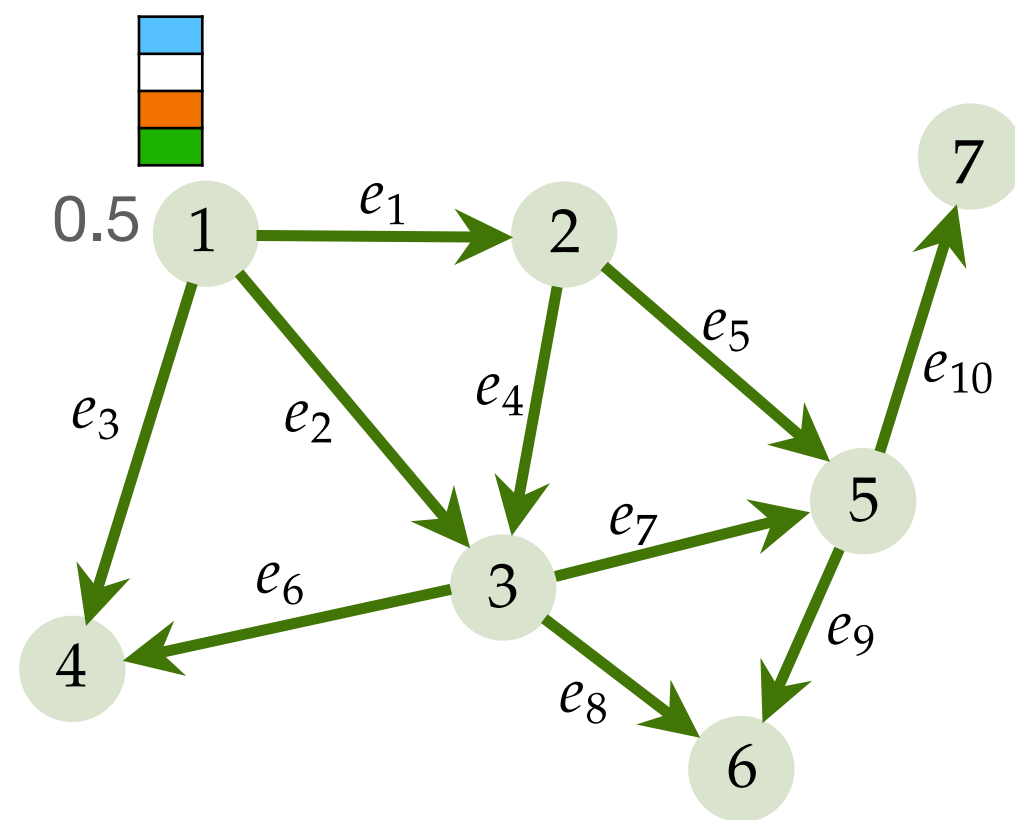


# Functions on simplices

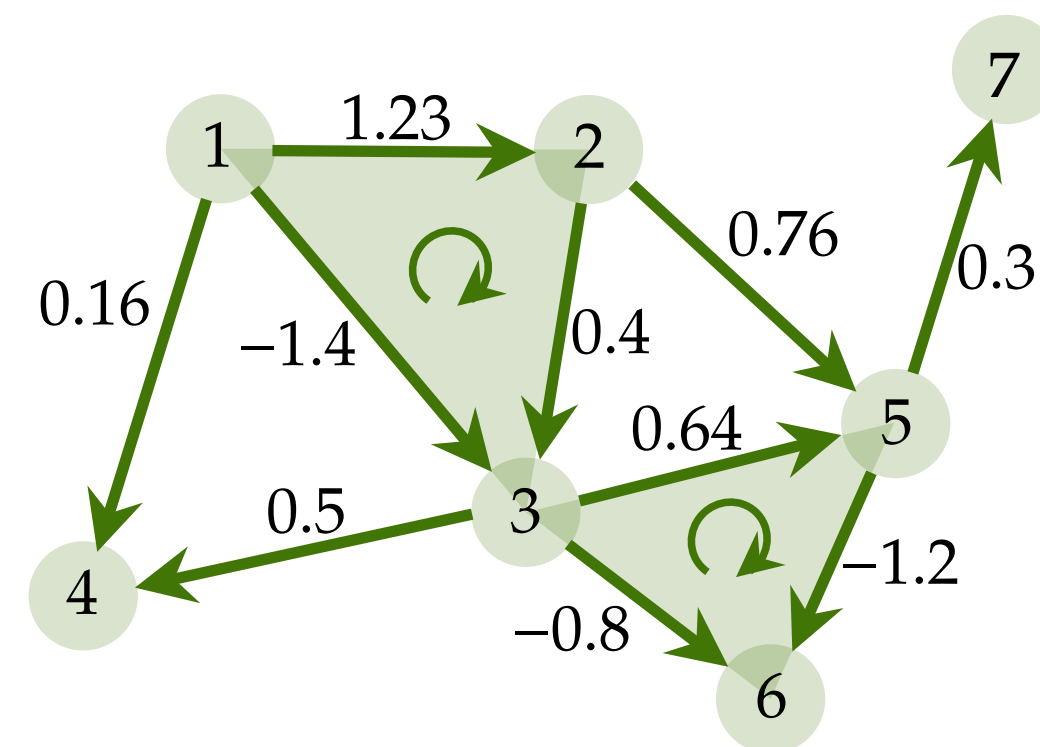
## Signals on nodes, edges, triangles, ...



