

Testing for Emergence

Aaron L Bramson

Center for the Study of Complex Systems
University of Michigan

aaronbramson@gmail.com
www.complexityblog.com

Making Emergence Safe for Science

Aaron L Bramson

Center for the Study of Complex Systems
University of Michigan

aaronbramson@gmail.com
www.complexityblog.com

MARCA

WHAT IS IT GOOD FOR?

Aaron L Bramson

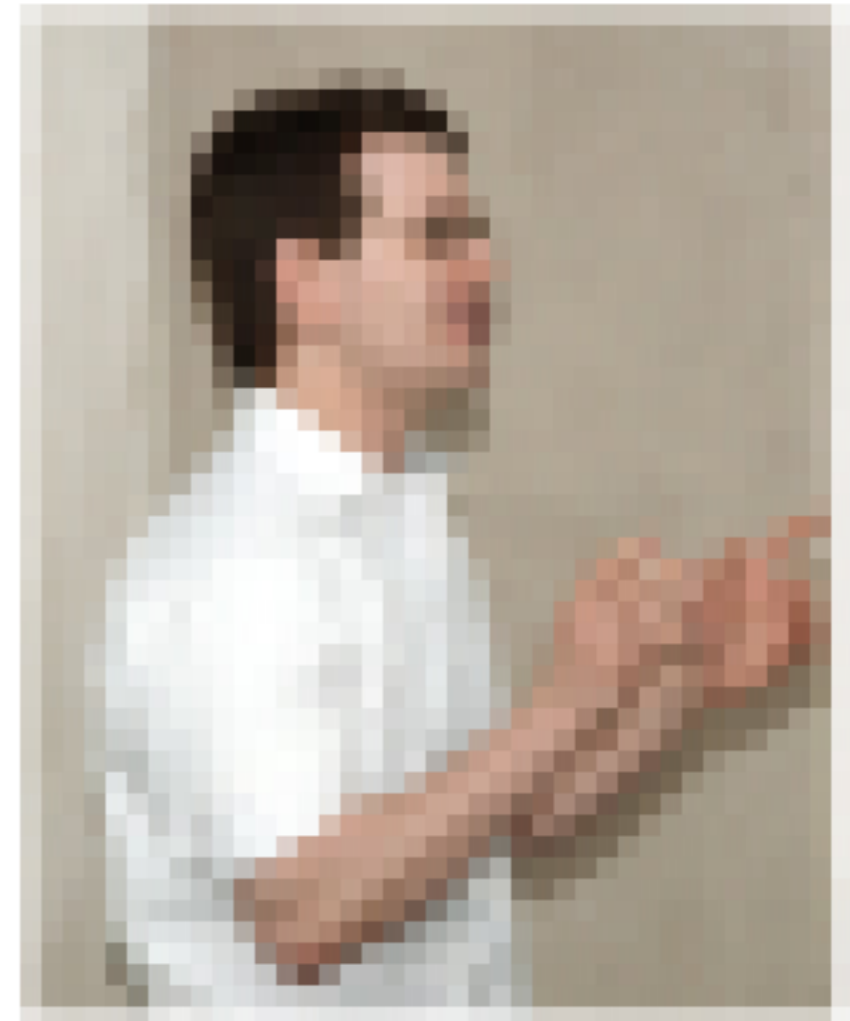
Mereology

The study of part-part and
part-whole relationships.



