

Software Architecture, Team Topologies and Complexity Science

James Lewis @boicy

 **thoughtworks**

“We cannot say there is a formal definition of the microservices architectural style...”

- Martin Fowler, James Lewis

**Componentisation
via services**

**Organised around
business capabilities**

**Decentralised data
management**

**Products not
projects**

**Decentralised
governance**

**Smart endpoints
and dumb pipes**

**Evolutionary
design**

**Infrastructure
automation**

**Designed
for failure**

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Flow, value and teams



“The bigger we get, the easier it becomes to get bigger.”

**the goal of successful
organisational design is to optimise
value flow**

**“Safely and sustainably reduce lead
time to thank-you”**

- Daniel Terhorst-North

What is value?

Generally it's "stuff"

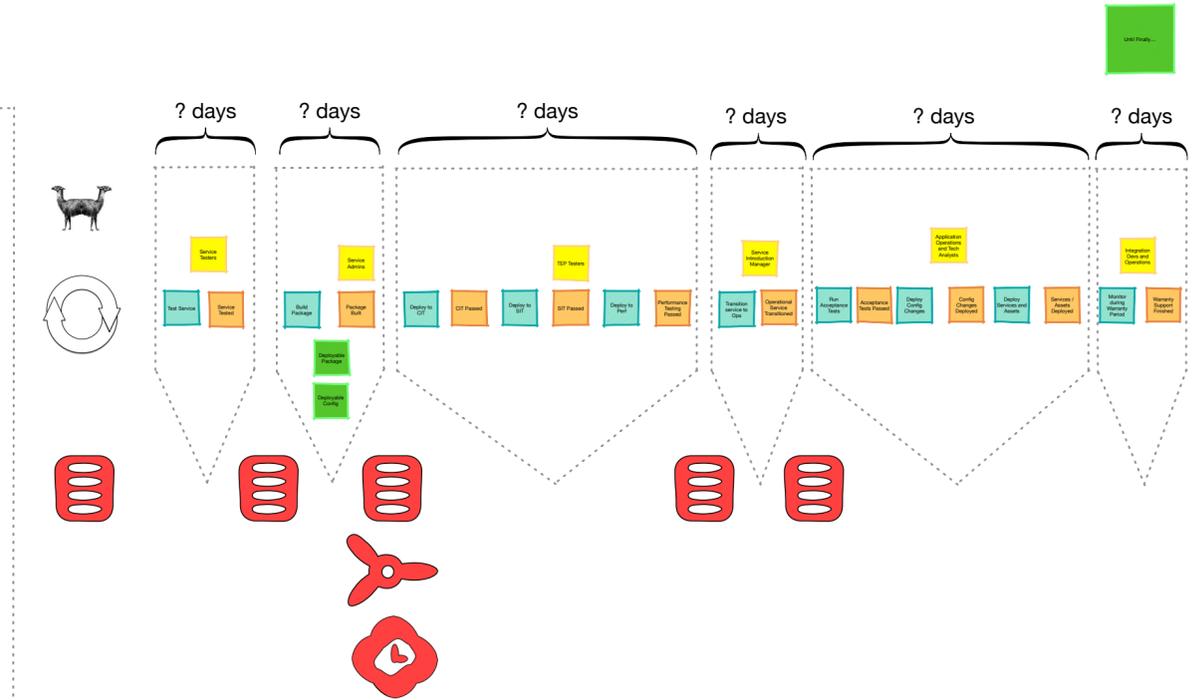
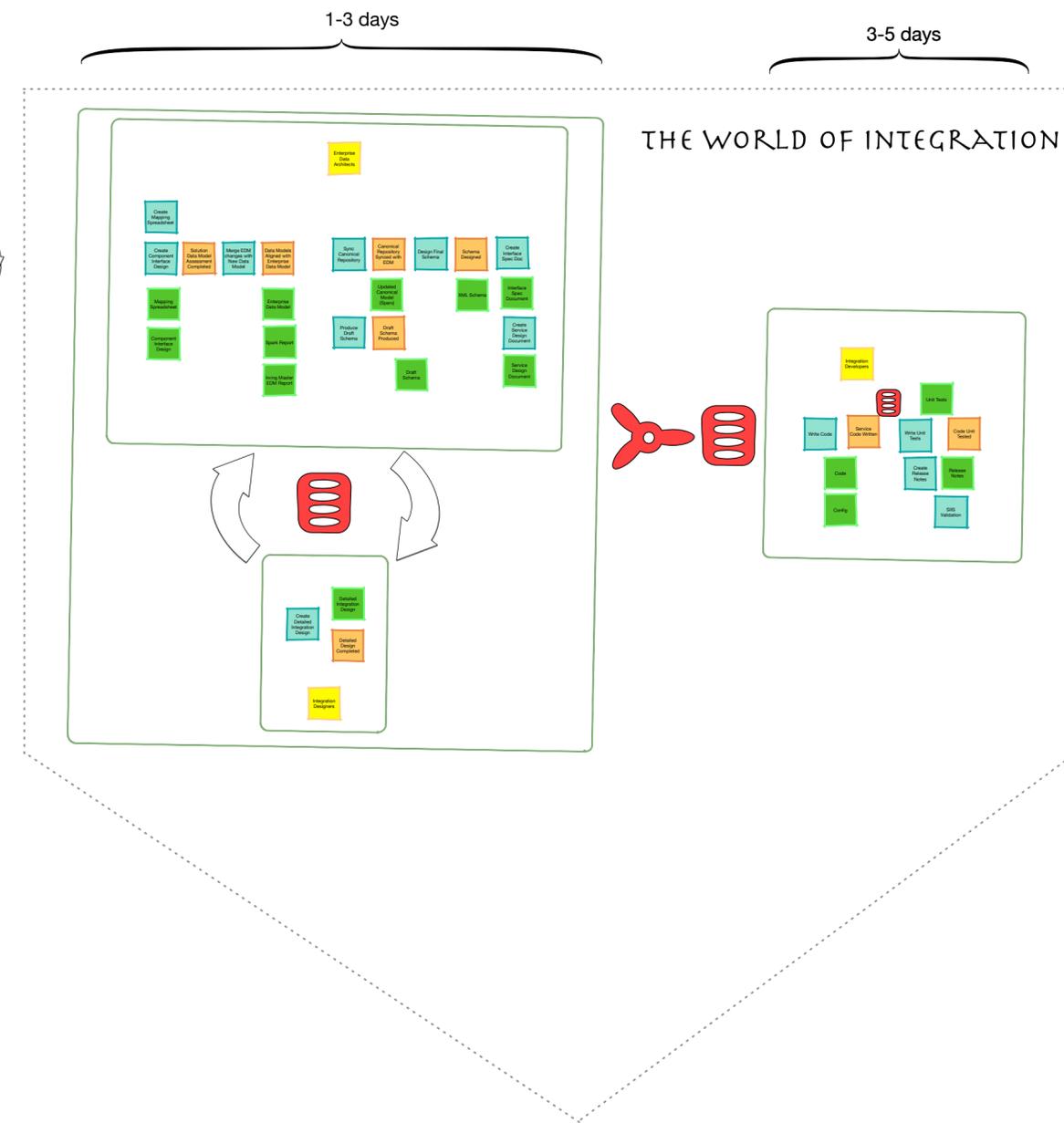
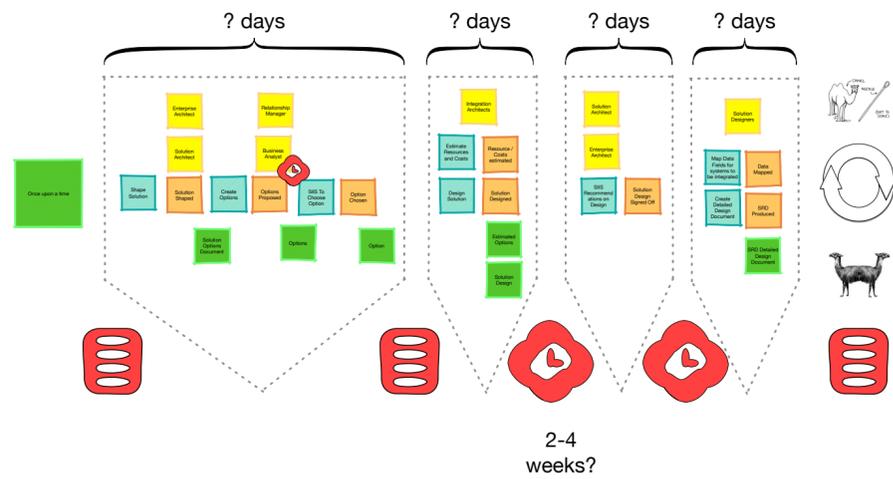
Squint and physical products and knowledge work are the same

raw materials → a thing

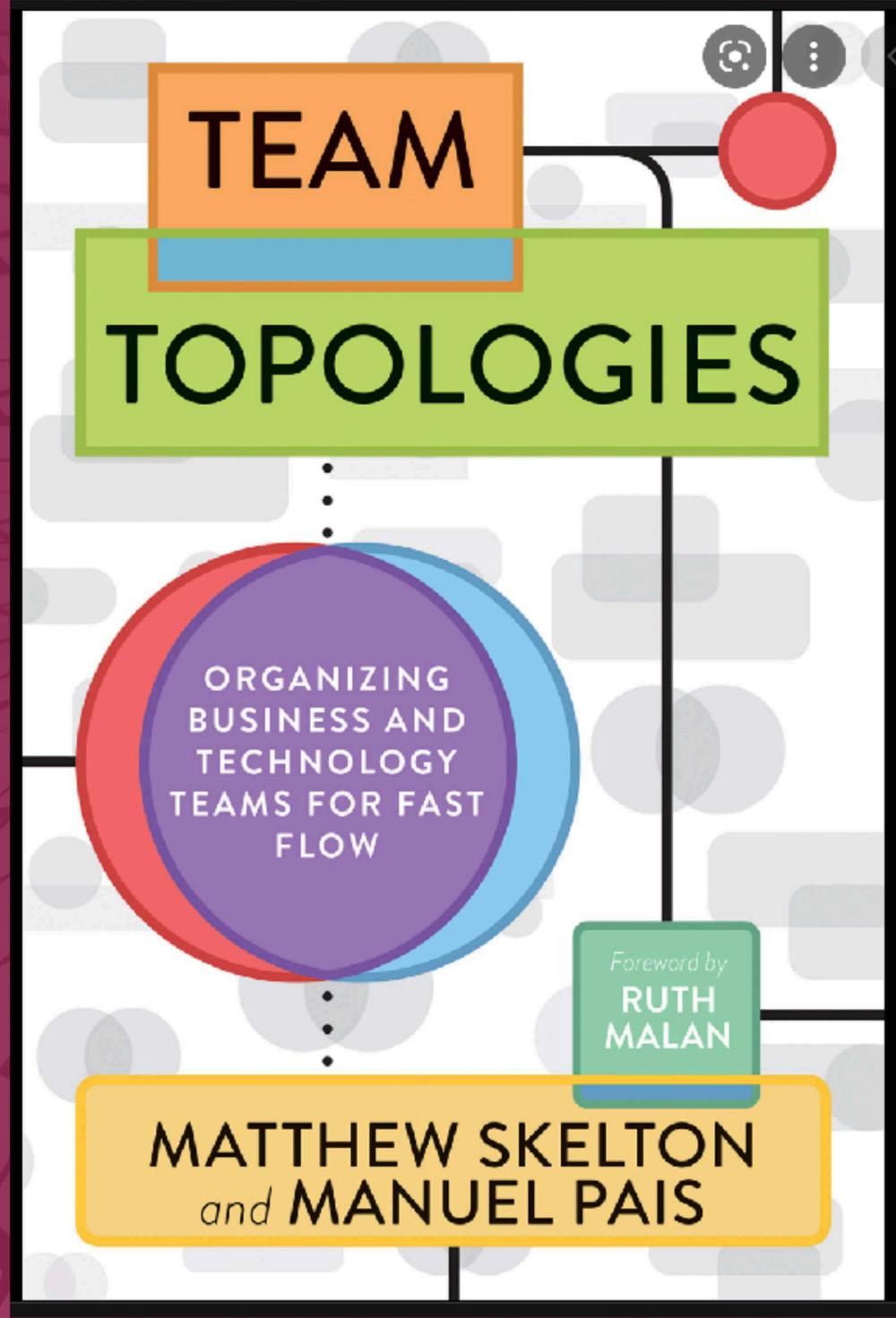
How long does stuff take?



Coordination, Scheduling, Queues







TEAM

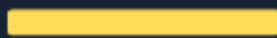
TOPOLOGIES

ORGANIZING
BUSINESS AND
TECHNOLOGY
TEAMS FOR FAST
FLOW

Foreword by
RUTH
MALAN

MATTHEW SKELTON
and MANUEL PAIS

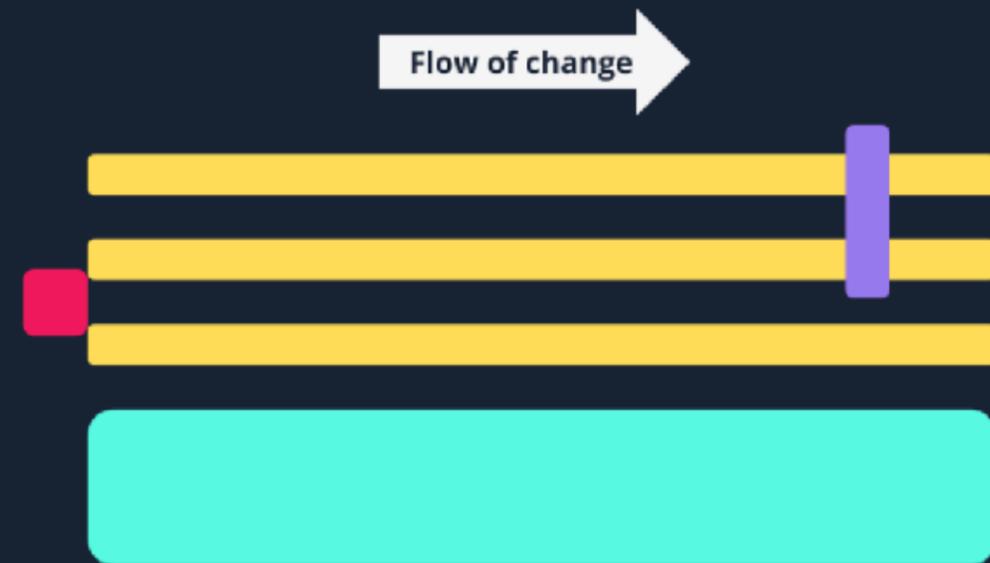
4 fundamental topologies

-  Stream-aligned team
-  Enabling team
-  Complicated Subsystem team
-  Platform team

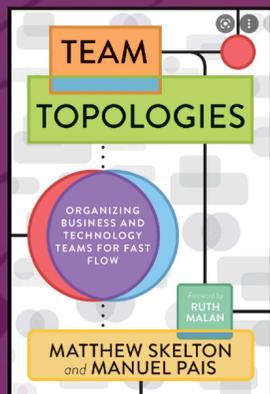


Four fundamental topologies

4 fundamental topologies



Four fundamental topologies shown with the flow of change



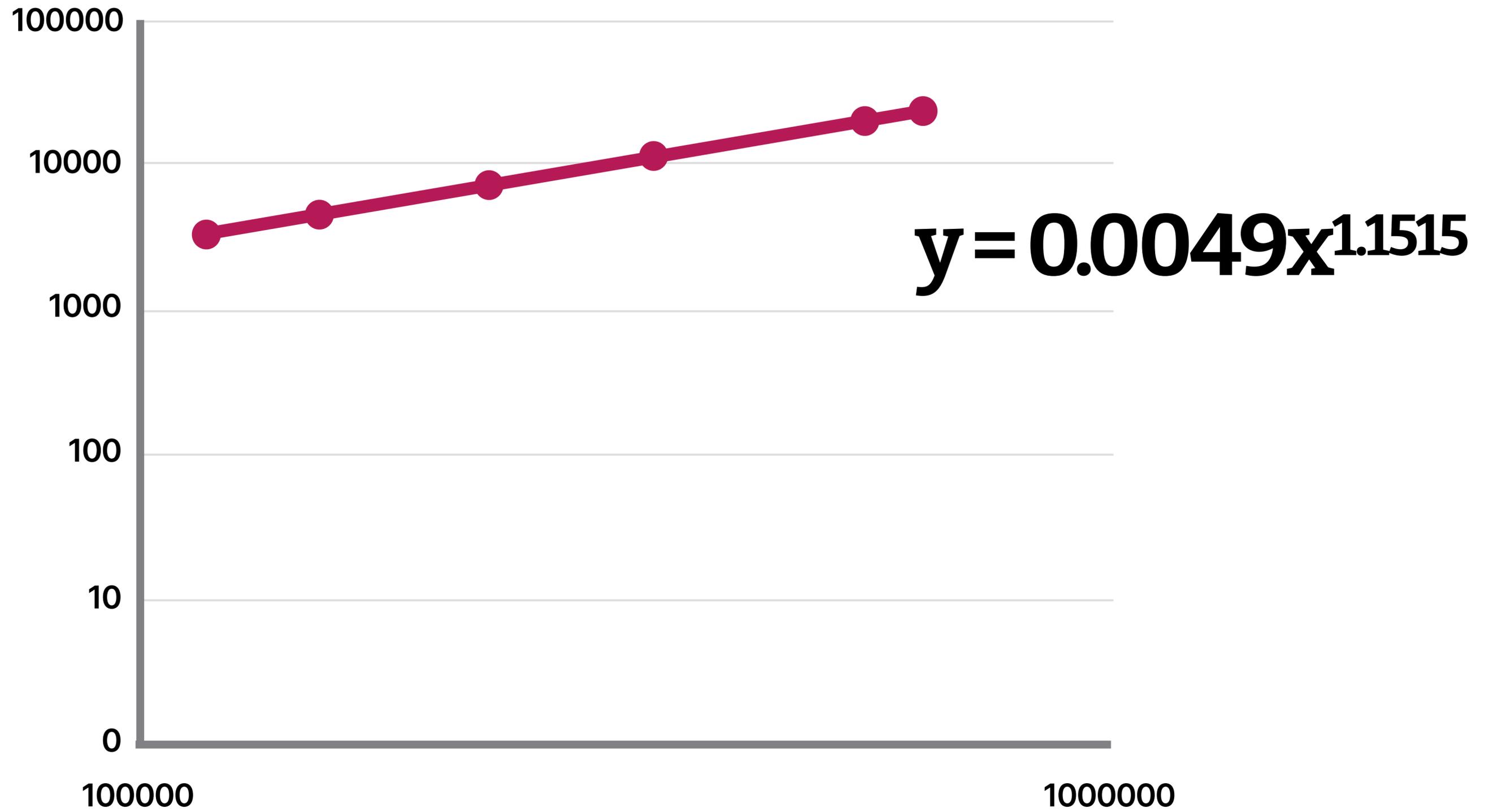
The curious case of Amazon



“The bigger we get, the easier it becomes to get bigger.”

