AUTONOMOUS SYSTEMS

SEMINAR 04
### PEAS and ODD+D

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How to act in case of the project?

- Phase 1: Topics of projects
- Phase 2: Literature research, state of the art
- Phase 3: Mind mapping
- **Phase 4: PEAS, ODD+D**
- Phase 5: MAS conceptualisation
- Phase 6: Verification and validation

PEAS = TASK ENVIRONMENT

- PEAS specification helps us with a design and an analysis of a multi-agent system (MAS)

- PEAS briefly describes our future developed system
  - **P**erformance measure
  - **E**nvironment
 - **A**ctuators
  - **S**ensors
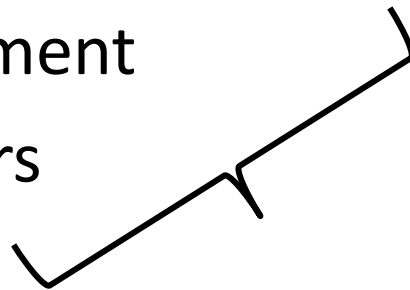
PEAS

Performance, **E**nvironment, **A**ctuators, **S**ensors

Performance measure

- An agent needs to know how to work towards goal fulfilment, but also to be told how well it is doing

- **Performance measure (PM)** = a group of criteria which determines how successful an agent is

- PM can be determined either from sensors or given as an external input

PEAS – Example 1
Automatic taxi driver
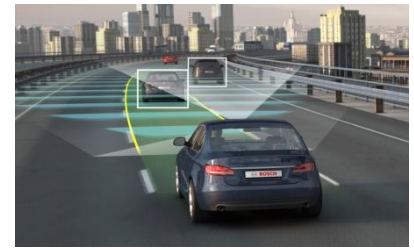
- **PM:** safety, speed, observance of rules, maximisation of profil, comfort, …

- **E:** roads, cars, padestrians, customers, …

- **S:** cameras, GPS, speedometer, …

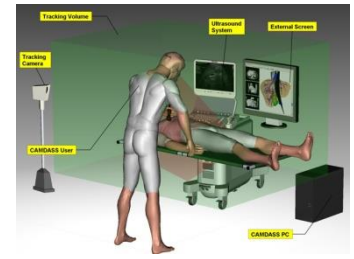- **A:** (steering) wheel, car horn, brake, engine, …

PEAS – Example 2
Robot sorting the components

- **PM**: a percentage of correctly separated components

- **E:** assembly line with components, baskets

- **S:** cameras, sensors for moving arms

- **A:** mechanical arm

PEAS – Example 3
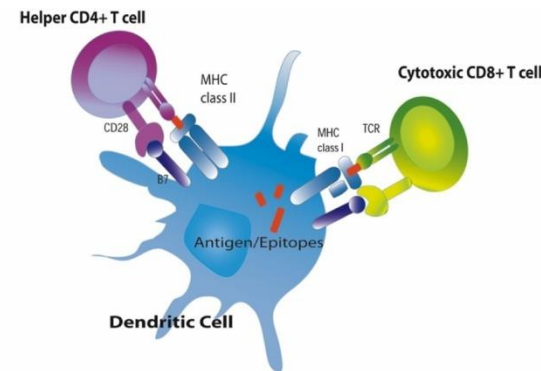## Medical diagnostic system

- **PM**: health patient, minimal costs, following rules of law

- **E**: patient, hospital, pharmacy, doctors, nurses, ...

- **S**: keyboard (recording of pacienta data, ...)

- **A**: information visualisation on monitor screen (proposing of medical tests, medication, ...)

PEAS – example 4
Simulator of a lymph node

- **PM**: elimination of viral particles => homeostasis maintenance

- **E**: blood stream (lymph node)

- **S**: receptors of cells

- **Actuators**: adhesion molecules, „actuators" releasing cytokines, …

Helper CD4+ T cell
MHC class II
CD28
B7
MHC class I
TCR
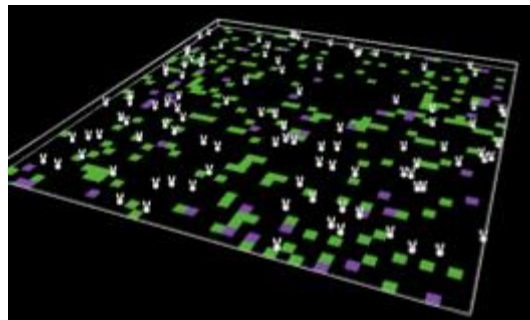Cytotoxic CD8+ T cell
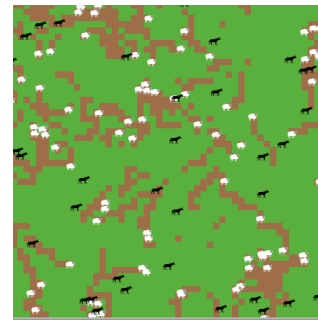Antigen/Epitopes
Dendritic Cell

We will start with an analysis of MAS Predator-Prey example (1)

