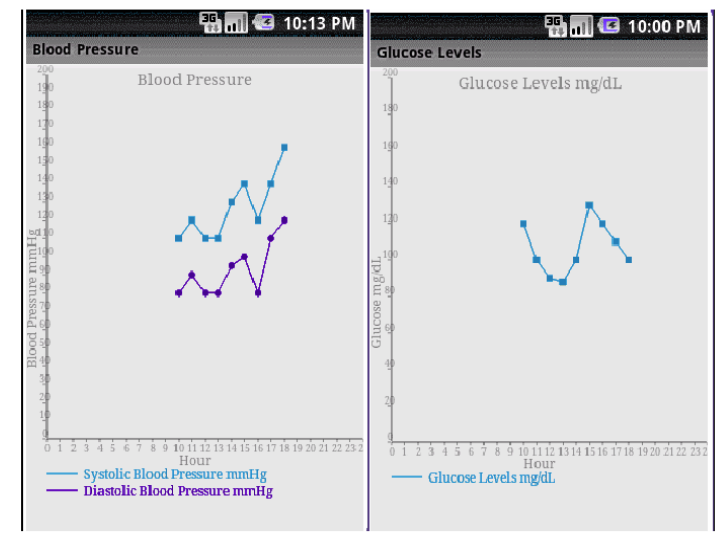
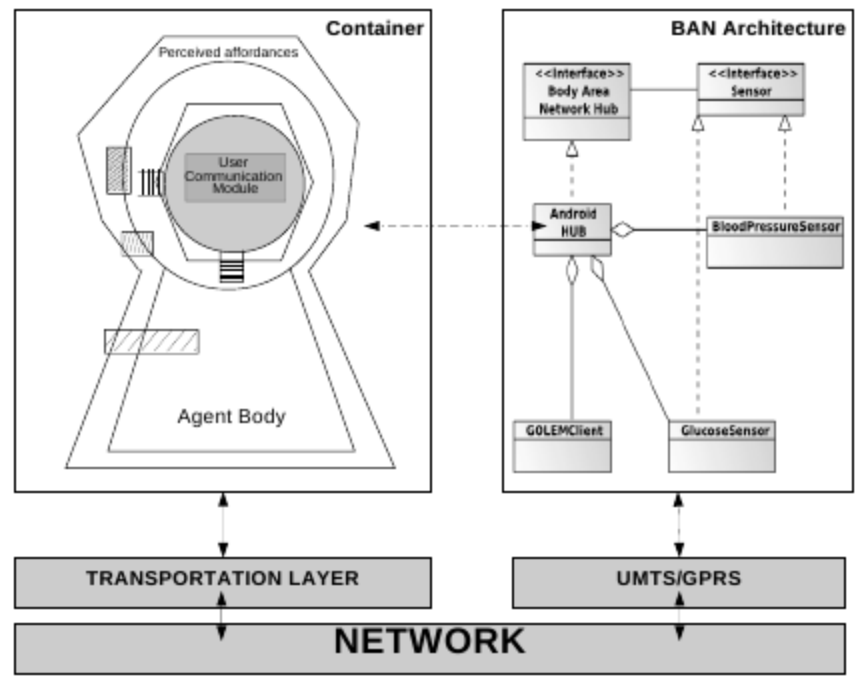
```
possible(E, T) ←  
  move: E [actor ⇒ avatar: A, move ⇒ Pos],  
  instance_of(Id, topology, T),  
  holds_at(Id, topology, borders, Bdr, T),  
  inside_borders(Bdr, Pos).
```

```
possible(E, T) ←  
  instance_of(Id, topology, T),  
  holds_at(Id, topology, borders, Borders, T),  
  outside_borders(Bdr, Pos),  
  neighbouring_at(this, [], [C], 1, Id, topology, borders, Bdr, T),  
  inside_borders(Bdr, Pos).
```

```
necessary(E, T) ←  
  happens(E*, T),  
  deploy: E* [deploy ⇒ avatar: Av],  
  not neighbouring_at(this, [], [C], 1, Av, caretaker, _, T),  
  deploy: E [agent ⇒ caretaker: A].
```

```
necessary(E, T) ←  
  happens(E*, T),  
  disconnect: E* [actor ⇒ A, new_container ⇒ C],  
  holds_at(A, avatar, caretaker, Id, T),  
  physical_act: E [move_to ⇒ C agent ⇒ Id].
```