“Adding manpower to a late software project makes it later.”

- Fred Brooks, Mythical Man Month





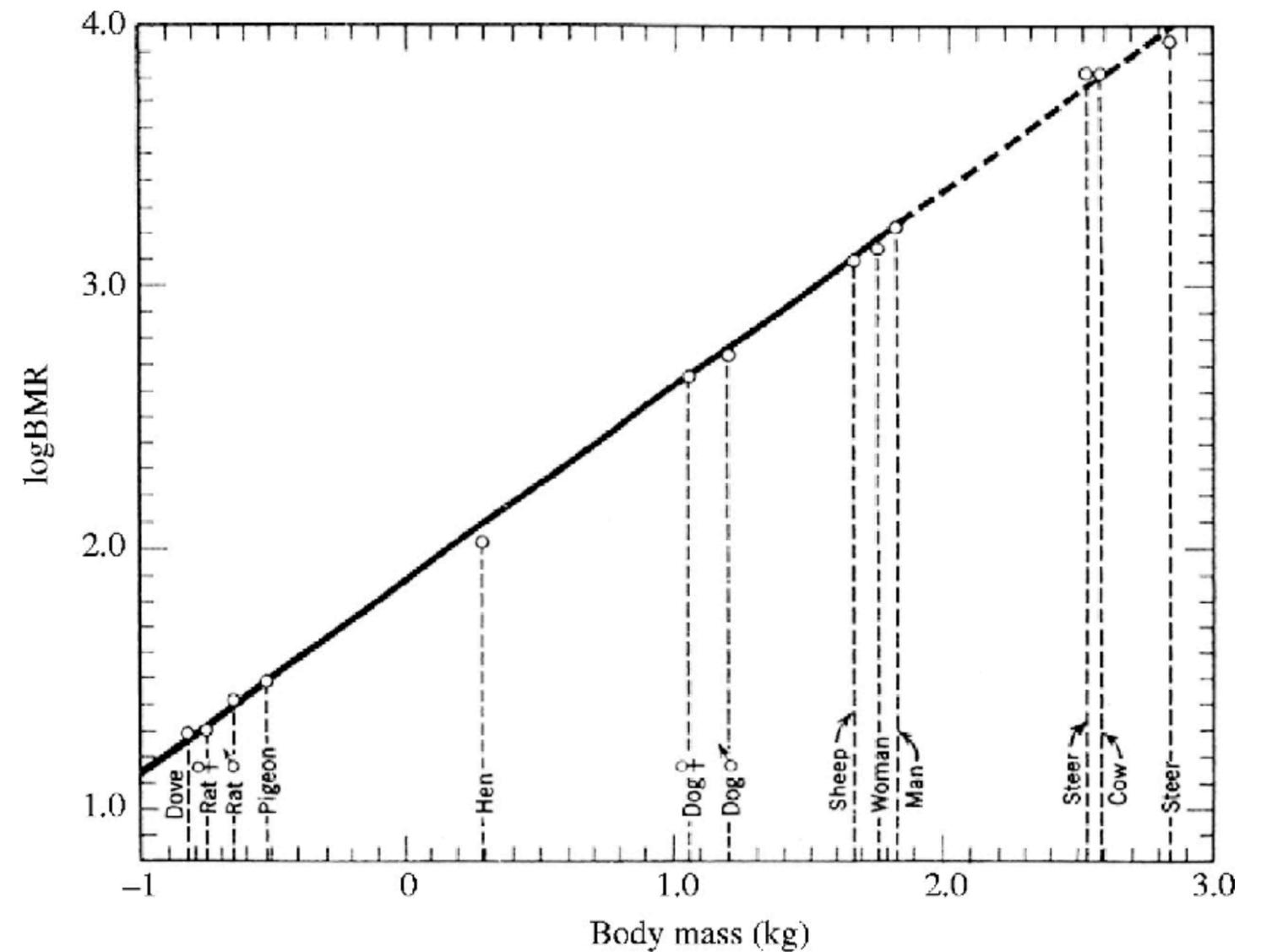
Complexity and Flow

**Complex
adaptive
systems**



**SANTA FE
INSTITUTE**

Mice and Elephants

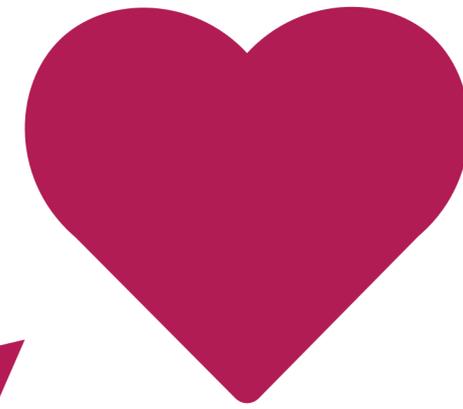


Geoffrey B. West, James H. Brown

Journal of Experimental Biology 2005 208: 1575-1592;

doi: 10.1242/jeb.01589

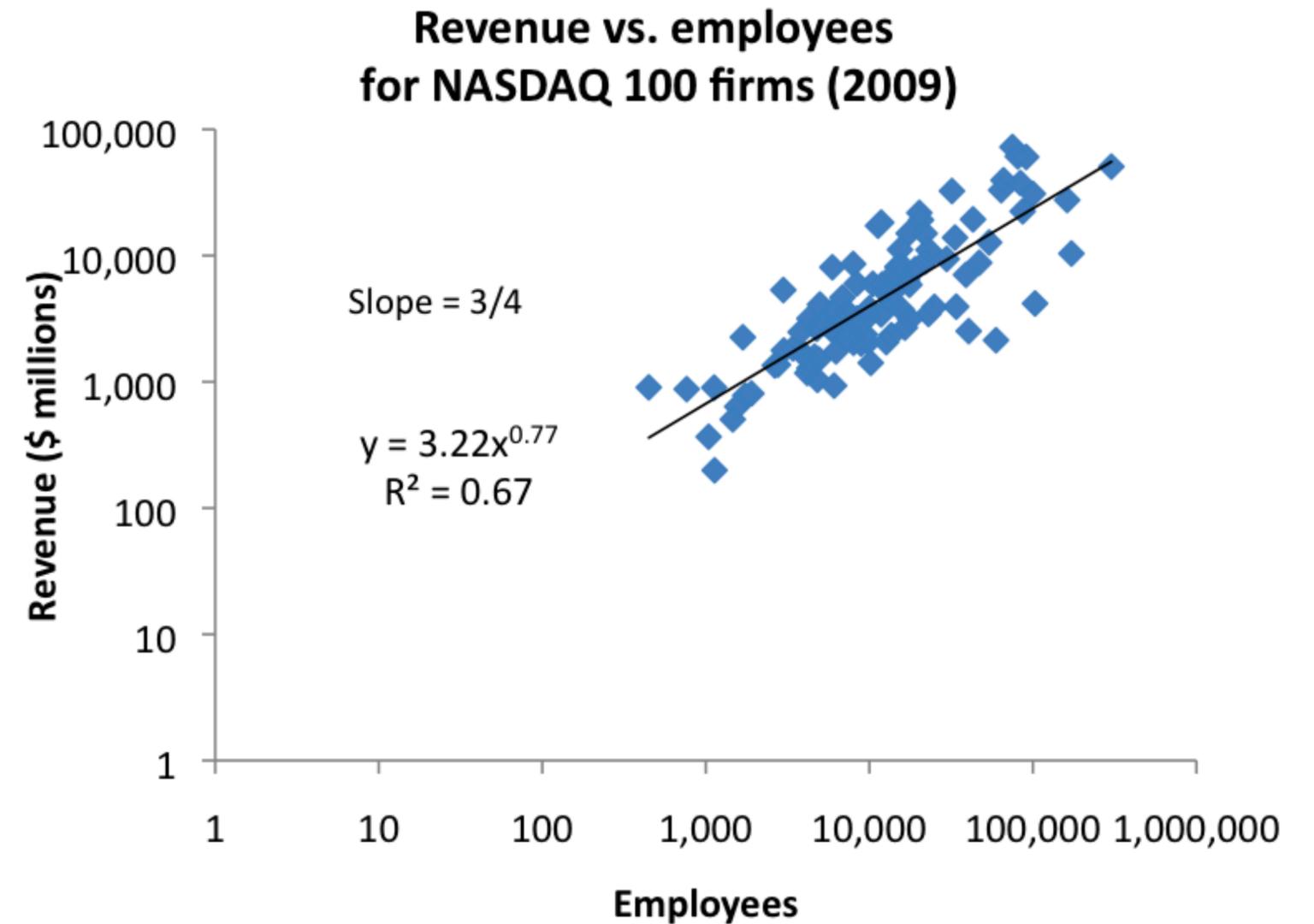
Metabolic rates in mammals follow a scaling law with an exponent of $3/4$.



0.75

As a mammal doubles in size it needs only 75% of the calories.

Mom 'n Pop stores and Aldi



Source data: Google Finance

<https://protobi.com/post/revenue-per-employee-and-biologic-scaling-laws>

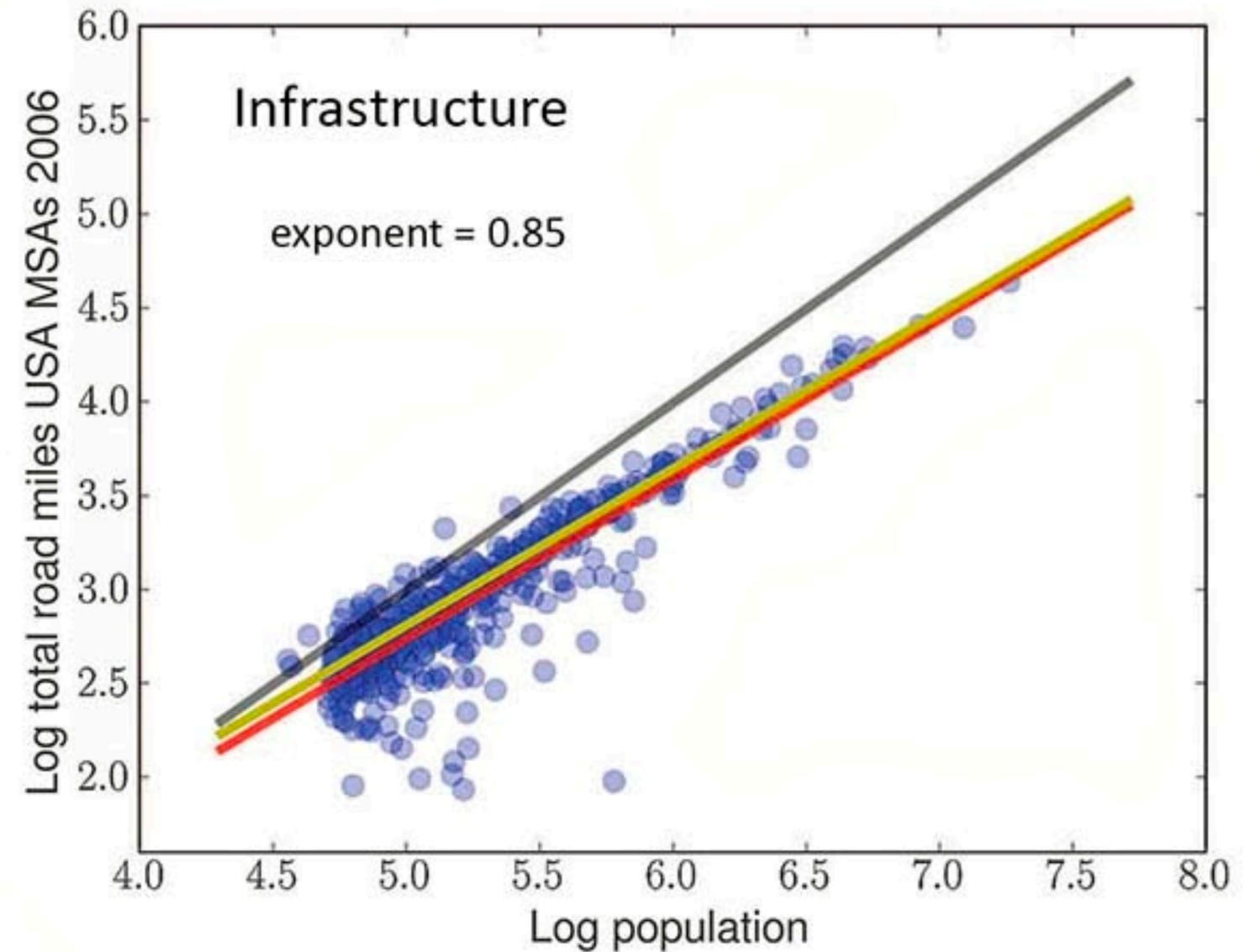
**Revenue scales with
employees following
a scaling law with an
exponent of 0.85.**



0.85

**As a company
doubles in size it
generates 85% of
the revenue.**

Utrecht and Rotterdam

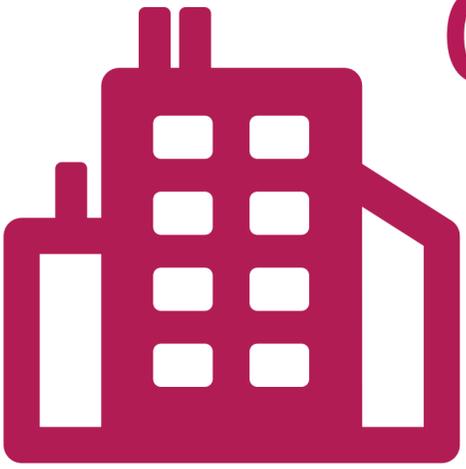
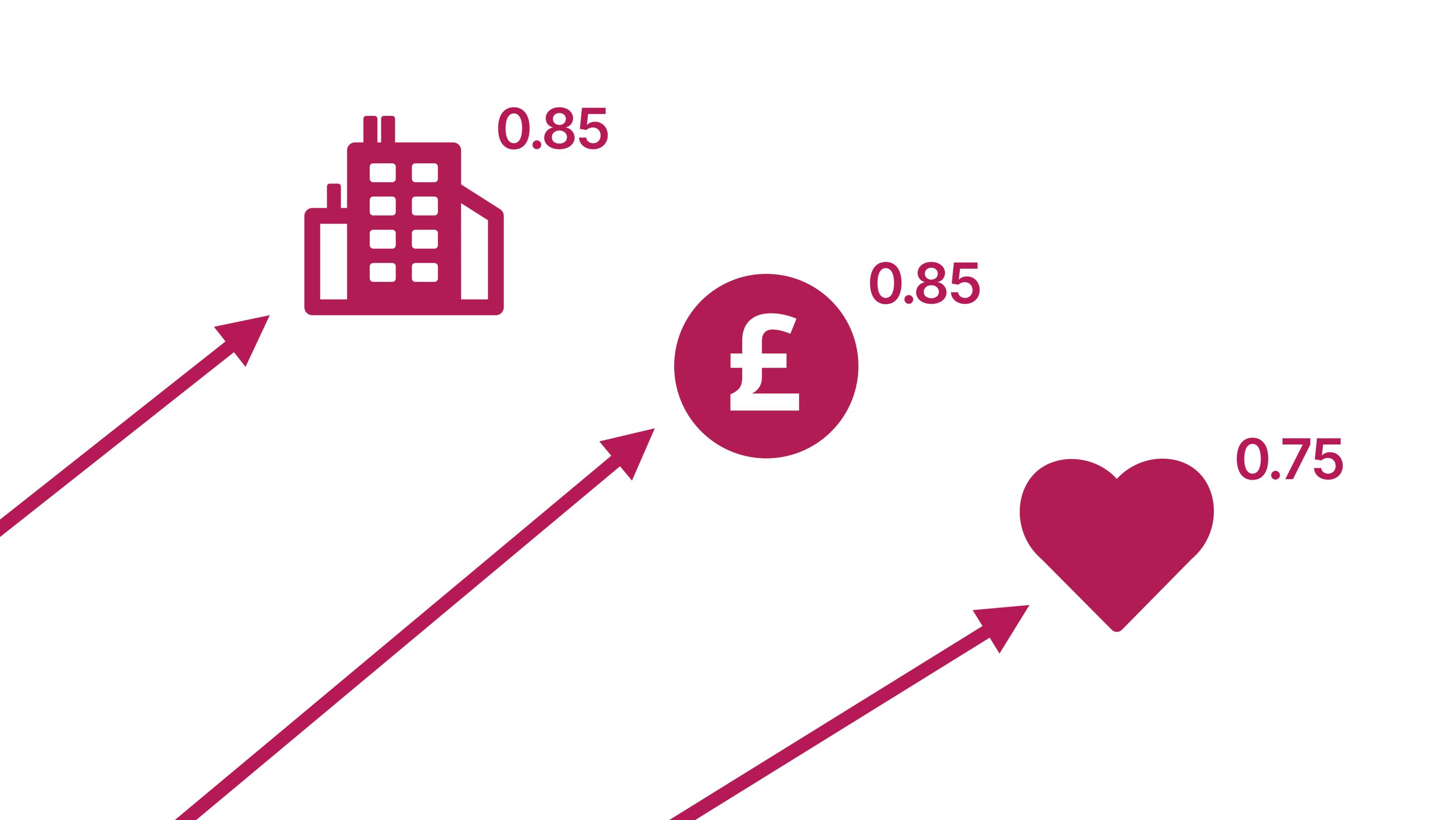


Bettencourt, Luís M. A.
2013 The Origins of Scaling in Cities. *Science* 340: 1438-1441.

