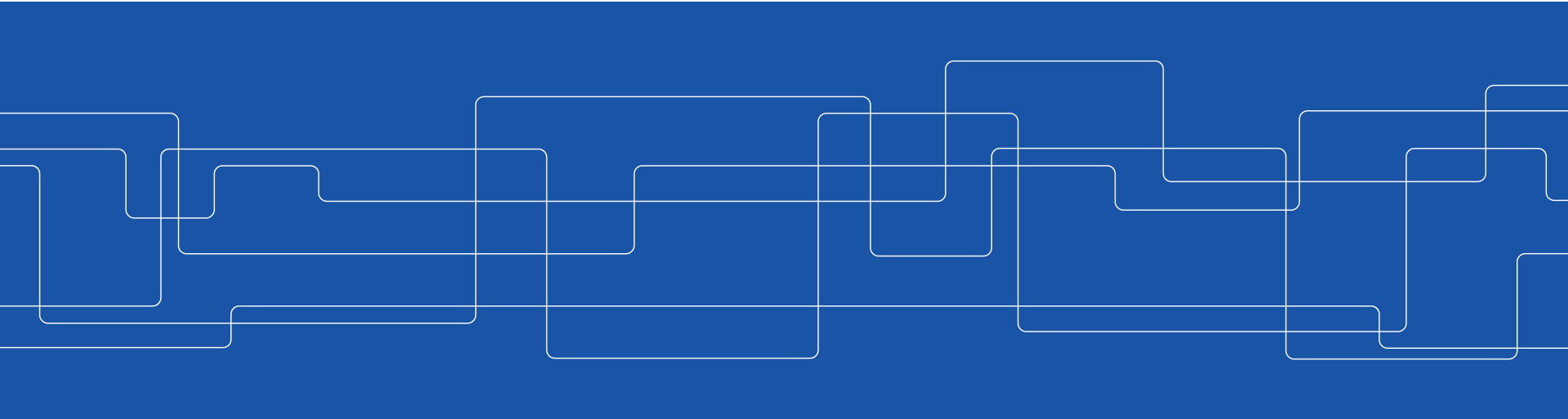
Representation Learning course - A broad overview

06.04.2021 Kickoff meeting

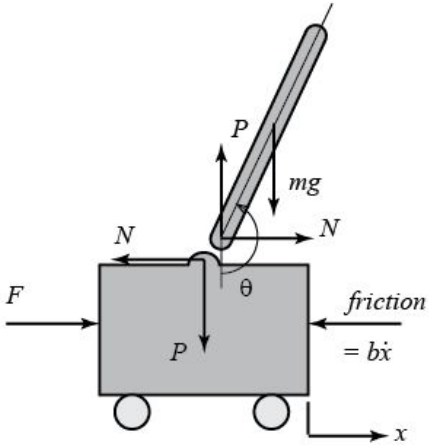


Overview

- Why representations matter
- Course overview
- Credits and deliverables
- Topic assignments and discussion

Why representations matter

Finding the right representation or model for a system/problem has been a widely successful approach:



Card pendulum

$$\begin{bmatrix} \dot{x} \\ \ddot{x} \\ \dot{\phi} \\ \ddot{\phi} \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & \frac{-(I+ml^2)b}{I(M+m)+Mml^2} & \frac{m^2gl^2}{I(M+m)+Mml^2} & 0 \\ 0 & 0 & 0 & 1 \\ 0 & \frac{-mlb}{I(M+m)+Mml^2} & \frac{mgl(M+m)}{I(M+m)+Mml^2} & 0 \end{bmatrix} \begin{bmatrix} x \\ \dot{x} \\ \phi \\ \dot{\phi} \end{bmatrix} + \begin{bmatrix} 0 \\ \frac{I+ml^2}{I(M+m)+Mml^2} \\ 0 \\ \frac{ml}{I(M+m)+Mml^2} \end{bmatrix} u$$

$$\mathbf{y} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} x \\ \dot{x} \\ \phi \\ \dot{\phi} \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \end{bmatrix} u$$

State space representation

https://ctms.engin.umich.edu/CTMS/index.php?example=InvertedPendulum&section=SystemModeling

Why representations matter: outfielder problem

The outfielder problem:

- How does a baseball outfielder know where to run to catch a fly ball?

