ANTS course schedule overview

Daily schedule:

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Lecture:  9:00 to 10:00
  Group: 10:00 to 12:00
  LUNCH: 12:00 to 13:00
Lecture: 13:00 to 14:00
  Group: 14:00 to 15:30
  Break: 15:30 to 16:00
Project: 16:00 to 17:30
Closing: 17:30 to 18:00
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Course location:

[Hotspot coworking](#) space ([link to map](#))

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.**

Please bring a laptop that has MATLAB installed, or have a login to matlab.mathworks.com.

Where to download course materials:

MATLAB code and data files are organized per-day. They're available here:

Code might be updated during the course; I'll let you know if you need to re-download any files.

Discord server direct link:

Udemy course direct link:

Big-picture overview of major course topics:

Monday
- Course intro, basic signal and noise features (ongoing, transient, noise)
- Simulating data to evaluate analysis methods
- ***Project: Simulate EEG data with different features***

Tuesday
- Fourier transform, part I (basic mechanics and implementation)
- Fourier transform, part II (frequency resolution, zero-padding, etc.)
- ***Project: Confidence intervals on power spectra***

Wednesday
- Complex Morlet wavelets, convolution theorem
- Getting power and phase results from wavelet convolution
- Parameters and their effects on TF results. Baseline normalization.
- ***Project: Time-frequency condition comparison (common baseline)***

Thursday
- Other time-frequency methods: filter-Hilbert, STFFT, multitaper. Resting-state data
- Phase-based connectivity, Laplacian spatial reference
- ***Project: one-to-all phase synchronization***

Friday
- Statistics: permutation testing and multiple comparisons
- Within-subjects and group-level statistics
- ***Project: permutation-based statistics on connectivity data***

ANTS course schedule: Monday 26 June

Philosophical themes (concepts to ponder during the day):
- The brain is really complex and it does a lot of things simultaneously. Neuroscience can be conceptualized as an attempt to separate 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.
- The power (and limitations) of using simulated data to understand analysis methods.

AI-assistance themes:
- LLM are getting really good. Embrace them and use them to your advantage.
- You take final responsibility, even if ChatGPT helped you.
- ChatGPT can help you generate, translate, debug, and understand code.

Concrete goals (by the end of the day, you will…):
- Become familiar with the eeglab EEG data structure.
- Understand the concepts of signal, noise, ongoing, transient, broadband, wideband, narrowband.
- Have a high-level background about DL/LLM history, and using ChatGPT for coding
- Be familiar with the two empirical datasets we'll use this week.
- Be able to simulate EEG data (channel-level and dipole-level).

Project description:
- Create an EEG dataset with three conditions (100 trials each) showing different time-frequency features:
  1) One time-frequency feature (e.g., alpha from 100-300 ms) that is phase-locked to time=0.
  2) The same time-frequency feature that is purely non-phase-locked.
  3) A different time-frequency feature that is partially phase-locked.
- Use ChatGPT as much as possible.

Work overview
Morning lecture: Introductions, course organization and overview, DL and ChatGPT
Group: EEGlab data format, empirical datasets, simulating EEG data
Lecture: Q&A, Levels of analysis understanding, analysis complexity, dipole sims., project goals
Group: dipole simulations, project work
Closing: Reflections, the end of coding?

Videos and code work:
Start with the first row: Watch the videos then go through the corresponding code file. Then move xto the next row (videos→code), etc.

Monday		
Topic	**Videos**	**Code file**
EEG, V1 datasets	15, 16, 17	**prac_1**
Simulate EEG data	19, 26, 28, 29, 30	**fund_1**
Simulate dipole data		**fund_2**

ANTS course schedule: Tuesday 27 June

Philosophical themes (concepts to ponder during the day):
- Spectral analysis is a method of source separation for features that differ in frequency, even if mixed in time.
- Nonstationarities are necessary for brain function, but are challenging for data analysis.
- "Signal" and "noise" can be difficult to distinguish.
- All analyses involve parameters and choices; some are easy to pick while others are more ambiguous.

AI-assistance themes:
- ChatGPT can help you refine your hypotheses.
- ChatGPT is like an amazing (though imperfect) and patient PI/collaborator.
- You take final responsibility, even if ChatGPT helped you.

Concrete goals (by the end of the day, you will…):
- Code the Fourier transform from scratch.
- Extract scaled amplitude and power from Fourier coefficients
- Analyze resting-state EEG data
- Compute power spectra in time windows from task-related data
- Understand confidence intervals and bootstrapping

Project description:
Compute and visualize empirical confidence intervals on a power spectrum obtained by bootstrapping.
Part 0: Generate scientific hypotheses about this project and ask ChatGPT for feedback, improvement, extensions, and analysis suggestions.
Part 1: Simulate dipole or channel data with an ongoing nonstationary oscillation.
Part 2: Use the restingStateAllChans file; compute and show power spectra, and their 95% C.I., from two channels that show a lot of alpha power, and little alpha power.