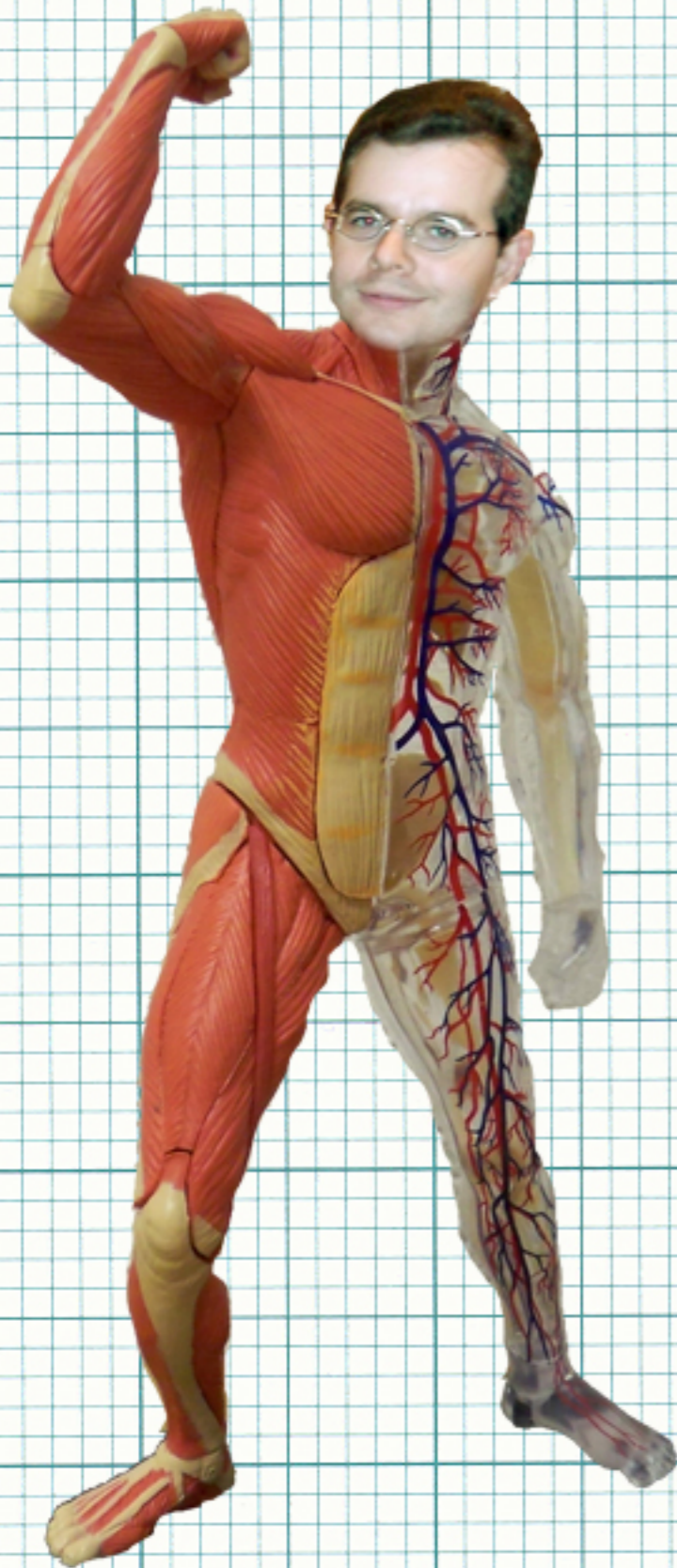
Lossy Compression

A description made from another description that **omits some details**.



Reduction

Take a whole system,
determine its parts,
and how those parts interact.





Constitution

Determine what parts
make up (constitute)
a whole.

Deep Thoughts

by
Jack Handey

Maybe in order to understand mankind,
we have to look at the word itself.

'Mankind'.

Basically, it's made up of two separate words

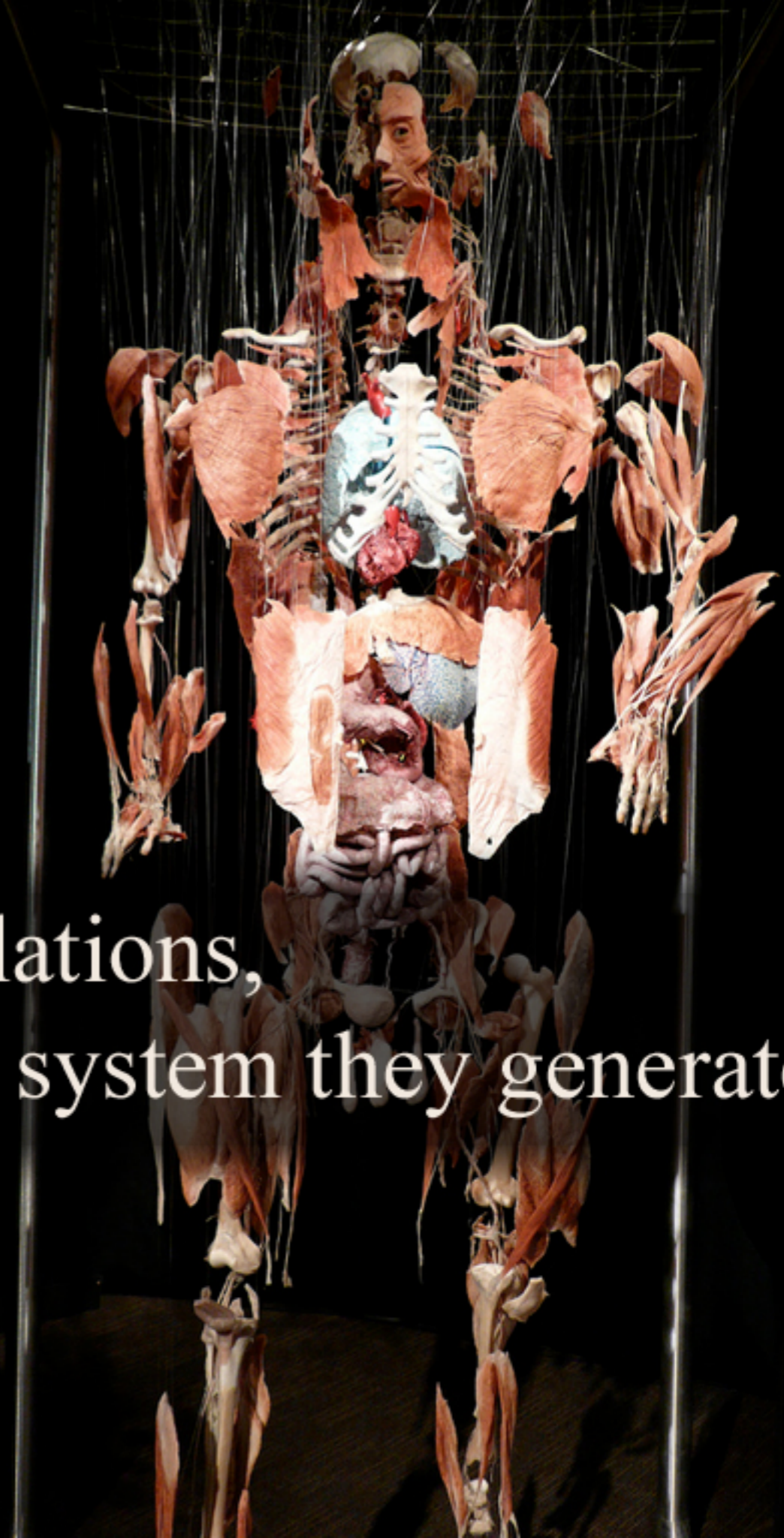
--- 'mank' and 'ind'.