**Infrastructure scales
with population with an
exponent of 0.85.**



**Road length,
petrol stations,
restaurants,
water pipes,
electricity cables.**



0.85



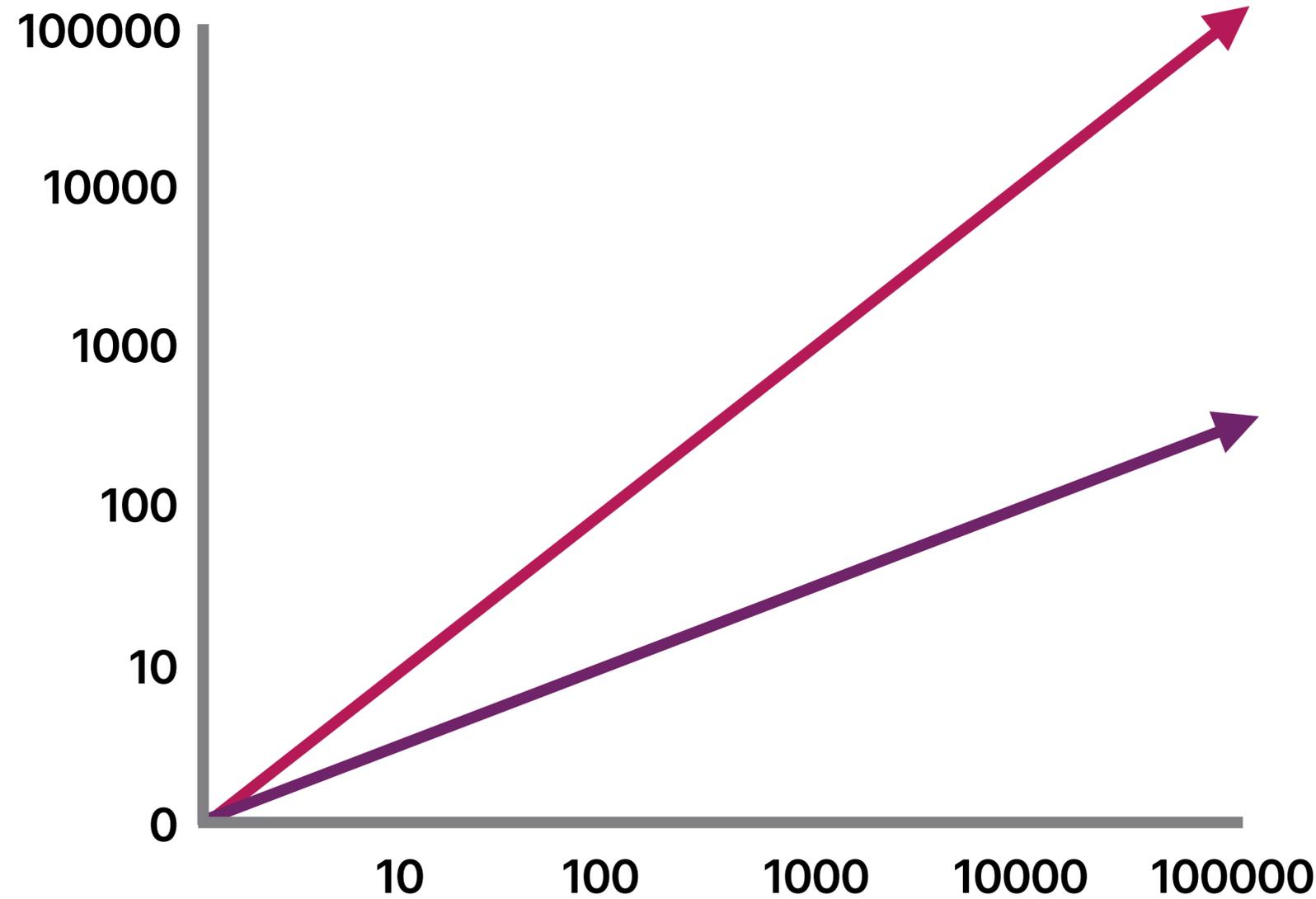
0.85



0.75

“Quantities that do not change when other parameters of the system change play a special role in science...”

- Geoffrey West. Scale: The Universal Laws of Life and Death in Organisms, Cities and Companies.



Linear scaling:
As x doubles, y also doubles

Sub-linear scaling:
As x doubles, y increases
by less than double

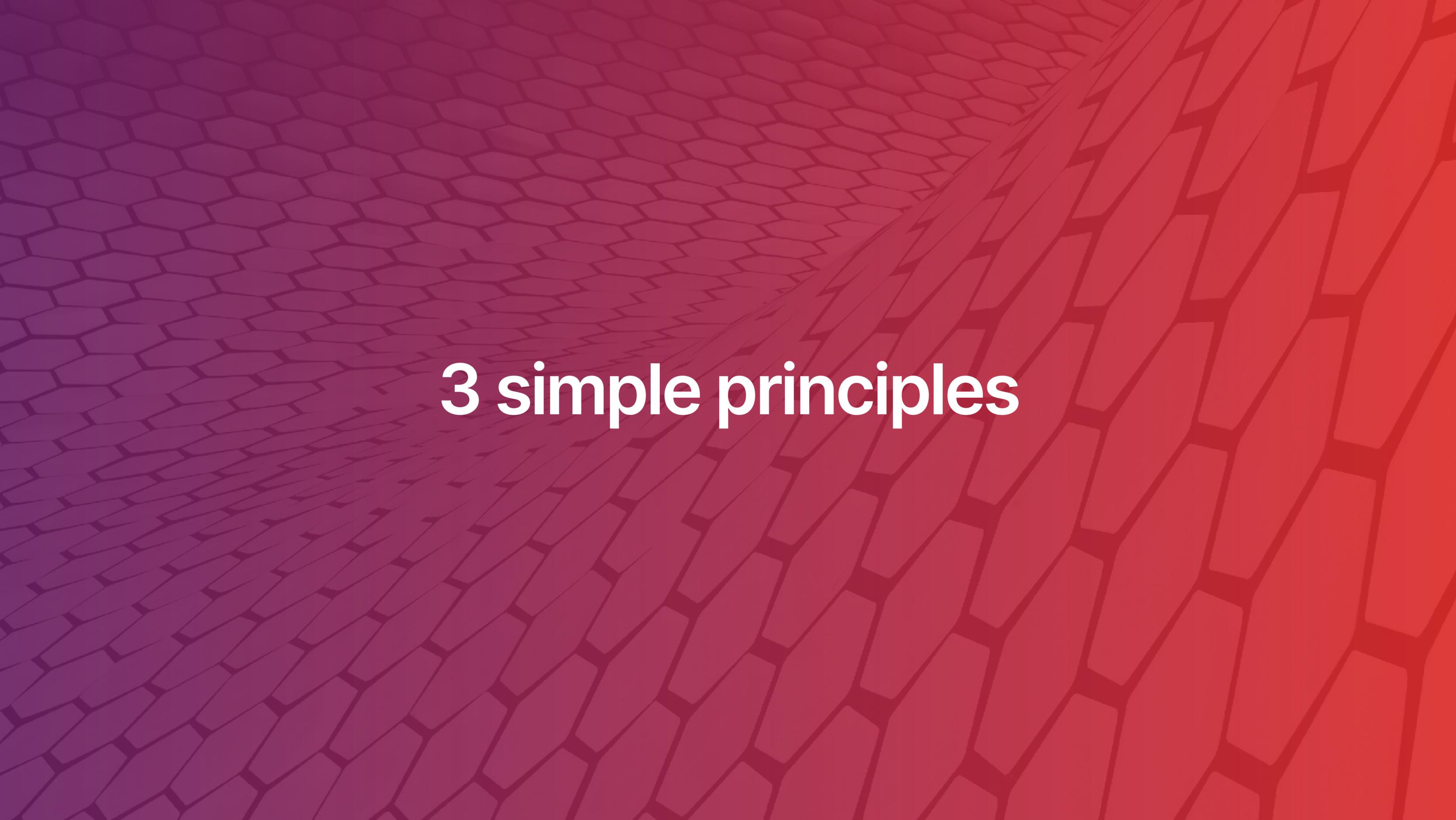
Complex adaptive systems

Self-similarity

Self-organisation

Complexity

Emergence

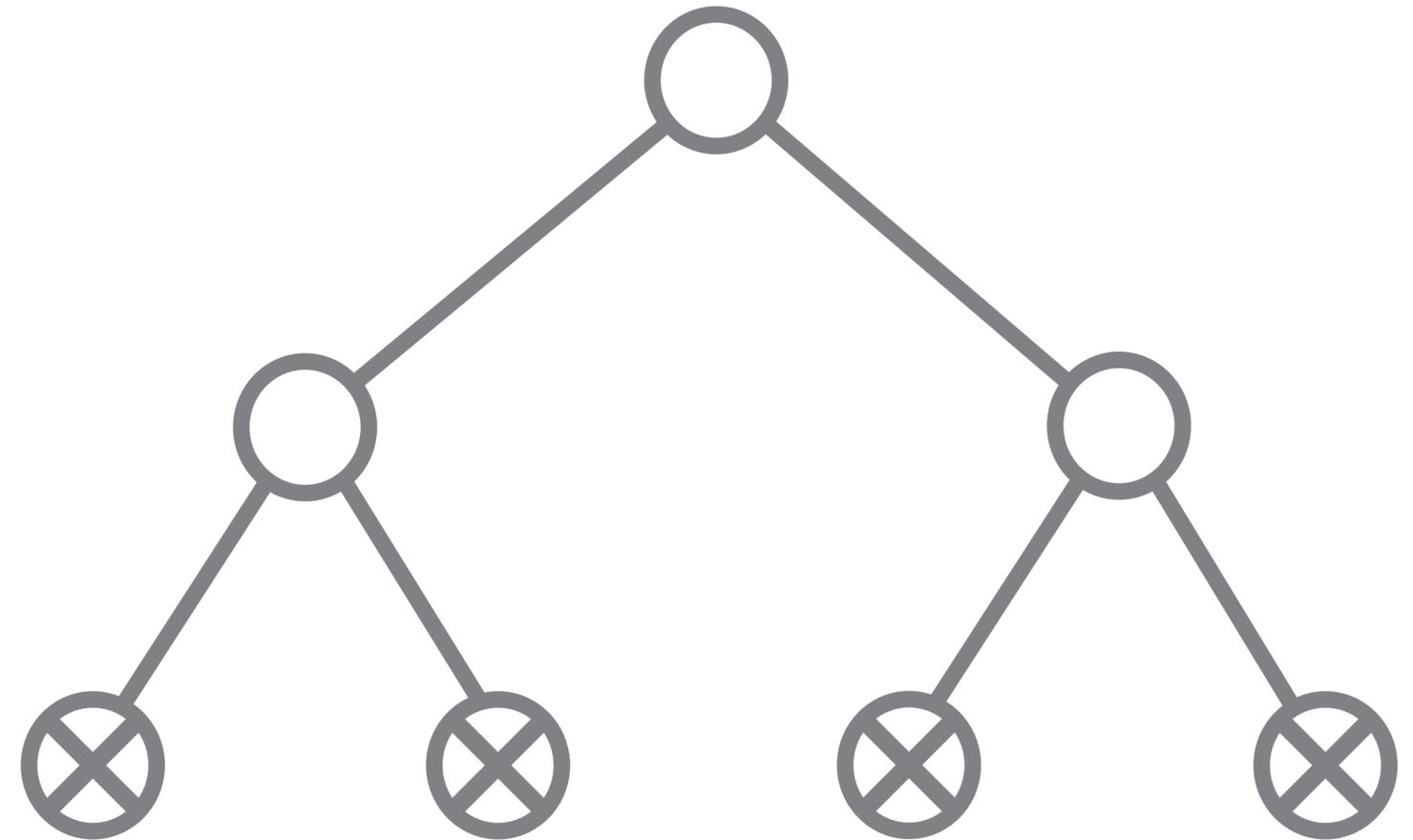


3 simple principles

1. Space filling fractal networks

2. Invariant terminating units

3. Optimisation



**Complex
adaptive
systems are
everywhere**

**Patterns can be described
using 3 principles**

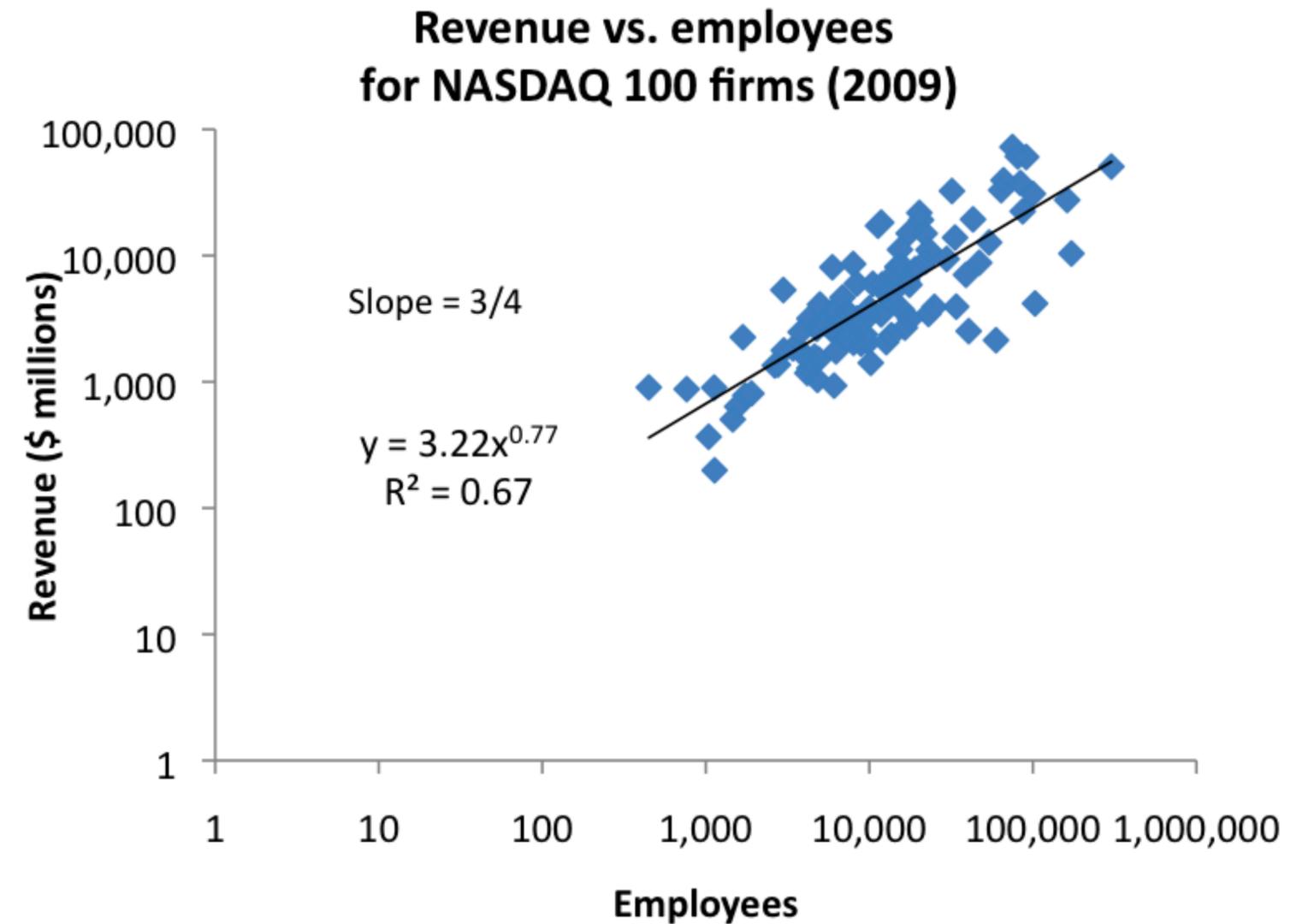
**Hierarchical fractal networks
scale following a power law
with an exponent <1**

