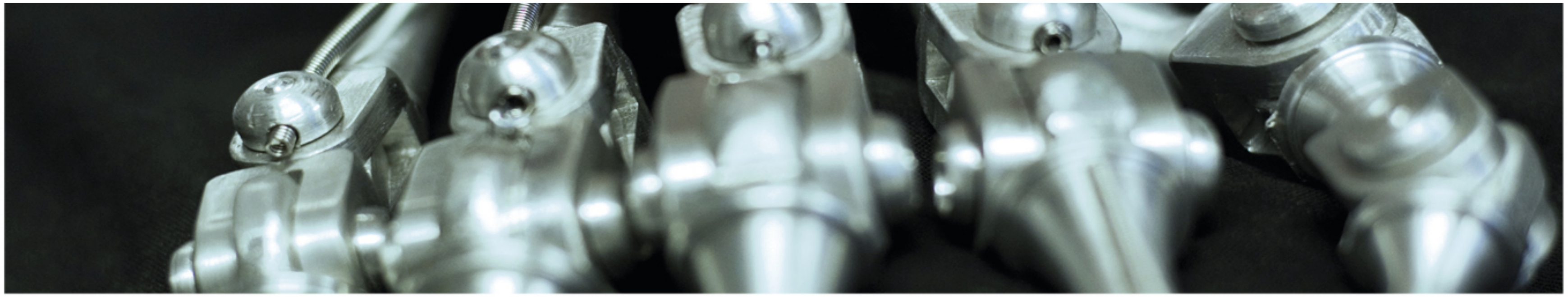


UiO : **Department of Informatics**
University of Oslo

INF3490 - Biologically inspired computing

Lecture 19 November 2013

Jim Tørresen and Eivind Samuelsen

INF3490/4490 Exam

- Format: Written
- Tid: December 3, at 14:30 (4 hours)
- “Closed book exam”: **No materials are permitted on the exam**
- **Location: See** http://www.uio.no/studier/emner/matnat/ifi/INF3490/h14/eksamen/index.html

Multiple-choice Questions on Parts of the Exam

The exam text consists of problems 1-30 (multiple choice questions) to be answered on the form that is enclosed in the appendix and problems 31-3? which are answered on the usual sheets. Problems 1-30 have a total weight of 60%, while problems 31-3? have a weight of 40%.

About problem 1-30:
Each problem consists of a topic in the left column and a number of statements each indicated by a capital letter. Problems are answered by marking true statements with a clear cross (X) in the corresponding row and column in the attached form, and leaving false statements unmarked. Each problem has a variable number of true statements, but there is always *at least one* true and false statement for each problem. 0.5 points are given for each marked true statement and for each false statement left unmarked, resulting in a score ranging from 0 to 60.

You can use the right column of the text as a draft. The form in the appendix is the one to be handed in (remember to include your candidate number).

Problem 1

Biologically inspired computing	A	Topic for a course at IFI	
	B	Is mostly relevant for safety-critical systems	
	C	Evolutionary computing is included in this field	
	D	Must be programmed in a specific language	

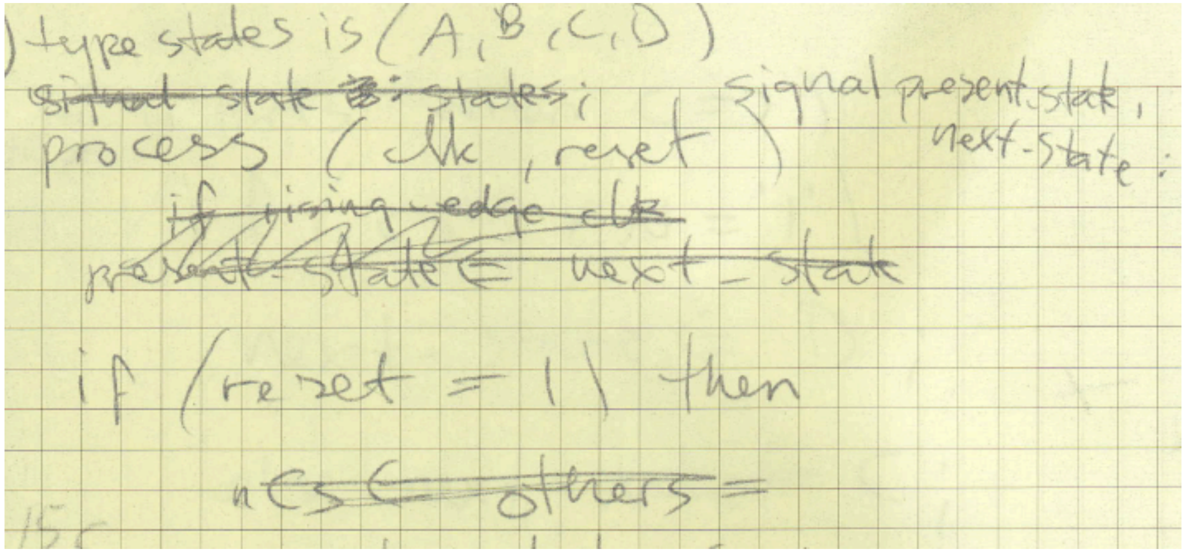
Reply on Multiple-choice Questions on Attached Form