What do these words mean?

It's a mystery, and that's why so is mankind.

Emergence

Take some parts and their relations,
and determine the whole system they generate.



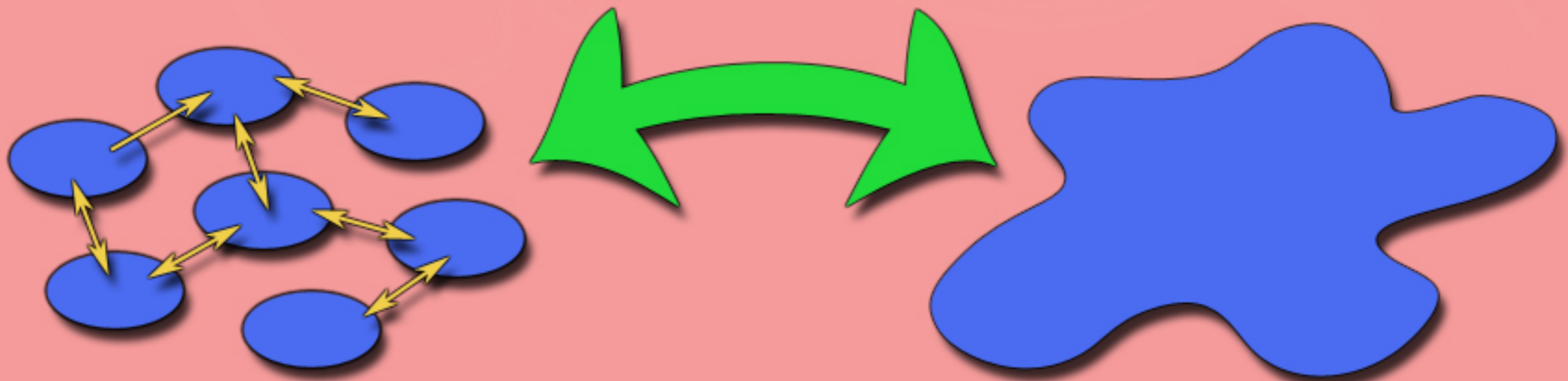
Bridge Laws

A translation of phenomena from one domain to another domain, or from one scale to another scale.

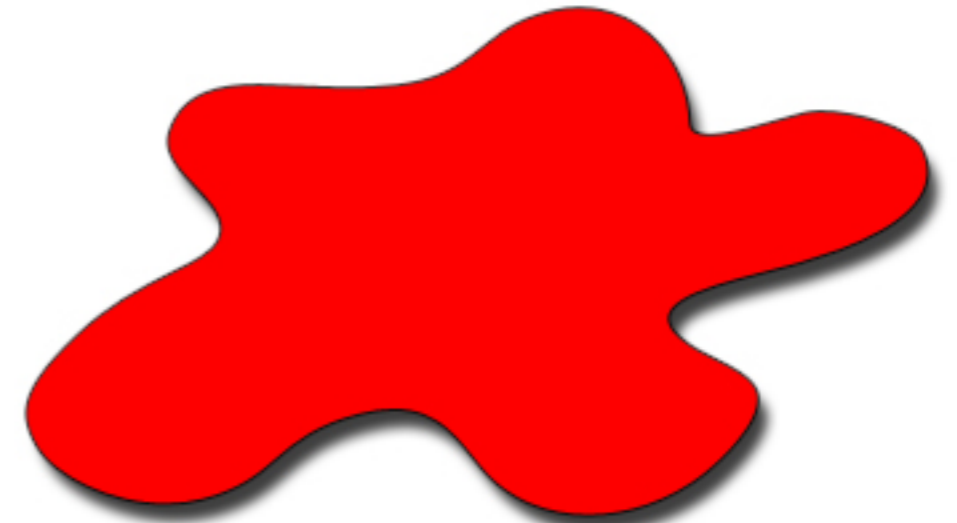


Reduction Emergence

Reduction and emergence are
mereologically inverse bridge laws.