Potential solutions:

- Trajectory prediction (TP)
- Optical acceleration cancellation (OAC)
- linear optical trajectory (LOT)

Strategies require different information and representations.

http://psychsciencenotes.blogspot.com/2011/10/prospective-control-i-outfielder.html

Why representations matter

“The success of machine learning algorithms generally depends on data representation, and we hypothesize that this is because different representations can entangle and hide more or less the different explanatory factors of variation behind the data.” [1]

Different representations can lead to different performance in followed downstream task.

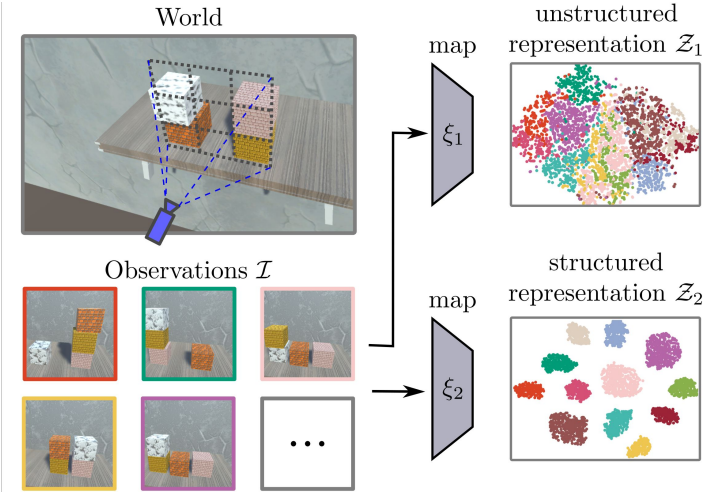
[1] Bengio, Y., Courville, A., & Vincent, P. (2013). Representation learning: A review and new perspectives. IEEE transactions on pattern analysis and machine intelligence, 35(8), 1798-1828.

Why representations matter

Examples:

SimCLR [2]

Latent Space Roadmap [3]



[2] Chen, T., Kornblith, S., Norouzi, M., & Hinton, G. (2020, November). A simple framework for contrastive learning of visual representations. In International conference on machine learning (pp. 1597-1607). PMLR.
[3] Lippi, M., Poklukar, P., Welle, M. C., Varava, A., Yin, H., Marino, A., & Kragic, D. (2021). Enabling Visual Action Planning for Object Manipulation through Latent Space Roadmap. arXiv preprint

Course overview

- 6 cp course (Topics in computer vision, Examiner: Dani)
- 2h per week (Mondays 8:30-10:30) for 8 weeks + final project
- 4 topics (Disentanglement, Generative models, Graph representations learning, and TBA)
- 1 lecture session and 1 discussion session per topic
- Runtime: 19.04.2021-07.06.2021

Credits and deliverables

To get the 6 credits a student need to do:

- Help prepare and hold 1 lecture
- Attend at least 7 out of the 8 sessions
- Do 4 paper annotations (RPTC style) upload to course web before session
- Deliver previously approved project

Credits and deliverables - Lecture

Help to prepare and hold a 2h lecture on a topic, following roughly this structure:

- Introduction and definitions (30 min)
- Overview of SOTA examples in simple language (50 min)
- Open questions and potential directions (20 min)
- Highlighting of sources used for the lecture and direction to further reading (10 min)

The lecture slides and the resources will be uploaded to the Course KTH social

Credits and deliverables - Attendance

Attendance:

- Attend at least 7 of 8 sessions.
- If you miss more you have to do a compensations assignment -> 2 page summary on the topic or similar.

