Module 3

Introduction to Computation for Brain Sciences

Professor Adam Hampshire

https://github.com/dragos-gruia/MSc-TranslationalNeuroscience-Module3

Module Aims

Introduction to the types of computational techniques used in brain sciences
- Lift the hood / demystify (beware the black box)
- Practical focus (doing as opposed to listening)

Learn about the relationship between brain function and cognition
- Network science / network dynamics
- Normal and abnormal brain function
- Inter-Individual differences

Gain foundation skills in Python programming
- Fundamentals of programming
- Data handling
- Pipeline development

Improve scientific writing skills
- hypothesis formulation & testing
- inference

Leads particularly well into computational project/workstream, but skills gained are more broadly transferable

Python Tutorials

Each day is a stand alone workshop

The focus is on learning through application

Workshop structure

- Brief morning introduction to the workshop

- Tutorial walkthroughs in the morning, learning how to program code for handling different datatypes

- Afternoon session – apply what you have learnt to a new dataset/problem
    - Code unsupervised
    - TAs will be in person to answers Qs

- Please make the most use possible of your TAs and ask them difficult questions

Two out of 7 workshops (not day 1) to write up and hand in
    - Write up must be undertaken independently - text will be compared

Tutorials are all in Python (Jupyter notebook) and are available from the links on BlackBoard.

Extensive materials on Python are available on the internet

Date	Time	Content	Activity/format	Room / Teams Link	Lecturer
WEEK 1					
Thursday 10th Nov	10:00-10:30	Module overview and outline of the assessments	Lecture	CXLB 1076 - 10th Floor Lecture Theatre/Lab Block	Adam Hampshire
	10:30-11:00	Introduction to programming in Python	Lecture	CXLB 1076 - 10th Floor Lecture Theatre/Lab Block	Valentina Giunchiglia
	11:00-13:00	Programming exercises	Tutorial	CXLB 1076 - 10th Floor Lecture Theatre/Lab Block	Adam Hampshire
	14:00-16:00	Programming challenge	Practical	CXLB 1076 - 10th Floor Lecture Theatre/Lab Block	Adam Hampshire
	16:00-17:00				
Friday 11th Nov	10:00-10:30	Online cognitive assessment	Lecture	CXLB 976 - 9th Floor Teaching Room	Adam Hampshire
	10:30-13:00	Tutorial walkthrough - handling big cognitive data	Tutorial	CXLB 976 - 9th Floor Teaching Room	Adam Hampshire
	14:00-16:00	Challenge. Analyse COVID-19 impact on cognition	Practical	CXLB 976 - 9th Floor Teaching Room	Adam Hampshire
	16:00-17:00	Private Study		CXLB 976 - 9th Floor Teaching Room	
WEEK 2					
Monday 14th Nov	09:30-10:30	Cognitive differences in self harm	Lecture	CXLB 976 - 9th Floor Teaching Room	Martina Di Simplicio
	10:30-11:30	Lived experience interview	Interview	CXLB 976 - 9th Floor Teaching Room	Martina Di Simplicio
	11:30-13:00	Cognitive bias analysis	Tutorial	CXLB 976 - 9th Floor Teaching Room	Adam Hampshire
	14:00-16:00	Challenge. Analyse attentional biases in self harm	Practical	CXLB 976 - 9th Floor Teaching Room	Adam Hampshire
	16:00-17:00	Private study			
Tuesday 15th Nov	10:00-10:30	Handling of 3D and 4D imaging data	Lecture	CXLB 976 - 9th Floor Teaching Room	Peter Hellyer
	10:30-13:00	Tutorial walkthrough (preexisting PD fMRI dataset)	Tutorial	CXLB 976 - 9th Floor Teaching Room	Peter Hellyer
	14:00-16:00	Challenge. Analyse the OCD brain endophenotype	Practical	CXLB 976 - 9th Floor Teaching Room	Peter Hellyer
	16:00-17:00	Private study		CXLB 976 - 9th Floor Teaching Room	
Wednesday 16th Nov	10:00-10:30	fMRI Graph theory and connectivity - data-driven and connectivity analysis	Lecture	CXLB 976 - 9th Floor Teaching Room	Peter Hellyer
	11:00-13:00	Tutorial walkthroughs	Tutorial	CXLB 976 - 9th Floor Teaching Room	Peter Hellyer
	14:00-16:00	Challenge. Analyse brain connectivity change in the psychedelic state	Practical	CXLB 976 - 9th Floor Teaching Room	Peter Hellyer
	16:00-17:00	ICA 1 3 page report set. Hand in Friday by 15:00		CXLB 976 - 9th Floor Teaching Room	