**...Walmart and a convenience
store are the same. (just different
sizes)**



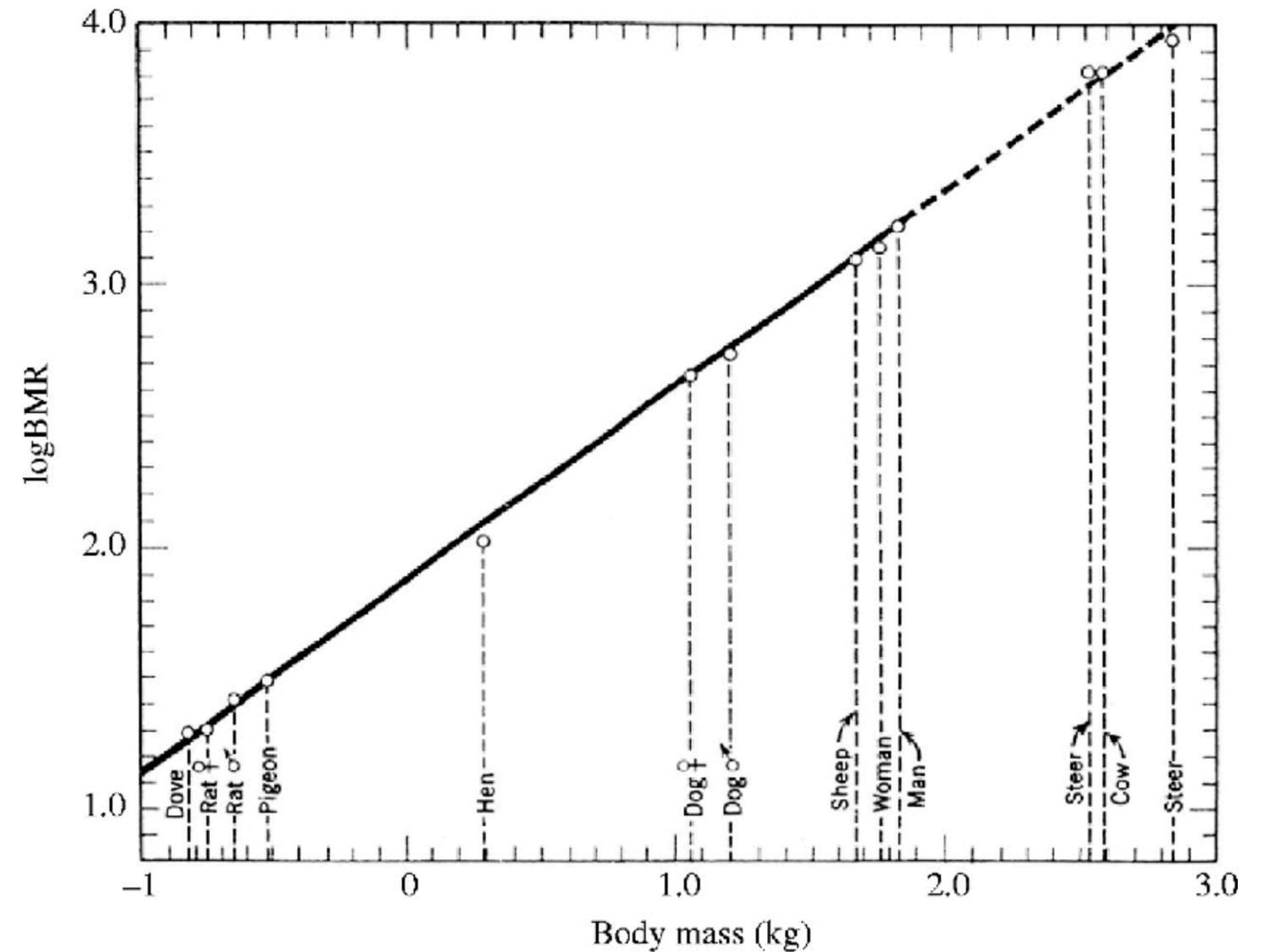
Corporate Metabolism

Why does
revenue growth
slow as size
increases?

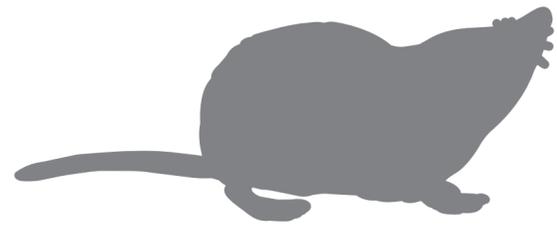


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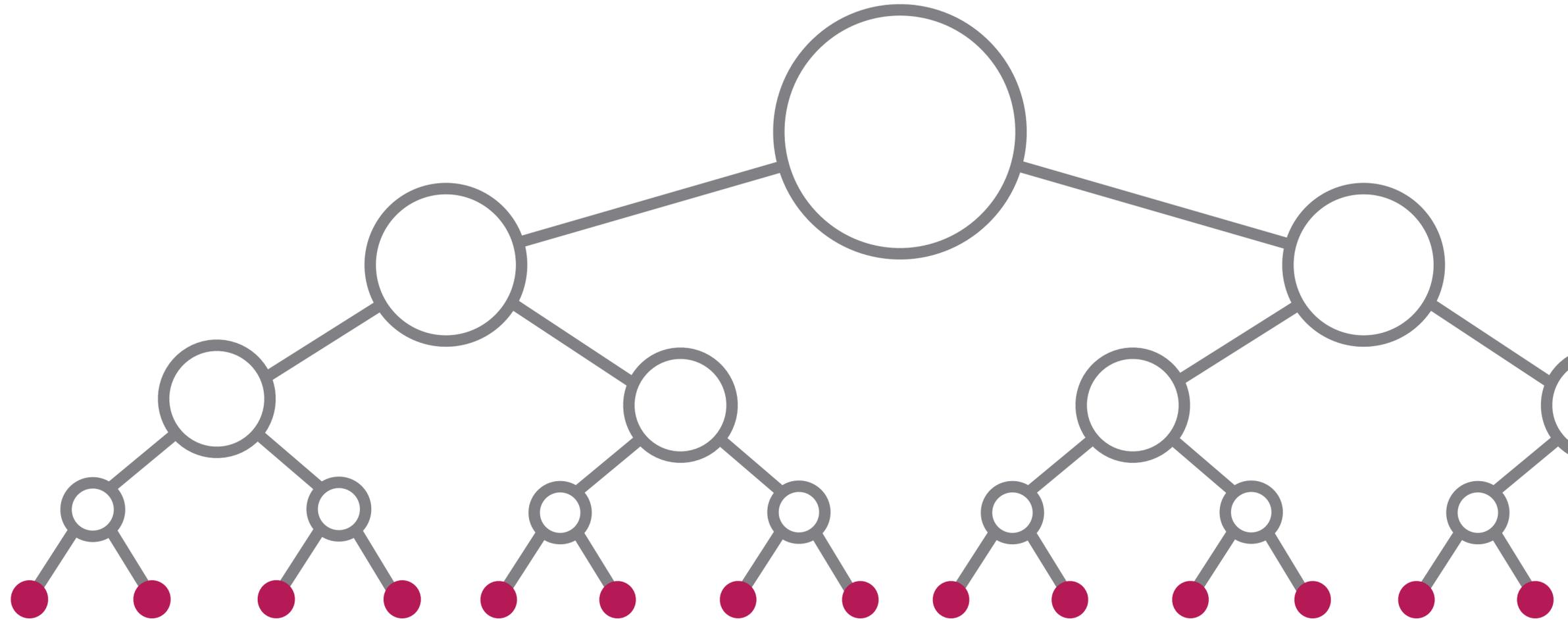
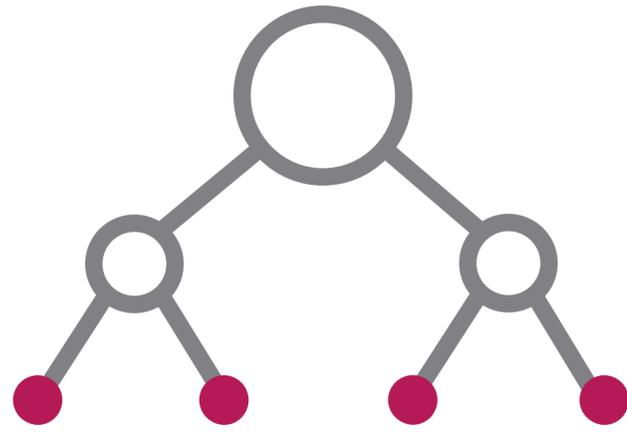
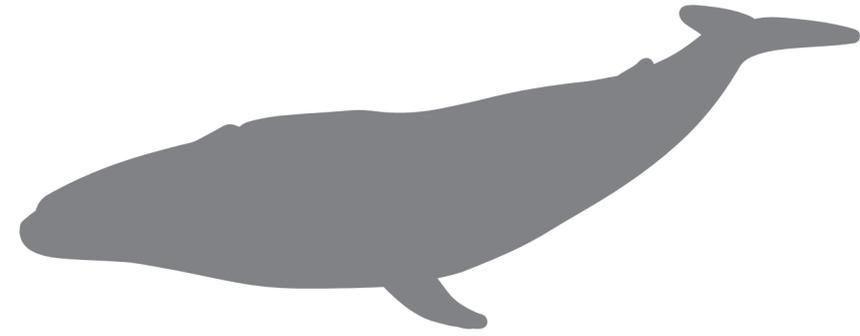
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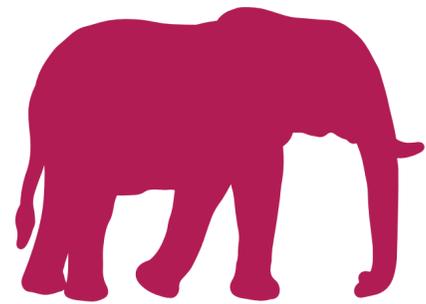


Hierarchies

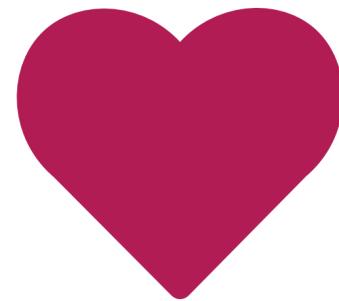


Same
size





**Bigger animals
are more
efficient (0.75)**



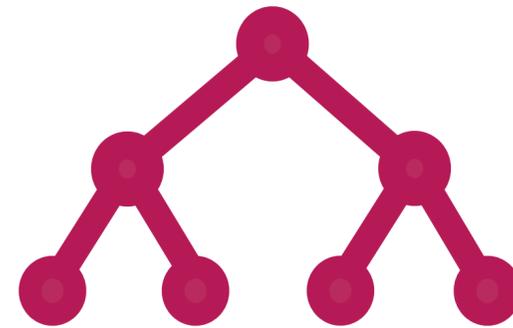
**Due to impedance
matching in the
circulatory system**



**Driven by
feedback from
evolution.**



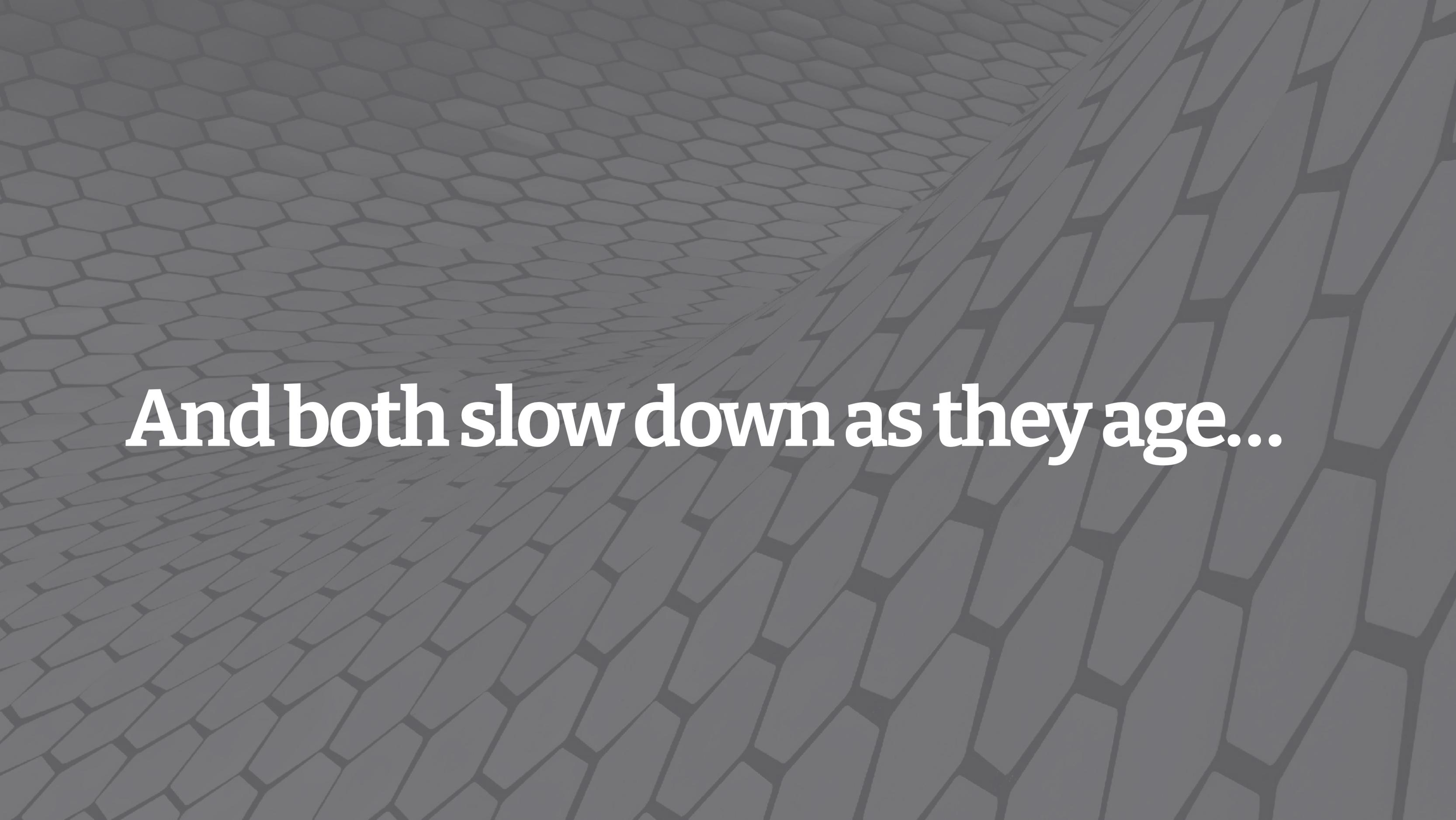
**Bigger companies
are more efficient
(0.85)**