Node function

$$f_0 : V \rightarrow \mathbb{R}$$

$$\mathbf{f}_0 = (f_0(1), \dots, f_0(N_0))^T$$



Edge function

$$f_1 : E \rightarrow \mathbb{R}$$

$$\mathbf{f}_1 = (f_1(e_1), \dots, f_1(e_{N_1}))^T$$

- Alternating property
- Magnitude and sign

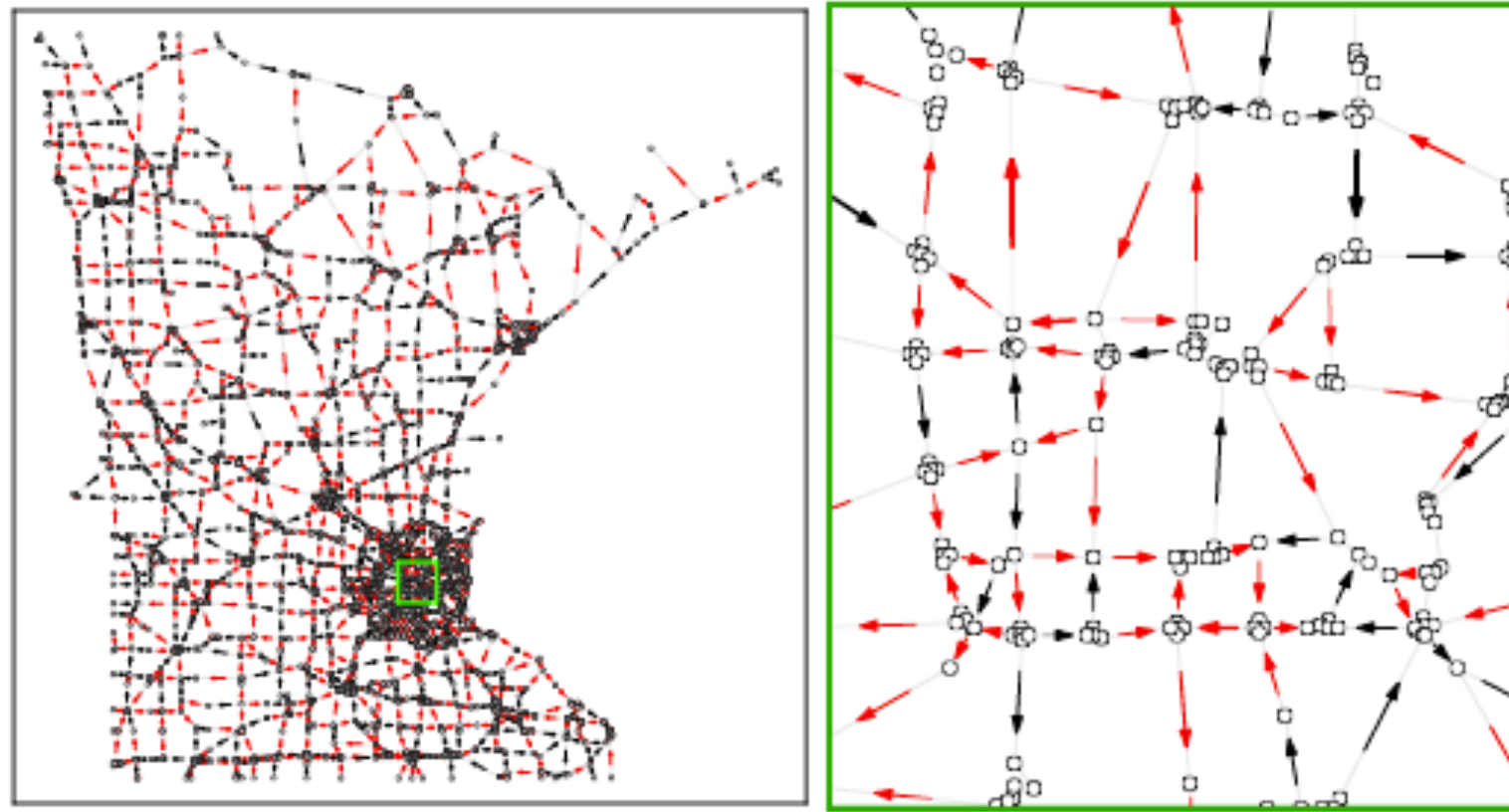
