240AR056 - Robot Learning

Coordinating unit: 240 - ETSEIB - Barcelona School of Industrial Engineering
Teaching unit: 707 - ESAII - Department of Automatic Control
Academic year: 2015
Degree: MASTER'S DEGREE IN AUTOMATIC CONTROL AND ROBOTICS (Syllabus 2012). (Teaching unit Optional)
ECTS credits: 4,5 Teaching languages: English

Coordinator: CECILIO ANGULO BAHON

Degree competences to which the subject contributes

Specific:
3. The student will acquire a set of knowledge and skills to basic and advanced level of mobile robotics, putting special emphasis on probabilistic models applied to mobile robotics.
4. The student will be able to select and program pattern recognition methods and learning based on the type of problem, after distinguishing if the situation so requires
5. The student will have knowledge to analyze, design and implement advanced robotic applications.

General:
1. Ability to conduct research, development and innovation in the field of systems engineering, control and robotics, and as to direct the development of engineering solutions in new or unfamiliar environments, linking creativity, innovation and transfer of technology
2. Have adequate mathematical skills, analytical, scientific, instrumental, technological, and management information.

Teaching methodology

Methodologies for this course:
Expositive method / seminar
Project / Problem based learning (PBL)

Learning objectives of the subject

The student who has taken the course should be able to:

Describe learning methods to model robots, tasks and environments
Distinguish between different levels of representation: from sensorimotor representation to abstraction task
Apply learning in scheduling
Designing control policies by imitation and reinforcement learning
Apply methods of probabilistic inference from multimodal sensory information (proprioceptive, tactile, vision)
Adequately represent the spatiotemporal structured information designed for robot learning
Investigate the factors for assessing the appropriateness of applying a learning method
Identify learning strategies for defining control structures in robotic systems
Using human factors issues for improving the functioning of robotic systems
Schedule learning algorithms in robotic simulation environment
# Study load

<table>
<thead>
<tr>
<th>Total learning time: 0h</th>
<th>Theory classes:</th>
<th>0h</th>
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<tr>
<td></td>
<td>Practical classes:</td>
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<td>Laboratory classes:</td>
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<td>Guided study:</td>
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<td>Self study:</td>
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# Content

<table>
<thead>
<tr>
<th>Topic</th>
<th>Learning time</th>
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<tbody>
<tr>
<td>- Forms of learning models for robots, tasks and environments</td>
<td>Learning time: 6h 40m</td>
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<tr>
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<td>Large group/Theory: 1h 30m</td>
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<td>Medium group/Practical: 1h 30m</td>
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<td>Small group/Laboratory: 0h 30m</td>
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<td>Self study : 3h 10m</td>
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<td>- Levels of representation: from sensorimotor representation to abstraction task</td>
<td>Learning time: 7h 10m</td>
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<td>Large group/Theory: 1h 30m</td>
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<td>Medium group/Practical: 1h 30m</td>
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<td>Small group/Laboratory: 1h</td>
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<td>Self study : 3h 10m</td>
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<tr>
<td>- Learning planning and handling</td>
<td>Learning time: 7h 10m</td>
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<td>Large group/Theory: 1h 30m</td>
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<td>Medium group/Practical: 1h</td>
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<td>Medium group/Practical: 1h 30m</td>
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<td>Self study : 3h 10m</td>
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<tr>
<td>- Robot learning models</td>
<td>Learning time: 7h 10m</td>
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<td>Large group/Theory: 1h 30m</td>
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<td>Medium group/Practical: 1h 30m</td>
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<td>Small group/Laboratory: 1h</td>
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<td>Self study : 3h 10m</td>
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<tr>
<td>- Spatiotemporal structured representation designed for robot learning: motor learning and motor primitives</td>
<td>Learning time: 7h 10m</td>
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<td>Large group/Theory: 1h 30m</td>
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<td>Medium group/Practical: 1h 30m</td>
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<td></td>
<td>Small group/Laboratory: 1h</td>
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<td>Self study : 3h 10m</td>
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**Description:**
Low-dimensional embedding of movements. Spatiotemporal joint motor interaction
# 240AR056 - Robot Learning

- **Integrating learning control architectures**
  - **Learning time:** 7h 10m
    - Large group/Theory: 1h 30m
    - Medium group/Practical: 1h 30m
    - Small group/Laboratory: 1h
    - Self study: 3h 10m

- **Learning by demonstration, by imitation and interactive**
  - **Learning time:** 7h 10m
    - Large group/Theory: 1h 30m
    - Medium group/Practical: 1h 30m
    - Small group/Laboratory: 1h
    - Self study: 3h 10m

- **Reinforcement Learning**
  - **Learning time:** 1h 20m
    - Small group/Laboratory: 1h
    - Guided activities: 0h 20m

- **Probabilistic inference methods from multimodal sensory information ( proprioceptive, tactile, vision)**
  - **Learning time:** 7h 10m
    - Large group/Theory: 1h 30m
    - Medium group/Practical: 1h 30m
    - Small group/Laboratory: 1h
    - Self study: 3h 10m

- **Active learning**
  - **Learning time:** 7h 10m
    - Large group/Theory: 1h 30m
    - Medium group/Practical: 1h 30m
    - Small group/Laboratory: 1h
    - Self study: 3h 10m
- Cognitive and developmental robotics

Learning time: 105h 10m
- Theory classes: 15h
- Practical classes: 11h
- Laboratory classes: 15h
- Self study (distance learning): 27h
- Group work (distance learning): 30h
- Large group/Theory: 1h 30m
- Medium group/Practical: 1h 30m
- Small group/Laboratory: 1h
- Self study: 3h 10m

Description:
Dynamical systems for modelling cognition in robotics

Qualification system

Written exams (0%-20%)
Questions, tests, problems, mini reports (0%-10%)
Formal reports (20%-50%)
Oral expositions (0-20%)
Teamwork (0-15%)

Re evaluation:
New Written Exam (80%)
Formal report (20%)

Bibliography

Basic:
