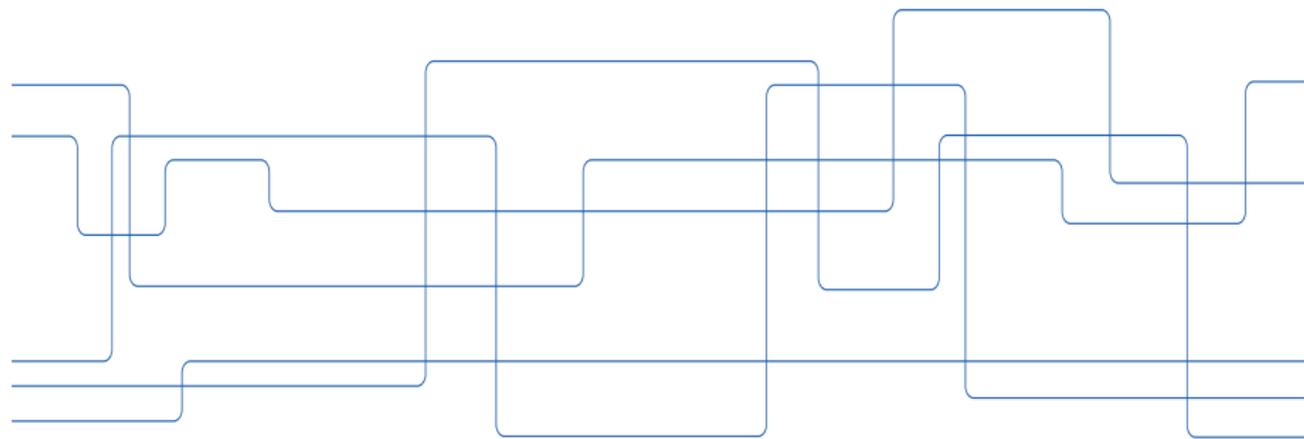# Master's programme: Machine Learning

Introduction by Josephine Sullivan, August, 2020

What is Machine Learning?

"*Machine learning is the science of getting computers to act without being explicitly programmed.*"

Andrew Ng via Coursera.

When do we use Machine Learning?

Use **Machine Learning** when

- Human expertise does not exist (navigating on Mars)

- Humans cannot explain their expertise (speech recognition)

- Models are based on huge amounts of data (genomics)

- Models must be customized (personalized medicine)
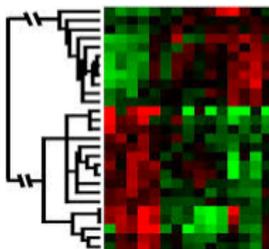
Task requiring Machine Learning

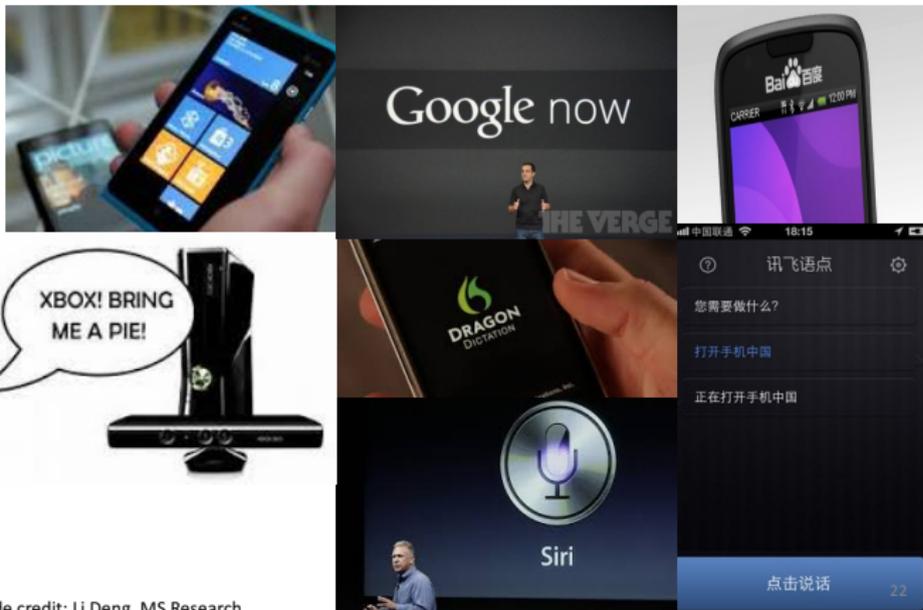- Can you write down rules to define a chair?

Task requiring Machine Learning

- Can you write down rules to define a chair?

- How could you encode these rules in a computer programme to recognise the image of a chair???

Machine Learning is pervasive today

Example: Speech Recognition

Slide credit: Li Deng, MS Research

Impact of machine learning (really deep learning) on speech technology.

Machine Learning is pervasive today

Example: Google translate

- Use neural networks to perform machine translation.
- Based on an RNN encoder-decoder neural network model.
  (encodes sentence and then decodes to target language.)

Machine Learning is pervasive today

Example: Netflix

- Netflix wants "*Everybody to be watching Netflix all the time!*"

- Netflix uses AI/Data/Machine Learning extensively to help with this goal.

- Examples of this use:
    - Personalization of Movie Recommendations
    - Auto-Generation and Personalization of Thumbnails / Artwork
    - Movie Editing (Post-Production)
    - Streaming Quality

For more details check out: How Netflix Uses AI, Data Science, and Machine Learning - From a Product Perspective

Skills you would like to develop?
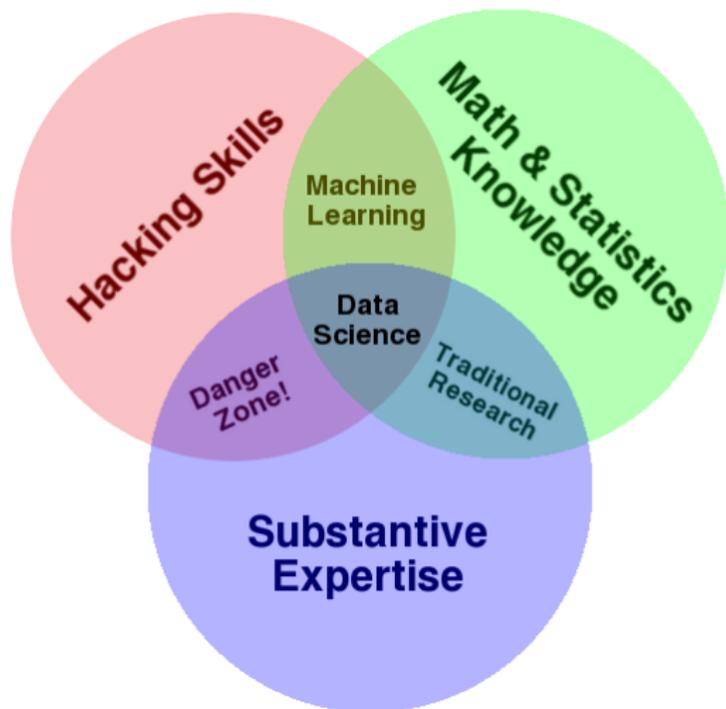
Staff and their roles in helping you

- Programme director's role
  - Approve course choices.
  - Give advice on course choice.
  - Give advice on your choice of degree project.
  - Approve your final transcript for graduation from the ML programme.

- Programme coordinator's role (<cs-master@kth.se>)
  - Administrative duties:
    Registering you for courses, processing forms, recording your course choices etc.

About me

- Irish (from Dublin)

- BA in mathematics from Trinity College Dublin, Ireland

- PhD in computer vision from Oxford University, UK

- Lecturer at EECS with a specialization in computer vision

- Member of *Robotics, Perception and Learning* (RPL) division

- Courses I'm responsible for at KTH:
    - DD2301 Program Integration Course in Machine Learning
    - DD2424 Deep Learning in Data Science

- Research interests: computer vision, deep learning and machine learning

EECS faculty who are ML experts

- Hossein Azizpour
- Henrik Boström
- Saikat Chatterjee
- Gustav Henter
- Pawel Herman
- Hedvig Kjellstöm
- Jens Lagergren
- Atsuto Maki
- Florian Pokorny
- Alexandre Proutiere
- Kevin Smith
- Bob Sturm
- Josephine Sullivan

(in alphabetic order & not an exhaustive list)

EECS Research Groups active in ML

- Robotics, Perception and Learning
- Computational Biology
- Speech, Music & Hearing
- Automatic Control

Programme overview

Course type	Number of Credits/Courses & When							
	I.1	I.2	I.3	I.4	II.1	II.2	II.3	II.4
Compulsory	30.0 hp							
Elective			0.0 - ~ 21.5 hp					
Cond. Elective: App domains		≥ 2 courses						
Cond. Elective: Theory		≥ 2 courses						
Project							30.0 hp	

Must take at least 6 courses from *Application Domain* ∪ *Theory* courses.

P1: Common compulsory courses

Code	Course	Credits
DA2205	Intro to the Phil. of Science and Research Methodology	7.5
DD2301	Programme Integration Course[1]	3.0
DD2380	Artificial Intelligence	6.0
DD2431	Machine Learning	7.5

[1]This course runs for the first 3 semesters of the programme.

P2: Common compulsory courses

Code	Course	Credits
DA2205	Intro to the Phil. of Science and Research Methodology	7.5
DD2301	Programme Integration Course[2]	3.0
DD2434	Machine Learning, Advanced	7.5

---

[2]This course runs for the first 3 semesters of the programme.