Triangle function

$$f_2 : T \rightarrow \mathbb{R}$$

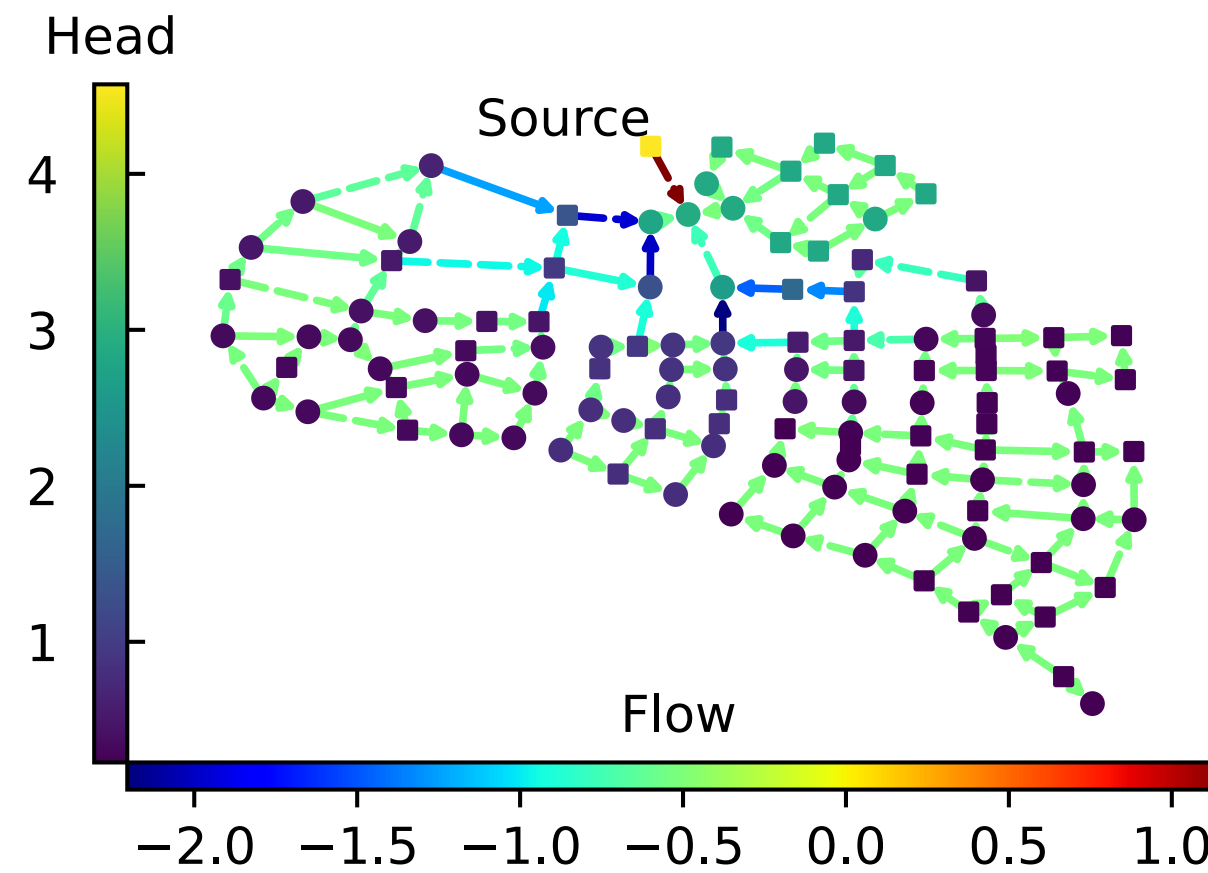
0-, 1-, 2-cochains in topology

- Flow-type data (natural)
  - Physical world: traffic flow, water flow, information flow...
  - Forex: exchange rates
