Introduction, PCA, SVD + Assignment 0

(Neural Networks Implementation and Application Tutorial)

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Overview

- Introduction
- Requirements, Materials, Assignments
- PCA, SVD
- Current assignment
- QA

Hello

Who am I?

Who are you?



Introduction

Choose and answer at least two questions:

- On scale from 1-10 how proficient are you in programming and mathematics?
- What topics of Neural Networks excite you the most?
- What topics of Neural Networks excite you the least?
- What programming languages do you know?
- How best can the tutorial sessions be helpful to your needs?

Also the following:

- Who is your groupmate?
- Will you be attending Vilém's or Noon's tutorials?

Requirements

Tutorial Requirements (exam admission)

- 60% of mandatory points (~10 assignments, 10 points each)
- Tutorial points only for exam admission (no final grade influence)

Tutorial Bonus Points

- ~2pts for extra exercises in the assignments
- 1pt for answering a question in a tutorial
- ??pt for fixing errors in tutorial presentations
 - github.com/zouharvi/uds-nnia-tutorial

Final Project

None

Transfer from last year

- Maybe possible (tbd)
- Assignments recommended (because of the exam)

What's available

- Lectures by Prof. Klakow (recorded)
- Tutorials (not recorded, but allowed for private sharing)
- Corrected homework
- Consultations
 - Only in specific cases
 - By default no email and no personal chat
 - Ask questions during the lecture / tutorials
- Public forum (please use Piazza)
 - Ask questions
 - ▶ Other students will also benefit from the answers
 - ▶ You can answer someone else's issue

Assignments

- Mandatory groups of 2
- Usually 2 exercises per assignment + a possible bonus question
- Jupyter notebook templates
 - Assignment + solution in the same notebook
 - Can use Google Colab or local runtime
 - Write solutions in Python files and import them
 - Submitted notebook must only contain your analysis and outputs
- Only one submission per group
 - Submit through Teams

Dates / Times

- Lecture:
 - ► Tuesday 14:15-15:45
- Tutorials:
 - ▶ Vilém: Wednesday 16:00-18:00
 - ▶ Noon: Thursday 08:30-10:00
- Assignments
 - ► Released (usually) by Wednesday 08:00 (available in Teams)
 - ▶ Deadline (next) by Wednesday 08:00 (submit in Teams)
- Exam: TBD

Tutorial Content

- Review of the topics covered in class
- Presentation of the past assignment
- Discussing the current assignment

Organization

Questions?

Assignment 0

- Questions?
- Did it work?
- How long did it take?

Feedback:

- Change TODO to Solution.
- Don't forget to write amount of work.
 - Useful for our estimates of difficulty.

Linear Algebra Basics

Few definitions (+how are they implemented in Python/Numpy/PyTorch)

- Scalars
- Vectors
- Matrices
- Tensors

Identify the following objects (Python lists):

- [5.0, 3.0]
- 5.0
- [True]
- [[5, 1], [0, 4]]
- [[True, False], [False, True]]
- [[[0,1], [0,1], [0,1]], [[0,1], [0,1], [0,1]]]

Linear Algebra Basics

A few operations and properties involving matrices:

- Transpose
- Inverse
- Dot product (i.e. matrix multiplication)
 - $C = AB, C_{i,j} = \sum_k A_{i,k} B_{k,j}$

Common Properties:

- $\bullet \ A(B+C) = AB + AC$
- A(BC) = (AB)C
- AB ≠ BA
- \bullet $(AB)^T = B^T A^T$

Linear Algebra Basics

Definitions:

- Eigenvector, Eigenvalue
 - $Av = \lambda v, v \neq \overrightarrow{0}$
- Eigendecomposition
 - $A = Q \cdot L \cdot Q^{-1}$
- Singular value decomposition (SVD)
 - $A = U\Sigma V^T$
- Principal Component Analysis:
 - Eigendecomposition or SVD of covariance matrix $W = \frac{A^T A}{n-1}$
 - Assume ordering of {eigen,singular}values from highest to lowest
 - Project to *k* dimensions: $A_k = AQ_k$

True or False? 👺

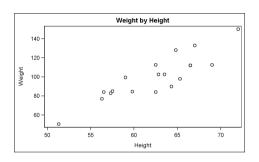
- Every real matrix has an eigenvalue decomposition (in \mathbb{R}).
- Every real matrix has a singular value decomposition (in \mathbb{R}).
- ullet Every real symmetric matrix has an eigenvalue decomposition (in $\mathbb R$).

Linear Algebra Basics - True or False? 🧐

$$A = \begin{pmatrix} 4 & 2 \\ 2 & 4 \end{pmatrix}$$

- Is $v_1 = (1, -1)$ an eigenvector of A?
- 2 Is $v_2 = (2,1)$ an eigenvector of A?
- **1** Is $v_3 = (2,2)$ an eigenvector of A?

PCA

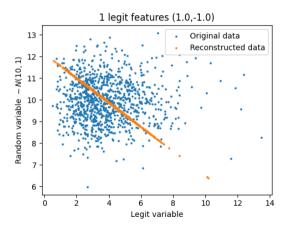


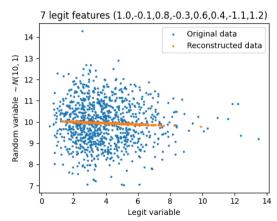
Questions (9)

- What will be the first principal component?
- Does anyone know how PCA works?
- What does it mean that we take only k largest principal components?

PCA

• Is it safe to say that the first component will always contain the most important information?





Standardization

- Is not normalization! $(x' = \frac{x}{|x|})$
- $X = \frac{X \text{mean}(X)}{\text{std}(X)}$
- Compute either:
 - With Numpy: X = (X-X.mean())/np.std(X)
 - With Scikit: StandardScaler().fit_transform(X)
- Why do we need standardization for PCA?



Assignment 1

• Any questions?

Typesetting Tips

- Do **not** write A * B, use \cdot or \times: $A \cdot B$, $A \times B$.
- Use LaTeX functions when available, e.g. \log , \sin : $\log(x)$, $\sin(x)$, **not** $\log(x)$, $\sin(x)$.
- Do **not** write plain text in math mode, use \$\text{ComputeEigenvalues}(X)\$

Resources

- Course Website: lsv.uni-saarland.de/neural-networks-implementation-and-application-winter-2021-2022-2
- Piazza: https://piazza.com/class/kvc3vzhsvh55rt
- Tutorial repository github.com/zouharvi/uds-nnia-tutorial
- Lecture & tutorial teams channels