These are slides, not a paper.

You'll need to watch the talk to understand the context.

Eve

Working around evolution.

steve{@(stevelosh}.com)

{twitter}

(website)

200,000 BCE

(modern humans evolved)

2012 CE

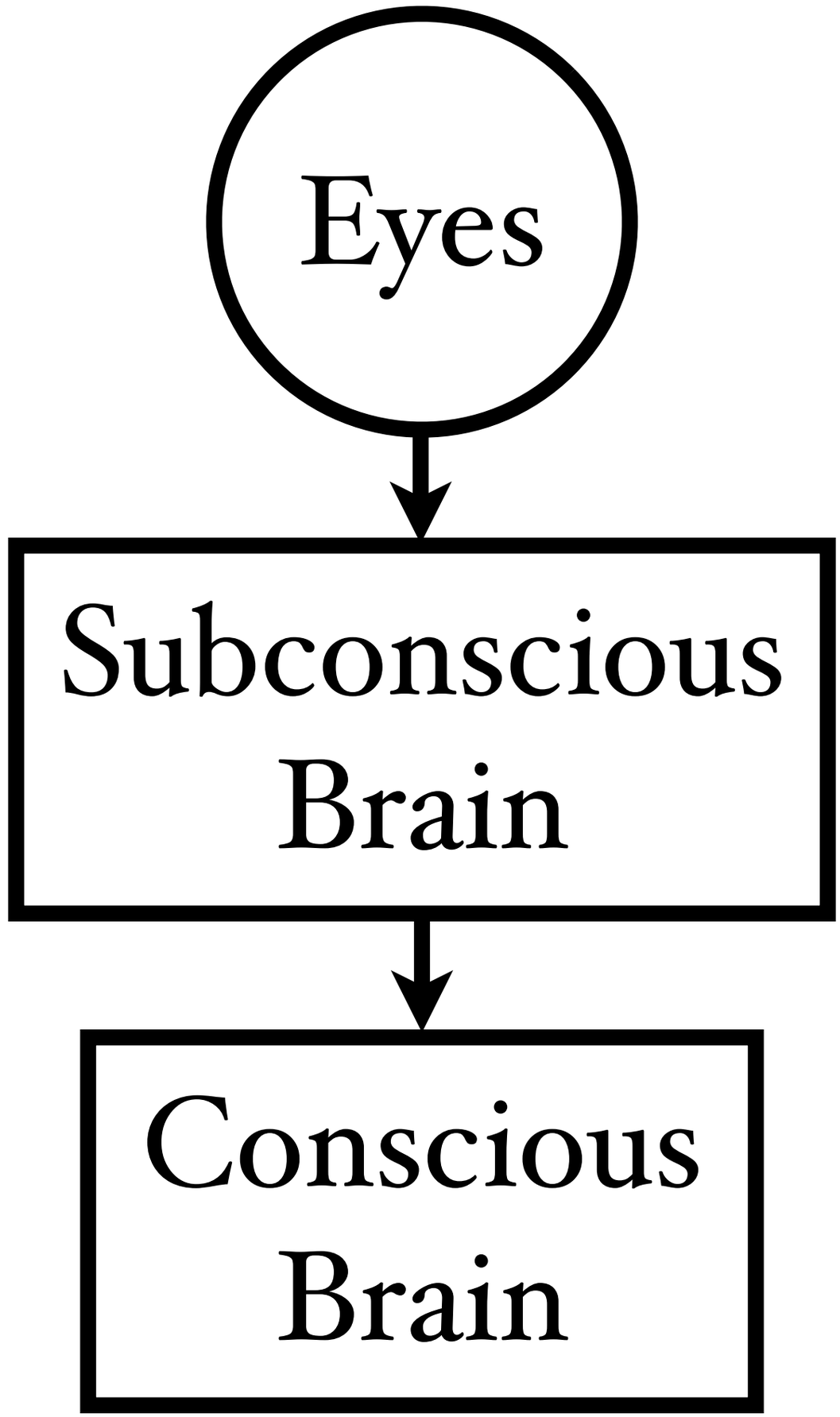
(present day)

Eat

Reproduce

Don't Die

Natural Selection


Eyes
Subconscious Brain
Conscious Brain

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GRASS
TREE
LION

Small numbers *of* medium-sized things

Small numbers

“Fewer than ten”

Medium-sized things

“Bigger than a child, smaller than an elephant”

Agriculture!

Large numbers *of* tiny and/or enormous things

"Two million rows

in the database"

*“One hundred **milliseconds** to serve an HTTP request”*

“65,536 blocks in a Minecraft chunk”

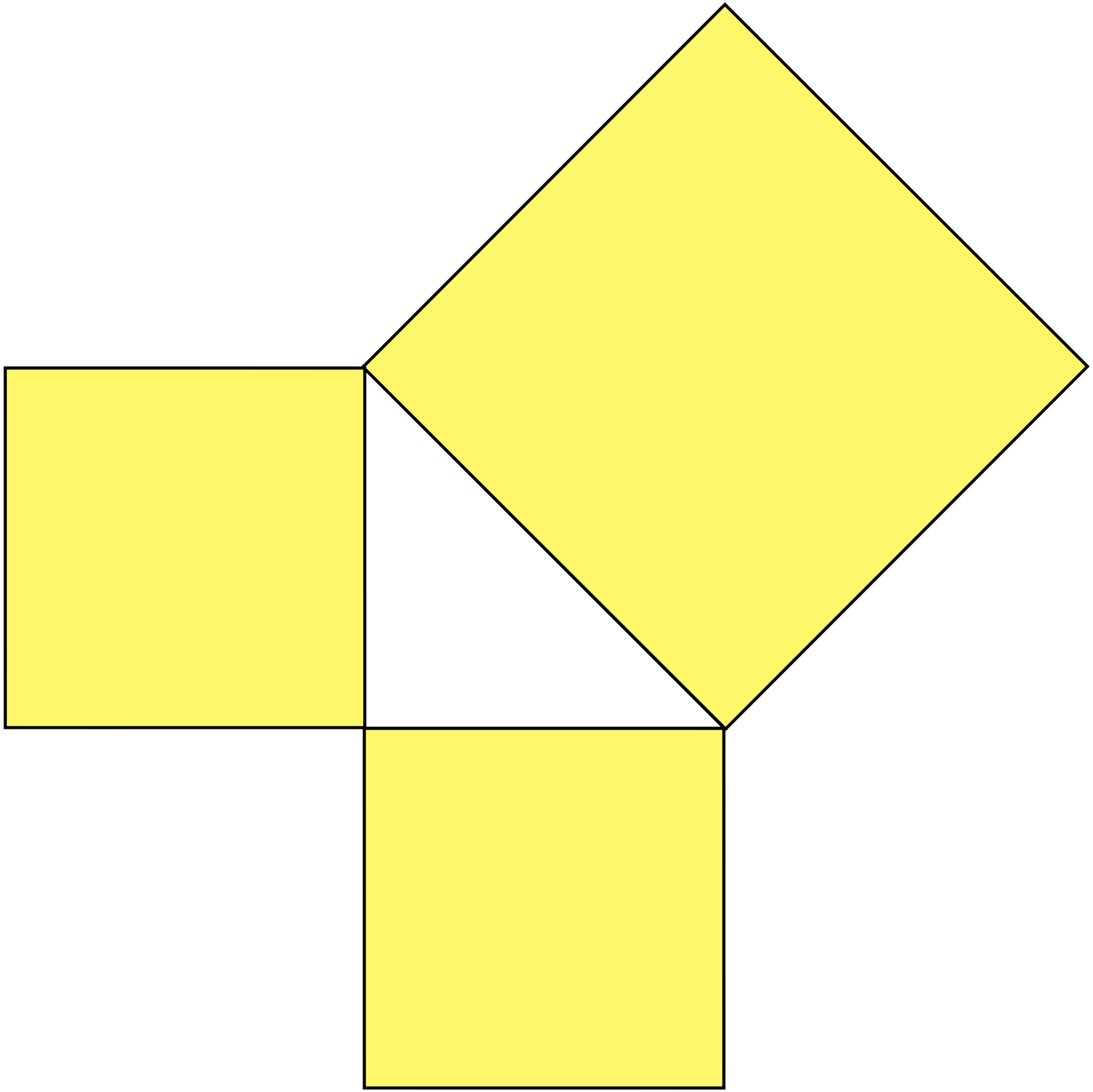
We are not alone!

