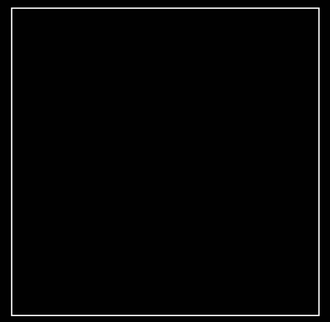
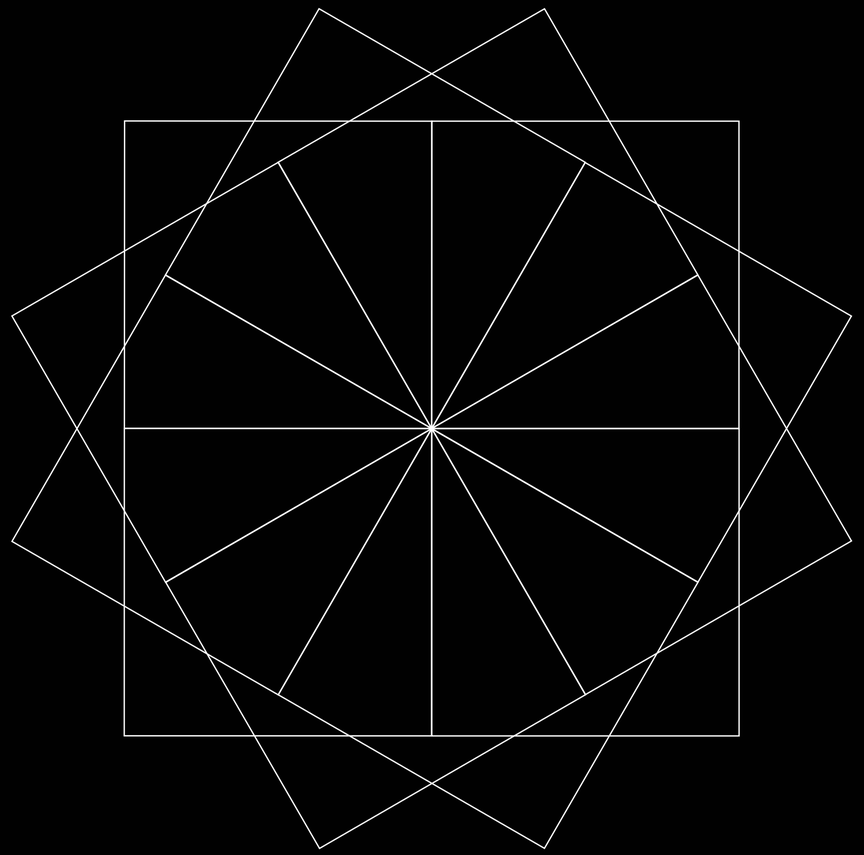
NICKELODEON PRESENTS

Mr. WIZARD'S World

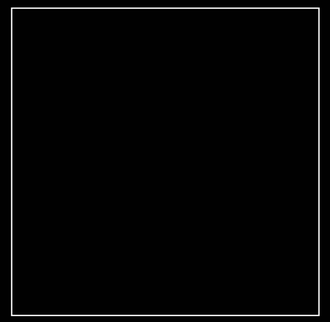
```
to square
  repeat 4 [fd 100 rt 90]
end
```



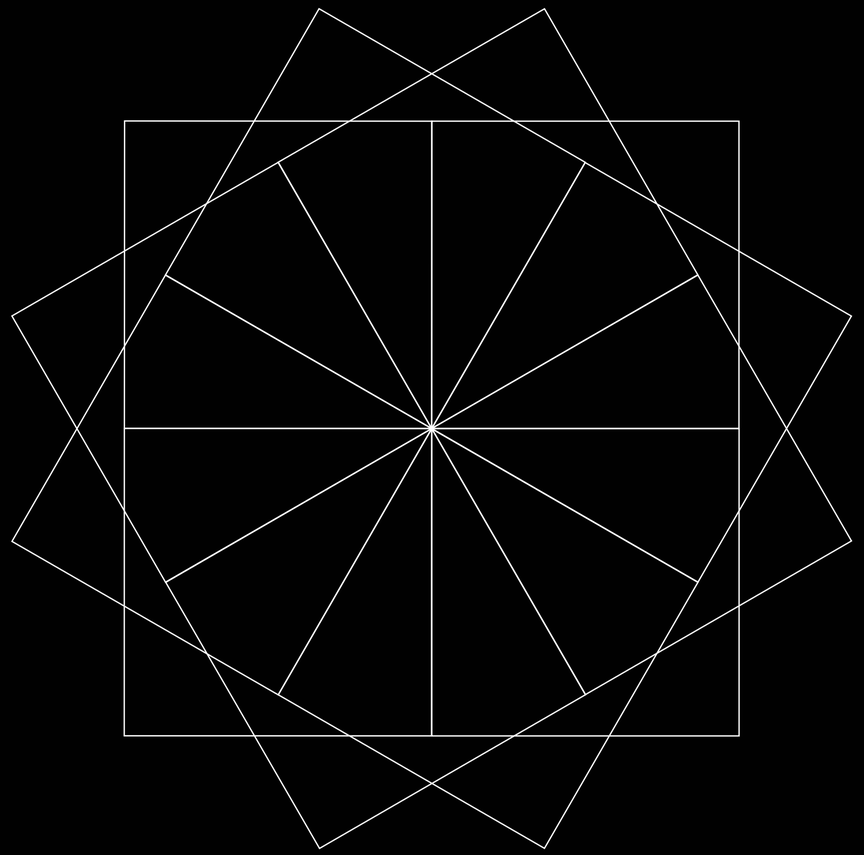
```
to flower
  repeat 12 [square rt 30]
end
```