  - Game theory (Candogan et al. 2011)
  - Ranking data (Jiang et al. 2011)
  - Edge-based vector field discretisation (computer graphics)
  - ...
- Representation learning
  - High-dim edge features

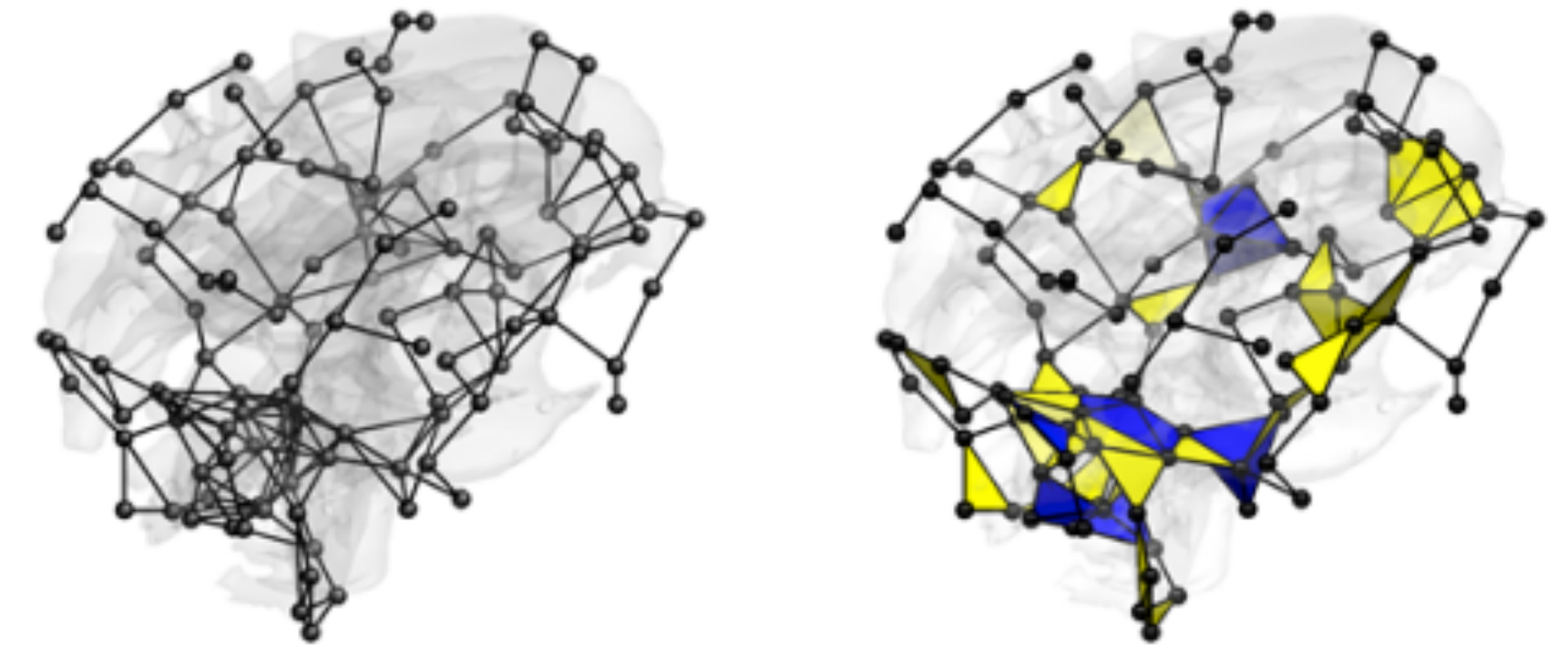
# Simplicial complexes and Data in real world