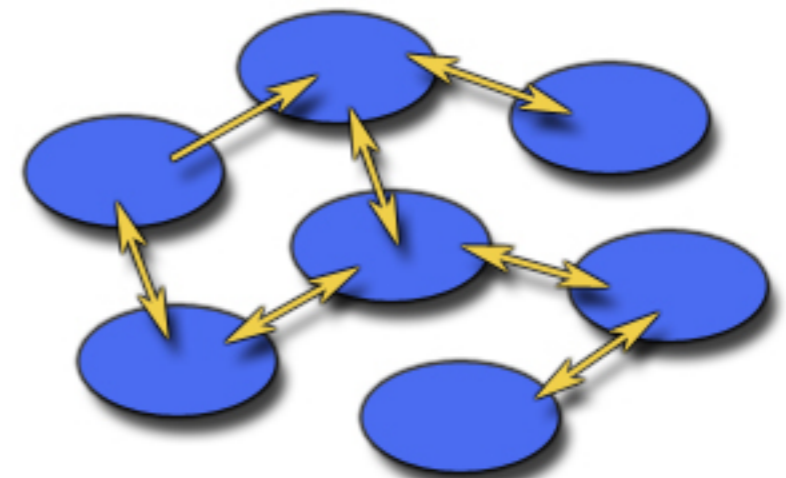
Supervenience



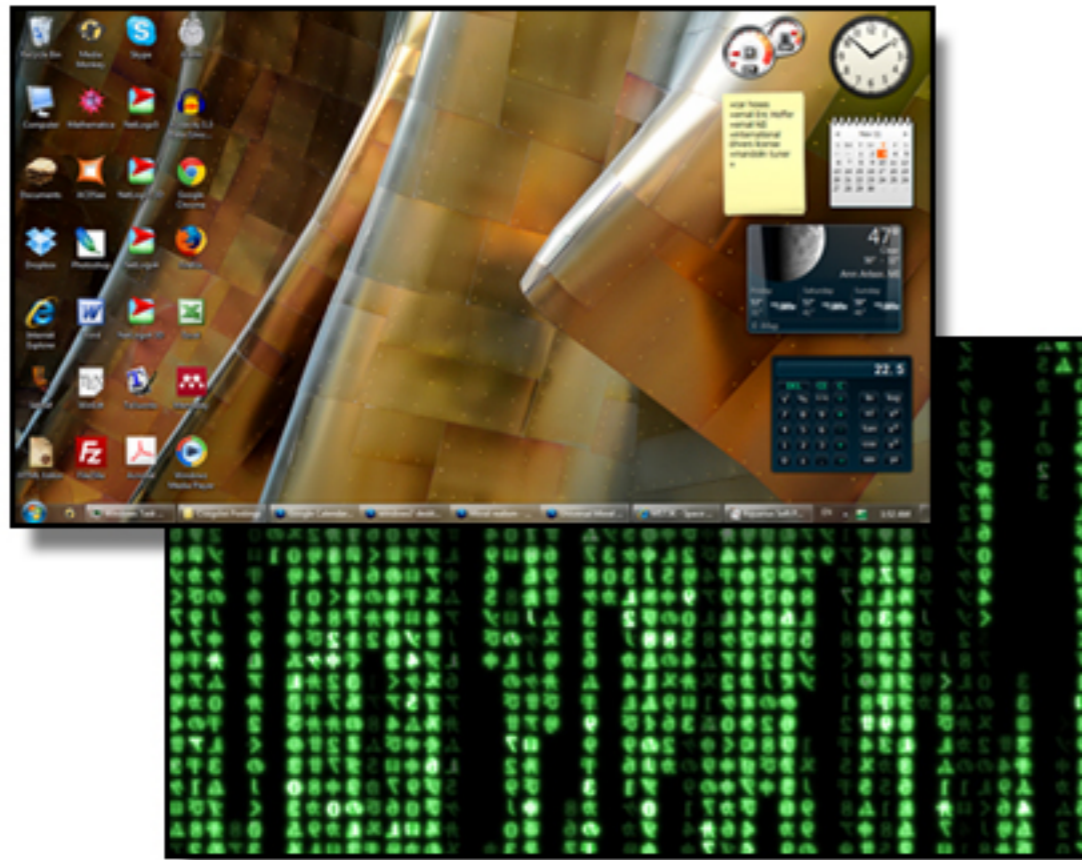
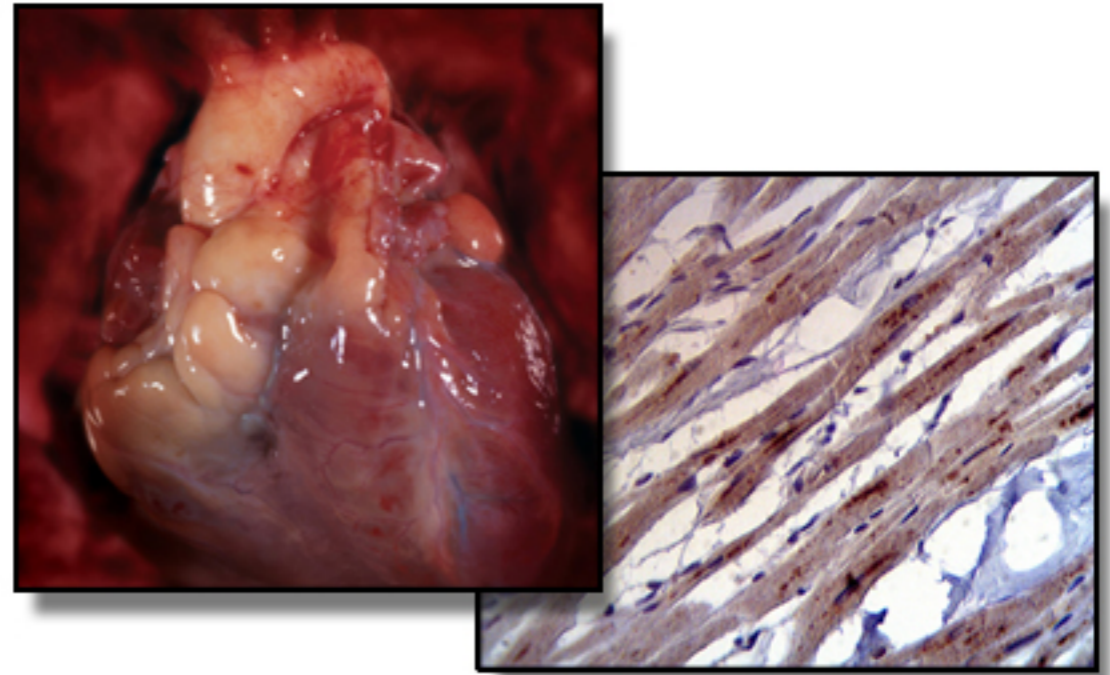
A** supervenes on **B