“10 to 100 trillion

cells in the human body”

"9.2×10^{37} proton-proton chain reactions per second in the sun"

Math & Science



Reason

Abstractions

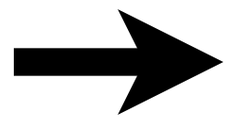
Large numbers of things → Small numbers of things

Logic

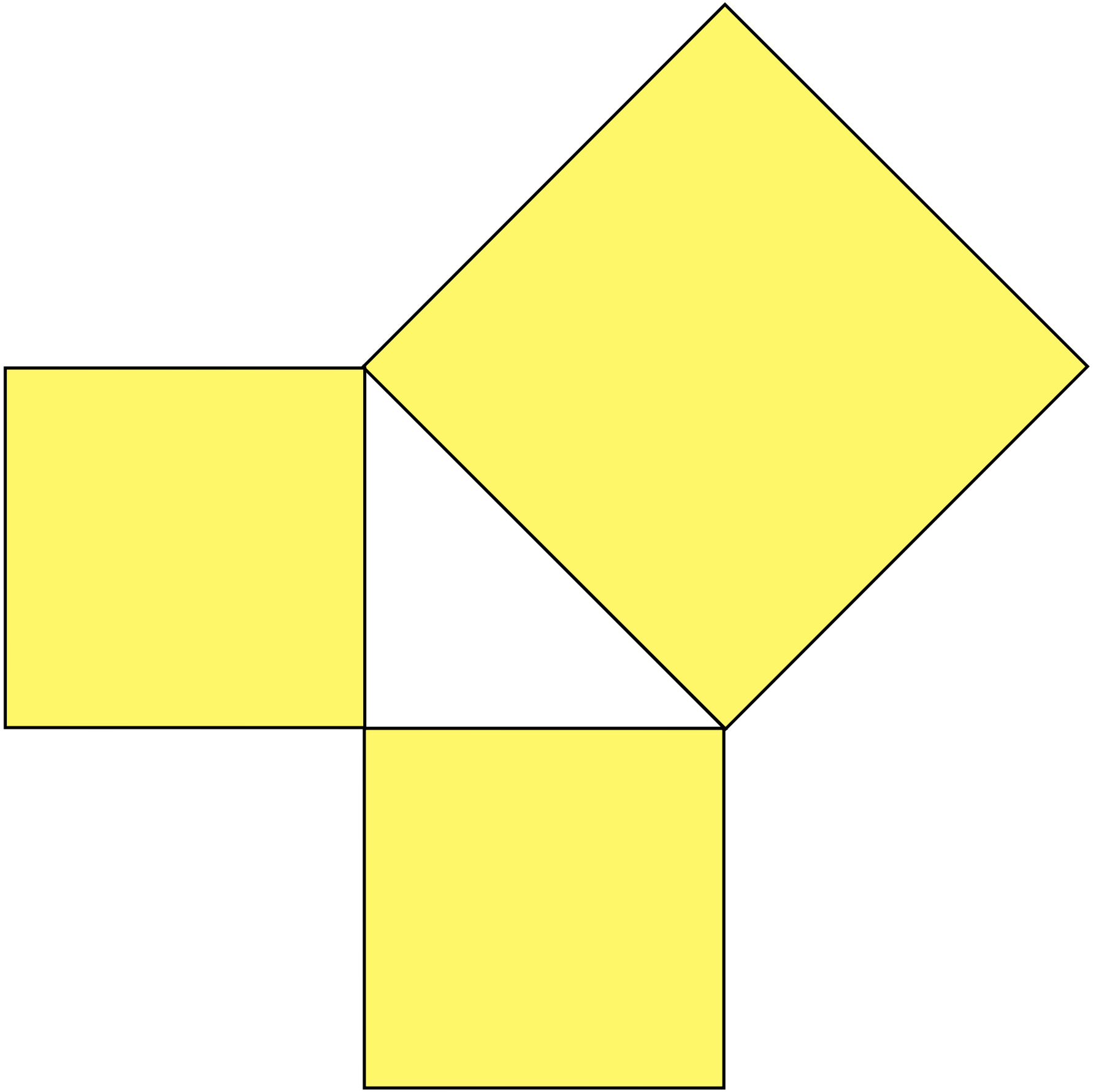
