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INF3490/INF4490 - Biologically inspired computing

Lecture 1 – 2016

Jim Tørresen

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INF3490/INF4490: Biologically Inspired Computing – Autumn 2016


- **Lecturer:**
  - Kai Olav Ellefsen (kaiolae@ifi.uio.no)
  - Jim Tørresen (jimtoer@ifi.uio.no)
  - Invited (Kyrre Glette + potential guest lecturer)
- **Lecture time:** Wednesday 10.15-12.00
- **Lecture room:** OJD 3437 Sem. room C (First lectures: Lille Aud)
- **Group Lecture (starting next week):**
  - Group 2: Tuesday 14:15-16:00 (OJD 3468 Computer Room Fortress)
  - Group 1: Thursday 10:15-12:00 (OJD 3418 Computer Room Limbo)
  - Group 3: Friday 10:15-12:00 (OJD 3468 Computer Room Fortress)
- **Course web page:** www.uio.no/studier/emner/matnat/ifi/INF3490

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Group Teachers

Torstein Brevig		**Tuesday**
Ole Herman Schumacher Elgesem		**Thursday**
Bård-Kristian Krohg		**Friday**

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INF3490/INF4490

Syllabus:

- Selected parts of the following books (details on course web page):
  - A.E. Eiben and J.E. Smith: Introduction to Evolutionary Computing, Second Edition (ISBN 978-3-662-44873-1). Springer.
  - S. Marsland: Machine learning: An Algorithmic Perspective. ISBN: 978-1466583283
  - On-line papers (on the course web page).
- The lecture notes.

Obligatory Exercises:

- Two exercises on evolutionary algorithms and machine learning.
- ***Students registered for INF4490 will be given additional tasks in the excercises.***

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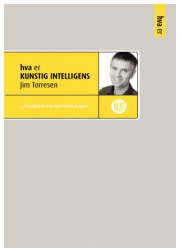
Supporting Literature in Norwegian (not syllabus)

Jim Tørresen: hva er KUNSTIG INTELLIGENS
Universitetsforlaget Nov 2013, ISBN: 9788215020211

Topics:

- Kunstig intelligens og intelligente systemer
- Problemløsning med kunstig intelligens
- Evolusjon, utvikling og læring
- Sansing og oppfatning
- Bevegelse og robotikk
- Hvor intelligente kan og bør maskiner bli?



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Username and Password Course Web Page

username: authorization

password: complete

23 August 2016 6

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Lecture Plan Autumn 2016 (tentative)

Date	Topic	Syllabus
24.08.2016	Intro to the course. Optimization and search.	Marsland (chapter 9.1, 9.4-9.6)
31.08.2016	Evolutionary algorithms I: Introduction and representation.	Eiben & Smith (chapter 1-4, not 1.4, 3.6 and 4.4.2)
07.09.2016	Evolutionary algorithms II: Population management and popular algorithms	Eiben & Smith (chapter 5-6, not 5.2.6, 5.5.7, 6.5-6.6 and 6.8) (+ Marsland 10.1-10.4)
14.09.2016	Evolutionary algorithms III: Multi-objective optimization. Hybrid algorithms. Working with evolutionary algorithms.	Eiben & Smith (chapter 9, 10, 12, not 10.4 and 12.3.4)
21.09.2016	Intro to machine learning and classification. Single-layer neural networks.	Marsland (chapter 1 and 3, not 3.4.1)
28.09.2016	Multi-layer neural networks. Backpropagation and practical issues.	Marsland (chapter 2.2 and 4)
05.10.2016	Break	
12.10.2016	Reinforcement learning and Deep Learning	Marsland (chapter 11) + online paper
19.10.2016	Support vector machines. Ensemble learning. Dimensionality reduction.	Marsland (chapter 8, 13, 6.2.)
26.10.2016	Unsupervised learning. K-means. Self-organizing maps.	Marsland (chapter 14)
02.11.2016	Swarm Intelligence. Evolvable hardware.	TBA (On-line papers on the course web page)
09.11.2016	Bio-inspired computing for robots and music. Future perspectives on Artificial Intelligence including ethical issues	On-line papers on the course web page
16.11.2016	Summary and Questions	

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What is the Course about?