if and only if there can be

*no change in **A** without a change in **B**.*



Supervenience



Emergence Relation

*Phenomenon **A** emerges from phenomena **B***
if and only if

A** has properties impossible for **B
and either:

1) ***A** supervenes on **B***

or

2) ***B** constitutes **A***



What Phenomena Emerge?

Objects



Properties

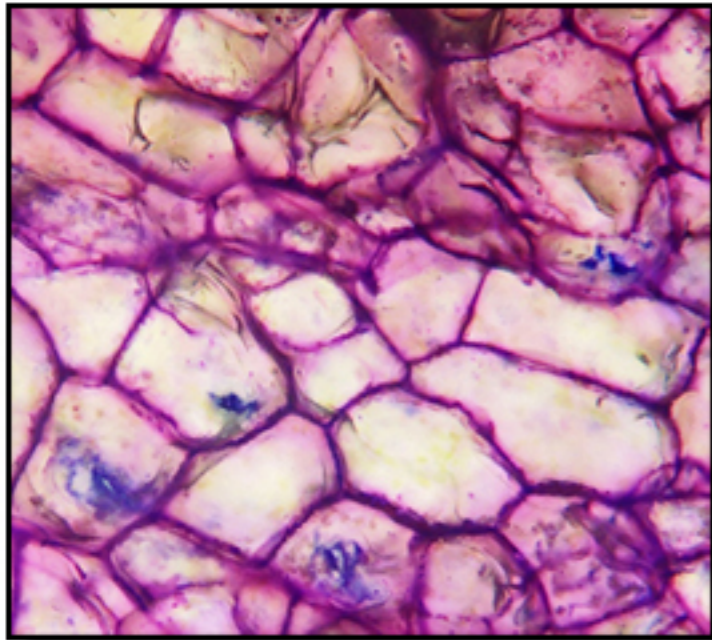


Behaviors

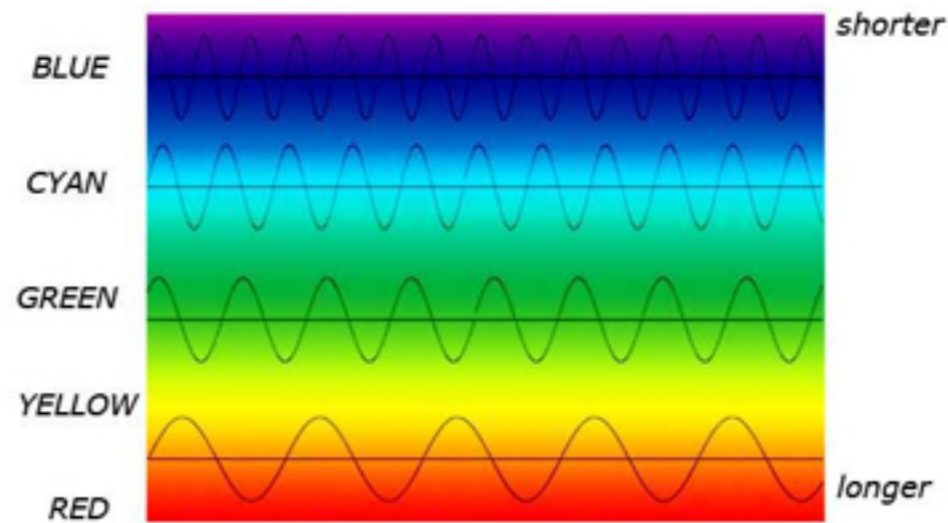


Emerges from What?