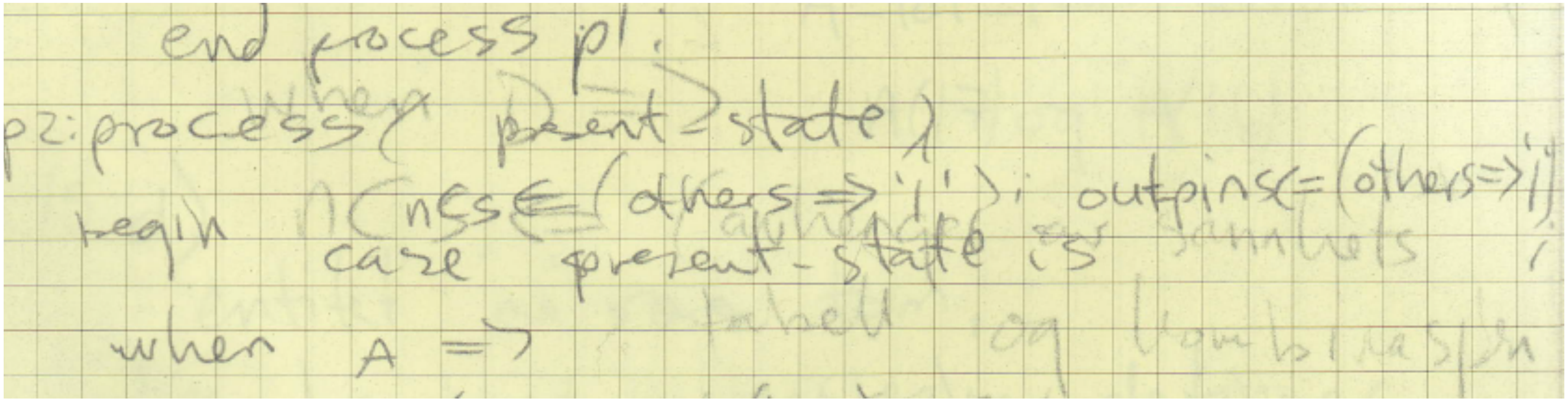
Appendix 1

INF3490/INF4490 Answers problems 1 – 30 for candidate no: __________

Problem	A	B	C	D
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Please Make Sure you can Read what you Write…

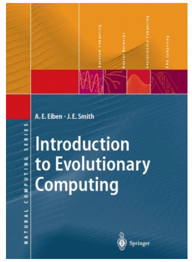


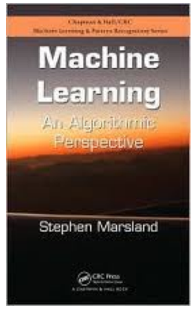


INF3490/INF4490

Course web page:

www.uio.no/studier/emner/matnat/ifi/INF3490





Syllabus:

- Selected parts of the following books (details on course web page):
  - A.E. Eiben and J.E. Smith: Introduction to Evolutionary Computing, 2nd printing, 2007. Springer. ISBN: 978-3-540-40184-1.
  - S. Marsland: Machine learning: An Algorithmic Perspective. ISBN:978-1-4200-6718-7
- On-line papers/chapters (on course web page)
- The lecture notes (except ROBIN research 12.11.13)

