Form from flow: How fluctuations shape network design

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Ideal networks are *efficient*

Want **big** vessels so flow is easy

vs.

Want small vessels so maintenance is cheap

No loops!

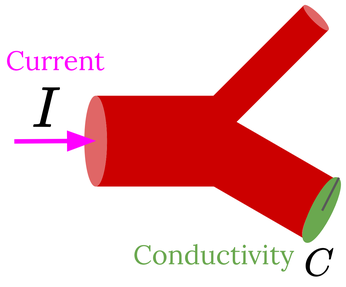
Why waste energy, make lot connections when few do trick

Make vessels big enough to carry their flow

Goal:

$$C = I^{2\gamma}$$

Constant that varies between systems



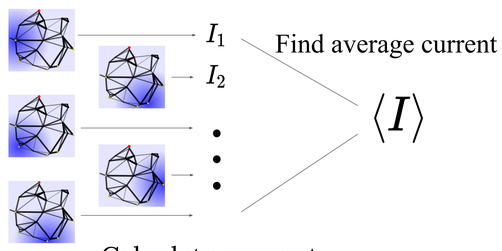
Many of these real systems have loops
2 possible explanations:

Fluctuations
Flow isn't always going to/from the same places

Damage
Flow has to make detours sometimes

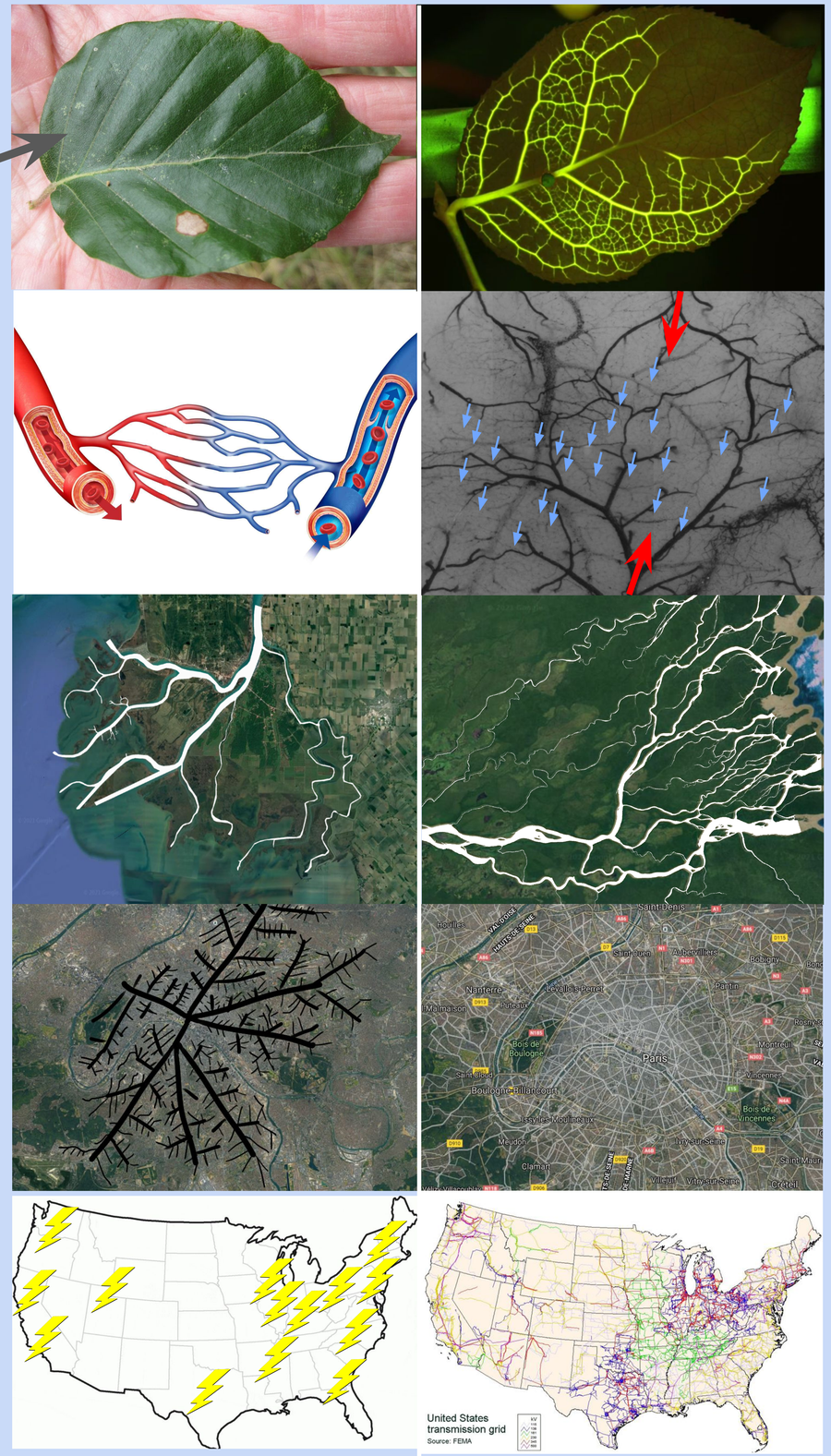
(future research)