Monday 21st Nov	10:00-11:00	Machine learning & Clinical polymarkers	Lecture	CXGH 1.14 - Glenister Lecture Theatre	Annalaura Lerede
	11:00-13:00	Tutorial walkthrough(Regression & classification)	Tutorial	CXGH 1.14 - Glenister Lecture Theatre	Annalaura Lerede
	14:00-16:00	Application	Practical	CXGH 1.14 - Glenister Lecture Theatre	Annalaura Lerede
	16:00-17:00	Private Study		CXGH 1.14 - Glenister Lecture Theatre	
Tuesday 22nd Nov	09:00-10:00	Substance use and substance addiction	Lecture	CXLB 976 - 9th Floor Teaching Room	Anne Lingford-Hughes
	10:00-10:30	Topic modelling	Tutorial	CXLB 976 - 9th Floor Teaching Room	Maria Balaet
	10:30-13:00	Latent Dirchlet Allocation tutorial	Practical	CXLB 976 - 9th Floor Teaching Room	Maria Balaet
	14:00-16:00	Modeling lived experience challenge		CXLB 976 - 9th Floor Teaching Room	Maria Balaet
	16:00-17:00	Private Study			
Wednesday 23rd Nov	10:00-11:00	Principles of Neuromodeling	Lecture	CXLB 876 - 8th Floor Teaching Room	Sadra Sadeh
	11:00-13:00	Tutorial walkthroughs	Tutorial	CXLB 876 - 8th Floor Teaching Room	Sadra Sadeh
	14:00-16:00	Challenge. Neuromodelling analysis	Practical	CXLB 876 - 8th Floor Teaching Room	Sadra Sadeh
	16:00-17:00	ICA 2 3 page report set. Private Study			
Thursday 24th Nov		Consdolidation and learning	Private Study		
Friday 25th Nov	10:00-17:00	ICA 3 (Hackathon)		CXLB 976 - 9th Floor Teaching Room	Adam Hampshire
Monday 28th Nov		Hand in ICA 2 by 10:00 (days 5,6,7, or 8)			

Assessment

Workshop write ups (60%)

- Assess understanding of how computational methods can be applied to answer translational neuroscience research questions
- 2 out of 7 workshops (not day 1)
- 3 pages including figures, 11 font & 2 cm margins
- State hypothesis, explain concisely what you did, what your results were, and interpret, including contextualizing with background literature

Hackathon (40%)

- Assess performance when solving a computational research problem under time pressure
- Mixture of group and individual work, with individual assessment
- Define the hypothesis
- Design the analysis pipeline
- Implement it
- Interpret and critically evaluate

Assessment – Lab Reports (2)

Example from day 2.

1) Explore the functional connectivity of the data: try at least three spatially different 'seed' voxels and produce maps of how they are connected to the rest of the brain. Briefly, what can you infer from the statistical maps?

2) As well as functional connectivity, produce a statistical map for head motion? Briefly, what are the implications of this for functional connectivity?

3) Which brain regions activate during the task?

You should prepare a **brief** report (no longer than 3 pages in 11-point font 2cm margins) of these analyses, containing figures of statistical maps as appropriate.

MARKS AWARDED

1.	Is the hypothesis/question defined clearly?	/10
2.	Is the description of the dataset correct?	/10
3.	Are the analysis/modelling steps appropriate and clearly described?	/15
4.	Are decisions regarding the selection of technique explained concisely?	/15
5.	Are the reported results correct?	/15
6.	Is the use of display items effective?	/10
7.	Does the discussion of implications/limitations show depth of understanding?	/15
8.	Are future directions considered/justified?	/10
TOTAL MARK		**/100**