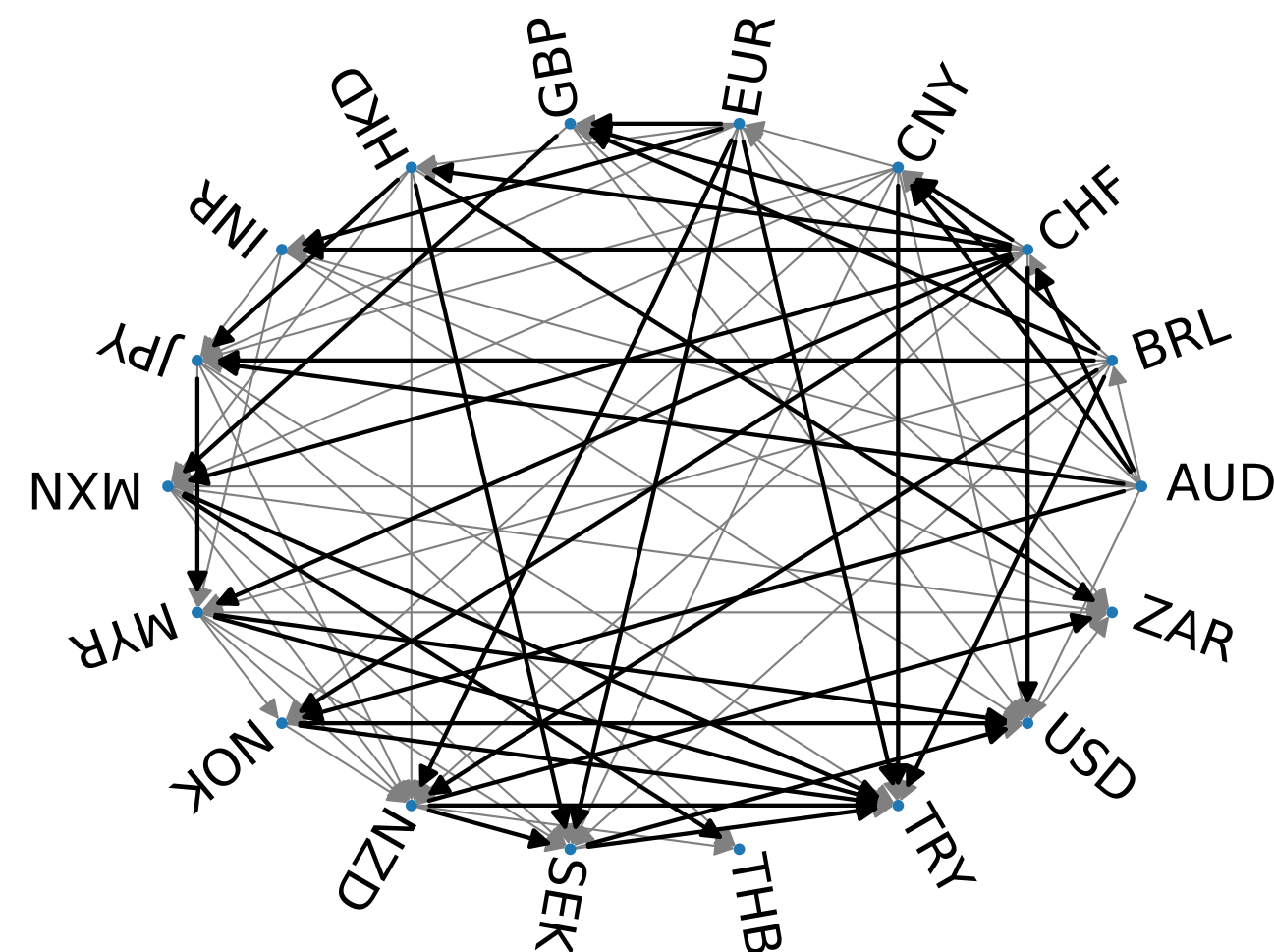
Traffic flows (Jia et al. 2019)



Water flows (Yang et al. 2023)