Hypothesis
Realistic fluctuations
↓
realistic loops in this model

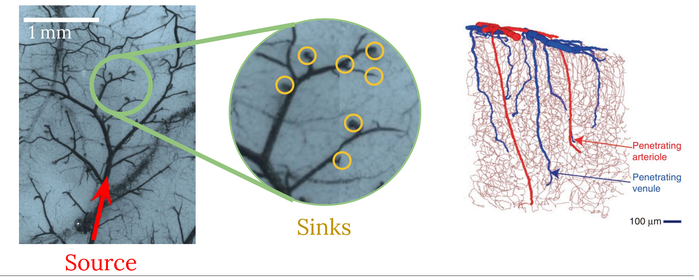


$$\frac{\mathrm{d}C}{\mathrm{d}t} = \underbrace{\langle I^2 \rangle^{\gamma}}_{\text{"use it"}} \quad \underbrace{- \; C}_{\text{or "lose it"}}$$

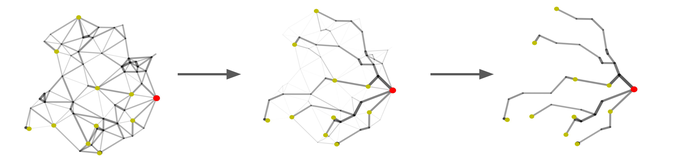
Ideal vs. Real



Model

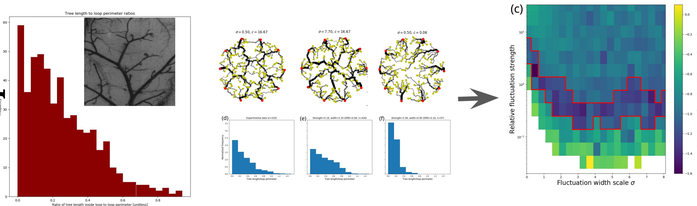


Simulate

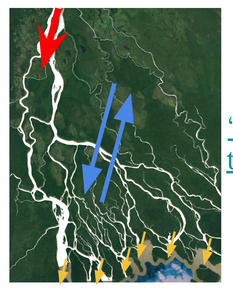


Click here to watch this happen!

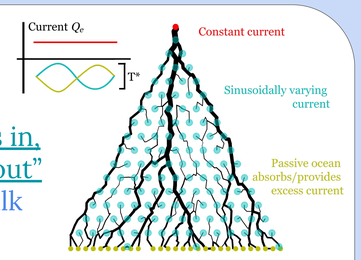
Compare



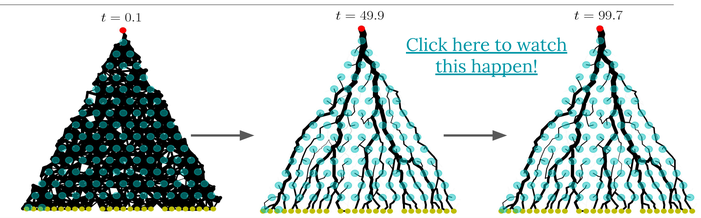
Model



"Tide goes in, tide goes out" of the bulk



Simulate



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Compare