

# Analyzing Neural Time-series Data

PSYCH 711/712 Course Outline

Winter Term, 2018

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**Meeting times:** Class times: Tuesdays, 10:30 - 12:30pm, every other week, PC 204

Journal club: Thursdays, 11:30 - 12:30pm, every other week, PC 316

**Overview:** The goal of this course is to introduce students to basic and some more advanced approaches of EEG/MEG signal processing and data analysis methods. The course is designed to accommodate students with little or no previous experience in this area. There will be two sections of this course: lectures and journal club meetings. In the lectures (2-hour meeting), the instructors will introduce the basic concepts of EEG signal processing and demonstrate practical implementations using MATLAB. Homework assignments/evaluations will involve a combination of theory-based questions and solving exercises in MATLAB based on the code in Mike X Cohen's book. In the journal club meetings (1-hour meeting), students and other interested members will meet to discuss current advances in EEG signal processing or data analysis techniques. Students registered in this course are required to attend at least six journal club meetings, to actively contribute to the discussion, and to either present a paper or write an essay on one of the papers discussed at the journal club.

**Software:** This course will use MATLAB during class and for assignments. This course assumes that students are familiar with the basic aspects of MATLAB programming (use of vectors, arrays, functions, for loops). Students can choose to use their own MATLAB version on their laptops, or to use the MATLAB installed on the computers in the computer cluster. Those who need to use MATLAB in the computer cluster are asked to notify the instructors ASAP to ensure that we have a sufficient number of licenses available.

## Required textbooks:

[Cohen, M. X. \(2014\). \*Analyzing Neural Time Series Data: Theory and Practice\*, The MIT Press.](#)

[Luck, S.J. \(2014\) \*An introduction to the event-related potential technique, 2nd Edition\*, The MIT Press](#)

McMaster Library has these e-books accessible online with McMaster IP.

### **Online materials:**

Students are encouraged to watch Mike X Cohen's excellent lectures based on his book, available at the website: <http://mikexcohen.com/lectures.html>

Workshops will be based on the MATLAB code which accompanies his book, available here: [http://mikexcohen.com/book/AnalyzingNeuralTimeSeriesData\\_MatlabCode.zip](http://mikexcohen.com/book/AnalyzingNeuralTimeSeriesData_MatlabCode.zip)

Students are also encouraged to consult this online discussion forum of his code:

<https://groups.google.com/forum/#!forum/analyzingneuraltimeseriesdata>

Those interested in Python, Lyndon Duong has shared his translation of the Matlab code to Python (which we will not be covering in class):

[https://github.com/lyndond/Analyzing\\_Neural\\_Time\\_Series](https://github.com/lyndond/Analyzing_Neural_Time_Series)

**Avenue To Learn:** We will use Avenue to Learn in the course under the code PSYC 712.

Assignments will be posted there and will be submitted through that system.

### **Class schedule:**

**Week 0: Thursday, Jan 11, 11:30am. PC 316. Organisational meeting.**

#### **Week 1:**

**LECTURE: Jan 16, 10:30 - 12:30. PC 204. Theories of EEG, Basics of Signal Processing**

- Required reading: Chapter 2, 3, 5, 6 of Cohen's book and Chapter 7 of Luck's book
- Matlab workshop: Intro to Matlab, work on code from Chapters 2, 4, 5, 6.

**JOURNAL CLUB: Jan 18, 11:30 - 12:30. PC 316.**

- Cohen, M. X. (2017). Where Does EEG Come From and What Does It Mean? Trends in Neurosciences.

#### **Week 2:**

**LECTURE: Jan 30, 9:30 - 11:30. PC 204. Preprocessing, Filtering, Artifact, ERP**

- Required reading: Chapters 7-11 of Cohen's book and Chapter 6, 8 & 9 of Luck's book
- Matlab workshop: work on code from Chapters 9, 10, 11
- Assignment #1 due.

**JOURNAL CLUB: Feb 1, 11:30 - 12:30. PC 316.**

- Widmann, A., Schröger, E., & Maess, B. (2015). Digital filter design for electrophysiological data—a practical approach. Journal of neuroscience methods, 250, 34-46.