- **Performance measure**:
  - predator: amount of killed preys
  - prey: amount of consumed grass
- **Environment**: 2D (3D) environment containing segments of grass without obstacles

3D   **2D**

We start with an analysis of MAS Predator-Prey example (2)

- **Sensors (perceptors)**:
  - predator and prey: **eyes**, nose, ears
- **Actuators**:
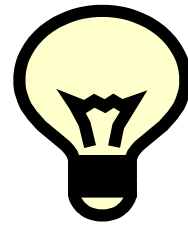 - predator and prey : **lower limbs**

ODD+D protocol

- **Main motivation**: proposition of standardised structure for models documentation which are developed with various approaches
- The first version: 2006 (Grimm, et al.)
- The second version: 2010 (Grimm, et al.)
- The newest version with decision making attribute (ODD+D): 2013 (Müller)

| Categories	ODD (2006)	ODD (2010)	ODD + D (2013)
	(Grimm, et al., 2006)	(Grimm, et al., 2010)	(Müller, et al., 2013)
	Structural elements		
Overview	Purpose	Purpose	Purpose
	State variables and scales	**Entities**, state variables, and scales	Entities, state variables, and scales
	Process overview and scheduling	Process overview and scheduling	Process overview and scheduling
Design concepts	Design concepts • Emergence • Adaptation • Fitness • Prediction • Sensing • Interaction • Stochasticity • Collectives • Observation	Design concepts • Basic principles • Emergence • Adaptation • Objectives • **Learning** • Prediction • Sensing • Interaction • Stochasticity • Collectives • Observation	Design concepts • Theoretical and empirical background • **Individual decision making** • Learning • Individual sensing • Interaction • Collectives • Heterogeneity • Stochasticity • Observation (+emergence)
Details			Implementation details
	Initialization	Initialization	Initialization
	Input	Input	Input
	Sub-models	Sub-models	Sub-models

ODD+D protokol

- **O**verview: the main ideas, hypothesis, questions which will be explored, accepted or rejected, key entities of a model

- **D**esign concepts: more detailed explanation of behaviour of agents, their interactions, abilities to learn, cooperate or predict future events with possibilities of decision making for each entity in a model

- **D**etails: implementation details (development environment, programming language, availability of a model, initial parameters of a model, …)

How many details should be included in the ODD +D protocol?

- Protocol has to contain so much information for full development (programming) of a model

NetLogo: Biology Wolf-Sheep predation
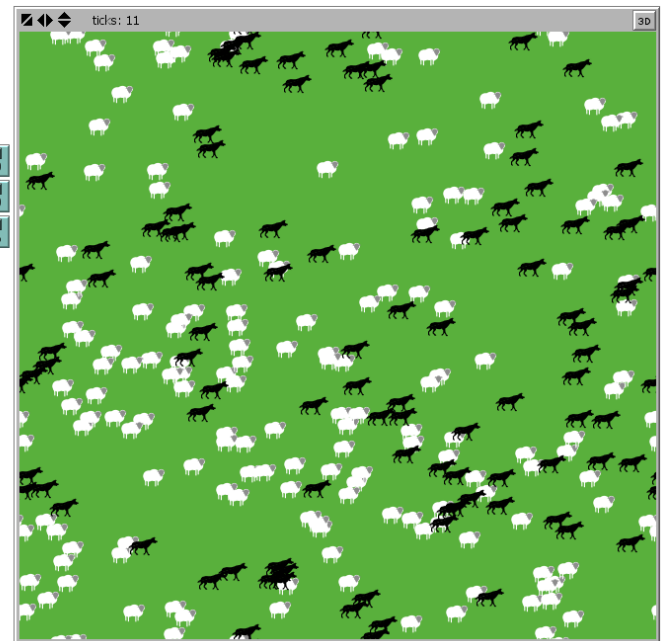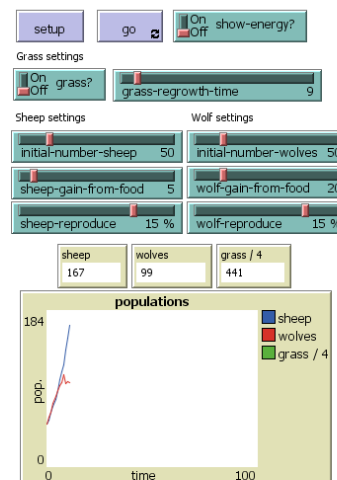
Examples of applications of the ODD+D protocol (protocol in action ☺)

- Ukazky\Husakova.Martina\...
  - Using the ODD protocol for comparing three agent-based social simulation models of land use change
  - Describing human decisions in agent-based models - ODD+D, an extension of the ODD protocol

Case studies

Sources

- Russell, S., Norvig, P. (2009). Artificial Intelligence: A Modern Approach (3rd ed.) (PEAS)

Seminar work and homeworks

- Complete:
    - a literature research and a state of the art
    - mind mapping
    - PEAS
    - ODD+D protocol