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

Module 3 - Introduction to Computational Methods for Brain Science

Module Lead: Prof Hampshire

Date	Time	Content	ctivity/form	Room / Teams Link	Lecturer
			WEEK 5		
	10:00-10:30	Module overview and outline of the assessments	Lecture	RCS1 311B - Versatile Teaching Laboratory (VTL) 3B SOUTH KEN	Adam Hampshire
	10:30-11:00	Introduction to programming in Python	Lecture	RCS1 311B - Versatile Teaching Laboratory (VTL) 3B SOUTH KEN	Valentina Giunchiglia
	11:00-13:00	Programming exercises	Tutorial	RCS1 311B - Versatile Teaching Laboratory (VTL) 3B SOUTH KEN	
	14:00-16:00	Programming challenge	Practical	RCS1 311B - Versatile Teaching Laboratory (VTL) 3B SOUTH KEN	
Thursday 9th Nov	16:00-17:00	Private study			
	10:00-10:30	Online cognitive assessment	Lecture	RCS1 311B - Versatile Teaching Laboratory (VTL) 3B SOUTH KEN	Adam Hampshire
	10:30-13:00	Tutorial walkthrough - handling big cognitive data	Tutorial	RCS1 311B - Versatile Teaching Laboratory (VTL) 3B SOUTH KEN	
	14:00-16:00	Challenge. Analyse COVID-19 impact on cognition	Practical	RCS1 311B - Versatile Teaching Laboratory (VTL) 3B SOUTH KEN	
Friday 10th Nov	16:00-17:00	Private study			
			WEEK 6		
	09:30-10:30	Cognitive differences in self harm	Lecture	RCS1 311B - Versatile Teaching Laboratory (VTL) 3B SOUTH KEN	Martina Di Simplicio
	10:30-11:30	Lived experience interview	Interview	RCS1 311B - Versatile Teaching Laboratory (VTL) 3B SOUTH KEN	Martina Di Simplicio
	11:30-13:00	Cognitive bias analysis	Tutorial	RCS1 311B - Versatile Teaching Laboratory (VTL) 3B SOUTH KEN	Valentina Giunchiglia
	14:00-16:00	Challenge. Analyse attentional biases in self harm	Practical	RCS1 311B - Versatile Teaching Laboratory (VTL) 3B SOUTH KEN	
Monday 13th Nov	16:00-17:00	Private study			
	10:00-10:30	Introduction to MRI analysis	Lecture	Hammersmith Wolfson Lecture Theatre 1	Peter Hellyer
	10:30-13:00	Tutorial walkthrough individual student dataset	Tutorial	Hammersmith Wolfson Lecture Theatre 1	
	14:00-16:00	Challenge. Analyse brain functional activity	Practical	Hammersmith Wolfson Lecture Theatre 1	
Tuesday 14th Nov	16:00-17:00	ICA 1 2 page report set. Private study			
	10:00-10:30	Analysis of functional network abnormalities in clini	Lecture	RCS1 212A - Versatile Teaching Laboratory (VTL) 2A SOUTH KEN	Adam Hampshire
	11:00-13:00	Tutorial walkthrough (preexisting PD fMRI dataset)	Tutorial	RCS1 212A - Versatile Teaching Laboratory (VTL) 2A SOUTH KEN	
	14:00-16:00	Challenge. Analyse the OCD brain endophenotype	Practical	RCS1 212A - Versatile Teaching Laboratory (VTL) 2A SOUTH KEN	
Wednesday 15th Nov	16:00-17:00	Private study			
Thursday 16th Nov		Private study			
Friday 17th Nov		Private study ICA 1 hand in at 15:00			

Thursday 16th Nov		Private study			
Friday 17th Nov		Private study ICA 1 hand in at 15:00			
WEEK 7					
	10:00-11:00	fMRI graph theory and connectivity	Lecture	Hammersmith Wolfson Lecture Theatre 1	Peter Hellyer
	11:00-13:00		Tutorial	Hammersmith Wolfson Lecture Theatre 1	
	14:00-16:00		Practical	Hammersmith Wolfson Lecture Theatre 1	
Monday 20th Nov	16:00-17:00	Private Study			
	09:00-10:00	Substance use and substance addiction	Lecture	Hammersmith Wolfson Lecture Theatre 1	Anne LH
	10:00-10:30	Introduction to unsupervised ML	Tutorial	Hammersmith Wolfson Lecture Theatre 1	Valentina Giunchiglia
	10:30-13:00	Clustering, PCA and ICA	Practical	Hammersmith Wolfson Lecture Theatre 1	
	14:00-16:00	Characterising drug use cateogries		Hammersmith Wolfson Lecture Theatre 1	
Tuesday 21st Nov	16:00-17:00	Private Study			
	10:00-11:00	Introduction to supervised ML	Lecture	Hammersmith Wolfson Lecture Theatre 1	Valentina Giunchiglia
	11:00-13:00	linear modelling and support vector machines	Tutorial	Hammersmith Wolfson Lecture Theatre 1	
	14:00-16:00	Predicting dementia	Practical	Hammersmith Wolfson Lecture Theatre 1	
Wednesday 22nd Nov	16:00-17:00	ICA 2 2 page report set. Private Study			
Thursday 23rd Nov		Consdolidation and learning	Private Study		
Friday 24th Nov	10:00-17:00	ICA 3 (Hackathon)		Hammersmith Wolfson Lecture Theatre 1	Adam Hampshire, Nir Grossman
Monday 27th 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**