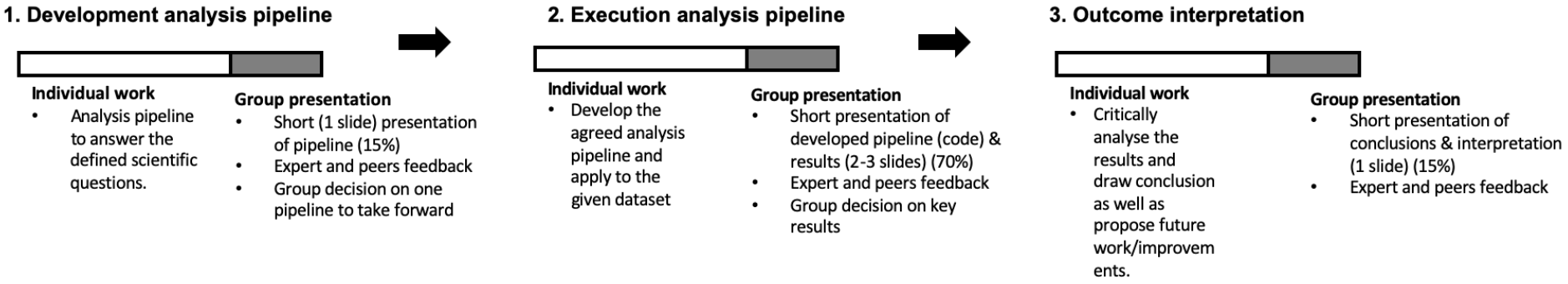
Assessment – Hackathon

Assessed on performance when solving a computational research problem under time pressure

Mixture of group and individual work, with individual assessment

- Define the hypothesis
- Design the analysis pipeline
- Implement it
- Interpret and critically evaluate

Computational Neuroscience Hackathon



Example Hackathon Mission

Questions

Longitudinal questionnaire data have been collected from >20,000 people at two timepoints. Half the participants were surveyed early in 2020 and then in Christmas 2020-21. The other half were surveyed in May 2020, mid lockdown, and then again in Christmas 2021, mid resurgence. A subset of the measures taken have been curated for you to analyse.

Work in groups to address scientific questions from the data

- Select a combination of questions to address
- Marks will relate to the number and difficulty of questions answered
- Recommendations include (but are not limited to)

Easy | What demographic has been sampled in this study?

Intermediate | How does mental health relate to age & other variables at baseline or during the pandemic?

Intermediate | Has mental health changed during the pandemic?

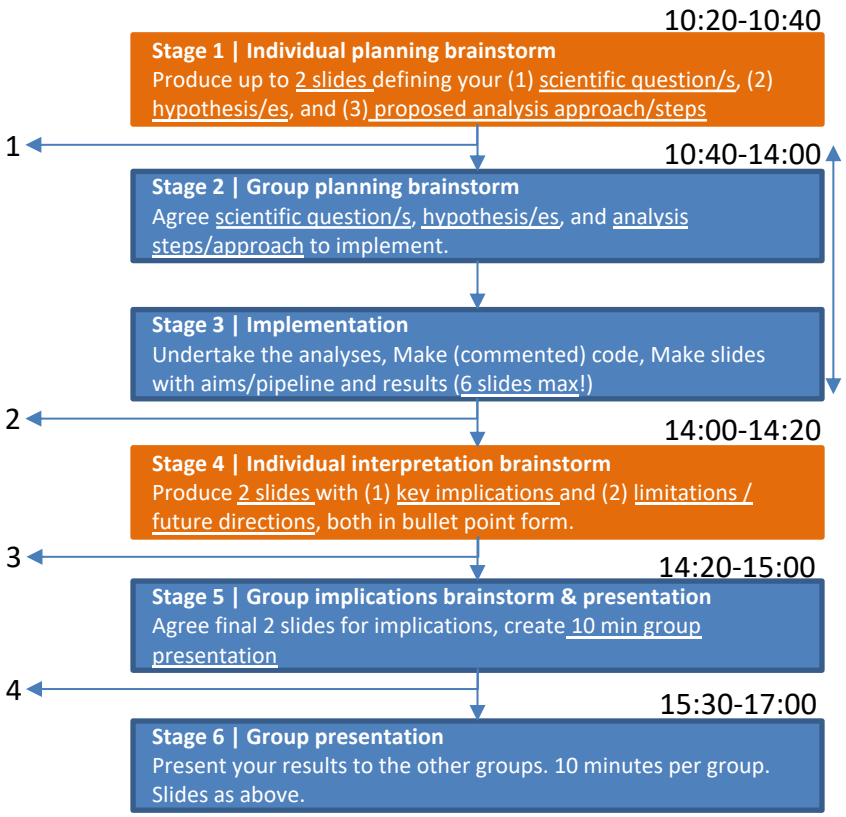
Difficult | Which sub-populations have been most affected?

Advanced | To what degree can mental health be predicted from demographic and lifestyle variables?

You have full access to the Internet, the website and your notes during this assessment ***but should not work across groups***

You can grab food/drinks/coffee at any point

Schedule



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