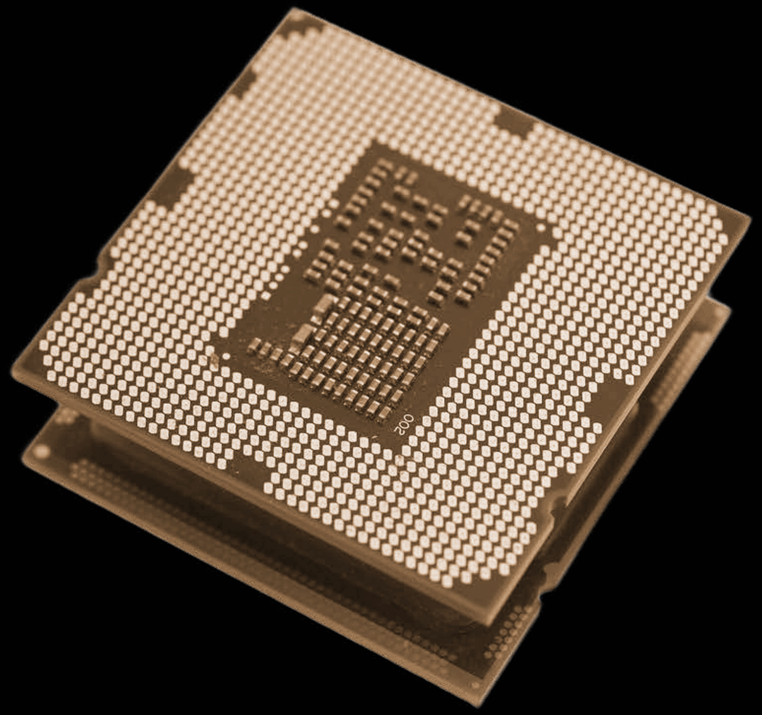


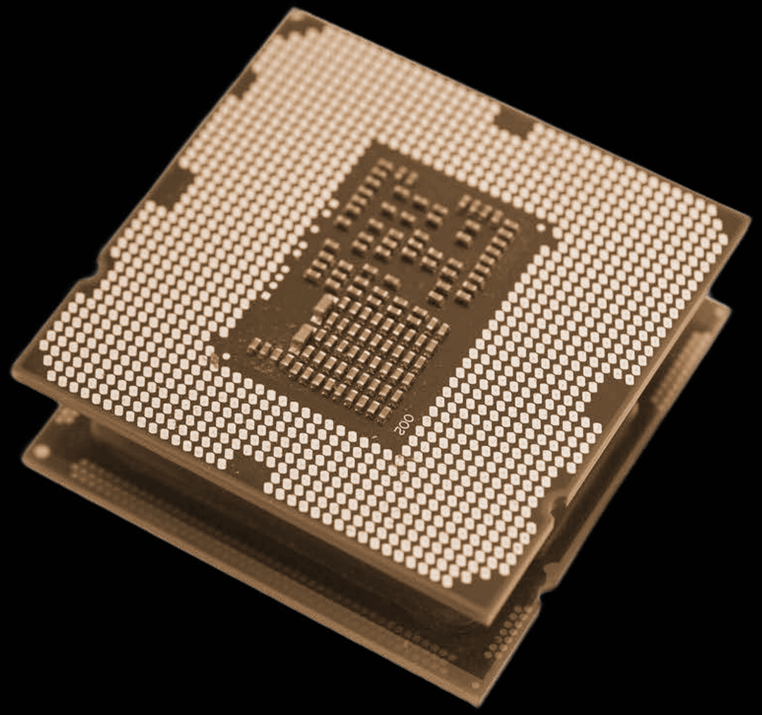
```
to square
  repeat 4 [fd 100 rt 90]
end
```

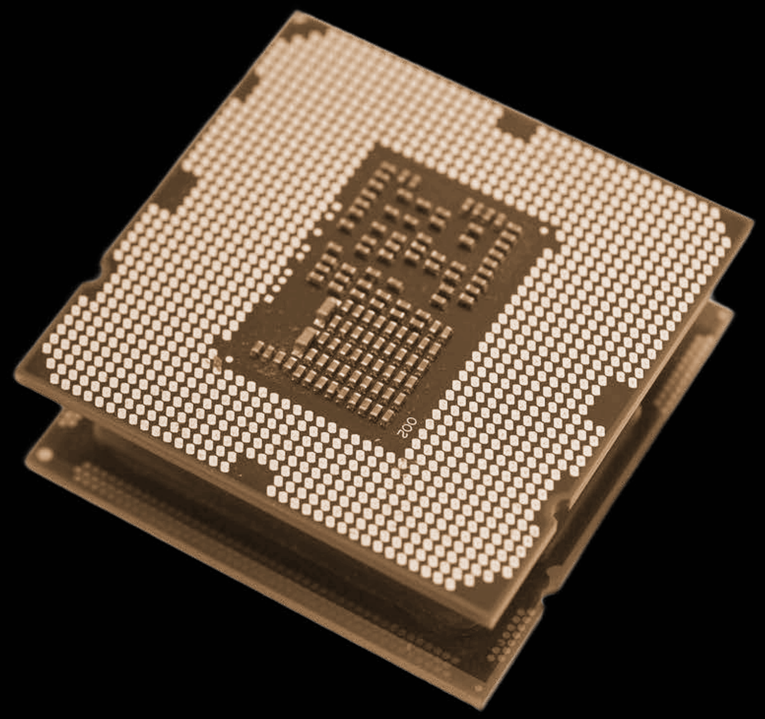


```
to flower
  repeat 12 [square rt 30]
end
```