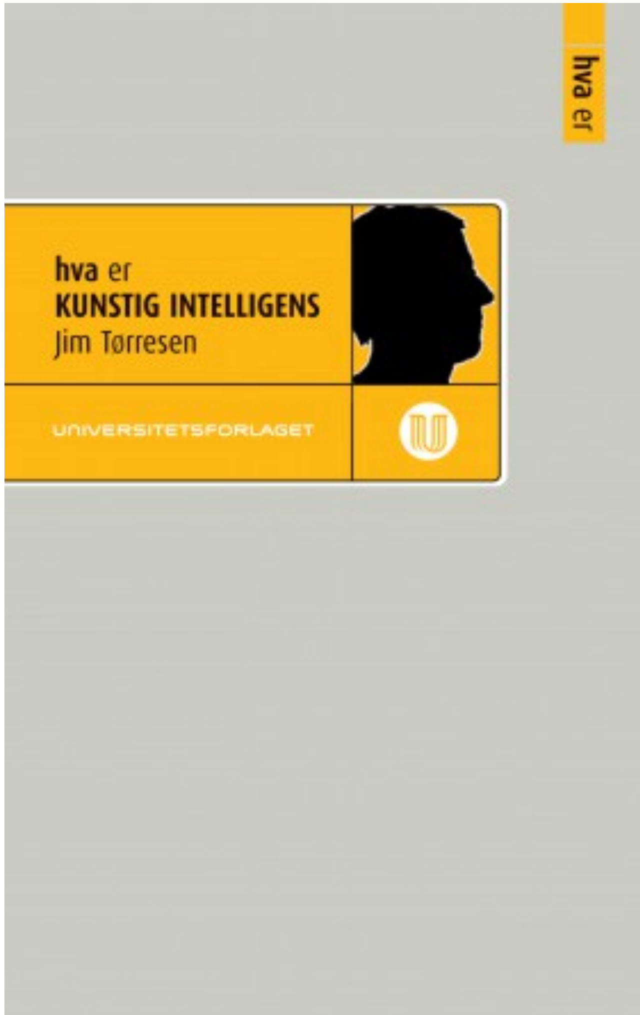
Obligatory Exercises:

- Two exercises on evolutionary algorithm and machine learning.

Book in Norwegian (not syllabus)

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?