**They develop deeper
hierarchies as they
age**



**Feedback
from market
forces.**

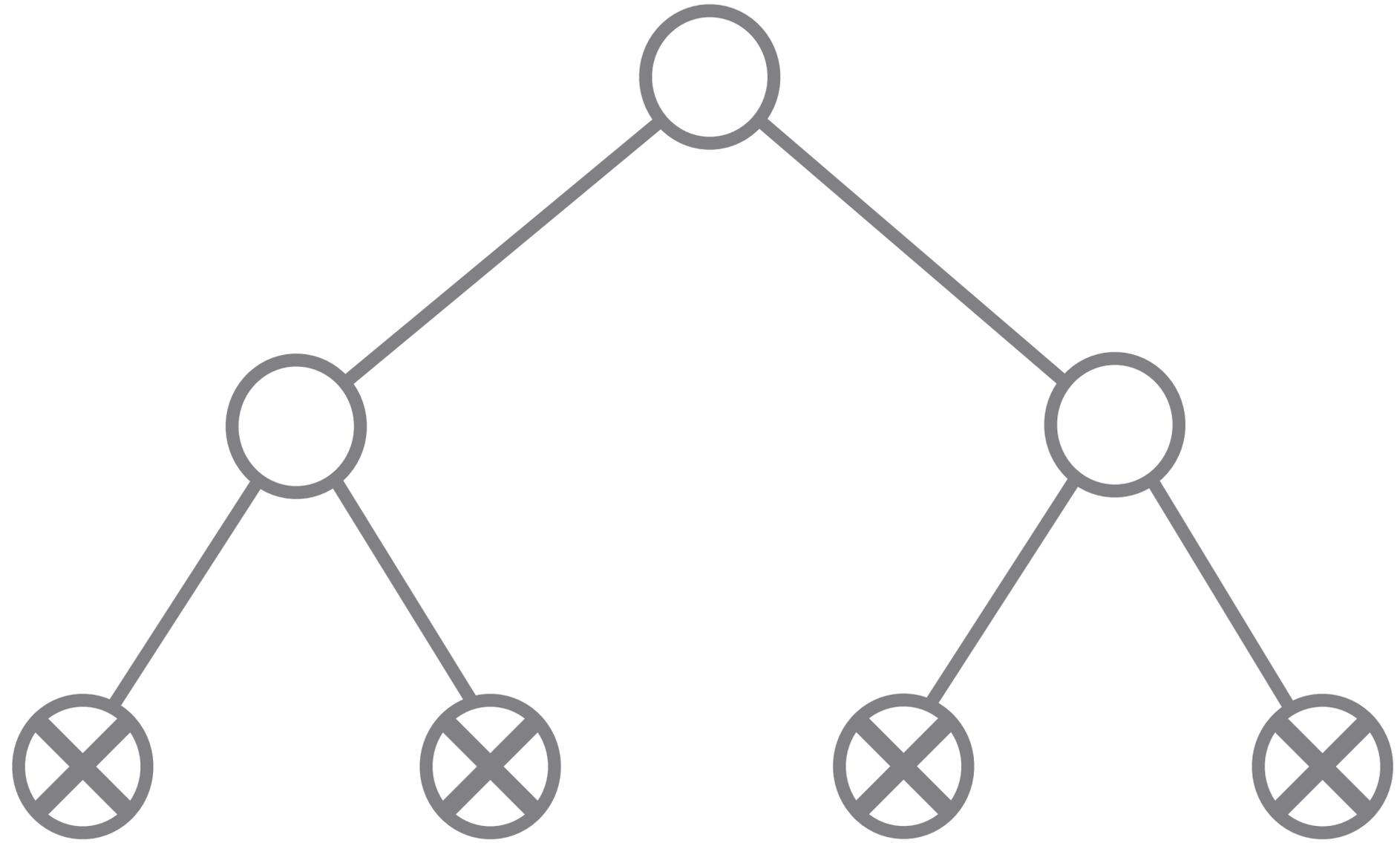
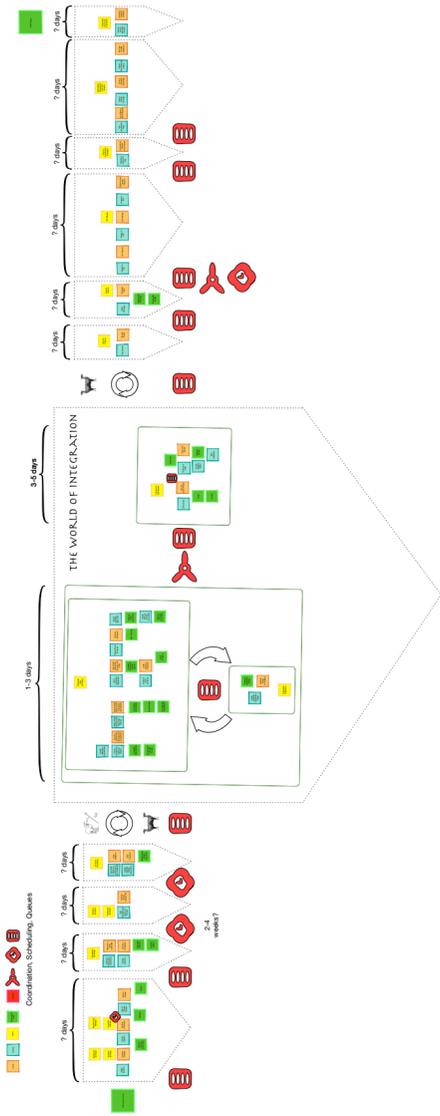


And both slow down as they age...

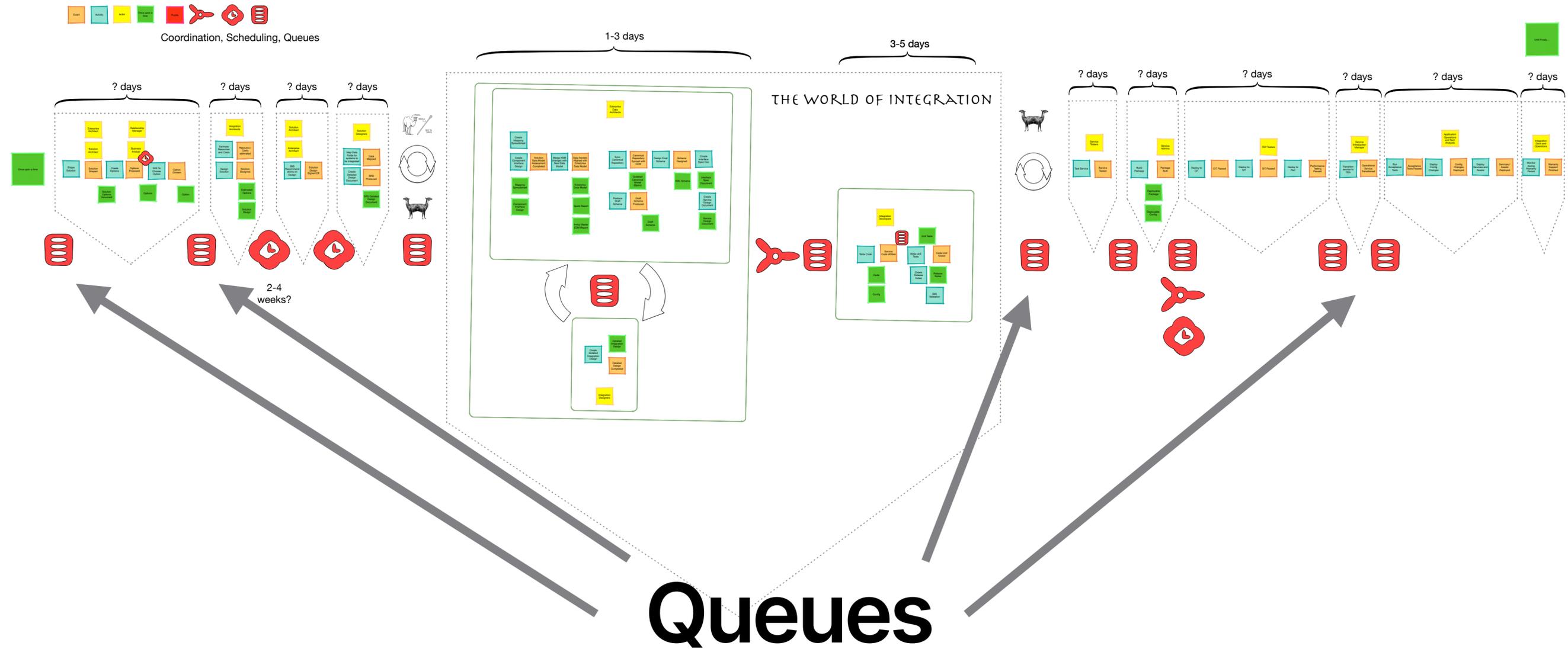


Back to flow

Value stream maps



Value stream maps



Corporate metabolism

As companies scale they add more processes and hierarchy

Therefore things slow down

...but we also deliberately block our corporate arteries.

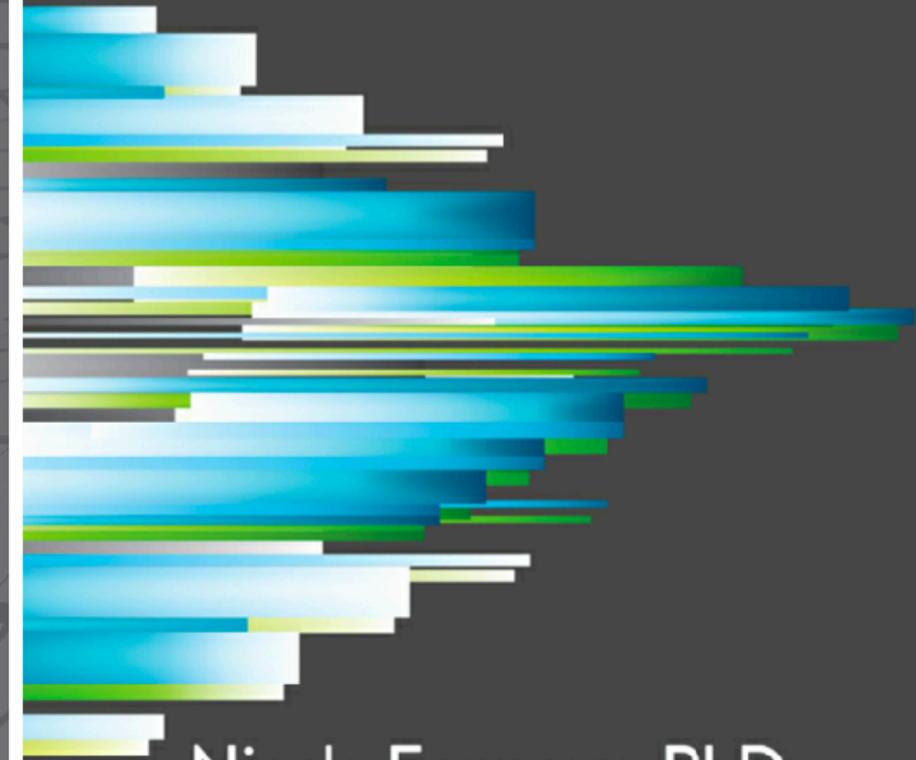


Sidebar : Identifying the signs of ageing

THE SCIENCE OF LEAN SOFTWARE AND DEVOPS

ACCELERATE

Building and Scaling High Performing
Technology Organizations



Nicole Forsgren, PhD
Jez Humble, *and* Gene Kim

*with forewords by Martin Fowler and Courtney Kissler
and a case study contributed by Steve Bell and Karen Whitley Bell*

Fun Fact:

Change Request Boards

Monitoring org. health

MTTR

Cycle time

**Change
failure rate**

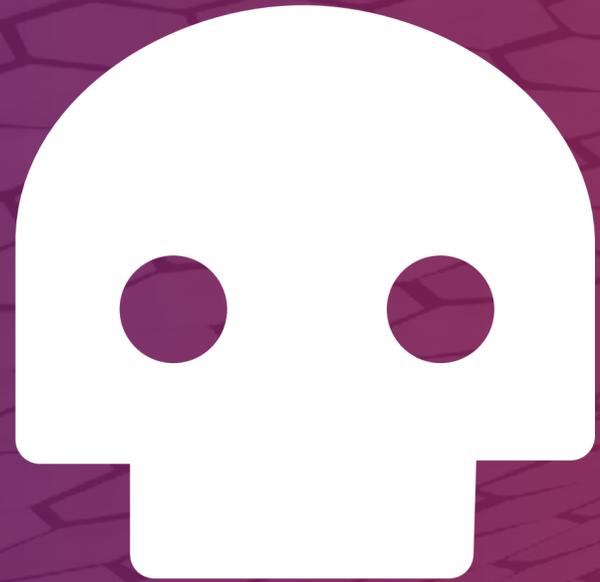
**Number
of deploys**

Identifying the signs of ageing

4 key metrics are leading indicators org. health

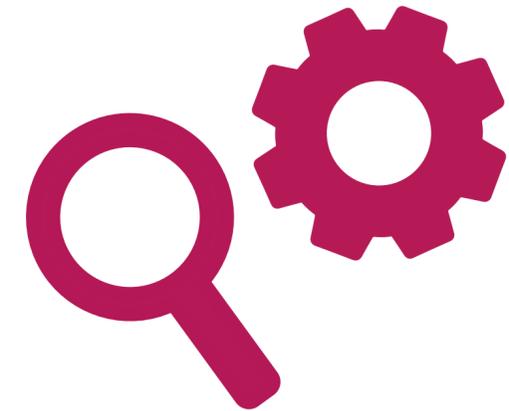
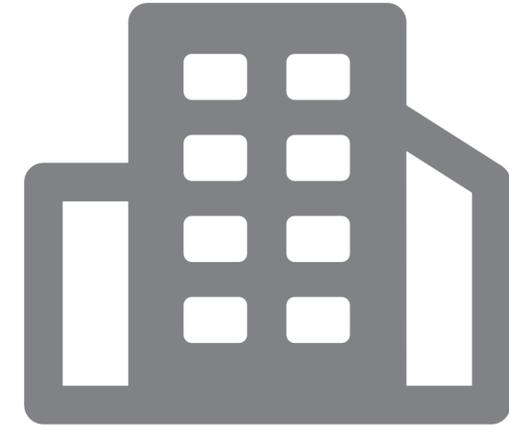
Like monitoring heart rate & blood pressure