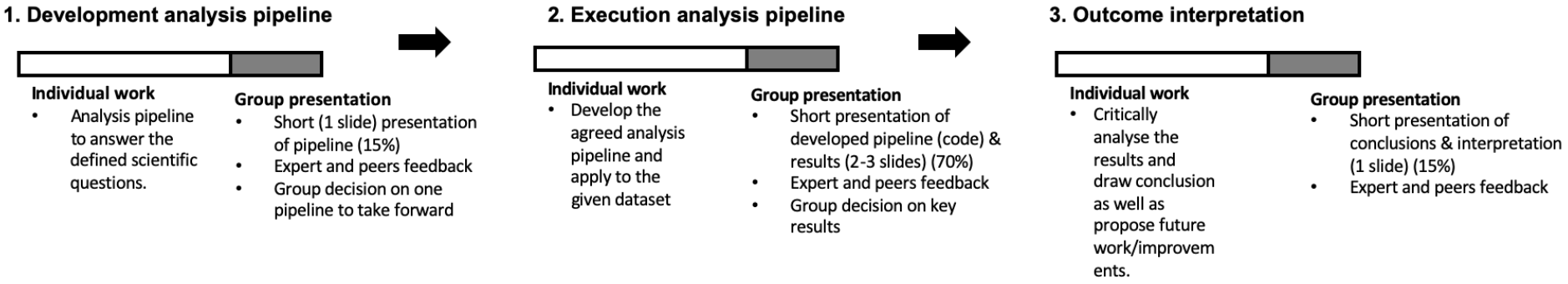
Assessment – Hackathon

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?

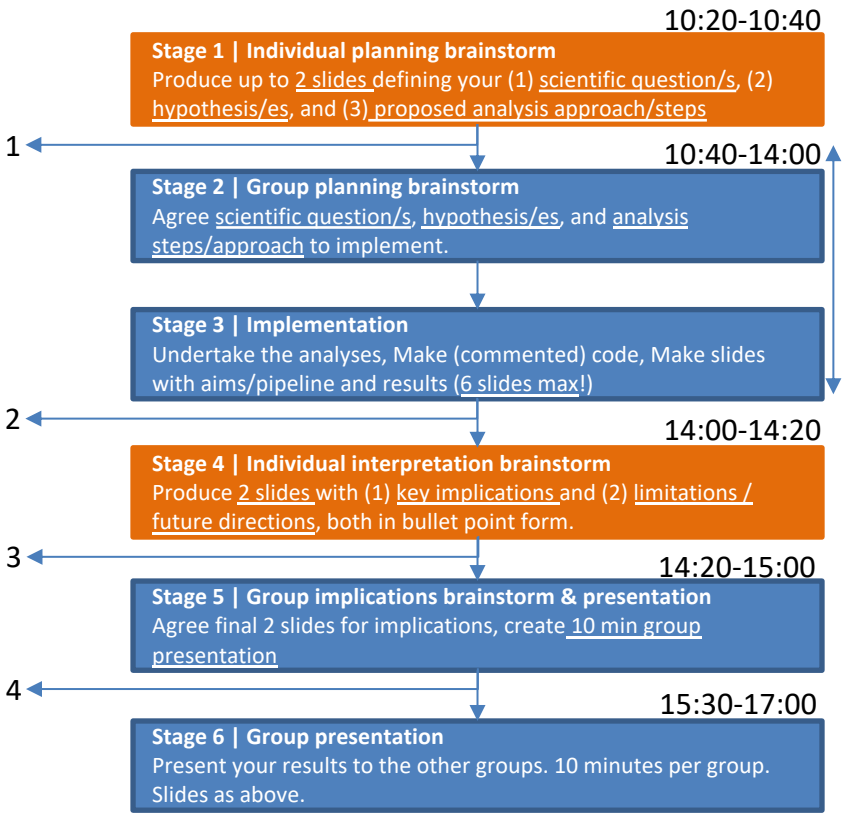
Difficult | Which sub-populations have been most affected?

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



group_stage_name.ppt in filenames

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