LAN course schedule overview

Dates: 15-19 August 2022
Learn: 9:00 to 12:00
LUNCH: 12:00 to 13:30
Learn: 13:30 to 18:00

What to bring to class:
I strongly encourage you to take notes on paper with a pen/pencil. A lot of empirical educational research has shown that learning, comprehension, and retention are better when taking notes by hand. **Lecture slides will not be made available.**
If at all possible, please use a computer that has MATLAB installed.

Where to download course materials:
MATLAB code and data files are organized per-day.
Code might be updated during the course; I'll let you know if you need to re-download any files.

Big-picture overview of major course topics:

Monday
- [*note: starts at 10.30!*] Introduction to multivariate neuroscience
- Spectral source separation via Fourier transform and filtering
- Simulating data to evaluate analysis methods

Tuesday
- Basic linear algebra (vectors, matrices, multiplication, independence, rank)
- Intermediate linear algebra (inverse, A^TA and covariance matrices)

Wednesday
- Eigendecomposition and the SVD
- Principal components analysis

Thursday
- Generalized eigendecomposition
- Linear discriminant analysis

Friday
- Independent components analysis, spatial filters comparisons
- Overfitting and inferential statistics

LAN course schedule details

Monday

Topics:
- Introduction to the course
- Neuroscience as source separation
- Why and how to simulate data for methods evaluation

Themes:
- The brain is really complex and it does a lot of things simultaneously. Neuroscience can be conceptualized as an attempt to separate the mixed sources.
- We can understand reality only by measuring it, but our measurement tools (physical and analytic) are imperfect and the data are noisy. Simulating data not only builds skills in data analysis, it also tells us how much we can trust analysis methods.

Code goals:
- Implement the Gaussian filter-Hilbert method for time-frequency analysis.
- Simulate EEG data using source dipole models.

Videos and code work:
The table below shows the workflow. Start with the first row: Watch the videos then go through the corresponding code files. Then move to the next row (videos→code), etc. The duration shows the approximate amount of time recommended to spend on each row (videos+code).

"YT" video refers to this link: https://youtu.be/S_RrWZ4eXoE

Monday			
Topic	**Videos**	**Code file**	**Duration (min)**
Fourier transform, narrowband filtering	YT	**fund_1, fund_2**	**120**
Simulate EEG data	29	**fund_3, prac_1**	**100**
EEG, V1 datasets		**prac_2**	**30**

Tuesday

Topics:
- Vectors and matrices. Dot products and matrix multiplications and inverse
- Linear independence and rank
- Covariance matrices
- Evaluating covariance matrices (rank, norms, distances)

Themes:
- Linear algebra rocks.
- A surprising amount of information is embedded in linear interactions

Code goals:
- Create and visualize covariance matrices
- Examine dynamics of task-related covariance properties

Videos and code work:
The table below shows the workflow. Start with the first row: Watch the videos then go through the corresponding code file. Then move to the next row (videos→code), etc. The duration shows the approximate amount of time recommended to spend on each row (videos+code).

Tuesday			
Topic	**Videos**	**Code file**	**Duration (min)**
Linear algebra I	14, 15, 16	**fund_1**	**90**
Linear algebra II	18, 19, 20	**fund_2**	**90**
Linear algebra III	22, 23	**fund_3**	**60**
Covariance	30, 31	**prac_1**	**50**
Covariance matrices	35	**prac_2, prac_3**	**50**
Cleaning covmats		**prac_4**	**20**
Optional	34, 37		

Wednesday

Topics:

- Eigendecomposition and special properties of symmetric matrices
- Singular value decomposition (SVD)
- Principal components analysis (PCA)

Themes:

- A design matrix is a statistical model of the world.
- Eigendecomposition and SVD are ways of discovering patterns in matrices.
- Everything is a model...

Code goals:

- Extract eigenvalues and eigenvectors from a covariance matrix
- Implement a PCA without and with the pca() function
- Explore PCA over different data features (time windows, frequencies)

Videos and code work:
The table below shows the workflow. Start with the first row: Watch the videos then go through the corresponding code file. Then move to the next row (videos→code), etc. The duration shows the approximate amount of time recommended to spend on each row (videos+code).

"YT" video is this one: https://www.youtube.com/watch?v=zEWcigeEQUw

Wednesday			
Topic	**Videos**	**Code file**	**Duration (min)**
Eigendecomposition	25	**fund_1**	**70**
SVD	26, 27	**fund_2**	**70**
Source separation	8, 9, 10, 11	**fund_3**	**55**
V1 eigenvalues		**prac_1**	**40**
PCA	39, 41, 44, 45	**fund_4**	**80**
PCA in data		**prac_2, prac_3, prac_4**	**45**

Thursday

Topics:
- Linear weighted combinations
- GED
- LDA

Themes:
- Toolboxes won't take you to the frontiers of science
- Spatial filters are extracted by linear weightings of channels
- Parameters are important

Code goals:
- Source separation via GED
- Simulate ground-truth EEG data for methods validation

Videos and code work:
The table below shows the workflow. Start with the first row: Watch the videos then go through the corresponding code file. Then move to the next row (videos→code), etc. The duration shows the approximate amount of time recommended to spend on each row (videos+code).

Thursday			
Topic	**Videos**	**Code file**	**Duration (min)**
GED	55, 57, 58, 60, 62	**fund_1, prac_1, prac_2**	**105**
Regularization	63, 66, 76, 78	**fund_2**	**55**
More on GED (watch for content, not code)	67, 68	**prac_3, prac_4**	**65**
Optional: LDA	Reading	**prac_5**	**100**
Optional	69, 80		

Friday

Topics:
- Independent components analysis
- Permutation-based statistics
- Overfitting and circular analysis (“double-dipping”)

Themes:
- Inferential statistics are imperfect quantifications of how much we trust a finding.
- The balance of objectivity and subjectivity in data selection
- Writing your own code is [great/dangerous]; using toolboxes is [great/dangerous]
- How much of EEG research is reproducible?

Code goals:
- Implement permutation testing
- Compute empirical p-values

Videos and code work:
The table below shows the workflow. Start with the first row: Watch the videos then go through the corresponding code file. Then move to the next row (videos→code), etc. The duration shows the approximate amount of time recommended to spend on each row (videos+code).

Friday			
Topic	**Videos**	**Code file**	**Duration (min)**
ICA	86	**fund_1, fund_2, fund_3, prac_1**	**95**
Overfitting	90, 91	**fund_4**	**30**
Statistics	92, 93	**prac_2, prac_3**	**70**
How to analyze data	Live lecture		

LAN group assignments

You will work in groups in this course. The table below shows group assignments. I've tried to create groups according to mismatching countries of origin.

You don't need to meet or work with your group before the course. I will tell you what you need to know on Monday.

Group number	Last name	Group number	Last name
1		4	
2		5	
3			