- Artificial Intelligence/Machine learning/Self-learning:
  - Technology that can adapt by learning
- Systems that can sense, reason (think) and/or respond
- Why bio-inspired?
- Increase intelligence in both single node and multiple node systems



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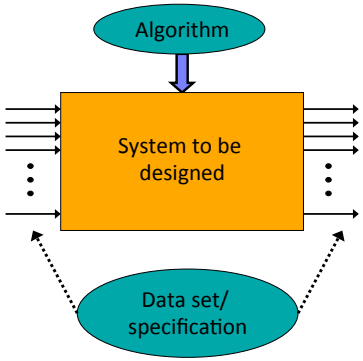
Self learning/Machine learning (ex: evolutionary computation)



Learning by examples

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Man/Woman vs Machine – Who are smartest?

- Machines are good at:
  - number crunching
  - storing data and searching in data
  - specific tasks (e.g. control systems in manufacturing)
- Humans are good at:
  - sensing (see, hear, smell etc and be able to recognize what we senses)
  - general thinking/reasoning
  - motion control (speaking, walking etc).

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Turing Test (1956)

- A machines is intelligent when a human **communicating with text** is **unable to distinguish** the machine from a human.
- Requirements:
  - recognize and generate ***natural language*** to communicate as a human
  - store the information for ***representing knowledge*** it has received or are receiving
  - ***reasoning*** based on stored information and draw new conclusions
  - be able to learn to ***adapt*** to new circumstances and extract patterns

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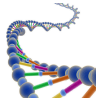
Major Mechanisms in Nature



- **Evolution:** Biological systems develop and change during generations.
- **Development/growth:** By cell division a multi-cellular organism is developed.
- **Learning:** Individuals undergo learning through their lifetime.
- **Collective behavior:** Immune systems, flocks of birds, fishes etc
- **Sensing** and **motion**

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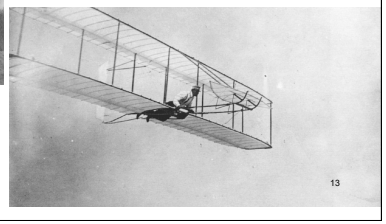
What Methods are best?



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Artificial Intelligence Application

- Smartphone user adaptation
- Detecting faces/people smiling in cameras
- Design of physical shapes
- Web search
- Route planning
- Service robots
- Driverless cars
- Active music
- ??

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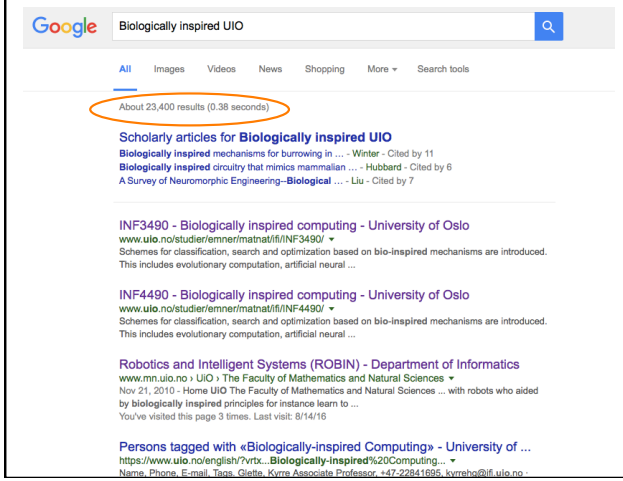

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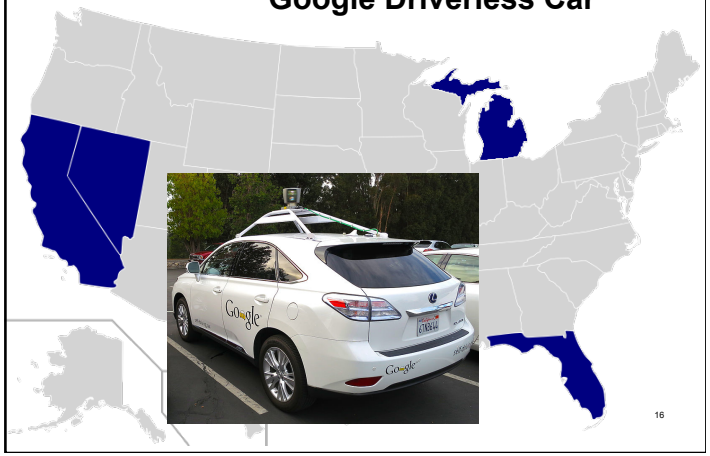
Google Driverless Car



