Computational Models in Cognition

The course will examine introduce a variety of methods for computational modelling, which will be applied to several domains of cognition. The models will be used to account for existent data and make further predictions. The course will also address controversies that involve competing models and theories.

Required background:
i) cognitive psychology, including memory, visual attention.
ii) Some computational background (basic maths, or programming, Matlab, etc).

Reading material is based on book sections and articles
Structure:

- weakly lecture
- 6 Practicals (TIRGUL); the practicals will help students to implement models, understand the articles and will give exercises to carry out.

Marking:
Course work: computational project (80%) + 3 exercises (20%) + Article presentation (5 points bonus)
A discussion paper (theoretical: 2 points)

Lecture provisory time-table:

1. **Introduction to modeling**: rationale, domains and examples. Neurons and networks. Firing-rates and spikes. Integrate-and-fire model. The neural code; Cell assemblies, the Hebbian-framework.
Practical-1: Introduction to Matlab; Using Matlab to plotting RT-distributions and calculate accuracy in experimental tasks.

2. *Article-1*: *Population-codes in the motor cortex* (Georgopoulos et al. 1993)
Connectionism (PDP framework); Localistic vs distributed representations; Learning and in neural networks. Perceptron and Back-Probagation; Semantic knowledge; Generalisation
Extra Reading: Chapter-1 from the PDP book, Rumelhat & McClelland (1986). On Moddle.

3. **Models of choice-RT (1)**: From Signal-detection to sequential sampling models
Practical-2: Introduction to model simulations, Race and Diffusion

4. *Article-2*: Gold & Shadlen 2001; TICS
Models of choice-RT(2): race and diffusion models (optimality).
Article-3: Mazurek et al (2003);

5. **Models of choice-RT (3)**: Leaky-Competing-Accumulators. Independent vs Competition models
Articles 4: White et al. 2010
Practical3 – LCA model

6. *Article-5*: Ossmy et al., 2013; Current Biol. (2013).
Models of choice-RT-4: Temporal-weighting of evidence (LCA vs Diffusion)

7. **Modeling value based decisions** (risk, choice biases, and attentional selection)
Extra reading: Usher, Tsestos, Glickman & Chater (2019).
Practical4 : Fitting accuracy and RT with the diffusion model
8. *Article-6*: Glickman et al. (2018); Psych Sci.

Modeling decision between food items based on eye-movements (Attention Drift Diffusion);

9. *Article-7*: Krajbich et al. 2010
Models of Attention-1: salience, pop-out and Visual Search; Figure-ground.
Practical-5: Value based decision and selective integration model

10. *Article-8*: Vergese (2001). Neuron
Models of Attentional-2. Cueing, Stroop, the flanker test; attentional control, task-conflict.

11. *Article-9*: Flanker model (Cohen-Servan, 1992); *Article-10:* Kallantrof et al. 2017
Models of Memory: Activation memory; the activation buffer, modeling dissociation between STM/LTM.
Practical-6: The Stroop model

12. **Modelling decision confidence, sequential control.**
Article-11: Cognitive Control (Botvinick et al 2001)

Some reading to start with:

Introduction to Connectionsism:
Chapter-1 from the PDP book, Rumelhat & McClellend (1986). On Moddle.
Integrate and Fire models
http://icwww.epfl.ch/~gerstner//SPNM/node26.html