Abstractions → New Abstractions

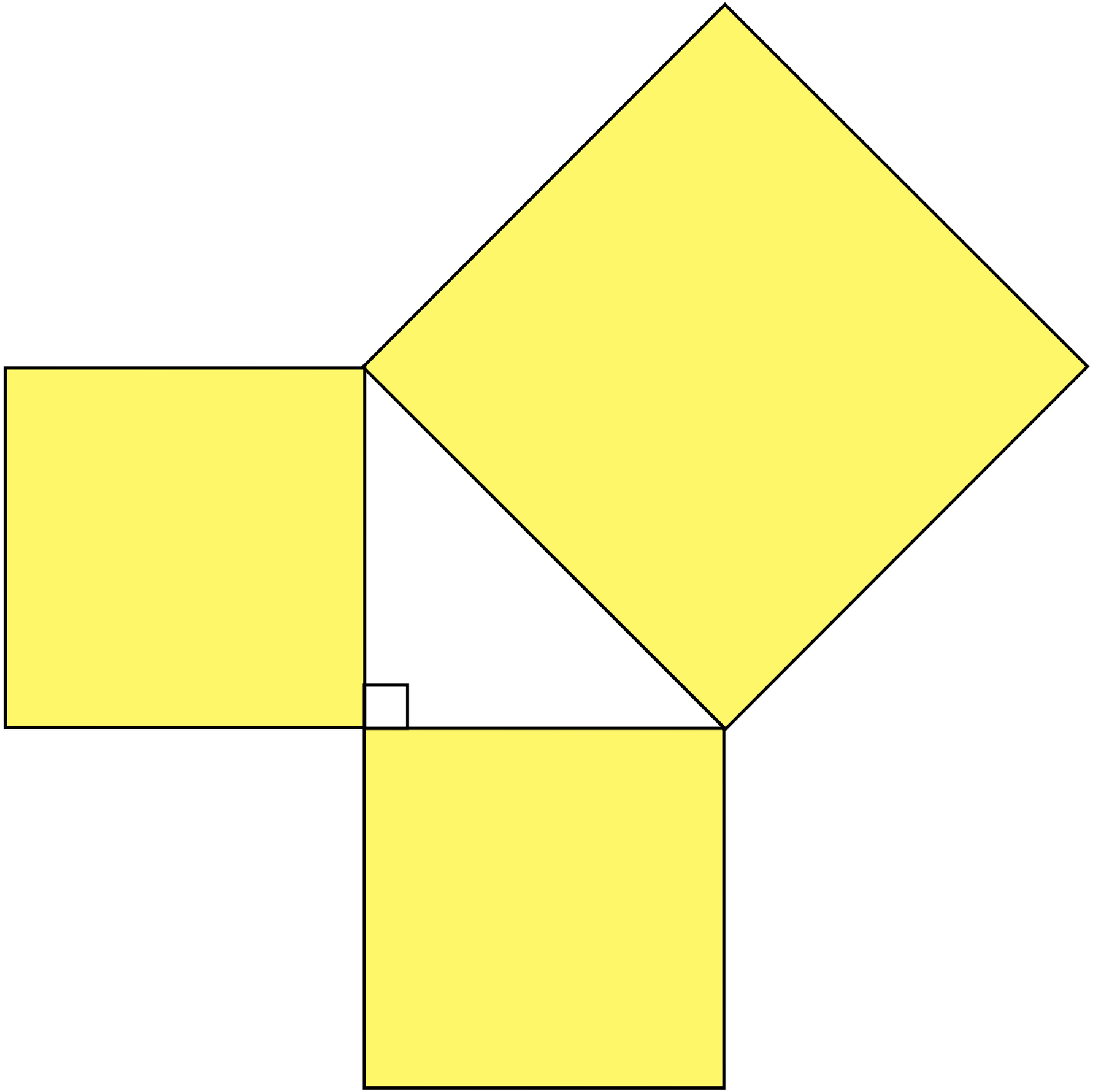
Abstractions

Small number of abstractions



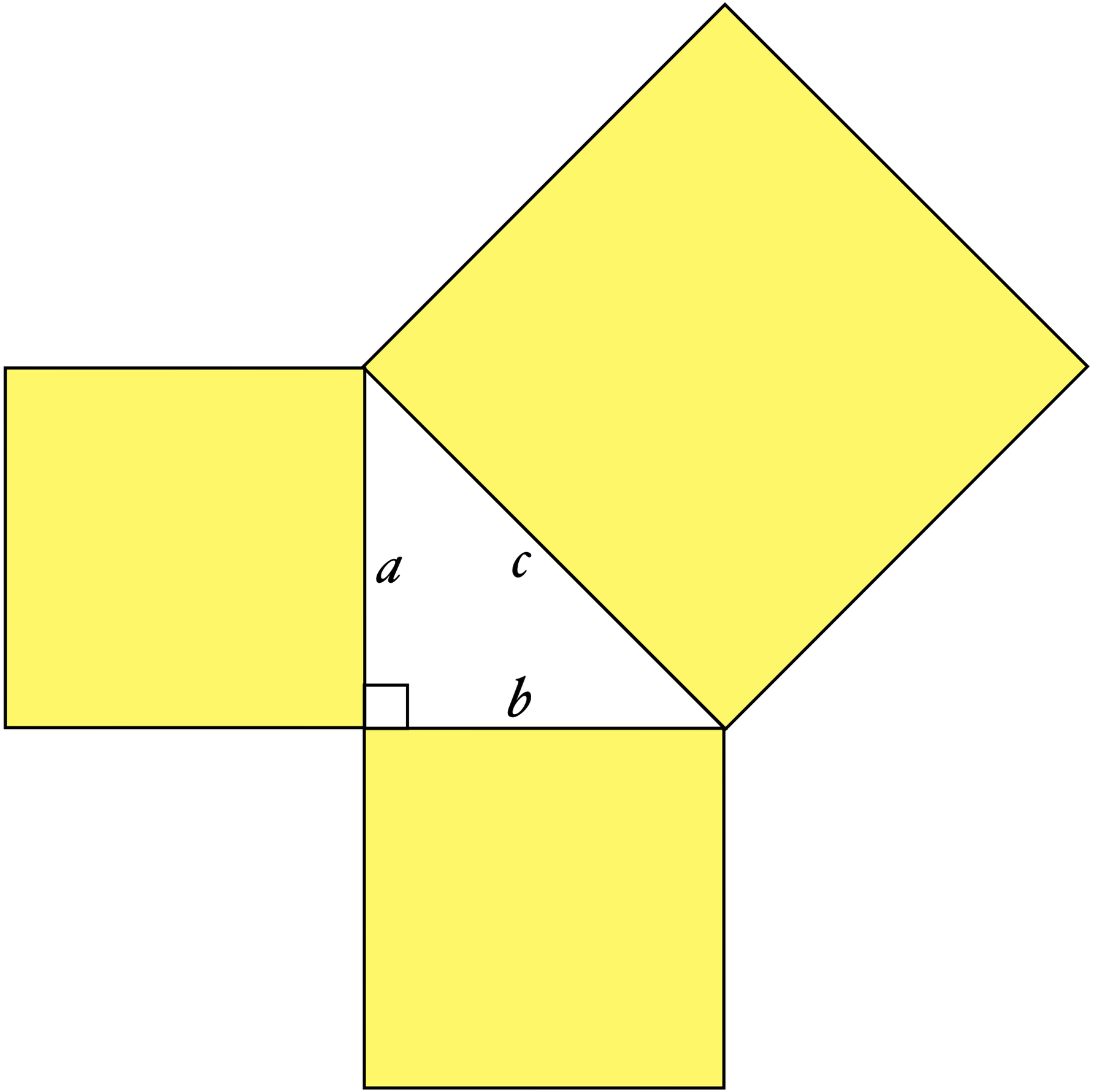
Many things in the real world

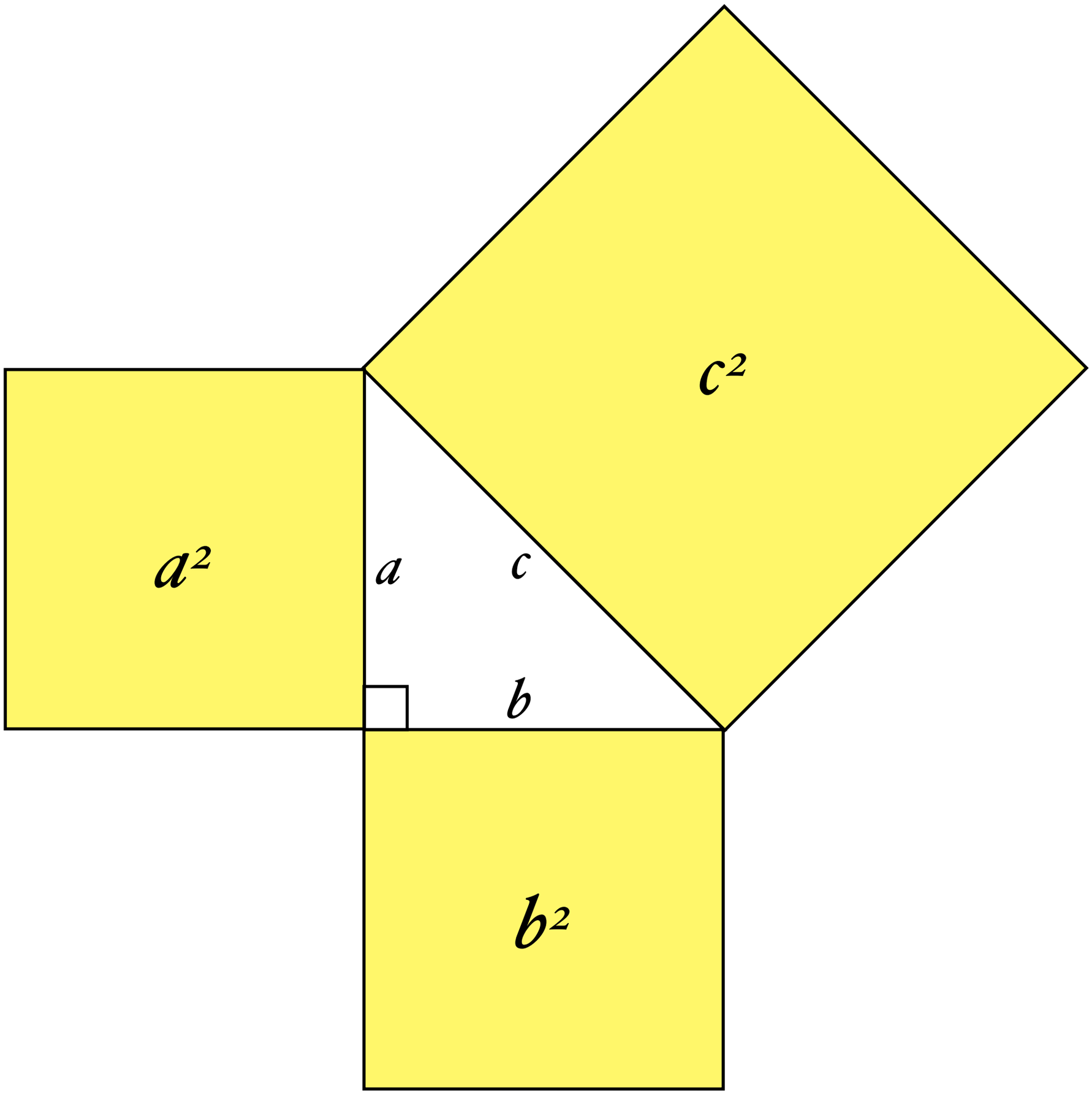


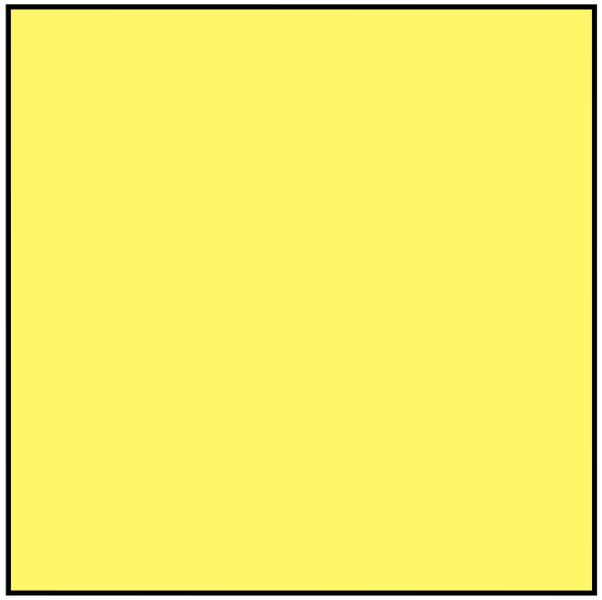


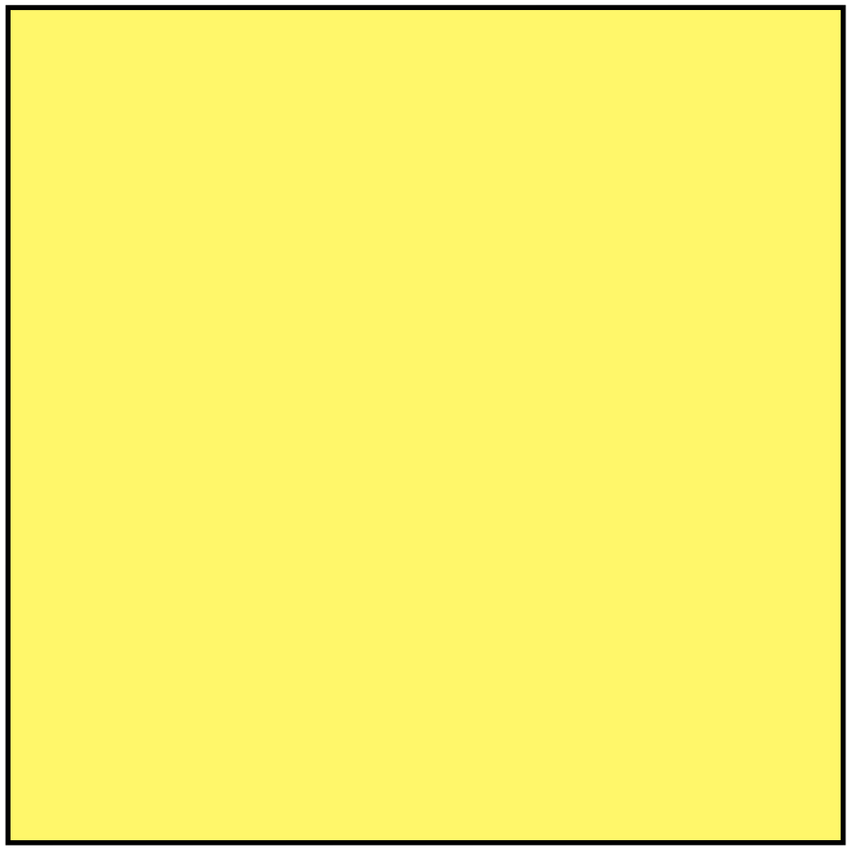