Work overview
Morning lecture: Concepts in the Fourier transform, ChatGPT for scientific reasoning
Group: Foundations of the Fourier transform
Lecture: Q&A, non-stationarities, confidence intervals, bootstrapping
Group: FT applications, project work
Closing: Reflections, ethics of AI-assisted science

Videos and code work:
Special note for this table: fund_1 can be skipped (or go through the answer file quickly). I apologize for having so many videos in a row…

Tuesday		
Topic	**Videos**	**Code file**
Fourier fundamentals	51, 53, 54, 56, 58, 60	~~fund_1~~
The Fourier transform	65, 67, 72, 74	fund_2
Non-stationarities	77	fund_3
Bootstrapping		fund_4
Resting-state	80	prac_1
Averaging spectra		prac_2

ANTS course schedule: Wednesday 28 June

Philosophical themes (concepts to ponder during the day):
- Time-frequency analysis combines temporal and spectral source separation.
- Trade-off between individual results and group-level consistency. Smoothing is a good thing.
- TF analyses increase data dimensionality, which increases the importance of hypotheses.
- All analyses involve parameters and choices; some are easy to pick while others are more ambiguous.

AI-assistance themes:
- ChatGPT can help you write.
- ChatGPT can write for you.
- ChatGPT can summarize and explain technical papers.

Concrete goals (by the end of the day, you will...):
- Create, parameterize, and visualize complex Morlet wavelets in time and frequency domains.
- Implement convolution in time and frequency domains.
- Create a time-frequency power map!
- Flexibly adjust time-frequency trade-off parameters

Project description:
- Compute and visualize a time-frequency condition comparison. Using sampleEEGdata, set the two conditions to be the first 40 trials ("early") and the last 40 trials ("late"). Use wavelet convolution to construct time-frequency representations. Use a baseline averaged from both conditions and applied separately to each condition. Visualize three TF maps: one per condition, and one comparison. Repeat the analysis for ITPC.
- Describe your results in a bullet-point list.
- Have ChatGPT transform that list into a results section.
- Then have ChatGPT generate hypotheses for which the analyses are appropriate and the results confirm.

Work overview
Morning lecture: Wavelet convolution concepts, ChatGPT and writing
Group: Create a time-frequency plot!
Lecture: Dealing with the curses of complexity and dimensionality in neuroscience
Group: time-frequency parameters; project work
Closing: Reflections; does clear thinking come from clear writing or clear reading?

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.

Wednesday		
Topic	**Videos**	**Code file**
Wavelets: time and freq	100	fund_1
Convolution	102, 104	fund_2
TF feature extraction	108, 109	fund_3
Power and ITPC maps	113, 114	fund_4
Parameters, baseline	116, 120	fund_5
Downsampling	132	prac_1
Resting-state data		prac_2_SOL

ANTS course schedule: Thursday 29 June

Philosophical themes (concepts to ponder during the day):
- All roads lead to Rome (there are many ways to do TF analyses).
- Capturing the transient nature of brain dynamics.
- The cultural persistence of data analysis methods.
- The importance of hypotheses.

AI-assistance themes:
- ChatGPT can explain data analyses and statistical methods.
- ChatGPT can help you brainstorm analyses to try.

Concrete goals (by the end of the day, you will…):
- Implement the filter-Hilbert method.
- Compute phase synchronization (ISPC and PLI).
- Learn about data selection.
- Visualize connectivity results.

Project description:
- In the EEG dataset, pick one channel and compute phase synchronization (ISPC or PLI) between that channel and all other channels — after applying the Laplacian transform. Store the results in a 3D matrix (channels X frequency X time). Visualize the data using topographical maps and TF plots.
- Put key lines of code into ChatGPT and ask for a plain-language explanation of the analysis (1) assuming you are a high-school student, and (2) assuming you are a university physics student.
- Ask for potential confounds in the analyses and for suggestions for how to test or rule out those confounds.
- Ask for other interesting analyses to perform with these data.

Work overview
Morning lecture: Foundations of all TF methods; connectivity concepts; ChatGPT as teacher
Group: Filter-Hilbert, phase synchronization, different approaches to compute synchronization
Lecture: How to do a connectivity analysis
Group: multichannel synchronization, project work
Closing: Reflections; the role of AI in education.