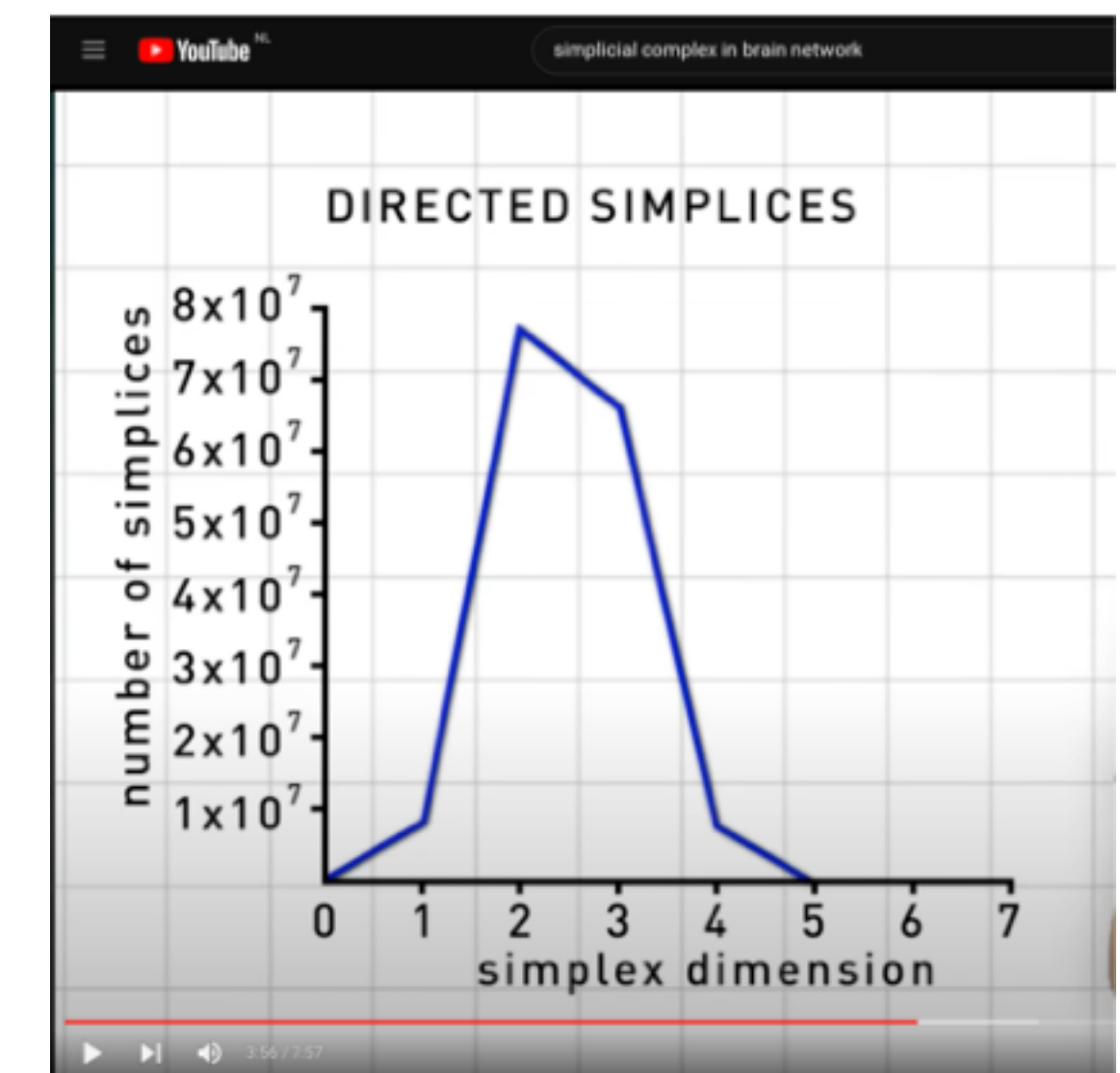
Neuroscience (Anand et al. 2023):  
1. Firing of neurons  
2. Activation of multiple brain regions



Foreign currency exchange (Jiang et al. 2011)

Others:

- Currents/Voltage in electric circuits/grid
- Game theory (Candogan et al. 2011)
- Ranking theory (Jiang et al. 2011)
- Information flows
- ...
- Discrete vector fields



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