Pythagoras

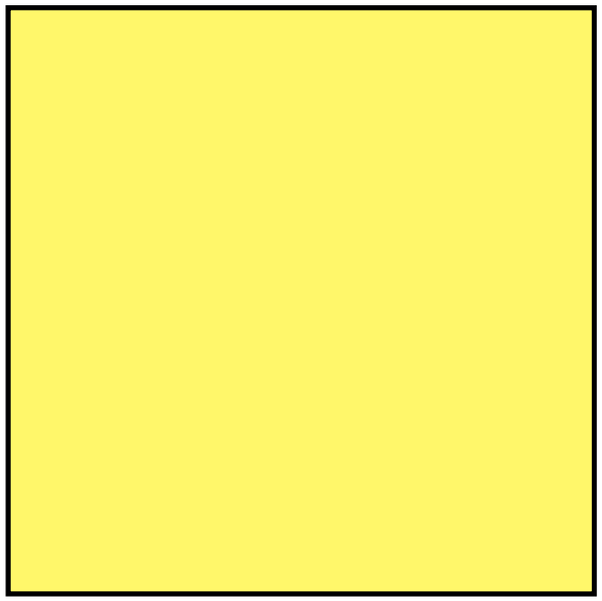
$$a^2 + b^2 = c^2$$


a
c
b


c^2
a^2
b^2
a
c
b







Eve

"The ancestor of ***every*** *living human on Earth"*

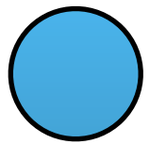
200,000 BCE

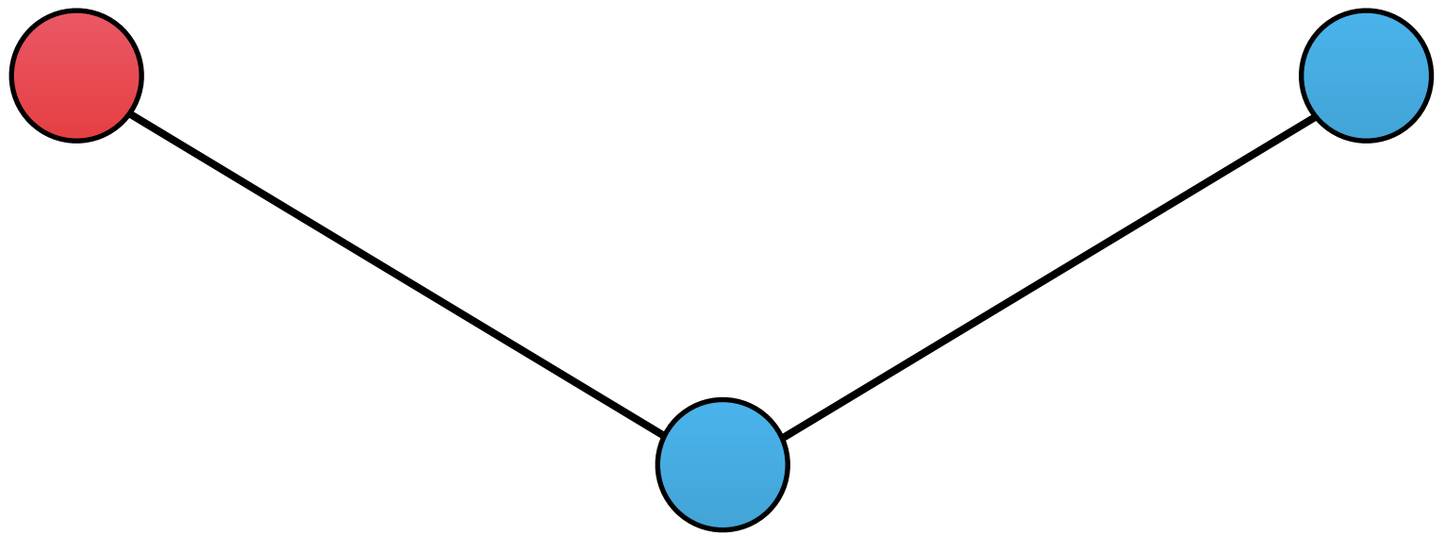
(modern humans evolved)