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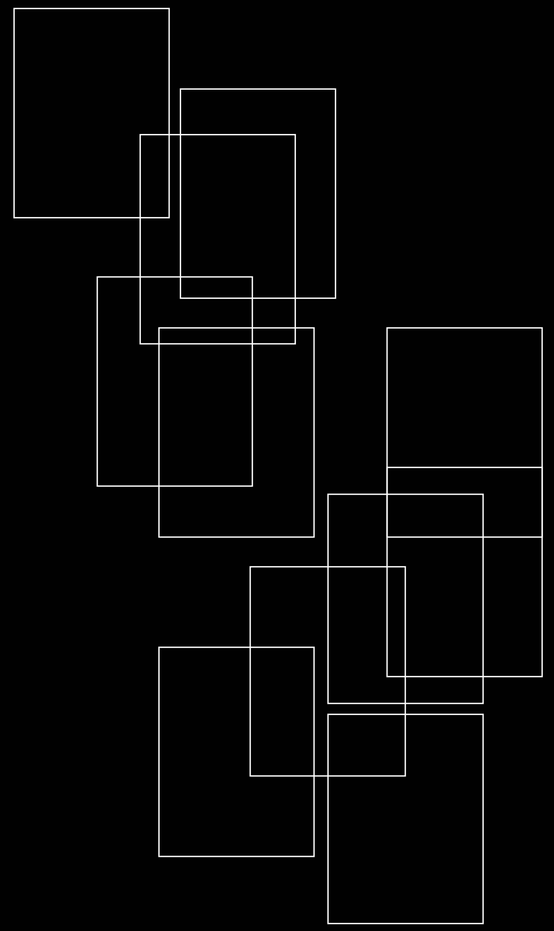
The Wonders of Abstraction

Eric Normand - September 19, 2024 - Heart of Clojure - Leuven, Belgium, Earth

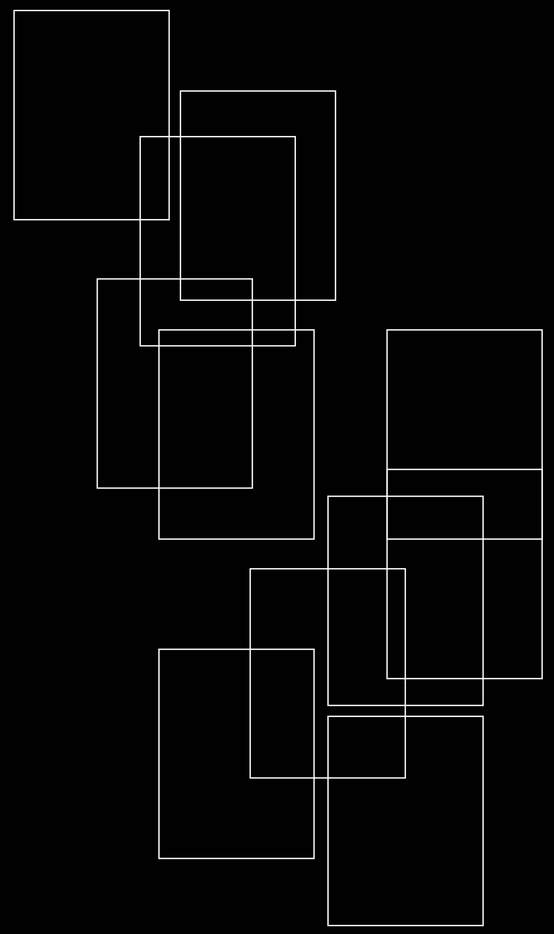
Abstraction

Encapsulation

Encapsulation



Encapsulation



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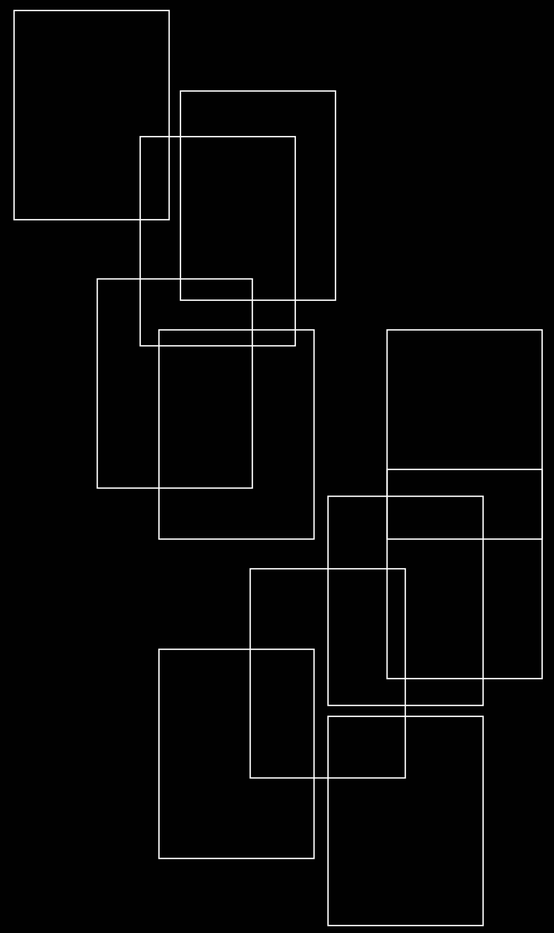