Credits and deliverables - Paper annotation

A brief description (6-9 sentences) of a text addressing **RPTC**:

- **R**: Relevance (1-2 sentences describing how a text relates to the topic under study)
- **P**: Perspective (if necessary, 1 sentence describing from where the authors are writing, e.g., engineering, industry, government)
- **T**: Theory (2-3 sentences describing the main contributions of the text)
- **C**: Critique (2-3 sentences assessing the accuracy of the contributions, the shortcomings, unanswered questions, other problems, where to go from here, etc.)

Annotation style taken from Bob Sturms cours: FDT3303 Critical Perspectives on Data Science and Machine Learning

Credits and deliverables - Annotation example

Tran and Li, “Sound event classification based on feature integration, recursive feature elimination and structured classification,” in Proc. Int. Conf. Acoustics, Speech, Signal Process., Apr. 2009.

This paper explores a feature selection algorithm to improve environmental sound classification, e.g., automatic detection of “cry”, “scream” and “door slam” in an acoustic environment. Sound classification methods can involve high-dimensional features, but working in high dimensions can result in high computational cost and limited estimation accuracy. Feature selection can counter these problems by reducing the dimensions of the features to the most significant. This paper applies a feature selection algorithm originally developed for analyzing genetic material to reduce hundreds of dimensions into dozens. The paper presents experiments showing classification performance increases. I can use this approach for feature extraction in musical instrument recognition.

Credits and deliverables - Project

Final project after the 8 weeks with deadline 30.09.2021

Write half a page project proposal including:

- High level overview and goal of the project
- Name of project members
- Rough timeline

Project proposals have to be approved by the examiner first.

If projects line up we will do a project presentation day.

Final report to be uploaded to the course social page

Topic assignments and discussion

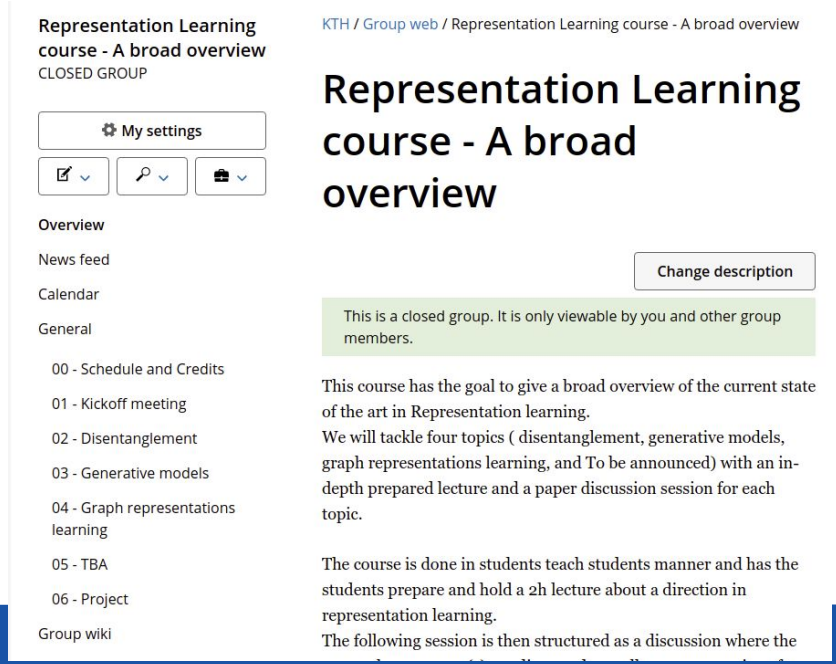
If you want to attend please enter your name in this google sheet + email and preference for presenting the topic:

https://docs.google.com/spreadsheets/d/1QarjWjRFSkr7klsULl-gVYYtJ4ToUO7YaA68xGH0rbY/edit?usp=sharing

Suggestion for the fourth topic?

Course social

Make sure you are added to the Course group on KTH social



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Questions ?