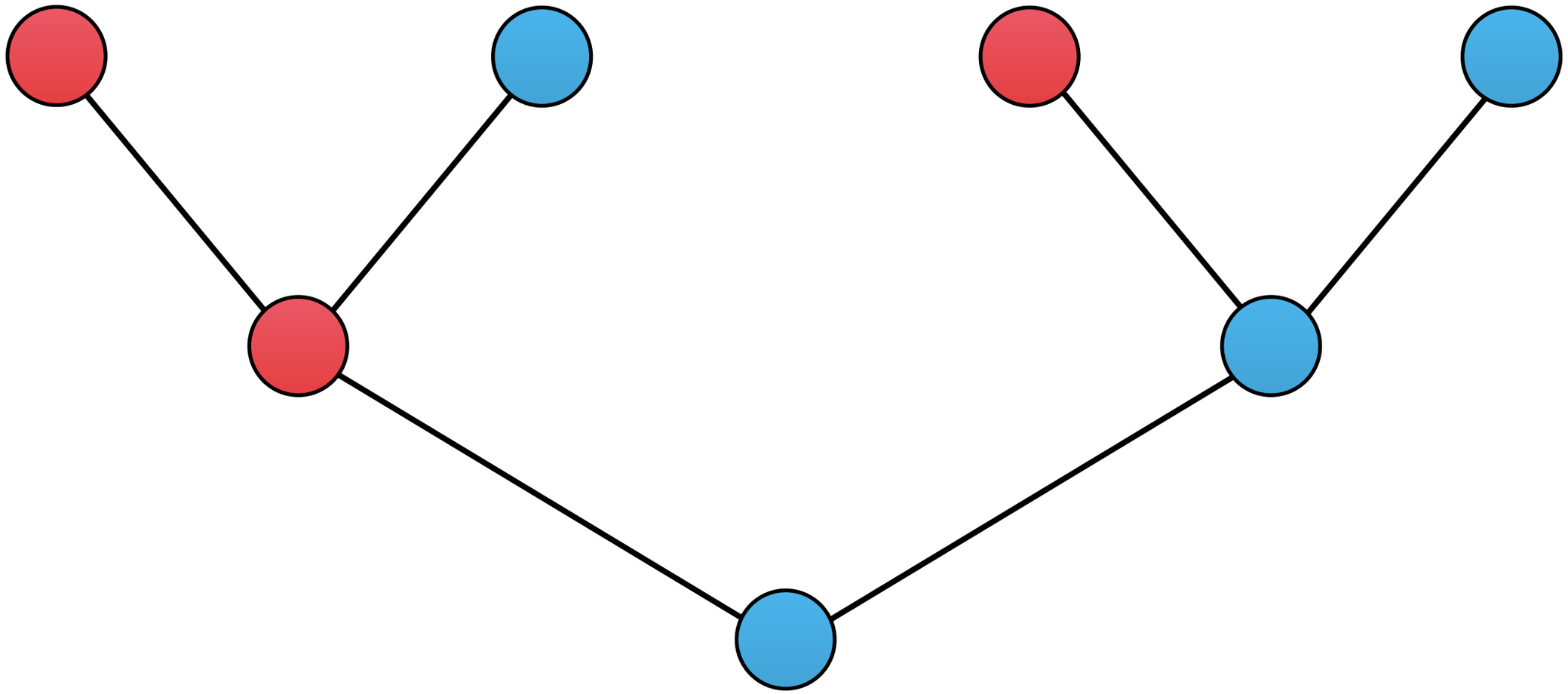
2012 CE

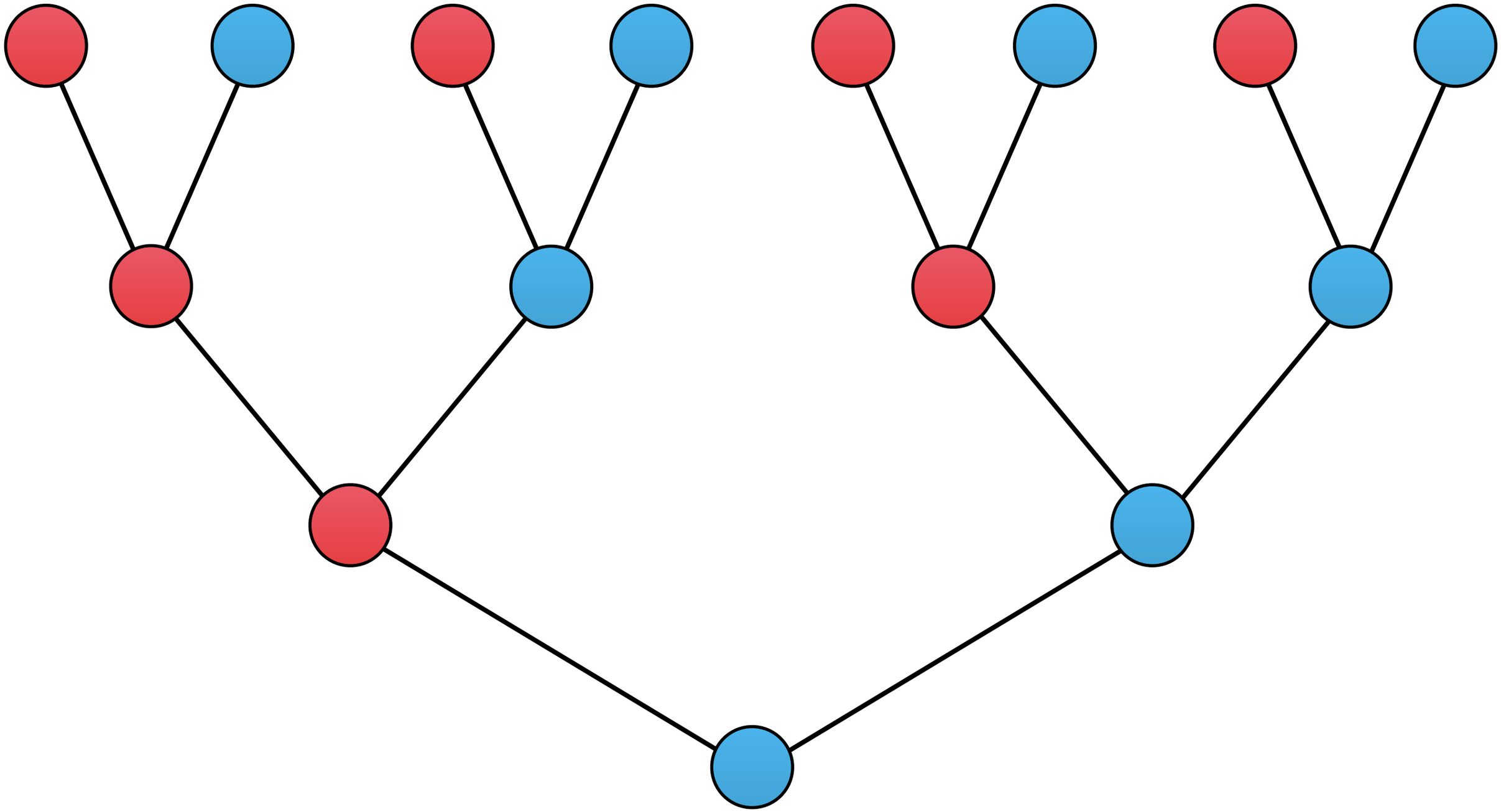
(present day)

Reason