Layers of abstraction

Layers of abstraction

Machine code

Layers of abstraction

Programming Language

Machine code

Layers of abstraction

Web framework

Programming Language

Machine code

Layers of abstraction

Application logic

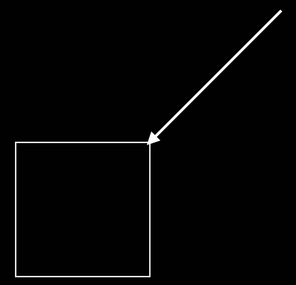
Web framework

Programming Language

Machine code

Indirection

Indirection



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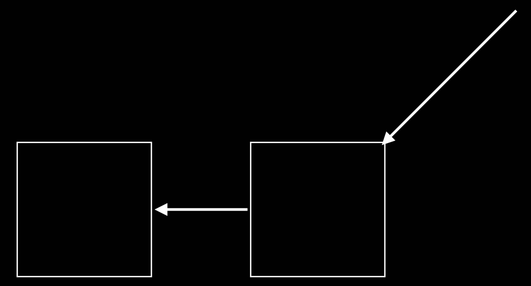

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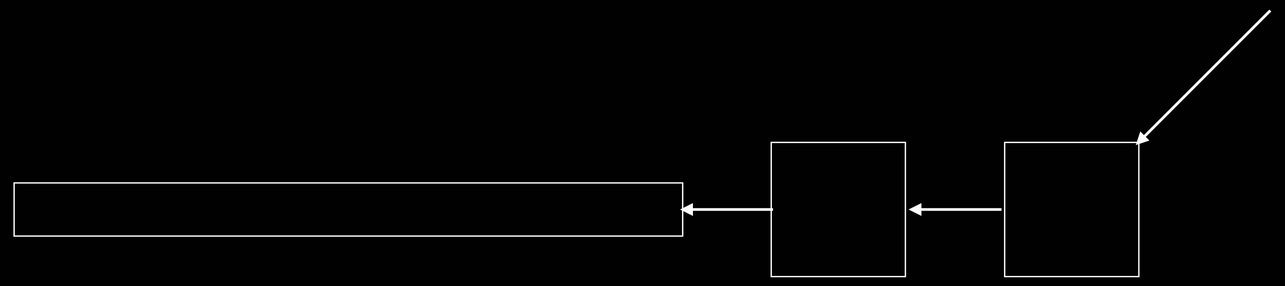

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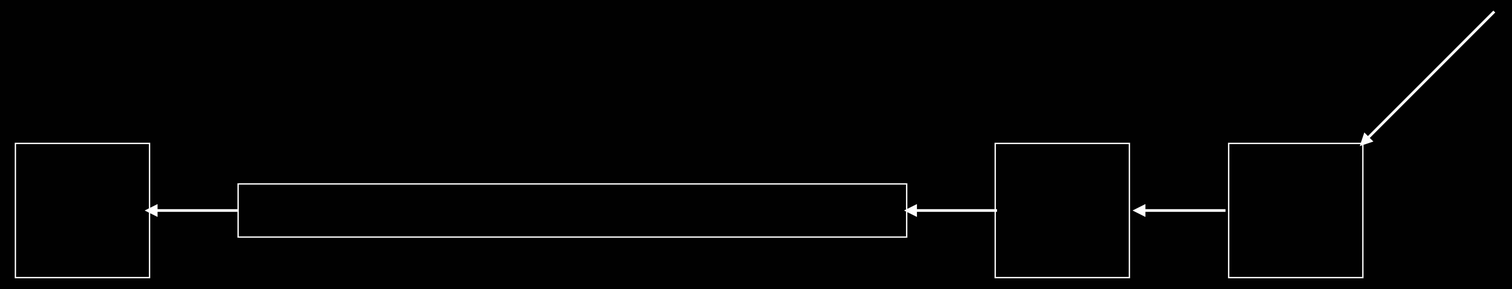

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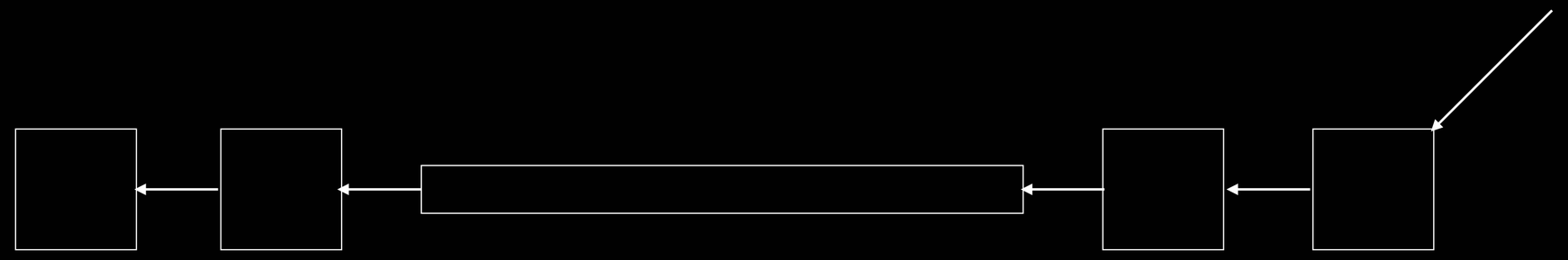

