Course plan
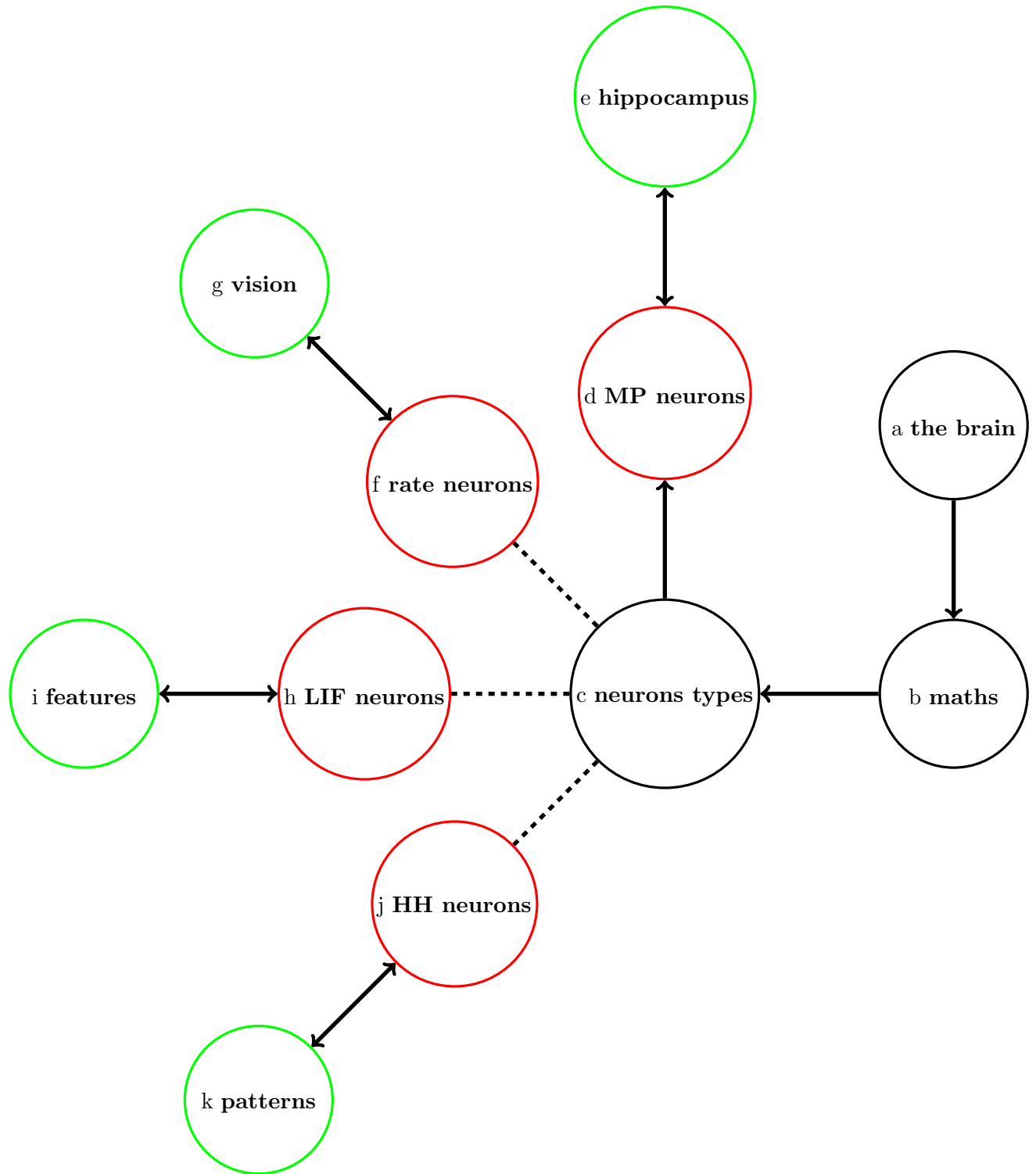
Key to the plan

(a) **the brain:** A quick and easy outline introduction to the brain and neuroscience.

(b) **some math:** An introduction to scientific computing and differential equations.

(c) **neuron types:** An overview of neuronal modelling.

(d) **MP neurons:** The McCulloch Pitts model of neurons, simple synapses.

(e) **hippocampus:** Hebbian plasticity, description of the hippocampus and auto-associative memory.

(f) **rate neurons:** The rate model of neurons, including receptive fields.

(g) **vision:** The visual pathway; V1, receptive fields in V1 and sparse coding.

(h) **LIF neurons:** Spiking, spike triggered averages and time histograms, the leaky integrate and fire neuron.

(i) **features:** Spike timing dependent plasticity and feature extraction.

(j) **HH neurons:** Ion channels and Hodgkin-Huxley neurons; Morris-Lecar and other models.

(k) **patterns:** Some ideas from dynamical systems, central pattern generators.

Rough lecture list

This is a rough guide, it might change as the course progresses.

1. Introduction to the course and to the brain. (a 01-29 Conor)

2. More on the brain. (a 01-31 Conor)

3. Scientific programming in Python or Julia. (b 02-05 Conor)

4. Introduction to differential equations. (b 02-07 Conor)

5. Numerical solutions to differential equations. (b 02-12 Conor)

6. Modelling neurons. (c 02-14 Cian)

7. The McCullough-Pitts neuron and Hebbian plasticity. (d 02-19 Cian)

8. The Hippocampus. (e 02-21 Cian)

9. CA3 as a auto-associative memory, pattern separation. (e 02-26 Cian)

10. Firing rates, dealing with neuronal data, receptive fields. (f 02-28 Cian)

11. Reading week (week 18)

12. The visual system. (g 03-12 Cian)

13. V1 and sparse coding. (g 03-14 Cian)

14. Spikes and analysing spike date. (h 03-19 Cian)

15. Simple models of neurons: leaky integrate and fire neurons. FI curves (h 03-21 Cian)

16. Synapses and synaptic plasticity. (i 03-26 Rui)

17. Long term plasticity. (i 03-28 Rui)

18. STDP and feature extraction. (i 04-02 Rui)

19. T.B.D. (04-04)

20. Easter break (3 weeks).

21. Ion channels. (j 04-30 Conor)

22. The Hodgkin-Huxley equation and spikes. (j/k 05-02 Conor)

23. Dynamical systems approachs, the Morris-Lecar model, phase diagrams. (k 05-07 Conor)

24. Central pattern generators, bursting. (k 05-09 Conor)