### Week 3:

#### **LECTURE: Feb 13, 9:30 - 11:30. PC 204. Frequency and Time-frequency analysis**

- Required reading: Chapters 12, 13, 15, 16 of Cohen's book and Chapter 8 of Luck's book
- Matlab workshop: Chapters 12, 13, 15, 16.
- Assignment #2 due.

#### **JOURNAL CLUB: Feb 15, 11:30 - 12:30. PC 316.**

- Gulbinaite, R., van Viegen, T., Wieling, M., Cohen, M. X. and VanRullen, R. (2017). Individual alpha peak frequency predicts 10 Hz flicker effects on selective attention, *The Journal of Neuroscience*, 37(42), pp. 1163–17. doi: 10.1523/JNEUROSCI.1163-17.2017.

### Week 4:

#### **LECTURE: Feb 27, 10:30 - 12:30. PC 204. Power, Phase and Normalization**

- Required reading: Chapters 18, 19, 21 (14, 20) of Cohen's book
- Assignment #3 due.

#### **JOURNAL CLUB: Mar 1, 11:30 - 12:30. PC 316.**

- Brüers, S. and VanRullen, R. (2017). At What Latency Does the Phase of Brain Oscillations Influence Perception?, *eNeuro*, 4(3)

### Week 5:

#### **LECTURE: Mar 13, 10:30 - 12:30. PC 204. Spatial Filters, ICA, Localization, Connectivity, Statistics**

##### **(This meeting will be 2-hour lecture)**

- Required reading:
  - Chapters 22, 24, 25, 33, 34, (32, 35) of Cohen's book
  - Jung, T. P., Makeig, S., Humphries, C., Lee, T. W., Mckeown, M. J., Iragui, V., & Sejnowski, T. J. (2000). Removing electroencephalographic artifacts by blind source separation. *Psychophysiology*, 37(2), 163-178.
  - Chaumon, M., Bishop, D. V., & Busch, N. A. (2015). A practical guide to the selection of independent components of the electroencephalogram for artifact correction. *Journal of neuroscience methods*, 250, 47-63.
- Assignment #4 due.

#### **JOURNAL CLUB: Mar 15, 11:30 - 12:30. PC 316.**

- Bastos, A. M., & Schoffelen, J. M. (2016). A tutorial review of functional connectivity analysis methods and their interpretational pitfalls. *Frontiers in systems neuroscience*, 9, 175.

**Week 6:**

**LECTURE: Mar 27, 10:30 - 12:30. PC 204. 2h MATLAB workshop on Chapters in week 5**

- Assignment #5 will be assigned this week and will be due April 10.

**JOURNAL CLUB: Mar 29, 11:30 - 12:30. PC 316.**

- Groppe, D. M., Urbach, T. P., & Kutas, M. (2011). Mass univariate analysis of event-related brain potentials/fields I: A critical tutorial review. *Psychophysiology*, 48(12), 1711-1725.
- Groppe, D. M., Urbach, T. P., & Kutas, M. (2011). Mass univariate analysis of event-related brain potentials/fields II: Simulation studies. *Psychophysiology*, 48(12), 1726-1737.

**Changes in schedule:** The instructors reserve the right to modify topics to be covered during the term depending on the pace of the class. Students are asked to check their McMaster email and Avenue to Learn during the term and to note any changes.

**Assessment:**

5 assignments worth 10% each. Assignments will be posted the day of class and will be due at the start of next class. Late submissions may be penalized with 2% per day. 50%

Journal club attendance and participation 20%

Presenting a paper in the journal club or written essay summarizing and critiquing one of the articles discussed in the journal club (Max 1000 words, excluding references). 30%

**Academic Integrity:** Students are responsible for demonstrating behaviour honest and ethical behaviour in their academic work, which includes submitting one's own work in coursework assignments. For more information on McMaster's policy on academic integrity, please visit: <http://mcmaster.ca/academicintegrity>