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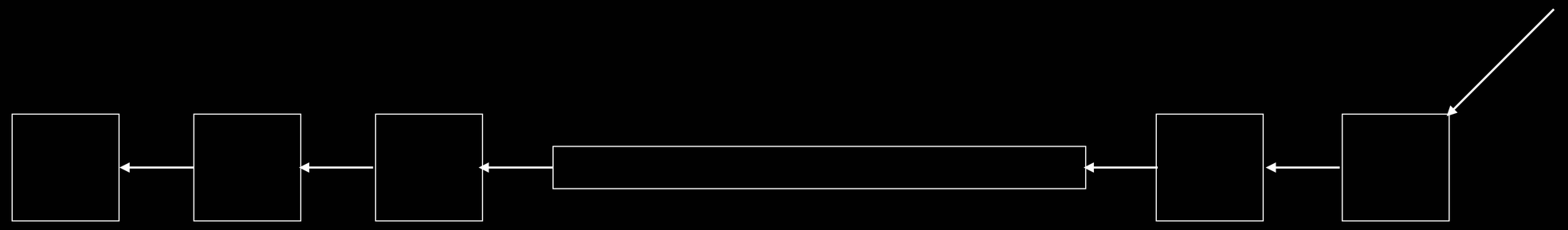


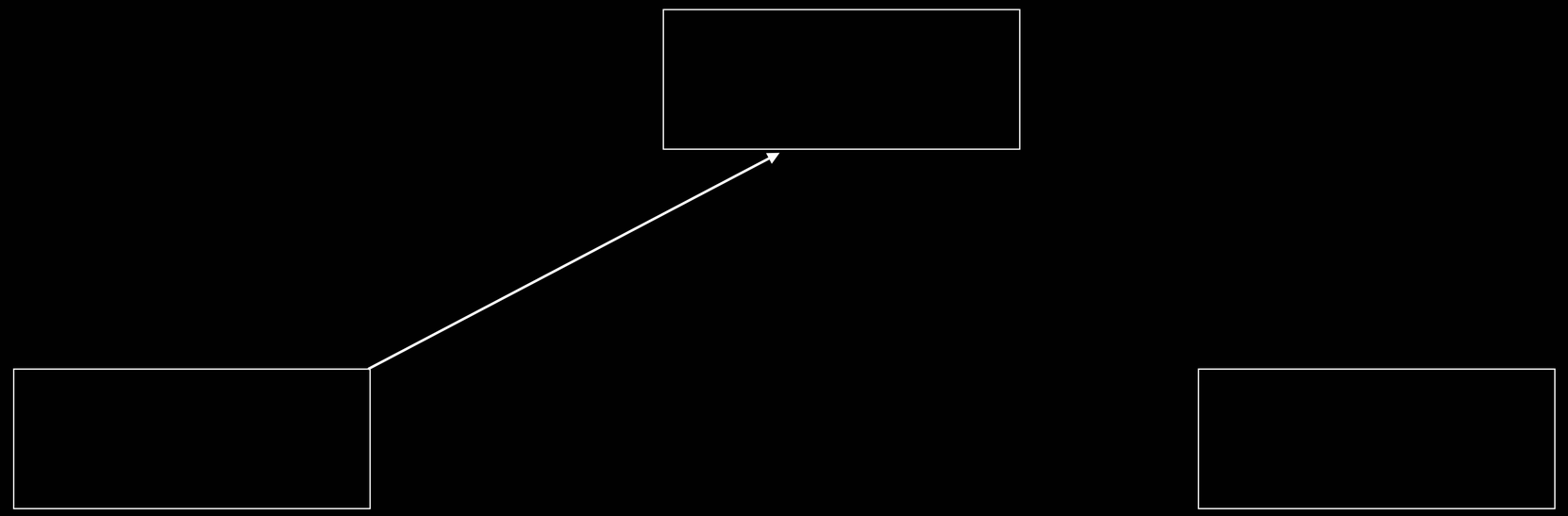
Reuse

Reuse

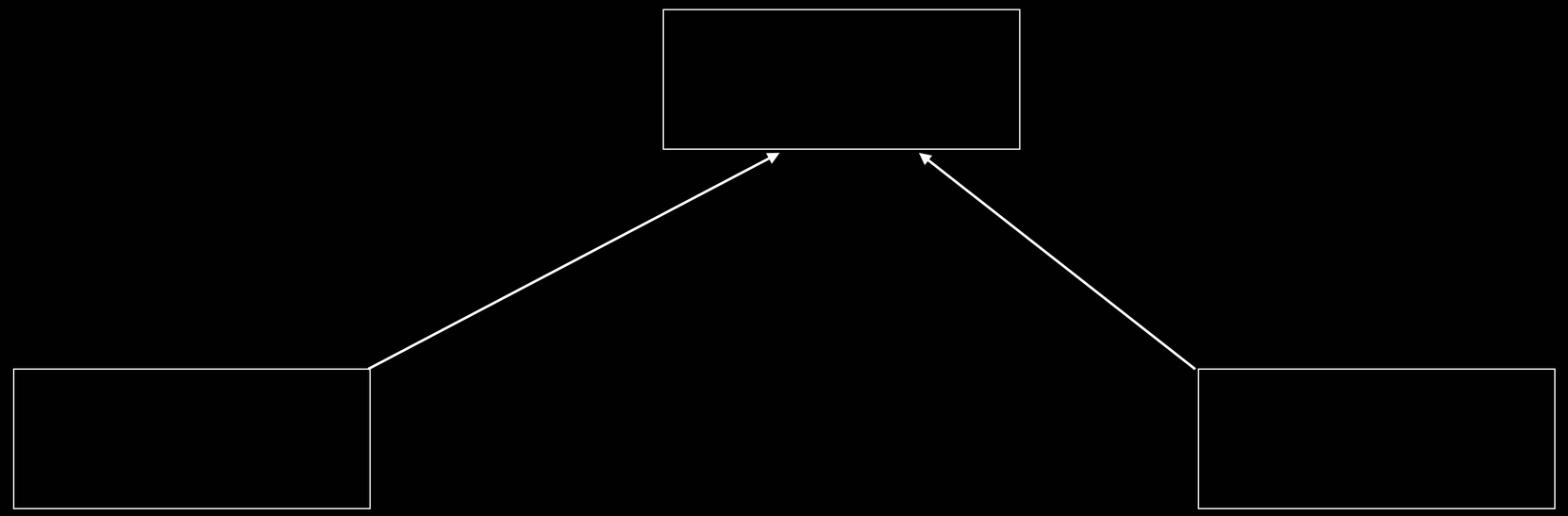
Reuse