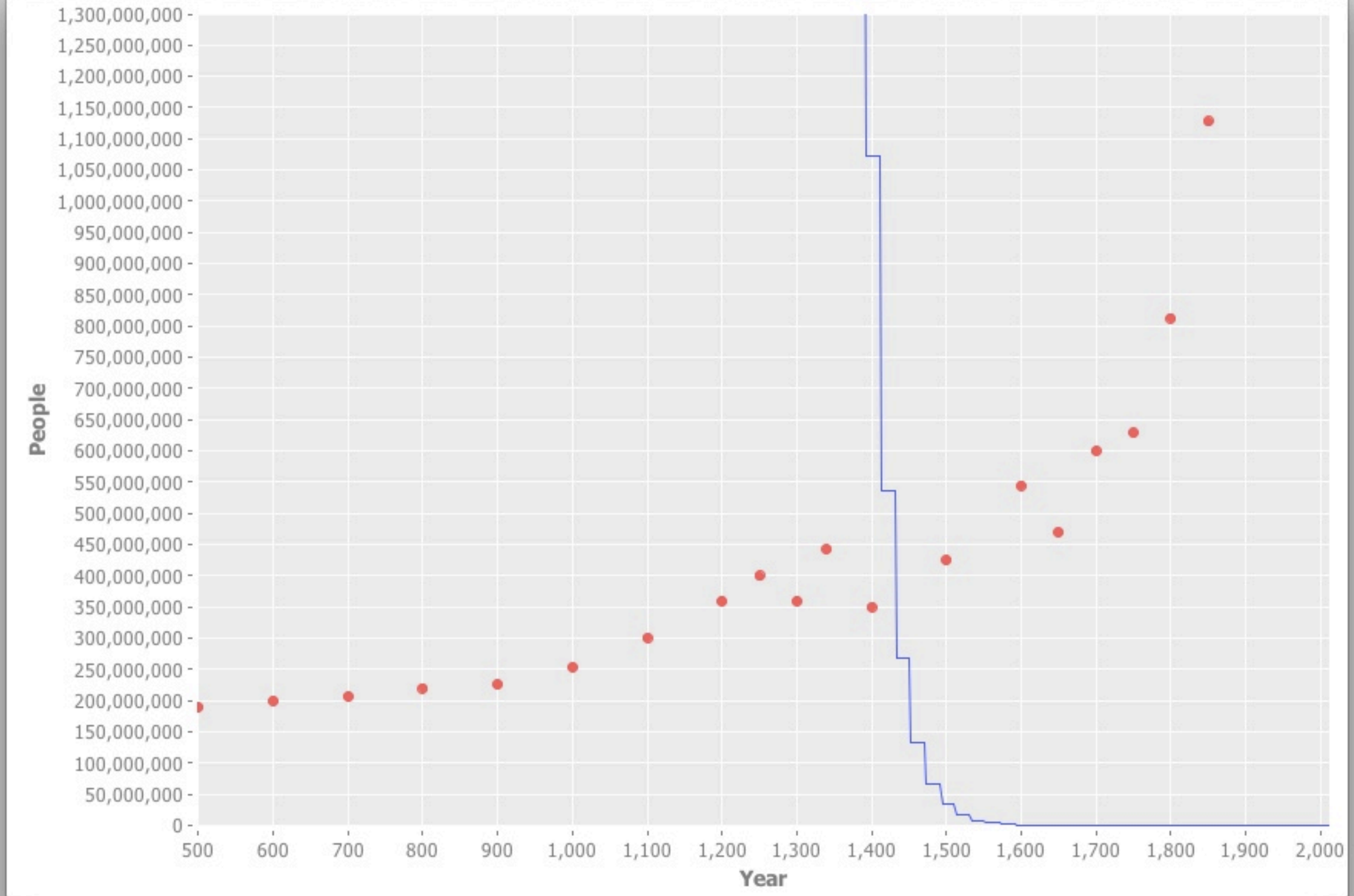
Generations Ago	Ancestors
1	2
2	4
3	8
4	16
5	32
6	64
7	128
8	256