Username and Password Course Web Page

username: authorization

password: complete

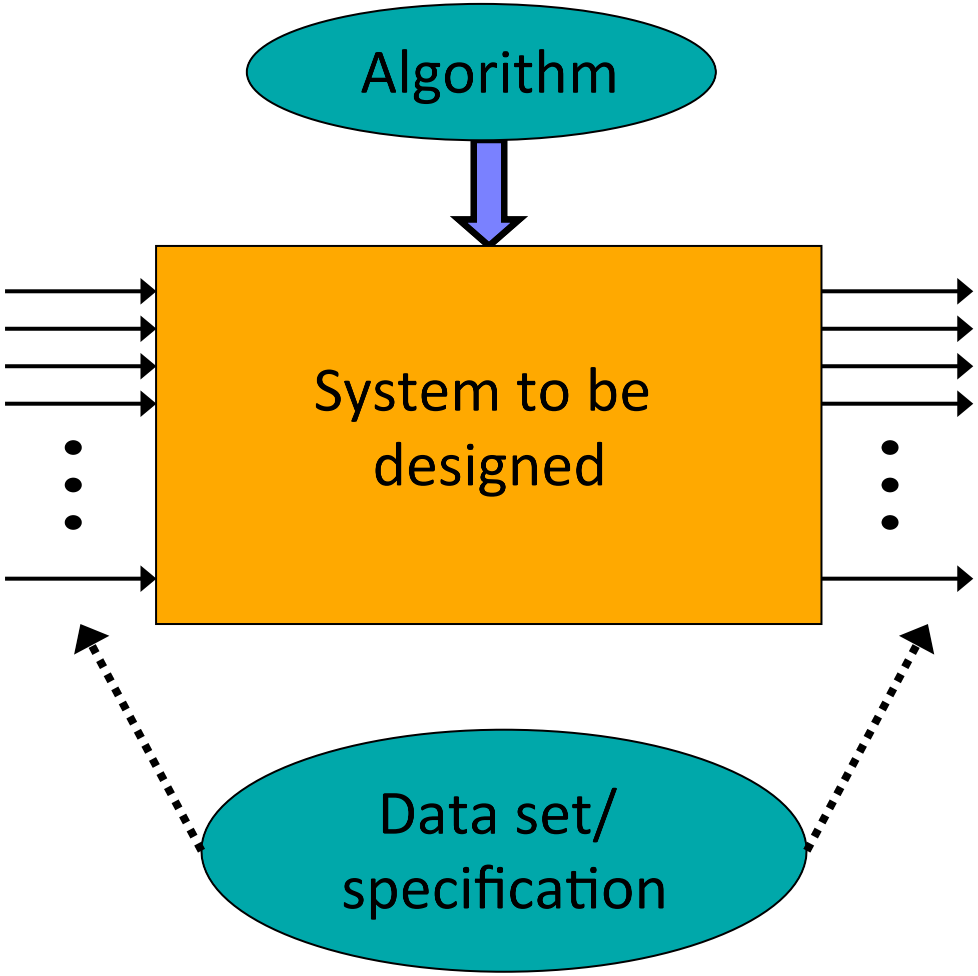
Lecture Plan Autumn 2014

Date	Topic	Syllabus
27.08.2014	Intro to the course. Optimization and search.	Marsland (chapter 11.1, 11.4-11.6)
03.09.2014	Evolutionary algorithms I: Introduction. Evolutionary strategies and evolutionary programming.	Eiben & Smith (chapter 1, 2, 4 and 5.1, 5.3-5.8)
10.09.2014	Evolutionary algorithms II: Genetic algorithm and representations. Genetic programming	Eiben & Smith (chapter 3, 6) (Marsland 12.1-12.4)
17.09.2014	Evolutionary algorithms III: Multi-objective optimization. Working with evolutionary algorithms.	Eiben & Smith (chapter 9, 10 and 14)
24.09.2014	Intro to machine learning and classification. Single-layer neural networks.	Marsland (chapter 1 and 2)
01.10.2014	Break (no lecture)	
08.10.2014	Multi-layer neural networks. Backpropagation and practical issues	Marsland (chapter 3)
15.10.2014	Swarm Intelligence and evolvable hardware	**On-line documents**
22.10.2014	Support vector machines. Ensemble learning. Dimensionality reduction.	Marsland (chapter 5, 7 and 10.2)
29.11.2014	Unsupervised learning. K-means. Self-organizing maps.	Marsland (chapter 9.1 and 9.2)
05.11.2014	Reinforcement learning	Marsland (chapter 13)
12.11.2014	Bioinspired computing for robots and music. Future perspectives on Artificial Intelligence	**On-line documents**
19.11.2014	Summary. Questions	

What is the Course about?

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

Self learning/Machine learning (ex: evolutionary computation)

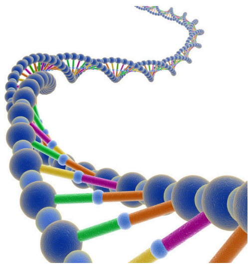


Learning by examples

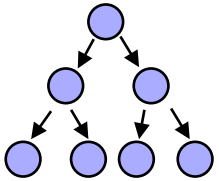
Man/Woman vs Machine – Who are smartest?

- 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).

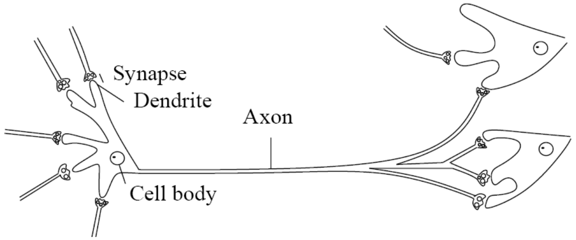
Major Mechanisms in Nature



- **Evolution:** Biological systems develop and change during generations.