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.

Thursday		
Topic	**Videos**	**Code file**
Filter-Hilbert	124	**fund_1**
EEG Laplacian	166	**fund_2**
Phase synch	164	**fund_3**
ISPC time/trials	173	**fund_4**
ISPC and PLI	169, 171	**prac_1**
Connectivity matrices	187	**prac_2**

ANTS course schedule: Friday 30 June

Philosophical themes (concepts to ponder during the day):
- Inferential statistics are imperfect quantifications of how much we trust a finding.
- The balance between 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?

AI-assistance themes:
- ChatGPT can help with personal and professional development

Concrete goals (by the end of the day, you will…):
- Implement permutation testing in simple and TF data.
- Compute empirical p-values.
- Extract "islands" in thresholded images.
- Index and select data from individuals.

Project description:
- In the sampleEEG dataset, compute phase synchronization between two channels. Use permutation testing to evaluate the statistical significance of the synchronization. Apply cluster thresholding to correct for multiple comparisons.
- Describe your results to ChatGPT and ask for recommendations about which journal to submit to. Ask the question twice: Once explaining to ChatGPT that you need the publication to be competitive for a postdoc/faculty job, and then again explaining that you will leave academia and don't care about publications per se; you just want to have a feeling of completion and accomplishment.

Work overview
Morning lecture: Classical vs. empirical statistics, LLN+CLT, ChatGPT as mentor
Group: Nonparametric statistics and corrections
Lecture: Truth and reproducibility, the role of deep learning in neuroscience
Group: stats in real data; project work
Closing: Reflections; Will AI take our jobs? Closing remarks

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.

Friday		
Topic	**Videos**	**Code file**
Permutation testing	200	**fund_1**
Multiple comparisons	203, 204, 208	**fund_2**
Perm test in V1 data		**prac_1**
Group stats	209, 211	**prac_2**

Information about evening social programs

You are here not only to learn, but also to have fun and meet your future friends and colleagues. Every evening has a unique social event. These events are optional, but I hope you'll join for some/all of them.

Sunday 13 August
Description: Opening reception at Hotspot coworking space. Come check out the course location, have a drink and a snack, meet the instructor and your colleagues, and pick up your badge and bag.
There will be PING PONG and music and alcohol!!!!

Time: 6pm until 8pm. Because it's Sunday, the doors will be locked beforehand. When you arrive, tell the porter you are part of the "neuroscience workshop" and they will let you through the main gate. The coworking space is one floor up; you can take the elevator or the stairs (stairs are past the elevator on the left/right; you need to press the button "Press to exit"; it will beep and the door will unlock).

Cost: Free

Monday 14 August
Description: Hang out in the Roaba park. I will post the exact GPS coordinates in Discord. There are no specific activities scheduled; we just hang out and relax. If it rains, we will cancel.

Time: 6.30pm to 9pm.

Cost: Free, but there are no drinks or food provided. Feel free to bring some food for a picnic if you want. There are cafes and foodstalls in the area if you want to stay here for dinner. (Toilets are also available.)

Tuesday 15 August
Description: Traditional Romanian dinner! Come find out what the real Romanians eat :) The restaurant is great and there are plenty of veggie/gluten-free options. It's called Lacrimi si Sfinti. Link to map location.

Time: Starts at 6:30pm.

Cost: Free (mostly). Food and bottled water is paid by the summer-school. You pay for any alcohol you drink.

Wednesday 16 August
Description: Walking tour. Join us for a 2-hour walking tour of downtown Bucharest. Our tour guide is a professional guide who will take us on a dedicated and customized tour. The tour will end at "old town," which is a great place to have dinner! The tour starts at Hotspot immediately after class.

Time: 6pm - 8pm.

Cost: Free

Thursday 17 August
Description: Pubquiz! Test how much you really learned in the course 🙂 Location is Mark restaurant (next-door to the course location).

Time: Starts at 6pm.

Cost: Free (mostly)! We will provide food platters with snacks. You pay for your own alcoholic drinks…. except the team that wins the pubquiz! They drink for free!

Friday 18 August
Description: Get your certificate and enjoy the last day of the course! The closing ceremony includes dinner and drinks. Afterwards we'll go to a beautiful terrace with alcohol and see what happens… previous sessions have ended up at a dance bar until late (*note*: very optional).

Time: The closing ceremony starts at 6pm when class ends, will take place at Hotspot. Dinner will be catered (fancy Italian, made by real Italians). There will be wine, beer, whisky, and champagne. After dinner will be optional drinks at QP Pub.

Cost: Closing ceremony at Hotspot is free. You pay your own drinks at QP Pub.