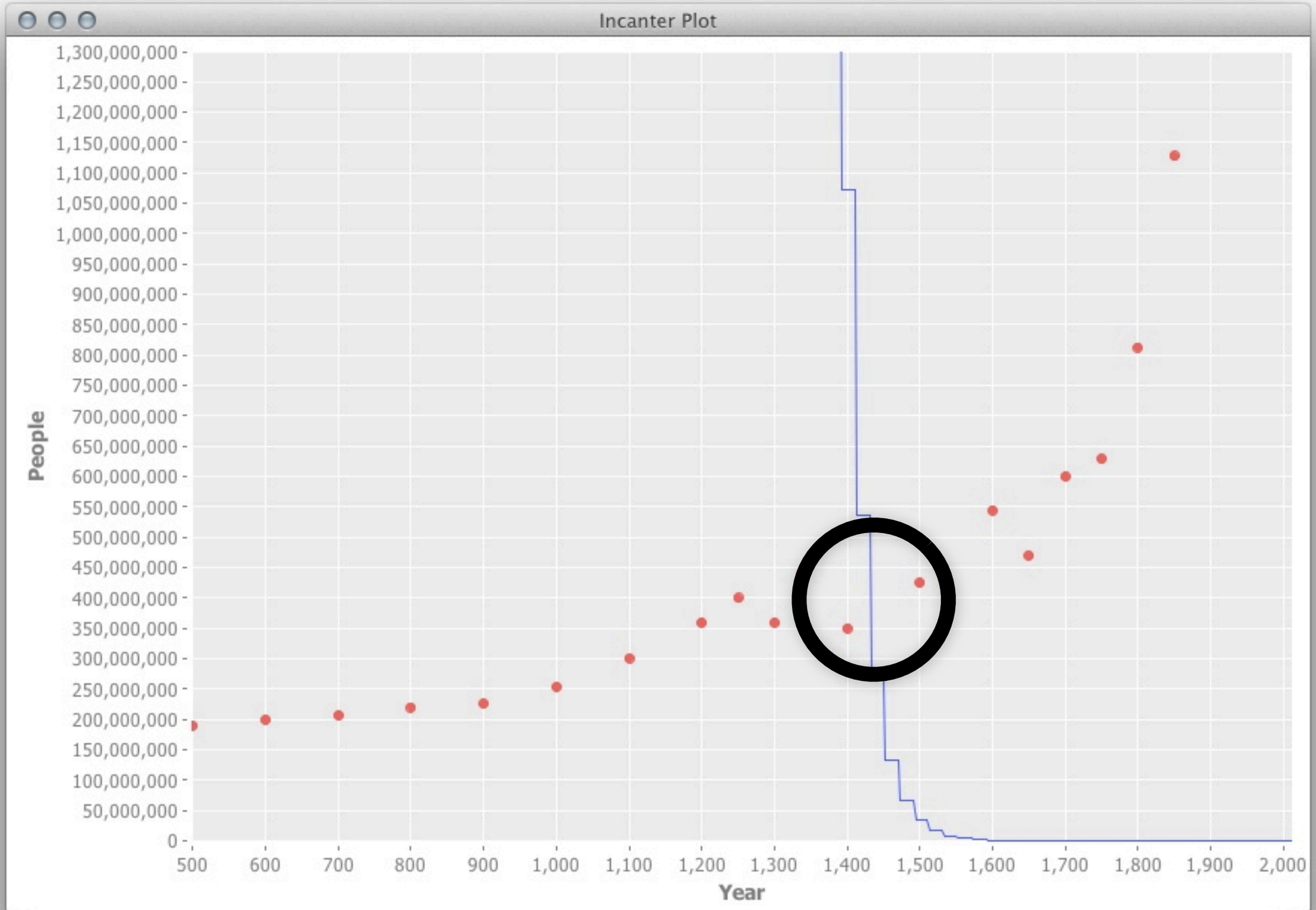
$$\text{ancestors} = 2^{\text{generations}}$$

$$\text{ancestors} = 2^{((2012 - \text{year}) / 20)}$$

```clojure
(ns eve.core
  (:use [incanter core io charts stats]))

(def world-population
  (read-dataset
    "https://raw.github.com/.../world-population.csv"
    :header true))

(defn number-of-ancestors [x]
  (let [years-ago (- 2012 x)
        generations-ago (int (/ years-ago 20))]
    (Math/pow 2 generations-ago)))

(doto (scatter-plot ($ :year world-population)
                    ($ :population world-population)
                    :x-label "Year"
                    :y-label "People")
  (add-function number-of-ancestors 500 2012)
  (set-x-range 500 2012)
  (set-y-range 0 1300000000)
  view)
```

Incanter Plot




Incanter Plot
People
1,300,000,000
1,250,000,000
1,200,000,000
1,150,000,000
1,100,000,000
1,050,000,000
1,000,000,000
950,000,000
900,000,000
850,000,000
800,000,000
750,000,000
700,000,000
650,000,000
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400,000,000
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300,000,000
250,000,000
200,000,000
150,000,000
100,000,000
50,000,000
0
500
600
700
800
900
1,000
1,100
1,200
1,300
1,400
1,500
1,600
1,700
1,800
1,900
2,000
Year

1450 CE

(Eve?)

200,000 BCE

(modern humans evolved)

2012 CE

(present day)

Measurement

Gather Data

and

Analyze it with Statistics

Learn!

On the Common Ancestors of All Living Humans

Douglas L. T. Rohde
Massachusetts Institute of Technology

November 11, 2003

Abstract

Questions concerning the common ancestors of all present-day humans have received considerable attention of late in both the scientific and lay communities. Principally, this attention has focused on 'Mitochondrial Eve,' defined to be the woman who lies at the confluence of our maternal ancestry lines, and who is believed to have lived 100,000–200,000 years ago. More recent attention has been given to our common paternal ancestor, 'Y Chromosome Adam,' who may have lived 35,000–89,000 years ago. However, if we consider not just our all-female and all-male lines, but our ancestors along all parental lines, it turns out that everyone on earth may share a common ancestor who is remarkably recent.

This study introduces a large-scale, detailed computer model of recent human history which suggests that the common ancestor of everyone alive today very likely lived between 2,000 and 5,000 years ago. Furthermore, the model indicates that nearly everyone living a few thousand years prior to that time is either the ancestor of no one or of all living humans.

1 Introduction

Advances in genetics have sparked interest in our common ancestors, the individuals from which all present-day humans descend. Initial interest focused on the topic of 'Mitochondrial Eve,' who is defined to be the most recent female ancestor from whom all individuals descend along strictly maternal lines (Cann, Stoneking, & Wilson, 1987; Vigilant, Stoneking, Harpending, Hawkes, & Wilson, 1991). An approximate date for Mitochondrial Eve of 100,000 to 200,000 years ago has been estimated based on the successive mutations in mitochondrial DNA, which are passed down from mother to child. A similar analysis can be performed on the strictly paternal lines of succession, using the Y chromosome, which is passed down from father to son, to determine the approximate date of 'Y Chromosome Adam.' This date was originally estimated to be 49,000 years ago (Dorit, Akashi, & Gilbert, 1995), a range that was more recently narrowed to 35,000–89,000 years ago (Ke et al., 2001).