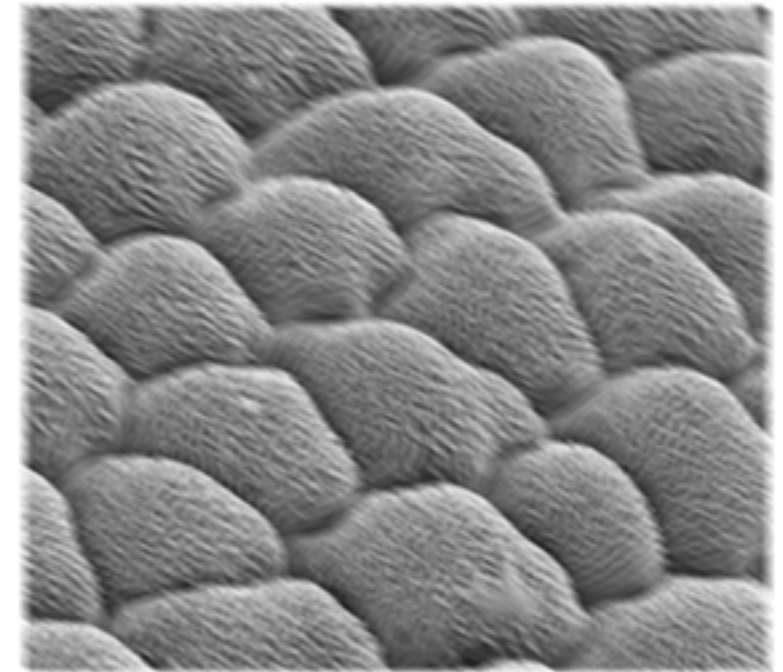
Objects



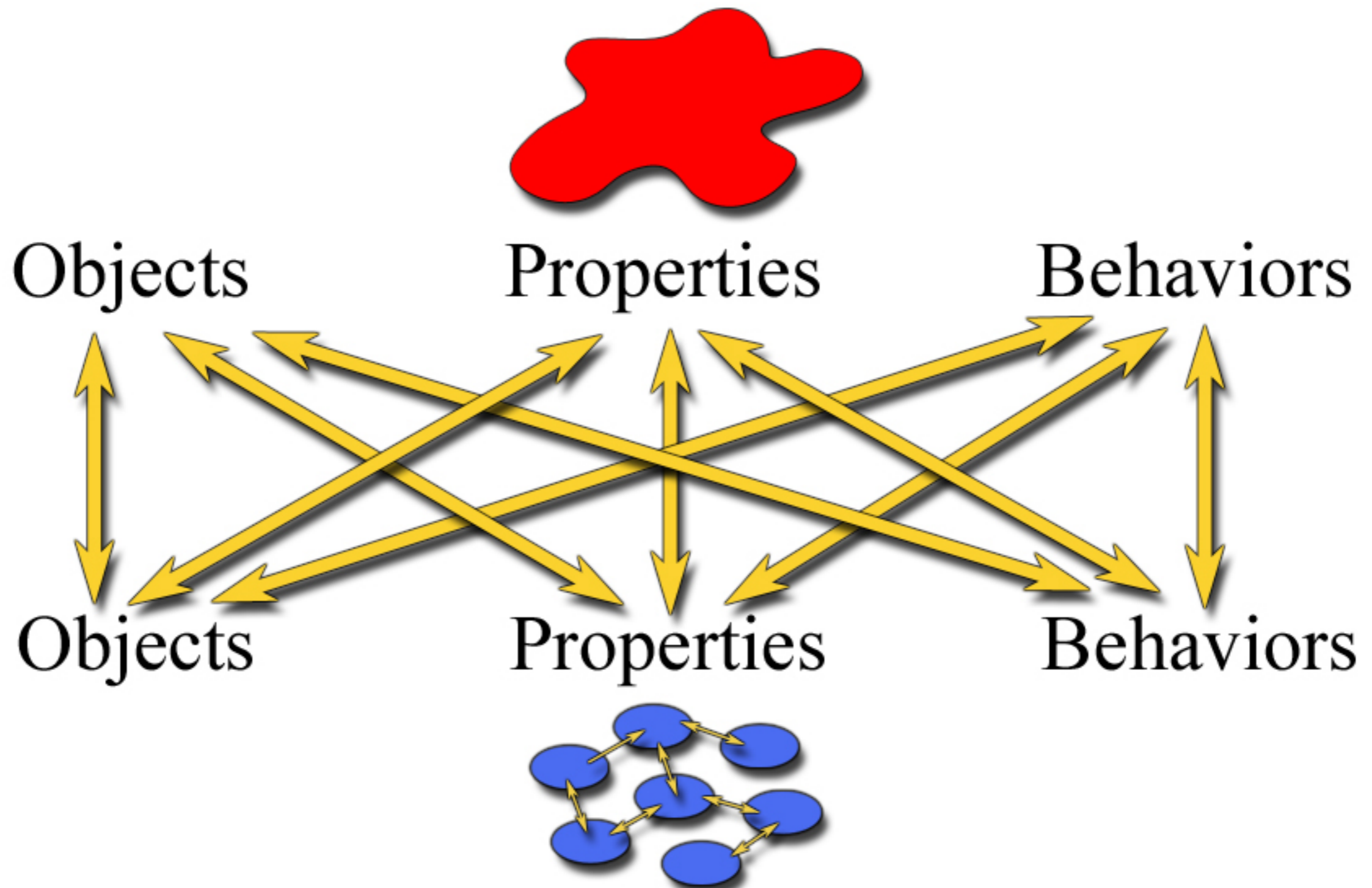
Properties



Behaviors



Cross-Level Translations





Object-Object Emergence



This Is About Models



Should we also require that

***A** is a lossy compression of **B**?*



Should we also