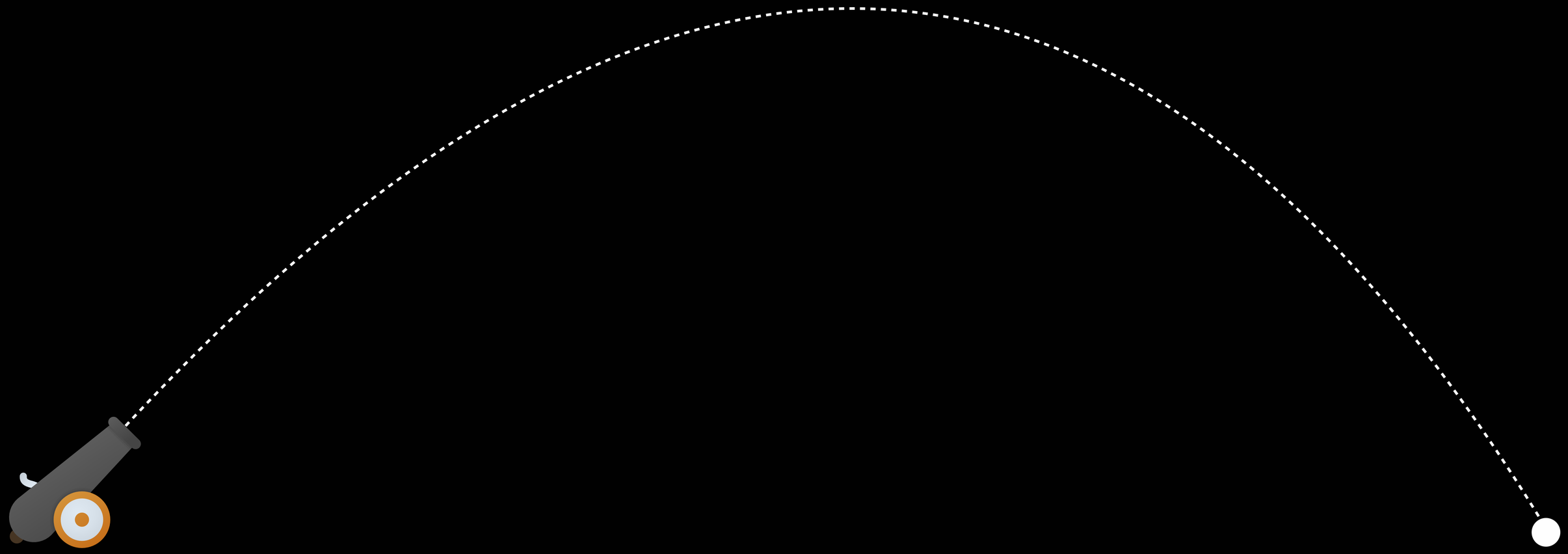
Reuse

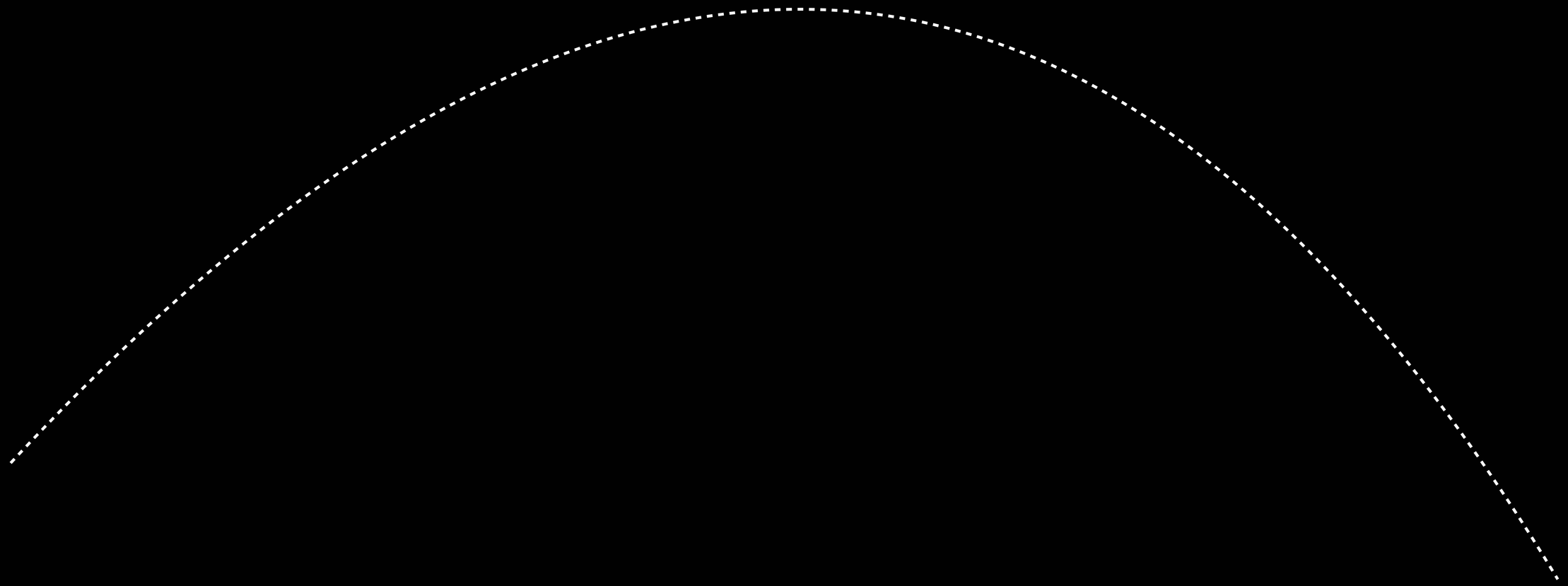
Reuse

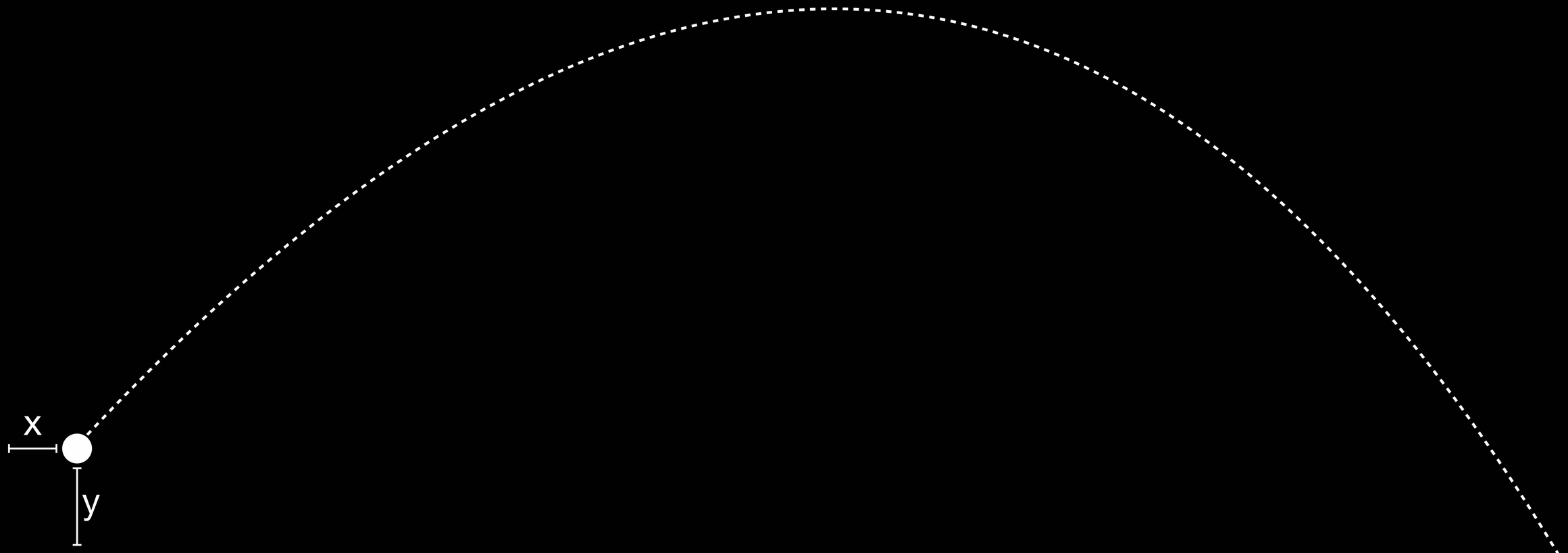