Nevertheless, an individual's strictly maternal and strictly paternal lines are just two of a vast number of possible paths back through his or her ancestors. What if we adopt a more common-sense notion of ancestry that includes ancestors reachable along any path of succession, using both mothers and fathers? It seems likely that our most recent common ancestor (MRCA) under this broader definition will be much more recent than either Mitochondrial Eve or Y Chromosome Adam. Unfortunately, the age of our MRCA cannot as easily be estimated on the basis of genetic information because the relevant genes are not passed from parent to child with only occasional mutations but are, rather, the product of recombination. As a result of recombination, a given gene may not pass from parent to child. In fact, an individual's DNA may retain none of the genes specific to a particular ancestor who lived many generations in the past. These additional complications make accurately dating the MRCA or reconstructing other details of population history on the basis of our genes extremely difficult, if not impossible (Hey & Machado, 2003).

However, alternative methods may be able to answer this question. Some researchers have produced estimates of the age of our MRCA by means of the theoretical analysis of mathematical models. Building on work by Kämmerle (1991) and Möhle (1994), Chang (1999) analyzed a model that assumes a fixed-size population, with discrete and non-overlapping generations, and random mating. That is, each child is the product of two parents, randomly selected from all members of the previous generation. Chang showed that, in this model, the mixing of genes occurs quite rapidly. In fact, the number of generations back to the MRCA is expected to be about $\log_2$ of the population size. With a population of 6 billion people, this model predicts that the MRCA is likely to occur in just over 32 generations, or 800–975 years. This suggests that our all-paths MRCA may be exceptionally recent

3,000 BCE

(Eve)

200,000 BCE

(modern humans evolved)

2012 CE

(present day)

Math and Science

work!

How can we learn from them?

Reason

Stop. Think.

"You have to keep a dozen of your favorite problems constantly present in your mind, although by and large they will lay in a dormant state.

Every time you hear or read a new trick or a new result, test it against each of your twelve problems to see whether it helps."

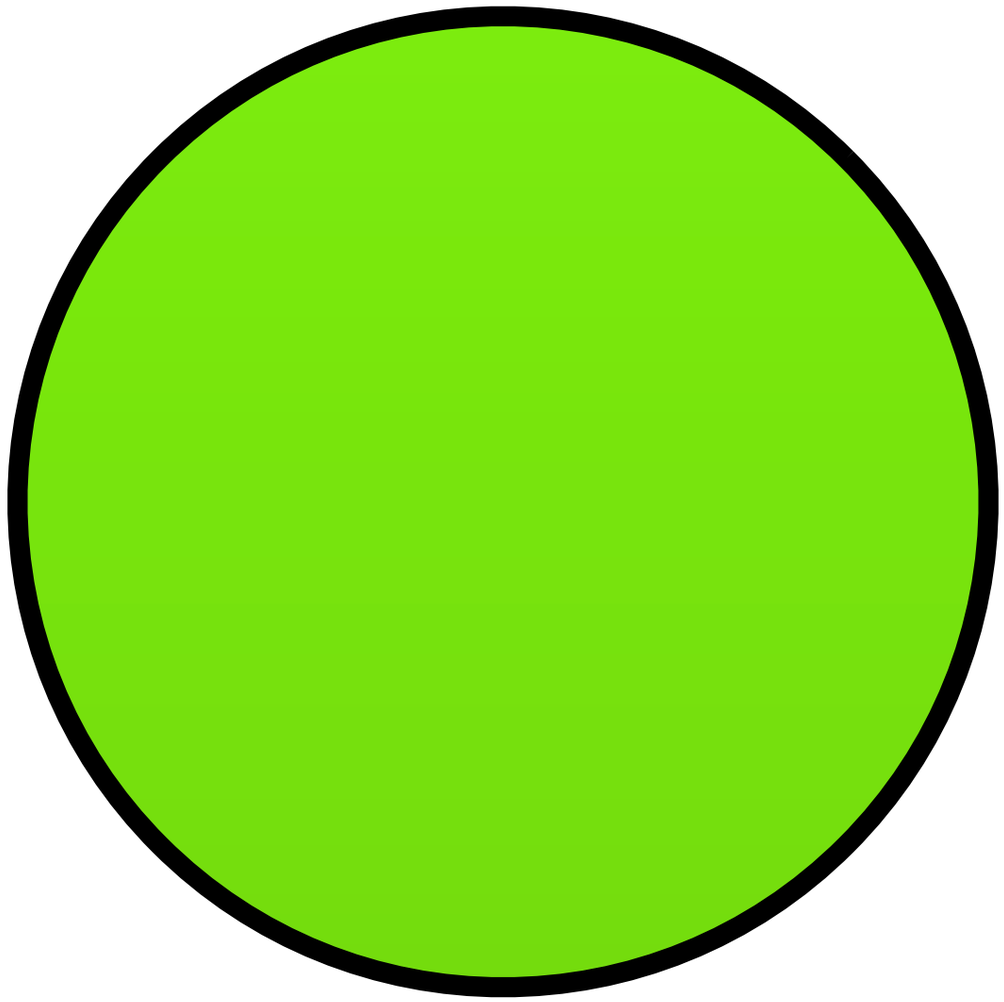
Write Reasonable Code

Measurement

Monitoring

IN

PRODUCTION!



Everyone who cares how fast Node.js serves Fibonacci numbers on your laptop

You

```clojure
(defn get-account-type [cash]
  (cond
    (< cash 1000)  :normal
    (< cash 10000) :silver
    :else          :gold))

(time (dotimes [_ 1000] (get-account-type (rand 20000))))
"Elapsed time: 8.857 msecs"

(time (dotimes [_ 1000] (get-account-type (rand 20000))))
"Elapsed time: 5.255 msecs"

(time (dotimes [_ 1000] (get-account-type (rand 20000))))
"Elapsed time: 4.37 msecs"

(dotimes [_ 1000000] (get-account-type (rand 20000)))

(time (dotimes [_ 1000] (get-account-type (rand 20000))))
"Elapsed time: 0.476 msecs"
```

Monitoring Tools

IN

PRODUCTION

Testing

One Unit Test

equals

1 bit of information

One Unit Test

equals

one of my assumptions is true
for one set of input
on one particular machine
at one particular point in time

Generative Testing

One Generative Test
equals
many bits of information

One Generative Test

equals

one of my assumptions is true

for **thousands of sets** of input

on one particular machine

at one particular point in time

Ape Brains


Jesus Christ it's a lion
GET IN THE CAR

Small numbers *of* medium-sized things

Math & Science

Reason

Measurement

Overcome

Evolution

Thanks!

http://www.census.gov/ipc/www/worldhis.html

http://pivotallabs.com/talks/139-metrics-metrics-everywhere

http://www.infoq.com/presentations/Simple-Made-Easy

http://greenteapress.com/thinkstats/

http://en.wikipedia.org/wiki/Human_microbiome

http://en.wikipedia.org/wiki/Sun

http://tedlab.mit.edu/~dr/Papers/Rohde-MRCA-two.pdf

http://incanter.org/

http://www.khanacademy.org/

http://en.wikipedia.org/wiki/QuickCheck

http://github.com/clojure/test.generative

http://github.com/sjl/bacon-eve

{ github.com
bitbucket.org } /sjl/eve

Thanks!