Avatars and Mobile Phones



The Agent Mind Cycle

```

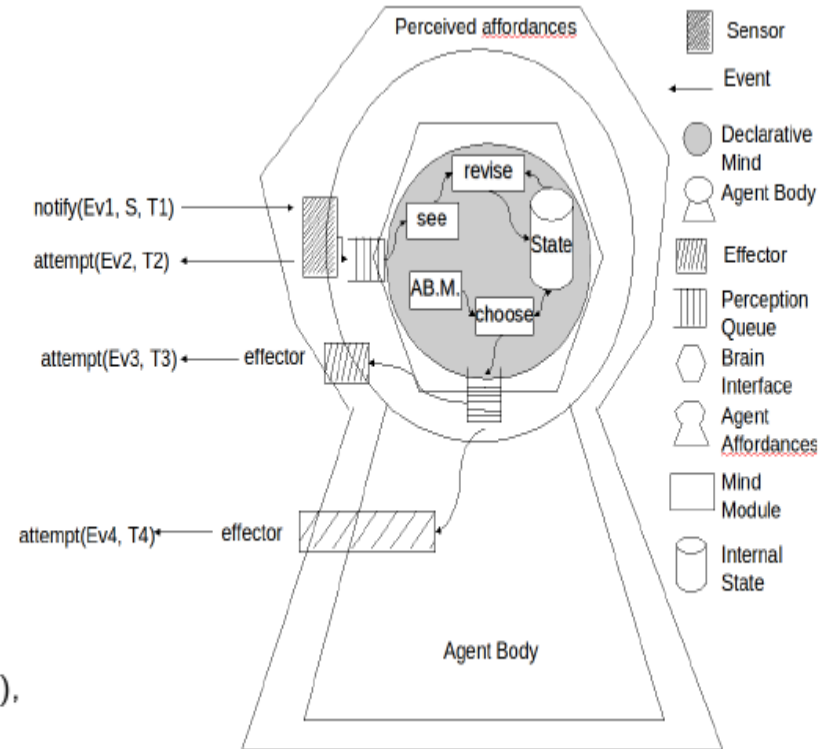
cycle(T)←
  see(Percept, T),
  revise(Percept, T),
  choose(Action, T),
  execute(Action, T),
  now(Tn),
  cycle(Tn).
  
```

```

choose(Action, T)←
  instance_of(AvatarID, avatar, T),
  findall(S, holds_at(AvatarID,symptom,S,T), Symptoms),
  findall(A, select(Symptoms,A,T), Acts),
  higher_priority(Acts, Action, T).
  
```

```

higher_priority(ActList, Act, T)←
  member(Act, ActList), priority(Act, P, T),
  not (member(ActX, ActList), not ActX = Act,
  priority(ActX, PX,T),
  PX > P).
  
```



Example of abductive rules

DomainKnowledge :

oedema ← preeclampsia(yes), protenuria(yes).

blood_pressure(S,D) ← preeclampsia(yes), protenuria(yes), pih(no), sys(160, S, 240), dias(100, D,150).

blood_pressure(S,D) ← preeclampsia(no), protenuria(no), pih(yes), sys(160, S, 240), dias(100, D,150).

glucose(G) ← macrosomia(yes), $G > 150$.

glucose(G) ← hypoglicemia(yes), $G < 80$.

bmi(BMI) ← macrosomia(yes), $BMI > 30$.

IC :

← preeclampsia(yes), protenuria(no).

← preeclampsia(yes), pih(yes).

← pih(yes), protenuria(yes).



Future Works

- **Introduce Planning to deal with Emergencies ?**
- **Storing of Historical Values and Patient Records ?**
- **Security ?**
- **Runtime Representation of Services ?**
- **Improve the resilience of the agent environment ?**

Conclusions

■ Significance:

- ▶ **New technology that can be used to improve the quality of life for patients with diabetes and can be extended to other chronic diseases**
- ▶ **Will not replace current treatment practices, but add new information**

■ Focus on intelligent layer for monitoring and alerting

QUESTIONS?