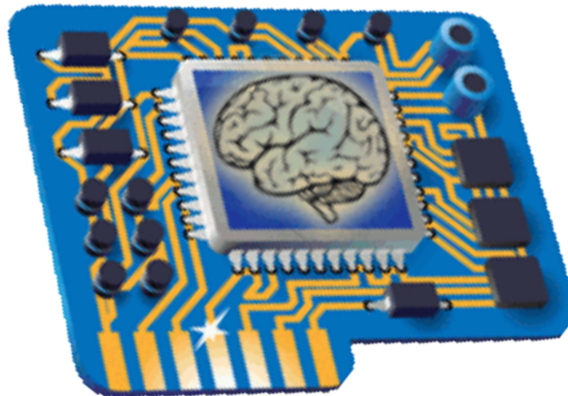


Proseminar
**Learning and Intelligence in Embedded
Systems**



Dr. Anas Toma
TU Dortmund

04.04.2019

Course Information

- Lecturer: Dr. Anas Toma
- Language: English
- Classroom sessions: Thursdays at 12:15, U09, OH16
- Reference book: *Intelligence for Embedded Systems - A Methodological Approach*, Cesare Alippi, Springer International Publishing Switzerland 2014
- More references:
 - *Artificial Intelligence – A Modern Approach*, Stuart J. Russell and Peter Norvig, Pearson Education 2016
 - *Embedded System Design*, Peter Marwedel, Springer 2006

Outline

■ Introduction

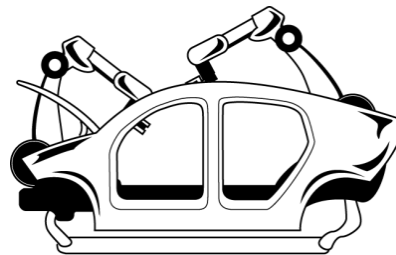
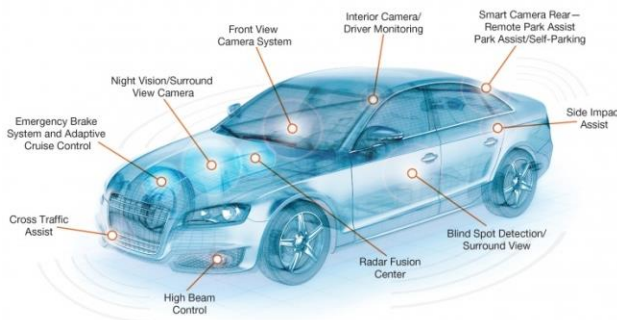
- Embedded Systems
- Why do we need to use Artificial Intelligence in Embedded Systems?!
- Basic Artificial Intelligence Techniques

■ Organization

- Topics
- Tasks
- Regulations
- Schedule

Embedded Systems

- **Embedded System (ES)**: a computer system designed to perform **special-purpose tasks**
- Over **96%** of the computer chips are produced for embedded systems [1]
 - the remaining **4%** is used in the normal computers!



[1] P. Pop. Integration of AI and OR Techniques in Constraint Programming for Combinatorial Optimization Problems. Springer Berlin Heidelberg, 2005.
[Pictures' sources: www.autotechreview.com, www.disney.com, www.google.com/glass/start/]

Embedded Systems - Common characteristics

- Tasks-specific
 - **Specific predefined tasks**
 - **Known input domain**
 - Cost, size, performance and power consumption are optimized
 - As much as enough for the requirements
 - e.g. CPU is fast enough to meet a deadline
- Resource-constrained. Limited:
 - Computational capabilities
 - Battery life
 - Memory
- Real-time

Why do we need to use Artificial Intelligence (AI) in Embedded Systems?!

- More and more complex applications
- New or changing environment
 - new or unknown inputs
 - uncertainty or faults
- Prediction
- Advances in embedded processor

Machine learning techniques

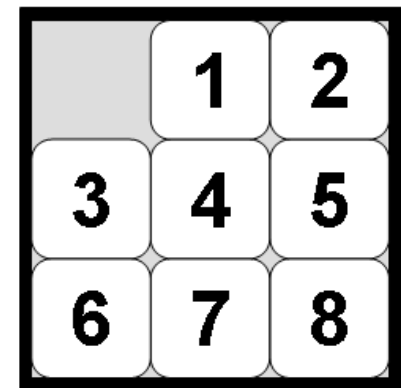
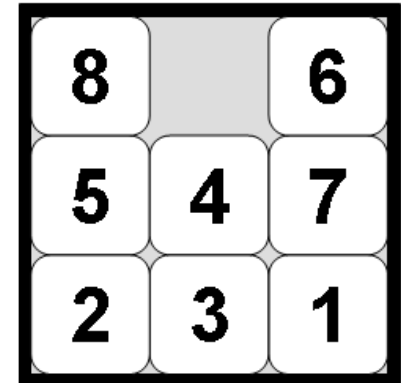
- Provide intelligent decisions
- Learn from examples
- Adapt to changing conditions

Basic Artificial Intelligence Techniques

- Problem-solving
 - Searching
 - Constraint Satisfaction
- Knowledge and reasoning
 - Knowledge Representation
 - First-Order Logic and inference
- Learning
 - Learning from Examples
- Perception
 - Object Recognition

Basic Artificial Intelligence Techniques

- Let us solve the 8-puzzle!
- How long does it take?
 - Manually (<http://mypuzzle.org/sliding>)
 - Searching algorithm (<https://n-puzzle-solver.appspot.com/>)
 - 3x3
 - 4x4
 -
- Time and space complexity?
- More difficult problems?
- Can we use any AI technique in ES's?



Outline

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- Embedded Systems
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Topics

1. Emotional cognitive mechanisms
2. Power supply voltage and processor frequency levels adaptation
3. Adaptive sensing and its policies
4. Energy harvesting level adaptation
5. Clock Synchronization
6. Localization and Tracking
7. Application code level adaptation
8. Passive and active learning
9. Introduction to fault diagnosis systems

Tasks

- Rehearsal presentation (20 - 25 minutes)
 - Discussion
 - Evaluation and feedback
 - No final presentation without the rehearsal!

- Short summary report
 - Your opinion on the topic
 - Usefulness, feasibility, overhead of the adopted AI technique
 - No final presentation without the report!

- Final presentation (20 minutes)

Regulations

- Admission to the final presentation
 - Present your topic (rehearsal presentation)
 - No final presentation without the rehearsal on time!
 - Formal approval for the absence (e.g. because of sickness)
 - Attend others' rehearsals
 - If you cannot attend because of a reasonable excuse, please send me an informal letter with clear explanation
- Submit the report
 - No excuse 😊

Schedule

- Introduction
 - 04.04.2019
- How to present and topics selection/ordering
 - 11.04.2019
- Rehearsals
 - 02.05.2019
 - 09.05.2019
 - 23.05.2019
 - 06.06.2019
 - 13.06.2019
- Final presentations
 - One or two sessions in July 2019

Schedule

Date	Activity
07.02	Preliminary Meeting
04.04	Introduction
11.04	How to present
11.04 - 02.05	Studying the topic and preparing the rehearsal
02.05	Rehearsals 1 + 2
09.05	Rehearsals 3 + 4
16.05	Conference trip (Lecture-free)
23.05	Rehearsals 5 + 6
30.05	Holiday
06.06	Rehearsals 7 + 8
13.06	Rehearsal 9
13.06 - July	Working on the final presentation
20.06	Holiday
04.07	Final presentations (Preliminary dates. Final dates will be assigned in agreement with all of the students)
11.07	

Thank You