Improvement limited by hierarchy and scaling laws

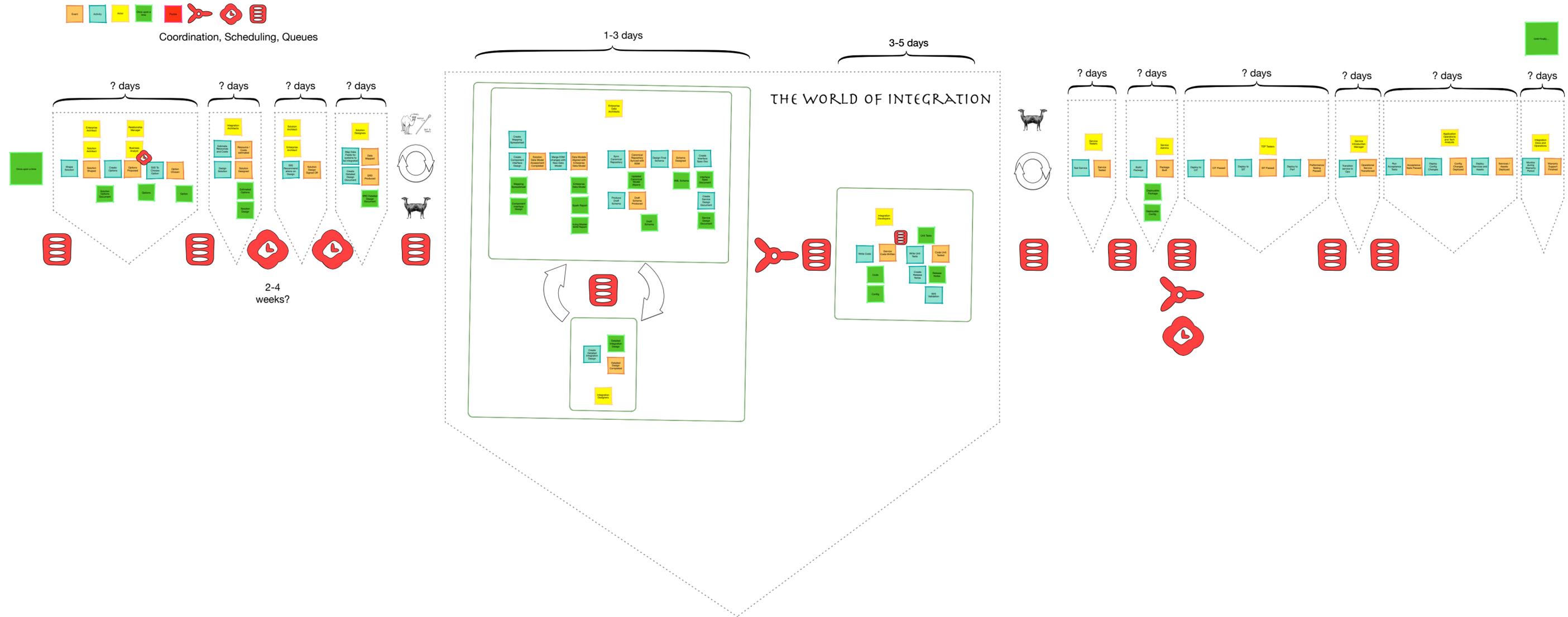


Organisational mortality

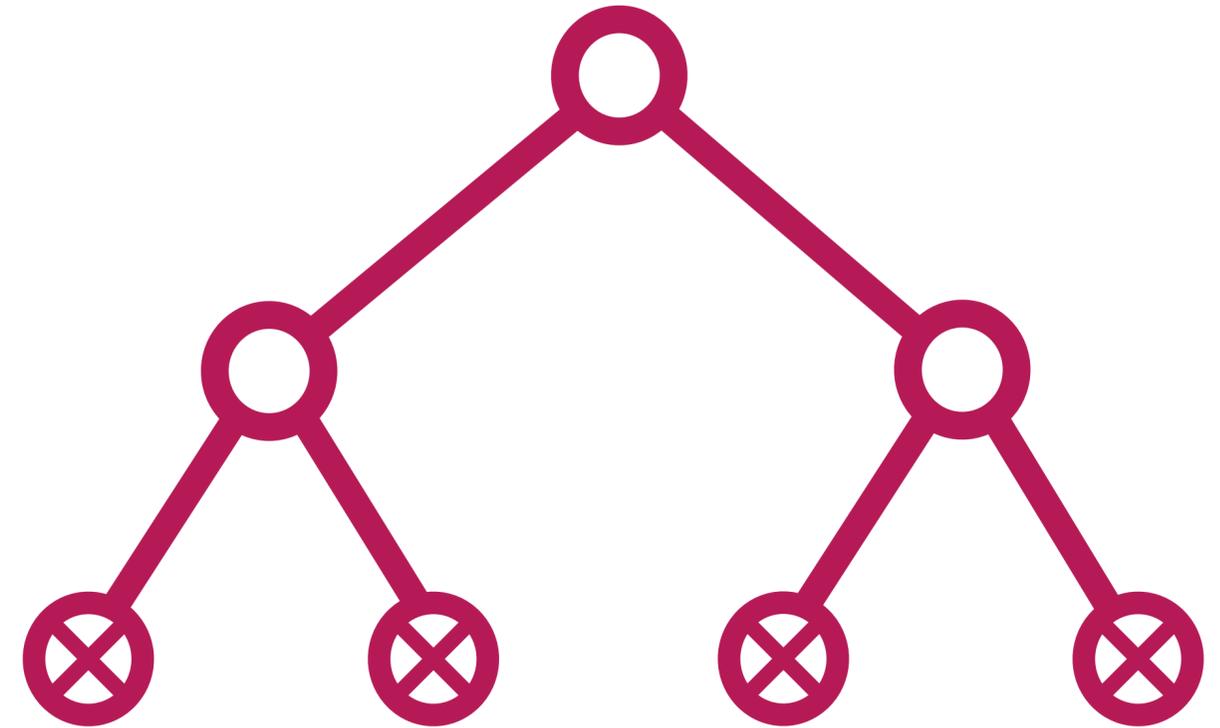
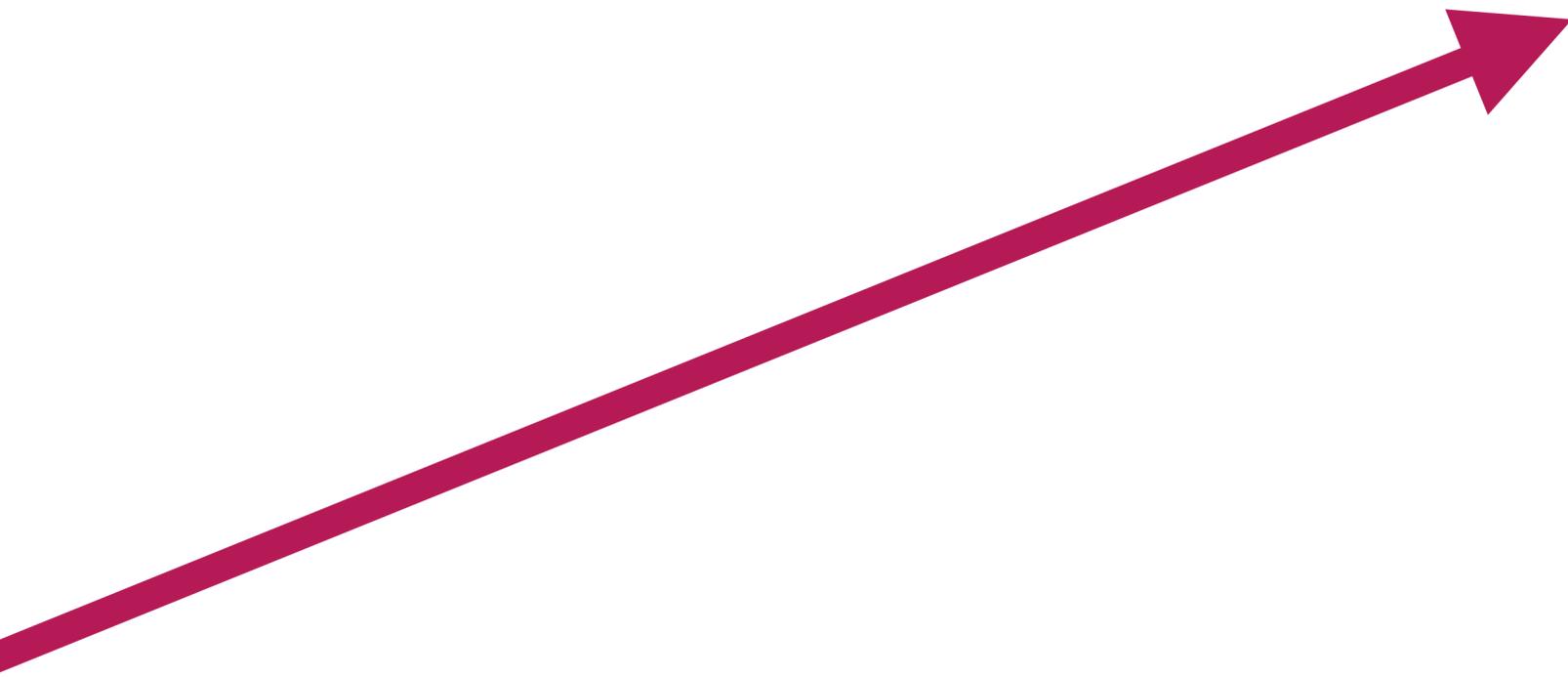
**Larger organisations
spend less of their
revenue on R&D.**



+ more and more process & constraints



Hierarchies grow and grow...



Hierarchical organisations:

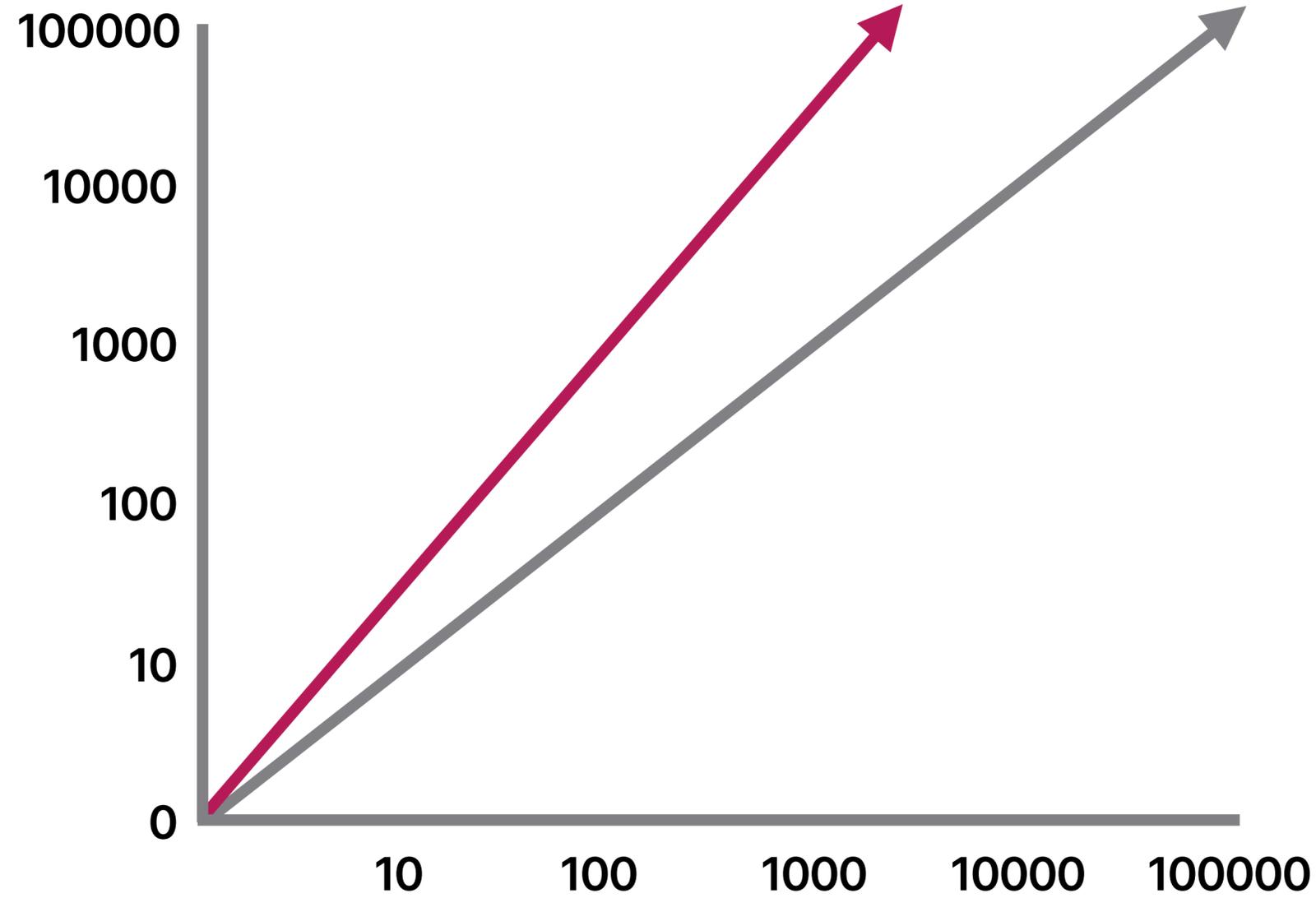
**Gain economies of scale
for infrastructure (~0.85)**

**Achieve sub-linear
growth in revenue (~0.85)**

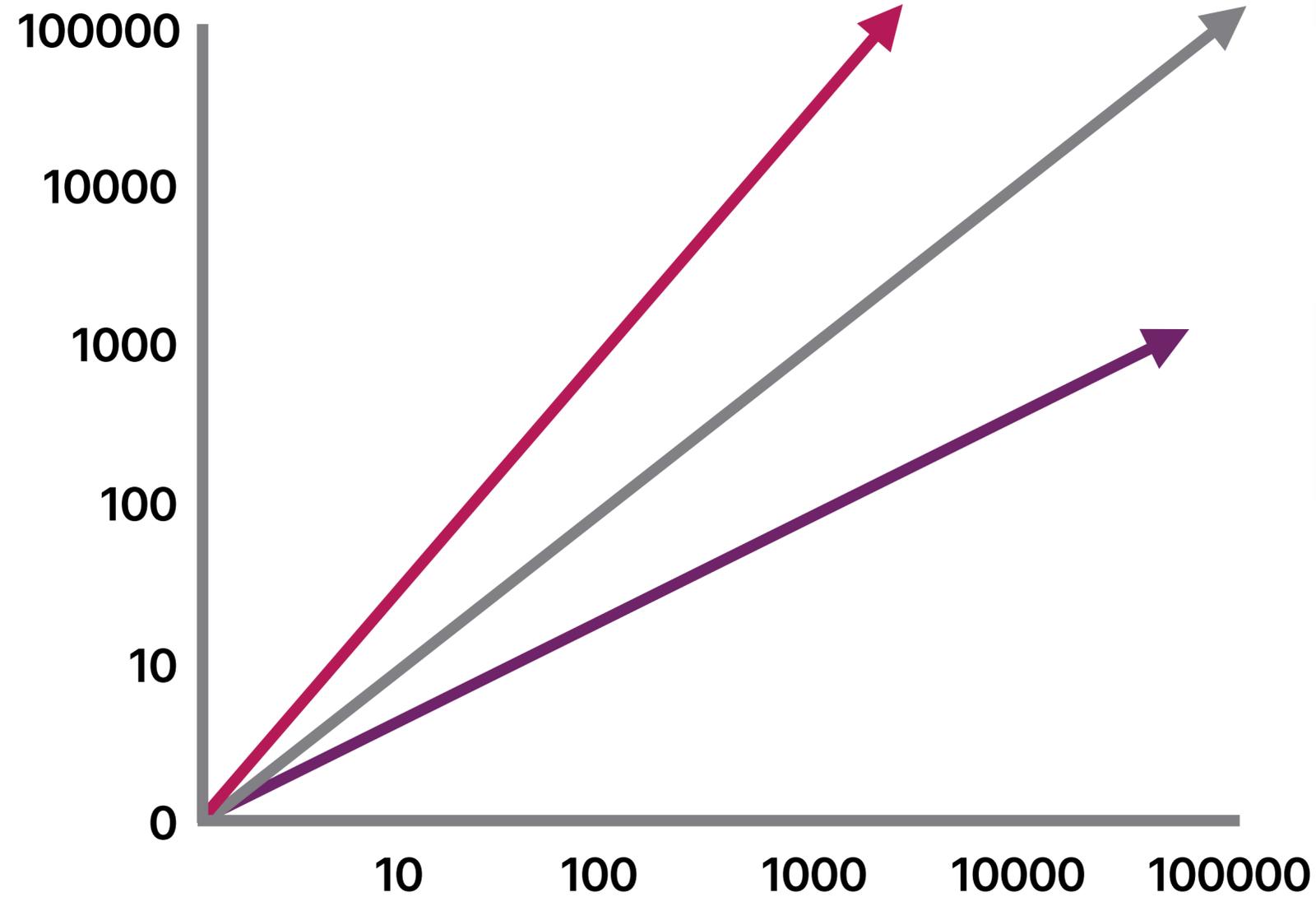
**reduce their metabolic rate... and
eventually die.**



Scaling Complex Adaptive Systems

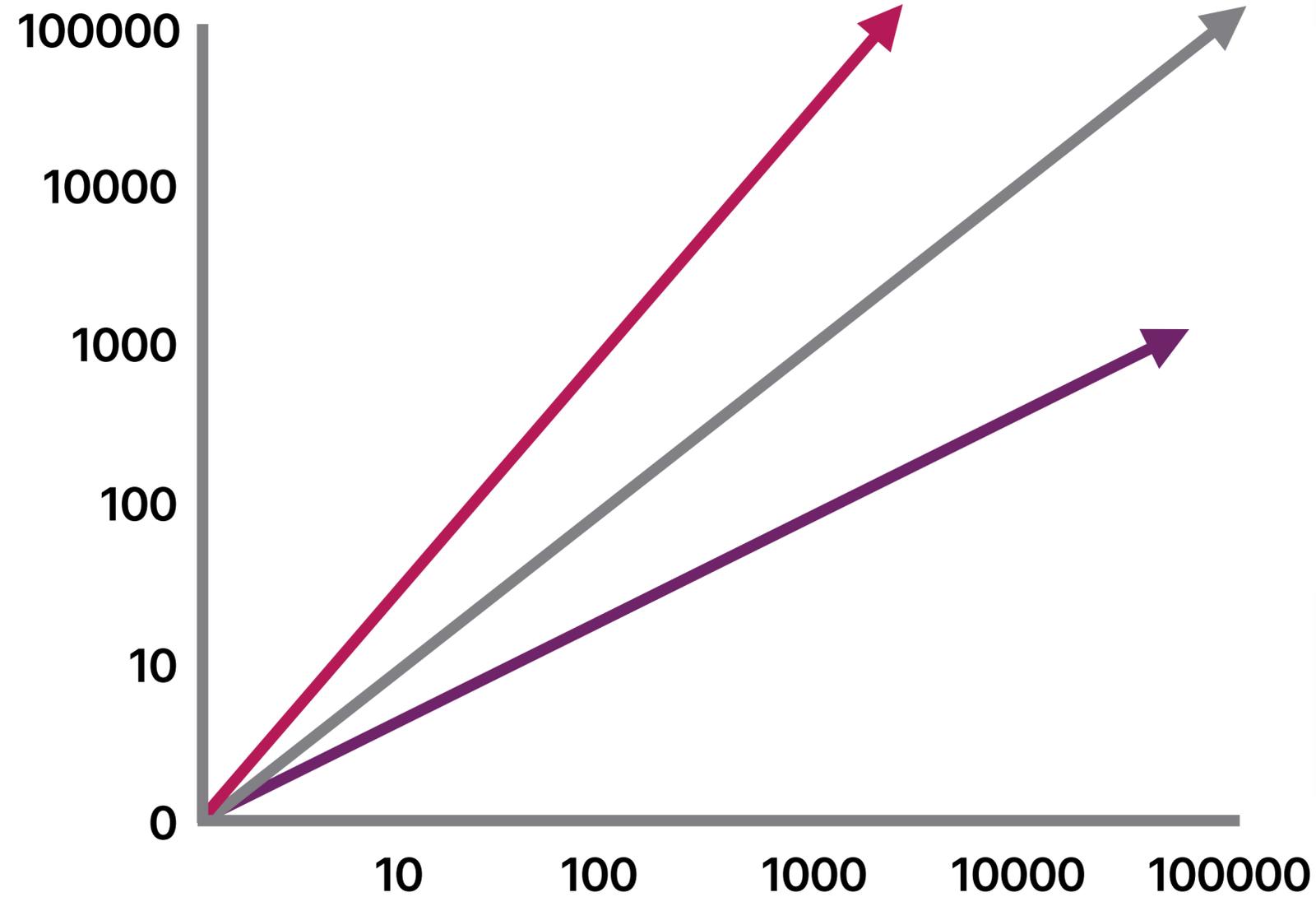


Super-linear scaling:
As x doubles, y increases
by more than double



Innovation, wages,
professionals, crime,
disease, pollution **(1.15)**

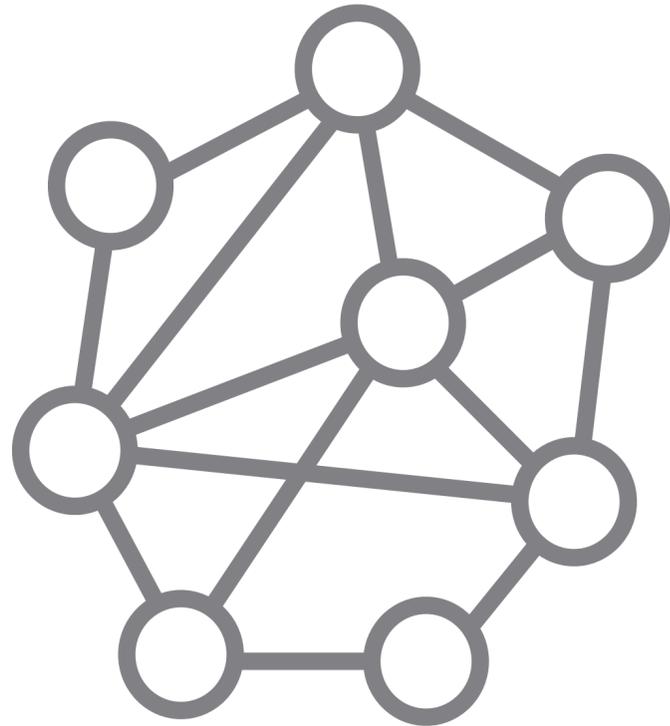
Road length, # petrol stations
& restaurants, water pipes,
electricity cables **(0.85)**