*restrict the domains of **A** and **B**?*

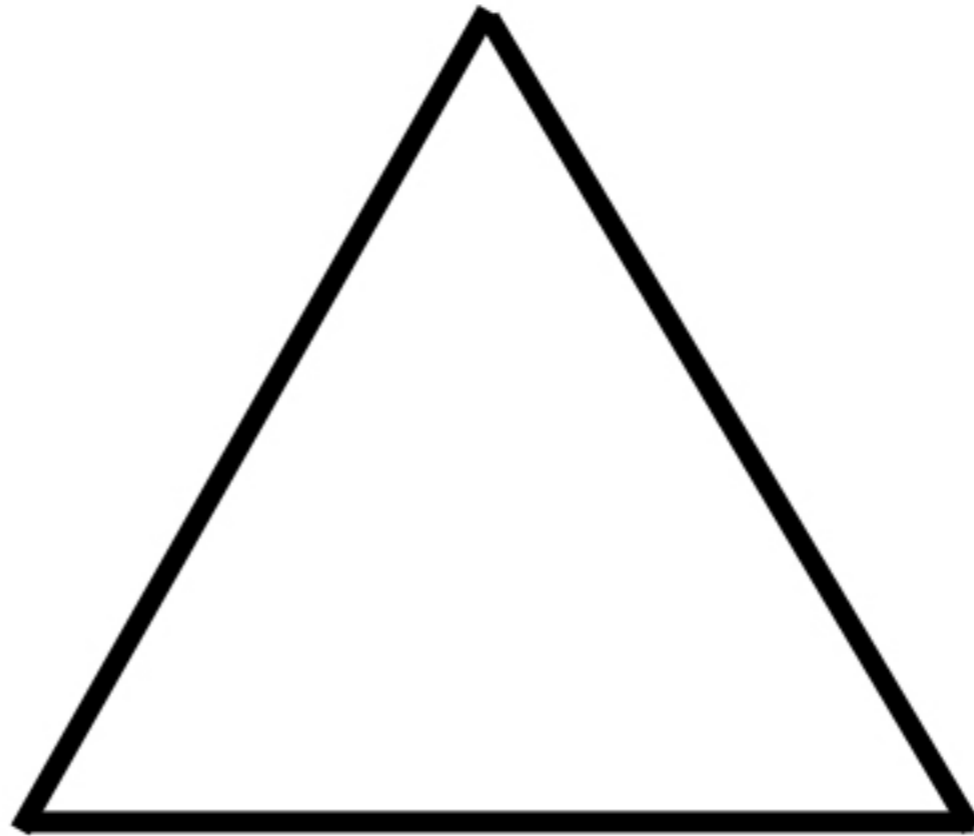


Should we also require

***A** or **B** to be in a specific category?*

Emergence in Math?

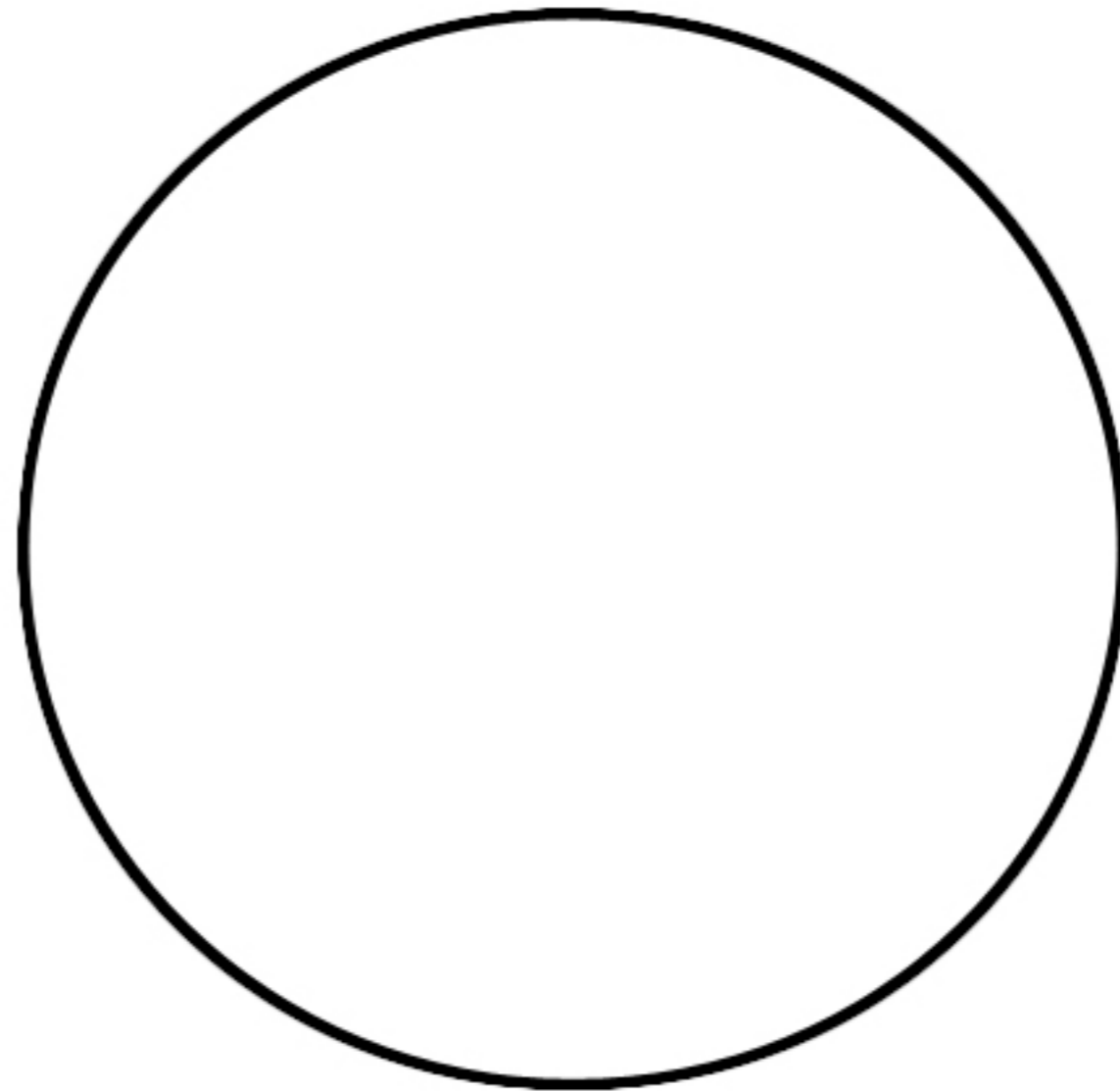
Emergence in Math?