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Google Driverless Car

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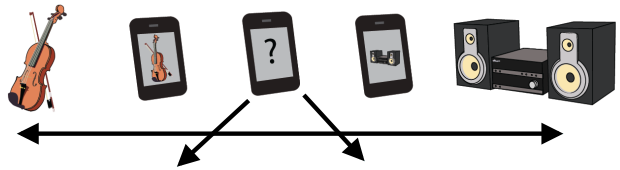
(Inter) Active Music



Direct Control
- Navigate within the song
- Control certain instruments (e.g. keep playing the chorus drumbeat in the verse)
- Change the tempo of the song

Indirect Control
- Use on-body sensors to adapt the music to the mood of the user
- Listen to music that pushes you to work out harder
- Fuse the musical preferences of multiple users into one song

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Apple app: https://itunes.apple.com/us/app/**pheromusic**/id910100415?ls=1&mt=8

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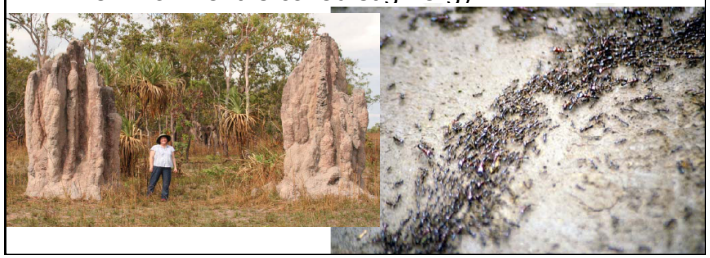
Ant Colony Optimization (ACO)

- Ants find shortest path to food source from nest.
- Ants deposit pheromone along traveled path which is used by other ants to follow the trail.
- This kind of indirect communication via the local environment is called stigmergy.



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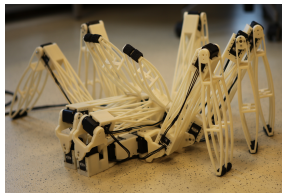
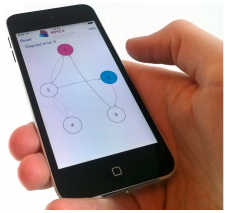
EPEC: Prediction and Coordination for Robots and Interactive Music

2 PhDs + 1 post-doc 2015-2019





Goal: *Design, implement and evaluate multi-sensor systems that are able to sense, learn and predict future actions and events.*

Funding: *FRIPRO, Research Council of Norway*

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MECS: Multi-sensor Elderly Care Systems

2 PhDs + 1 post-doc (2015-2019)

Goal: Create and evaluate multimodal mobile human supportive systems that are able to sense, learn and predict future events.

Project consortium:

- Robotics and Intelligent Systems group (coordinator)
- DESIGN group (IFI)
- National:
  - Oslo Municipality (Oslo kommune, Gamle Oslo)
  - Norwegian Centre for Integrated Care and Telemedicine (Tromsø)
  - XCENTER AS (3D sensor)
  - Novelda AS (ultra wideband sensor)
- International:
  - University of Hertfordshire
  - University of Reading Whiteknights
  - Giraff Technologies AB

Funding: *IKTPLUSS, Research Council of Norway*

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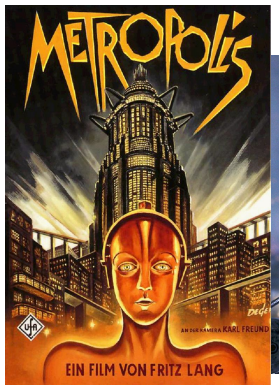
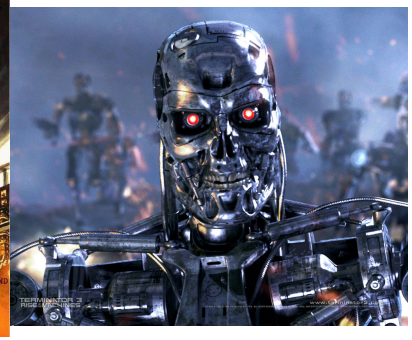
Is Terminator Coming Close?





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Repetiton Questions

- What is machine learning?
- Give some examples of intelligent mechanisms in nature

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