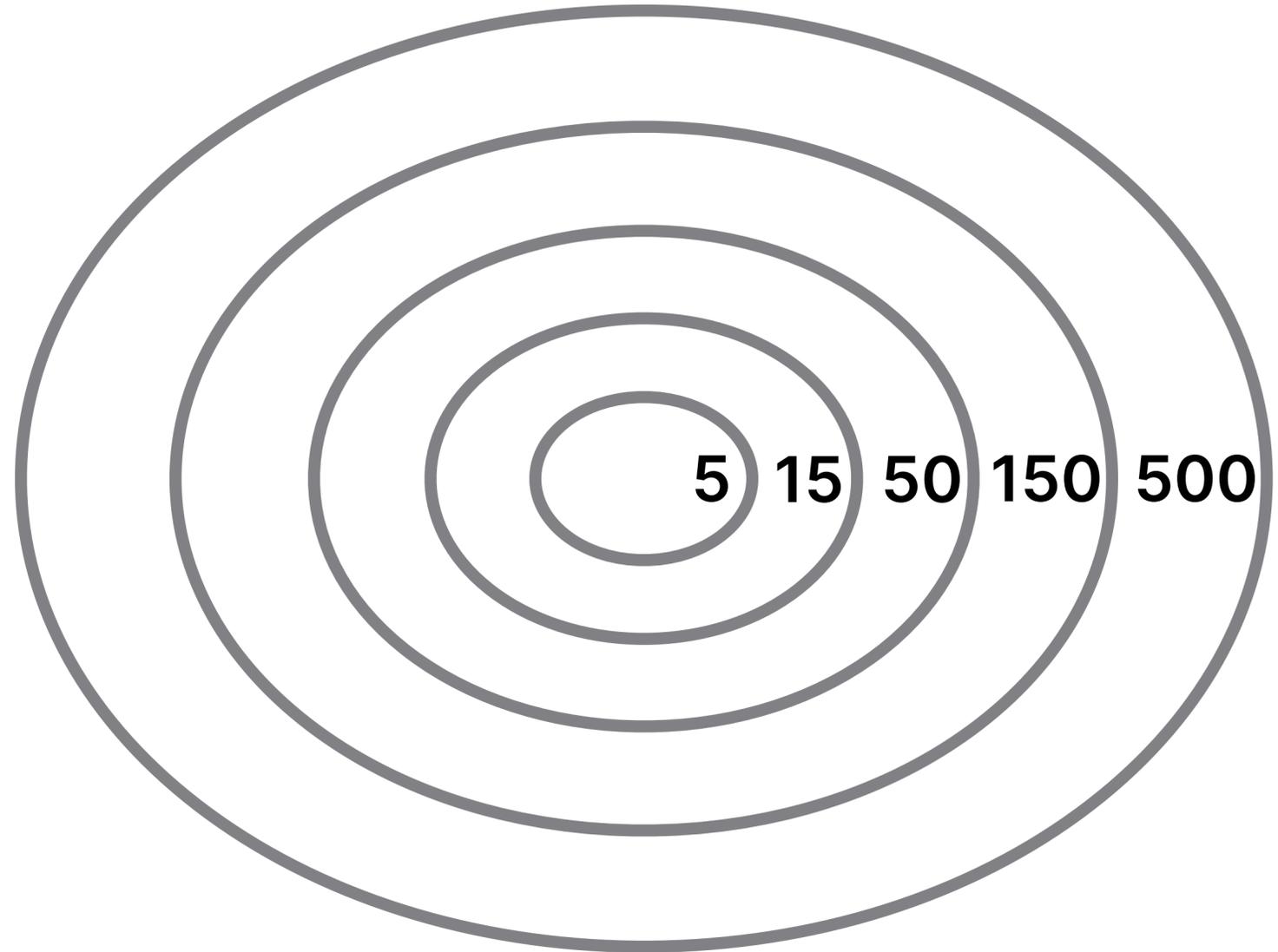
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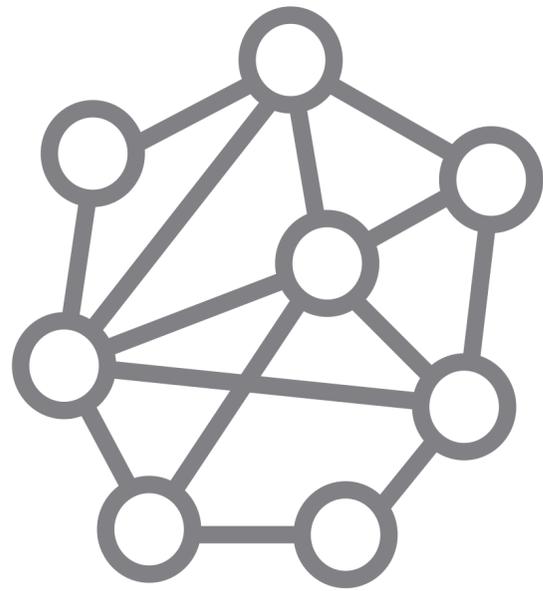
Walking speed **(1.10)**

Road length, # petrol stations
& restaurants, water pipes,
electricity cables **(0.85)**

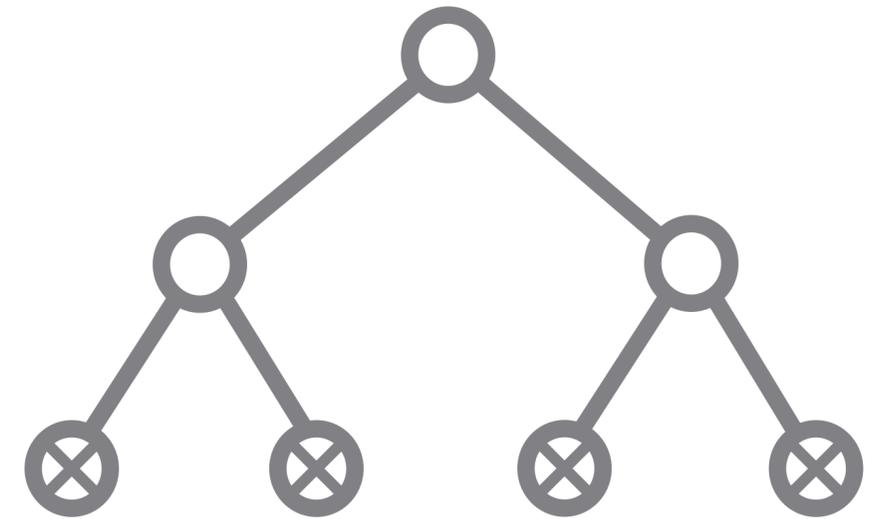
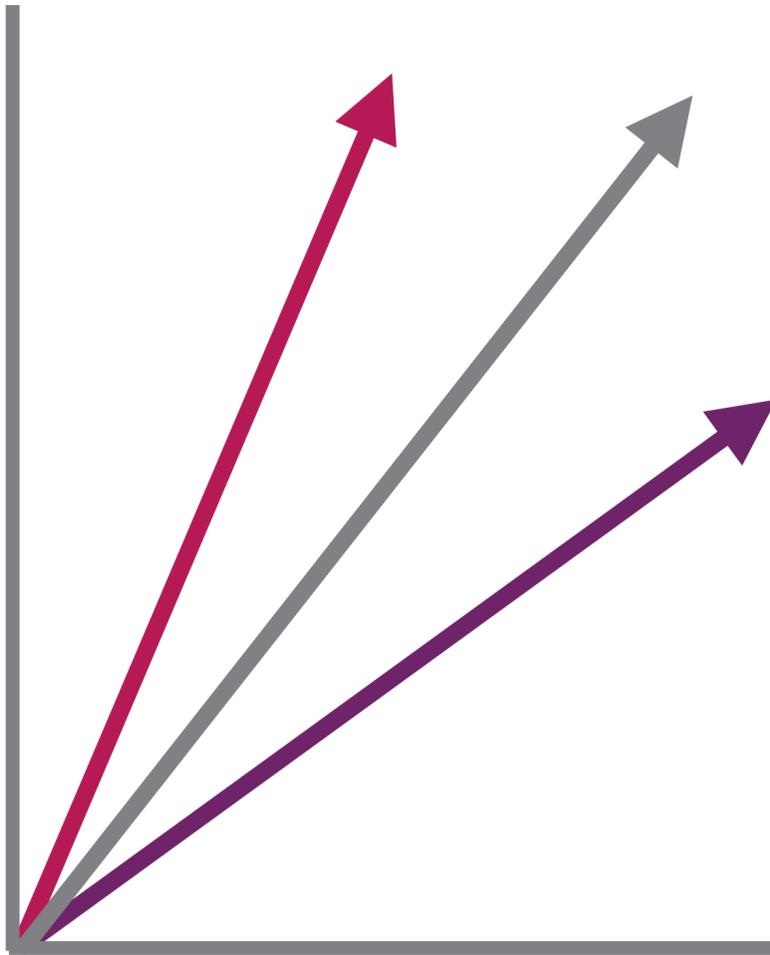


**Small world fractal space
filling network**

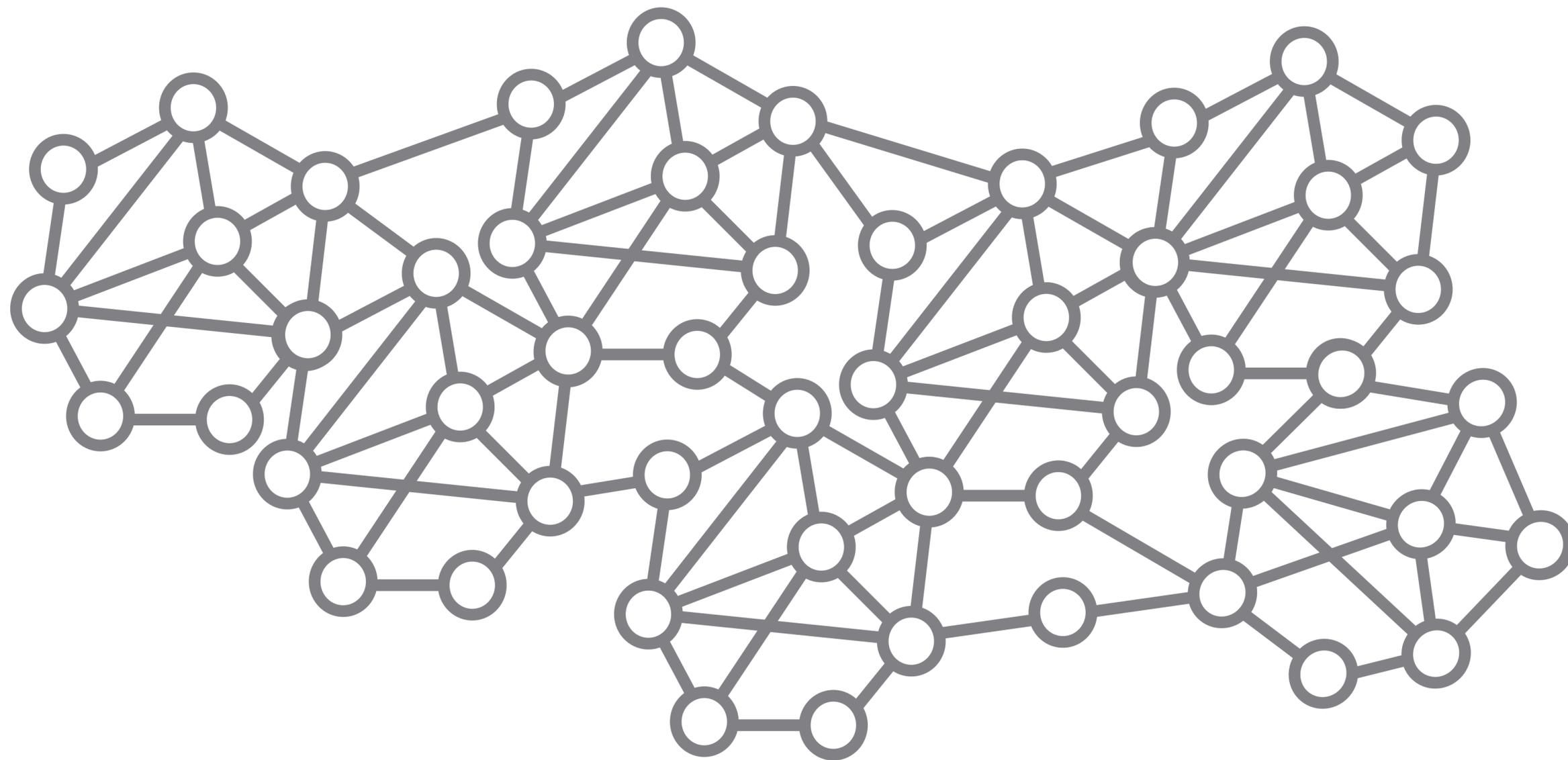




**Small world fractal
space filling network**



**Hierarchical fractal space
filling network**



As cities grow they

**Gain economies
of scale for
infrastructure**

**Gain returns to
scale for socio-
economic factors**

Rarely die

**Get 115% more
stuff for 85% of
the cost!**

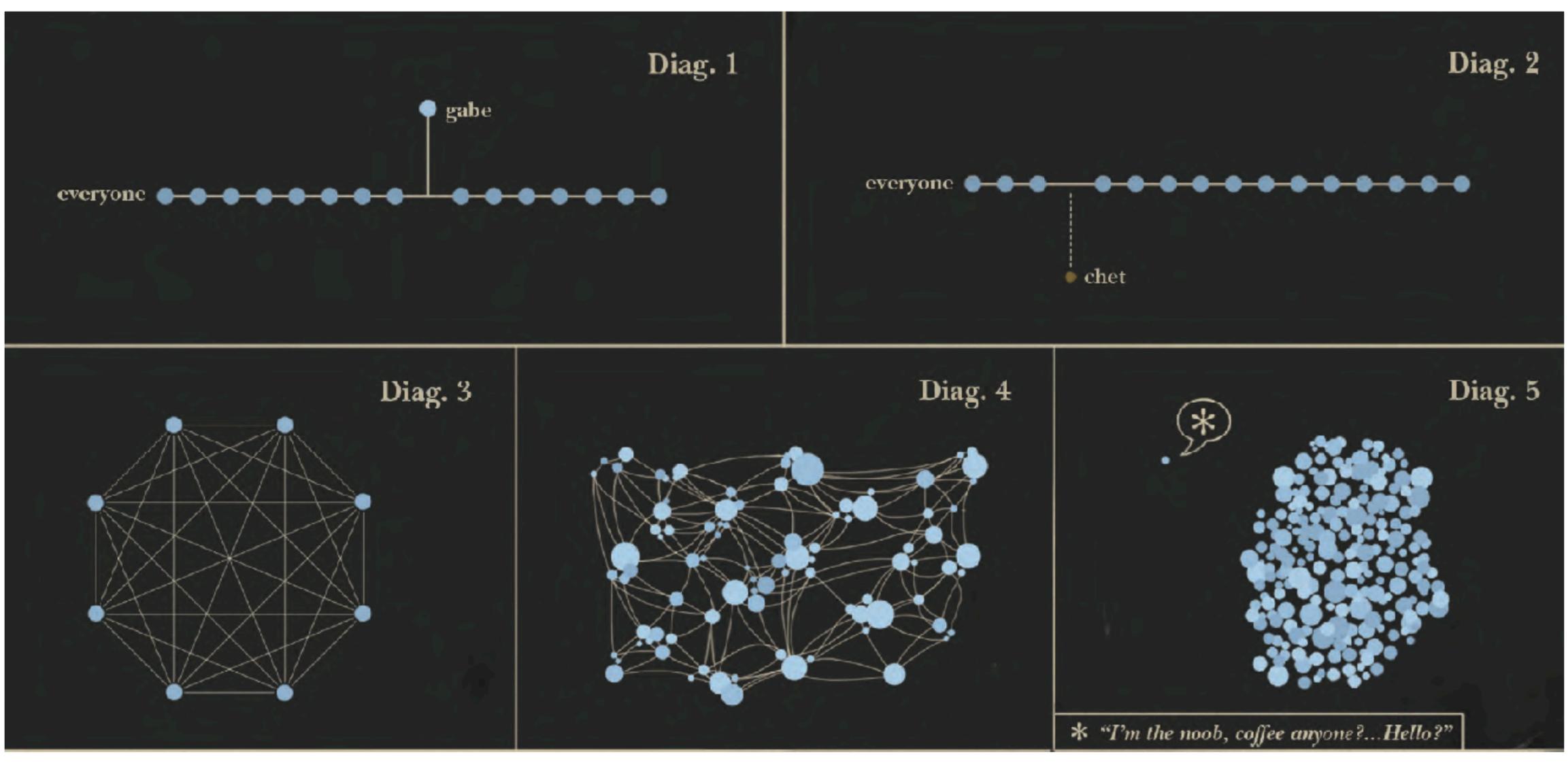


/thoughtworks

The background features a gradient from dark purple on the left to bright red on the right. Overlaid on this is a pattern of interconnected, irregular lines that resemble a cellular or honeycomb structure. The lines are a darker shade of the background colors, creating a textured, three-dimensional effect.