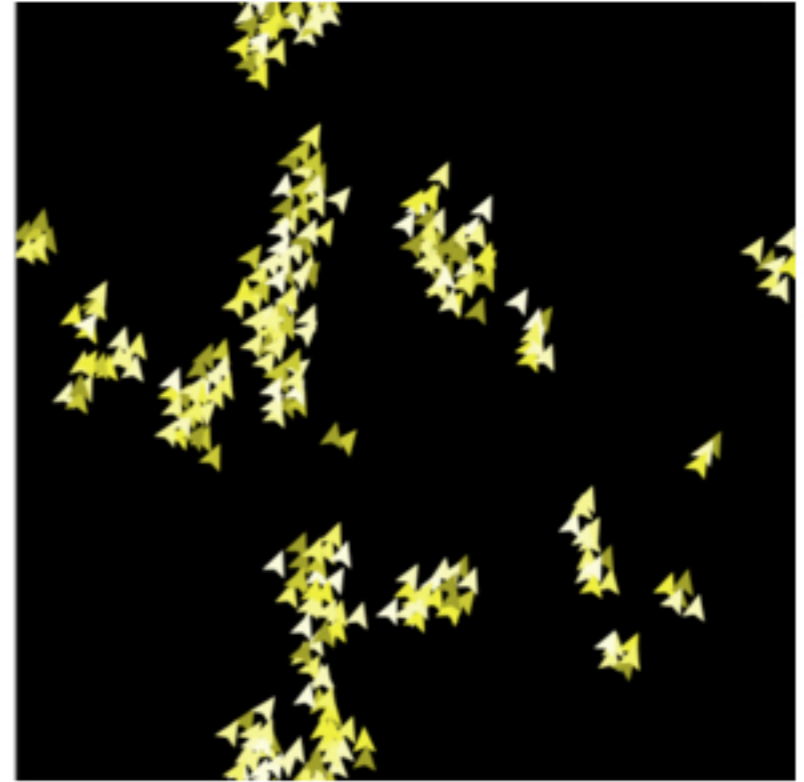
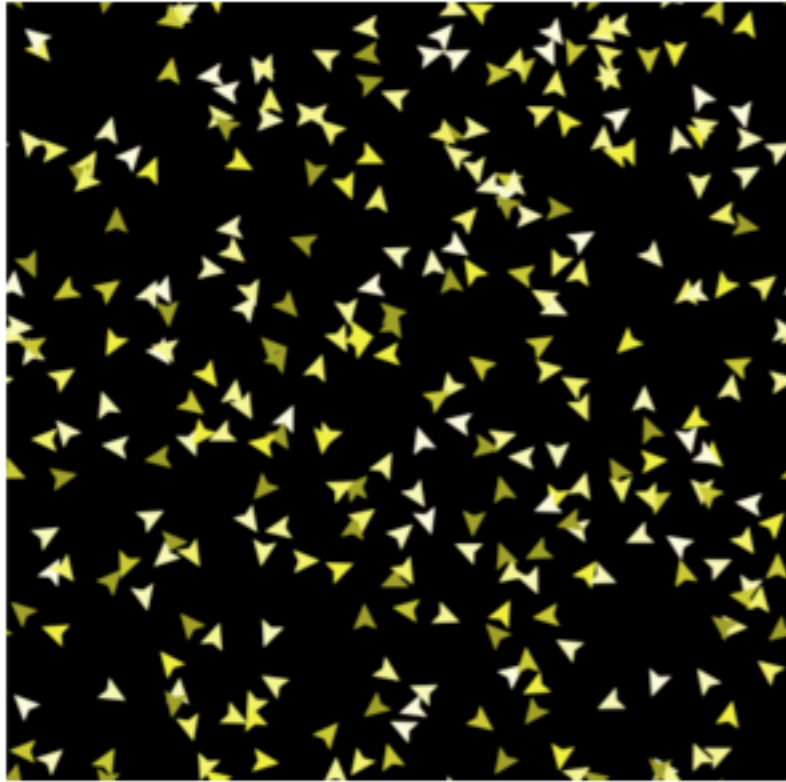
Emergence in Math?

$$\{(x,y)\} := (x-a)^2 + (y-b)^2 = r^2$$

Emergence in Math?



Are Objects Behaviors?



Are Properties Behaviors?



Are Behaviors Properties?



Develop Tests for Emergence

Truth evaluable claims about
repeatable and reproducible features
of relationships between
specific micro-level phenomena
and their generated macro-level phenomena.





The Time Is Now!