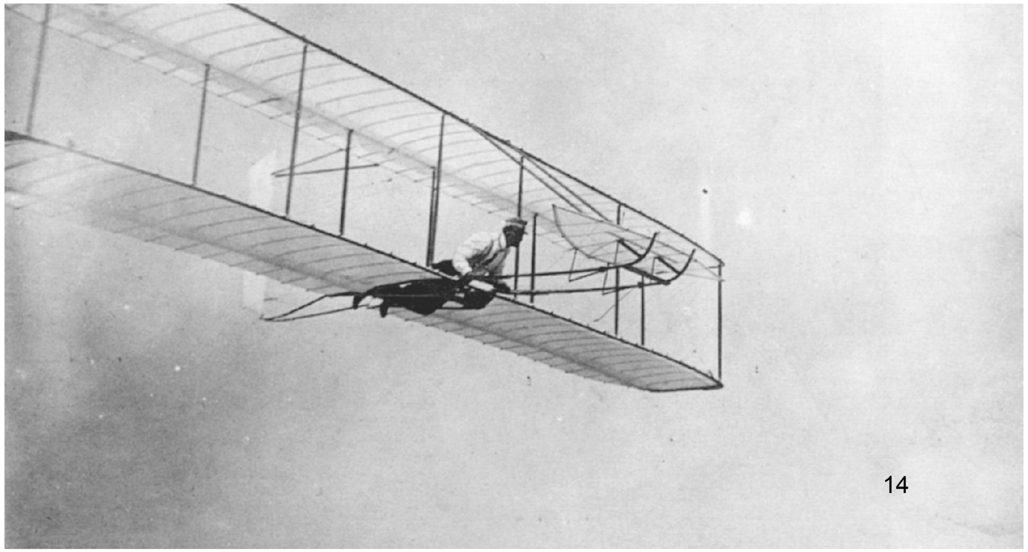
- **Development/growth:** By cell division a multi-cellular organism is developed.



- **Learning:** Individuals undergo learning through their lifetime.

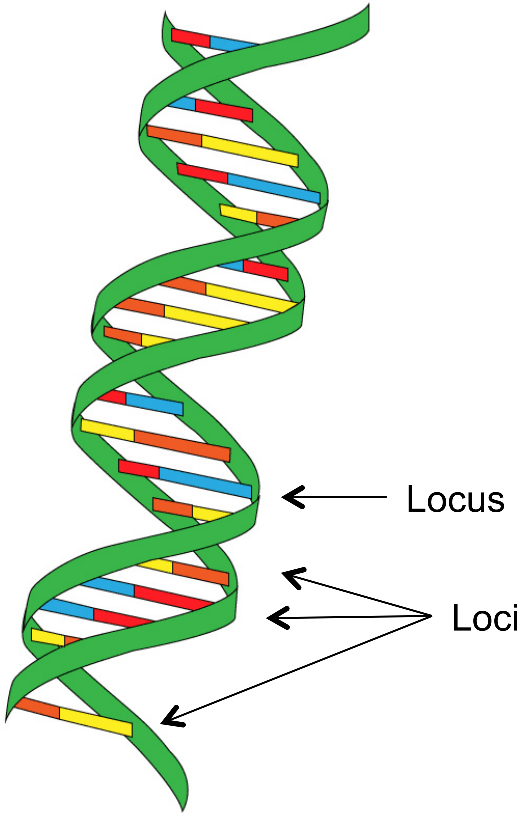
- **Collective behavior:** Immune systems, flocks of birds, fishes etc
- **Sensing and motion**

What methods are best?



Genotype vs phenotype

Genotype



Phenotype

The standard EA variants

Name	Representation	Crossover	Mutation	Parent selection	Survivor selection	Specialty
Genetic Algorithm	Usually fixed-length vector	Any or none	Any	Any	Any	None
Evolution Strategies	Real-valued vector	Discrete or intermediate recombination	Gaussian	Random draw	Best N	Strategy parameters
Evolutionary Programming	Real-valued vector	None	Gaussian	One child each	Tournament	Strategy parameters
Genetic Programming	Tree	Swap sub-tree	Replace sub-tree	Usually fitness proportional	Generational replacement	None

Representations

- Candidate solutions (**individuals**) exist in *phenotype* space
- They are encoded in **chromosomes**, which exist in *genotype* space
  - Encoding : phenotype=> genotype (not necessarily one to one)
  - Decoding : genotype=> phenotype (must be one to one)
- Chromosomes contain **genes**, which are in (usually fixed) positions called **loci** (sing. locus) and have a value (**allele**)

In order to find the global optimum, every feasible solution must be represented in genotype space

Off- / on-policy learning

- On-policy: SARSA
- Off-policy: Q-learning

"The difference may be explained as **SARSA learns the Q values associated with taking the policy it follows itself**, while Watkin's **Q-learning learns the Q values associated with taking the exploitation policy while following an exploration/ exploitation policy**."

- Wikipedia

Repetiton Questions

- What is AI/machine learning?
  - Self-learning/adaptive methods
  - Learning by examples (rather than being programmed)
- Give some examples of intelligent mechanisms in nature
  - Evolution
  - Development/growth
  - Learning
  - Collective behavior
  - Sensing and motion