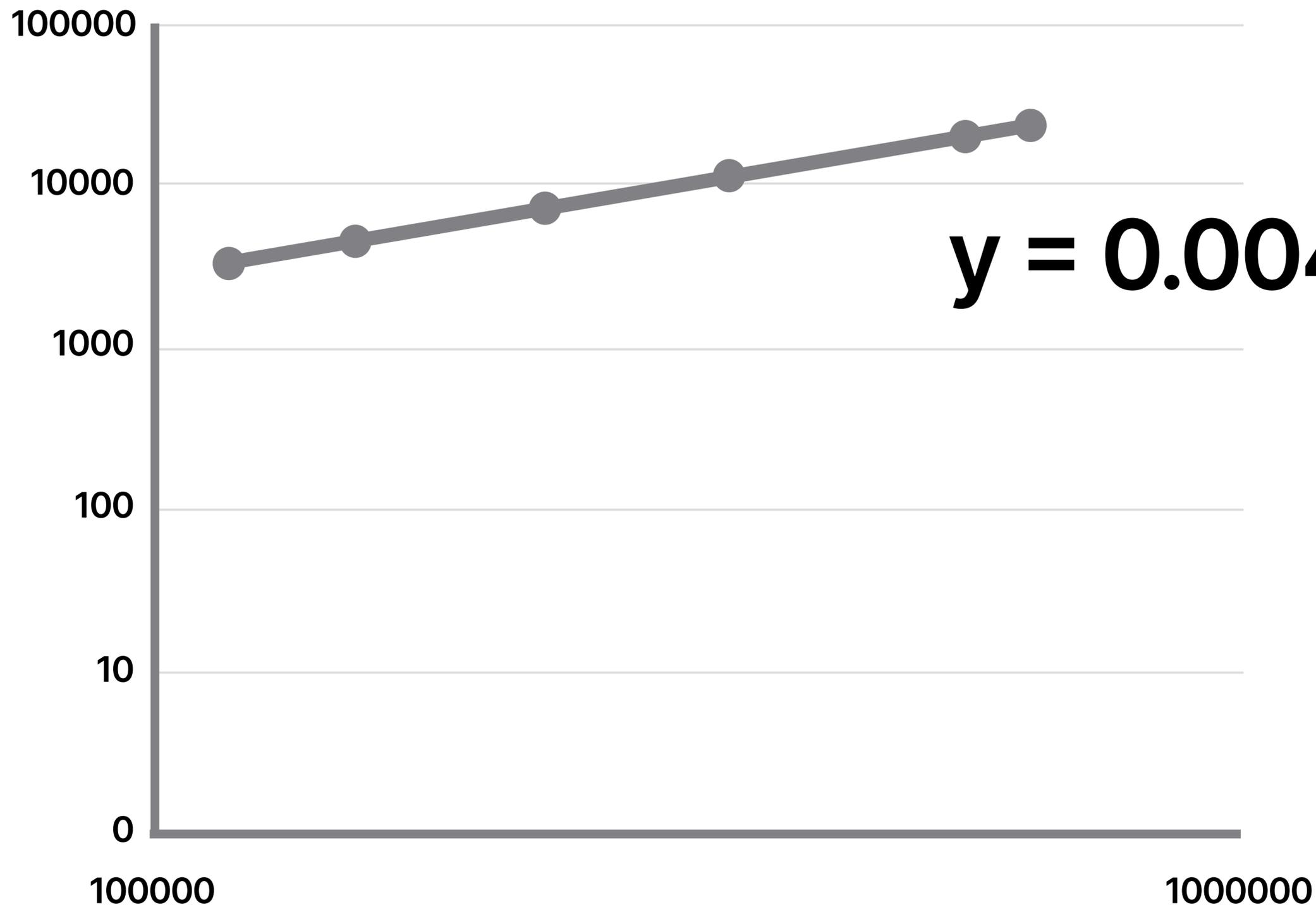
VALVE

VALVE



amazon

The image features the word "amazon" in a white, lowercase, sans-serif font. A white arrow is positioned below the text, starting under the letter 'a' and ending under the letter 'n', pointing to the right. The background is a gradient of red and purple, overlaid with a pattern of dark red, irregular, cell-like shapes that resemble a honeycomb or biological structure.



**Teams must
communicate
via interfaces**



amazon

**Teams must
communicate
via interfaces**

**All interfaces must
be externalisable**

amazon

**Teams must
communicate
via interfaces**



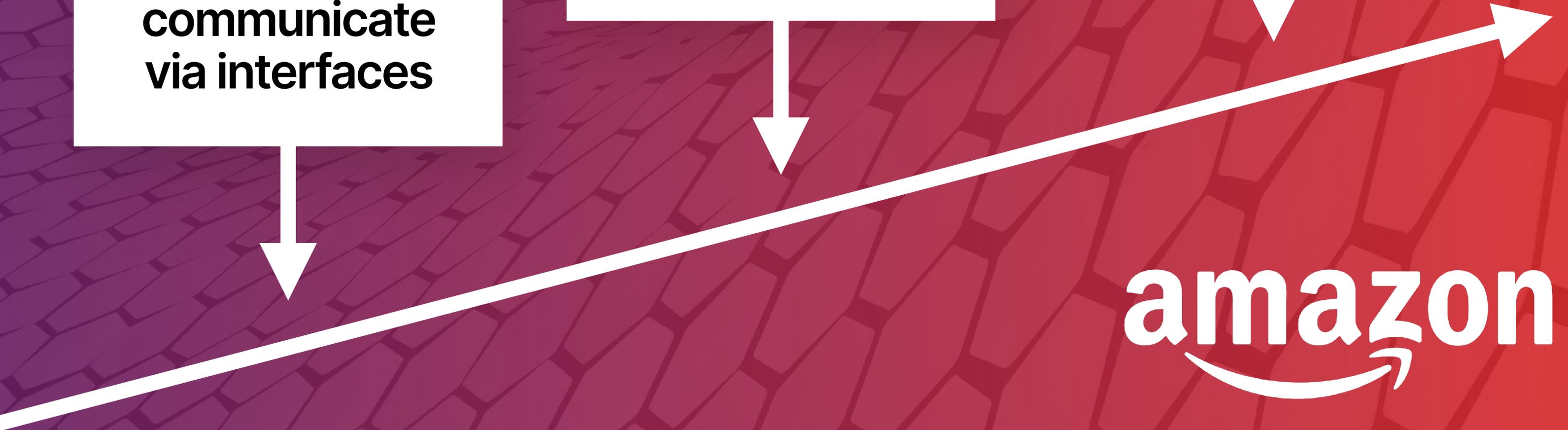
**All interfaces must
be externalisable**



**2 pizza
(Dunbars #)
teams**



amazon

The Amazon logo arrow, a white curved line with a small arrowhead pointing to the right, positioned below the word 'amazon'.

**Forcing
functions for
*flow***

**Limiting interaction to
nearby teams**

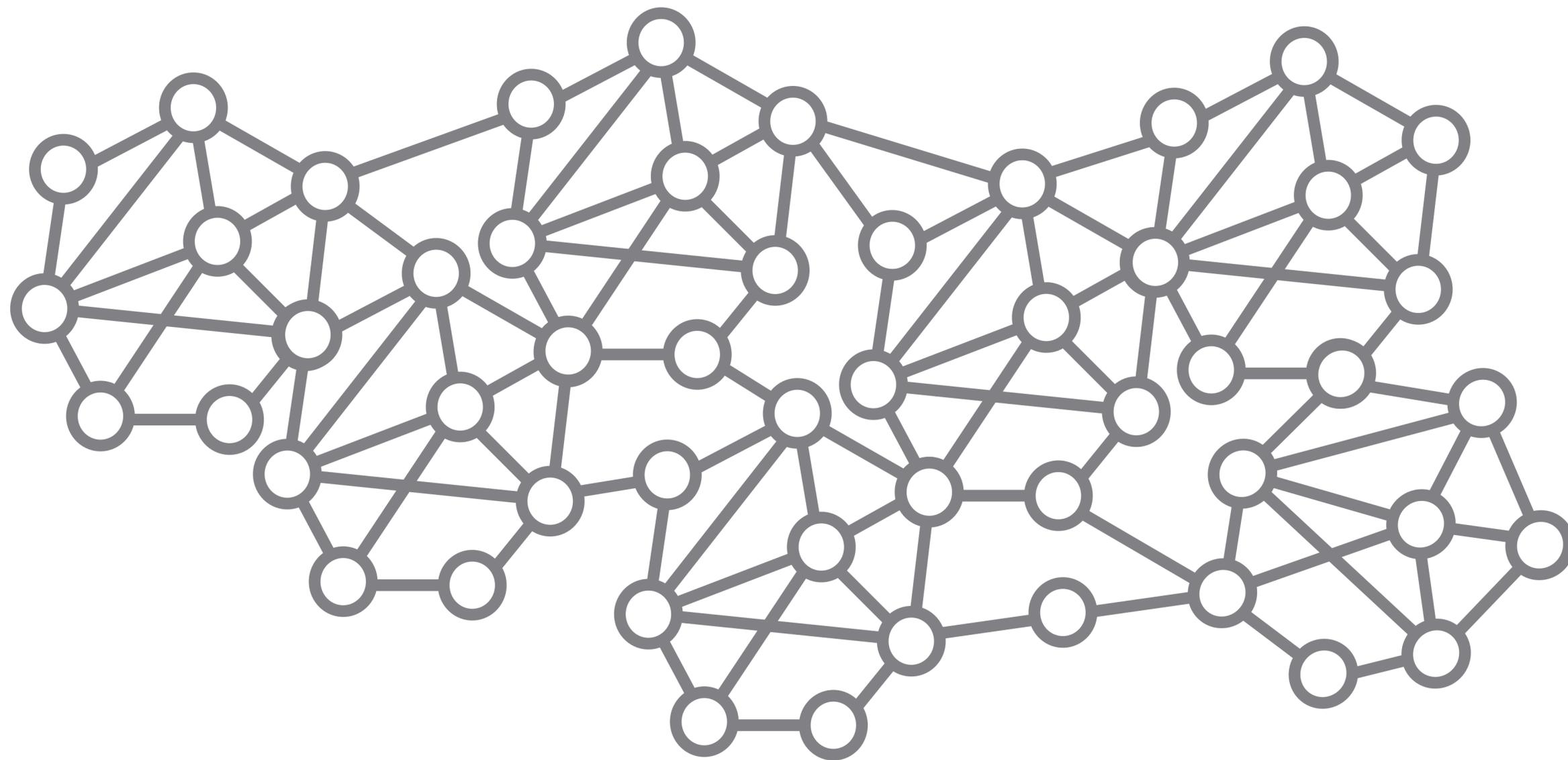
Team isolation

**Scale by Dunbar's
numbers**



**As most companies get bigger,
it gets harder to get bigger.**

**As Amazon gets bigger,
it gets easier to get bigger.**



The background features a gradient from dark purple on the left to bright red on the right. Overlaid on this is a pattern of interconnected, irregular lines that resemble a cellular or honeycomb structure, with the lines being a slightly darker shade of the background colors.

Software Architecture, Team Topologies and Complexity Science

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**Decentralised data
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**Products not
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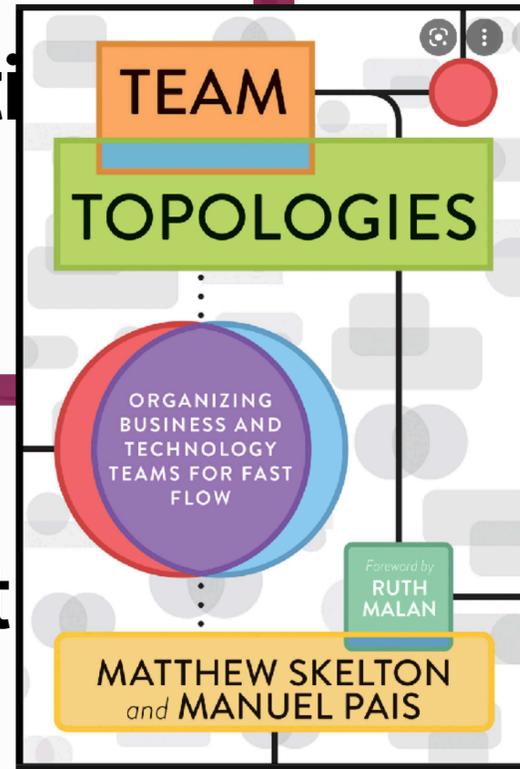
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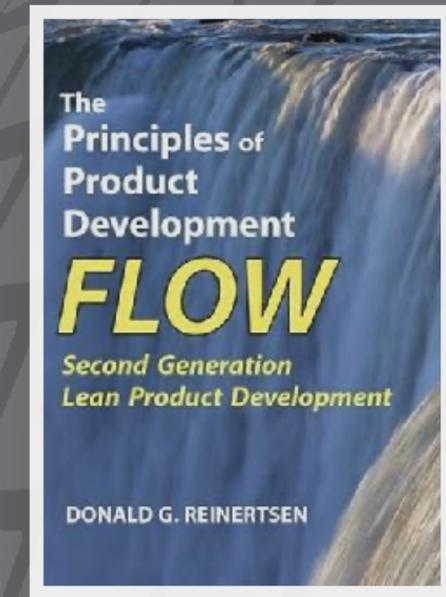
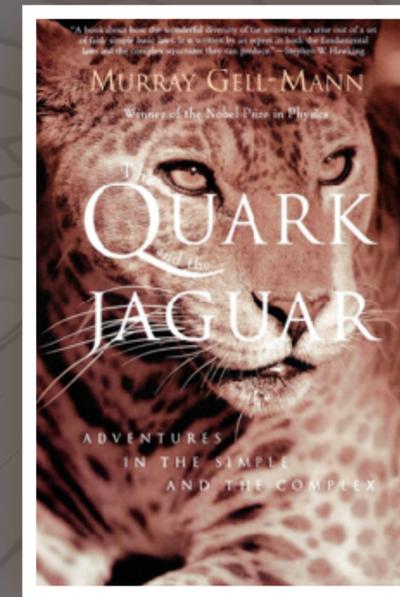
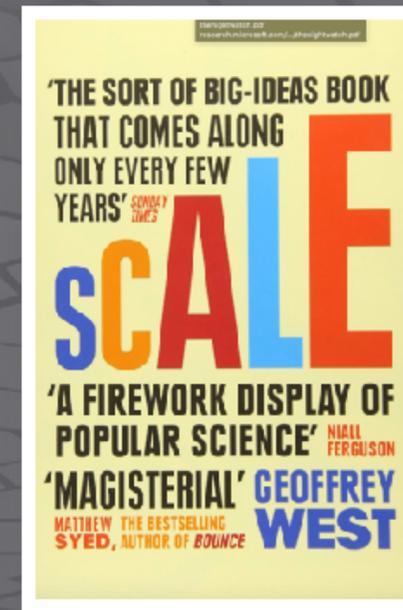
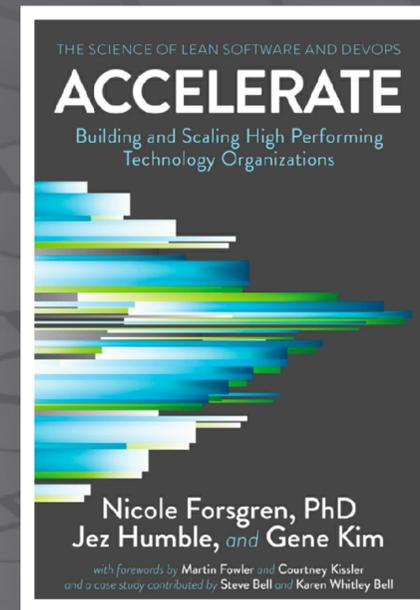
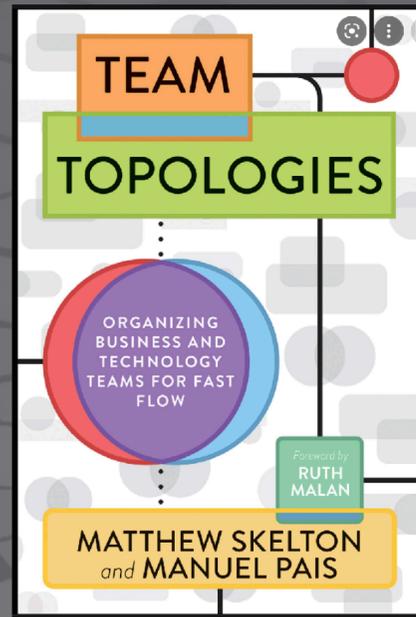


Social network effects imply super-exponential growth

Hierarchies slow metabolic rate

Team shapes for Flow

Forcing functions for Flow



A General Model for the Origin of Allometric Scaling Laws in Biology
Geoffrey B. West, James H. Brown, Brian J. Enquist

Bettencourt, Luís M. A. 2013, The Origins of Scaling in Cities. Science 340: 1438-1441.

<https://protobi.com/post/revenue-per-employee-and-biologic-scaling-laws>

The origin of allometric scaling laws in biology from genomes to ecosystems:
towards a quantitative unifying theory of biological structure and organization

Geoffrey B. West, James H. Brown. Journal of Experimental Biology 2005 208: 1575-1592; doi: 10.1242/jeb.01589