Conditionally elective courses

You must fulfill the following in your course choices:

- $\geq$ 6 courses from **Application Domains** $\cup$ **Theory** courses **with**
    - $\geq$ 2 courses from the **Application Domains** courses and
    - $\geq$ 2 courses from the **Theory** courses

Application Domains courses

Code	Name	Credit	Scheduled
Computer Vision			
DD2423	Image Analysis and Computer Vision	7.5	II.2 (I.2)
DD2424	Deep Learning in Data Science	7.5	I.4
EQ2425	Analysis & Search of Visual Data	7.5	2.1
Language Processing: Speech and Text			
DT2112	Speech Technology	7.5	I.3
DT2119	Speech and Speaker Recognition	7.5	I.4
DD2418	Language Engineering	6.0	II.2 (I.2)
Visualization			
DD2257	Visualization	7.5	I.4

Application Domains courses

Code	Name	Credit	Scheduled
Robotics			
DD2410	Introduction to Robotics	7.5	II.1
DD2425	Robotics and Autonomous Systems	9.0	II.1-II.2
DD2438	Artif. Intelligence and Multiagent Systems	15.0	I.3-I.4
DD2411	Research project in Robotics, perception & learning	15.0	I.3-I.4 II.1-II.2
Information Retrieval			
DD2476	Search Engines and Info. Retrieval Systems	9.0	I.3-I.4
Computational Biology			
DD2401	Neuroscience	7.5	I.4
DD2402	Advanced individual course in CB	6.0	I.4
DD2404	Applied Bioinformatics	7.5	II.2
DD2435	Math. Modelling of Biological Syst.	9.0	II.1-II.2

Theory courses

Code	Name	Credit	Scheduled
Mathematics			
SF1811	Optimization	6.0	I.3
EL2320	Applied Estimation	7.5	II.2 (I.2)
Statistics & Probability			
SF2930	Regression Analysis	7.5	I.3
SF2940	Probability Theory	7.5	II.1
SF2945	Time Series Analysis	6.0	I.4
DD2420	Probabilistic Graphical Models	7.5	I.3
DD2447	Statistical Methods in Applied Comp. Science	6.0	II.2 (I.2)

Theory courses ctd

Code	Name	Credit	Scheduled
Machine Learning			
DD2412	Deep Learning, Advanced	6.0	II.1
DD2437	Artif. Neur. Netw. and Ot. Learn. Sys.	7.5	I.3 (II.1)
EQ2341	Pattern Recognition & Machine Learning	7.5	II.1 (I.1)
EL2805	Reinforcement Learning	7.5	II.2
ID2222	Data Mining	7.5	II.2
ID2223	Scalable Machine Learning and Deep Learning	7.5	II.2
DD2430	Project Course in Data Science	7.5	II.1 - II.2

Recommended courses

Code	Name	Credit	Scheduled
DD2388	Program System Construction Using C++	6.0	I.3-I.4
DD2352	Algorithms and Complexity	7.5	I.3-I.4
DD2395	Computer Security	6.0	II.2 (I.2)
DD2448	Foundations of Cryptography	7.5	I.4
DH2642	Interaction Programming and the Dynamic Web	7.5	I.3
ID2213	Logic Programming	7.5	II.1
ID2221	Data-Intensive Computing	7.5	II.1
SF2568	Parallel Computations for Large-Scale Problems I	6.0	I.3-I.4

Logistics of course choices

- You should complete $\sim$30 credits per semester.

- Your should finish your course work (90 credits) by the end of the first semester in your second term.

- Goal is to be ready to start your degree project at the beginning of Semester 2, Year 2.

Principles guiding course choice?

- Specialize in one field
- Try lots of different subject domains.
- Pick the *best* courses.

All valid options. It is up to you, your interests and your background.

Common Questions

- **Can I take language courses & count them towards my 90 hp?**
  Yes. Once you fulfill the programme's course requirements you are free
  to choose the any course (within reason & it does not replicate) at KTH
  as an elective. You cannot have more than 30hp from first cycle courses
  included in your master's degree.

- **Can you register me for a course?**
  No, e-mail <cs-master@kth.se> to get help with this. My and Atsuto's
  role is to give you advice on and approve your course choices.

- **How do I find a thesis project?**
  Be proactive. Contact people. Keep your eyes and ears open. Remember
  the professors you liked

Future for Graduates

- Good basis for doctoral studies in
    - Machine Learning,
    - Artificial Intelligence,
    - Computer Vision,
    - Speech Technology,
    - Language Technology,
    - Information Retrieval, ...
- Good basis for employment in industry:
    - Ericsson, SAAB, Trimble, FLIR, ABB,
    - Elekta, Klarna, Spotify, Peltarion,
    - Microsoft, IBM, Google, Yahoo, consultancy firms,
    - Robotics and Information Retrieval companies, ...

High-demand for machine learning graduates at the moment in many sectors.