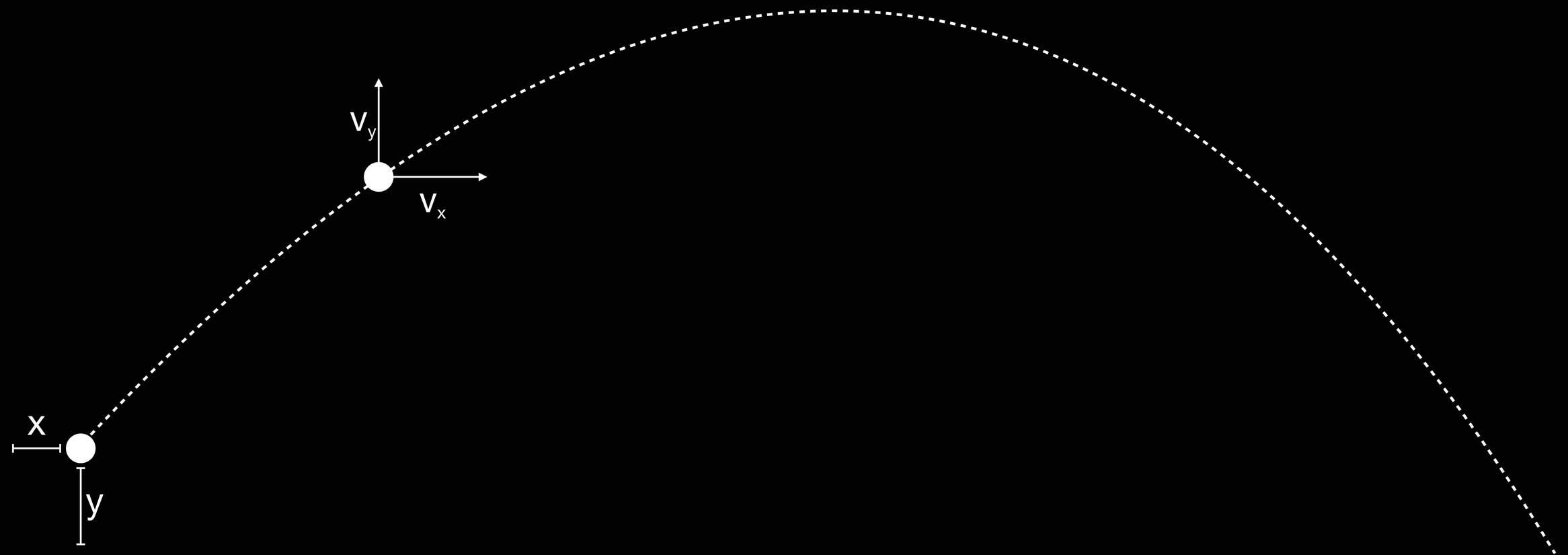
Reuse

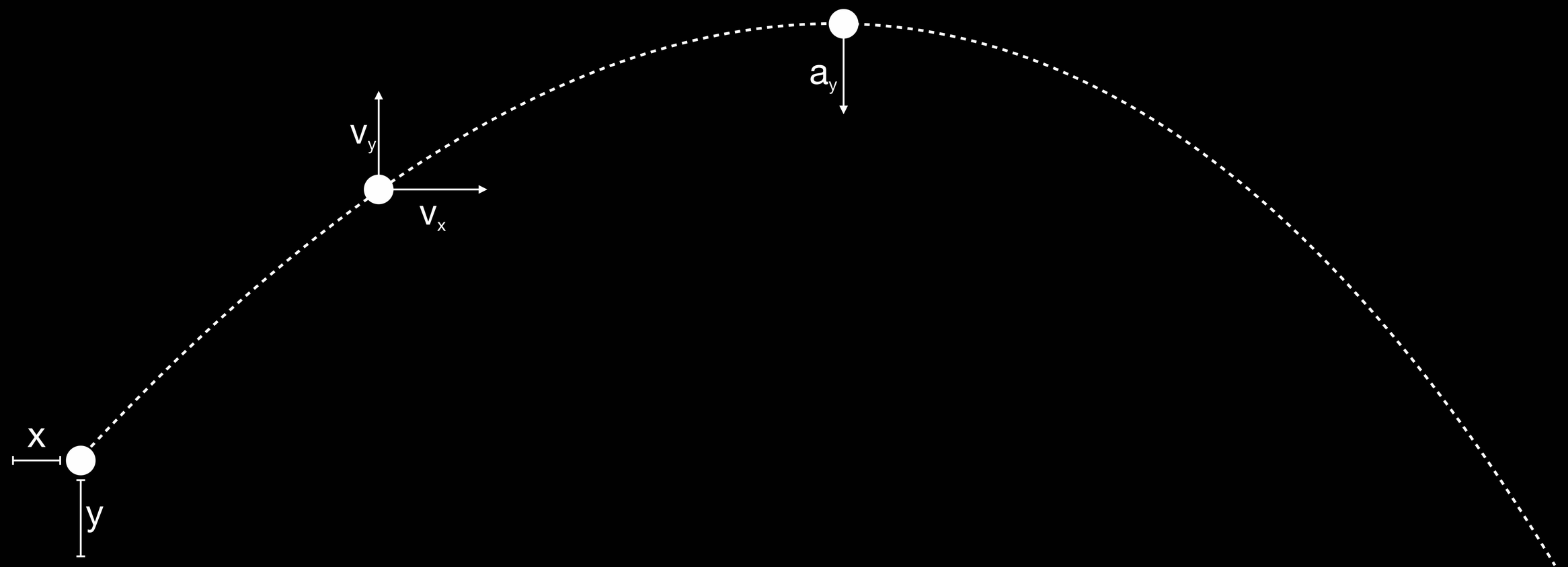


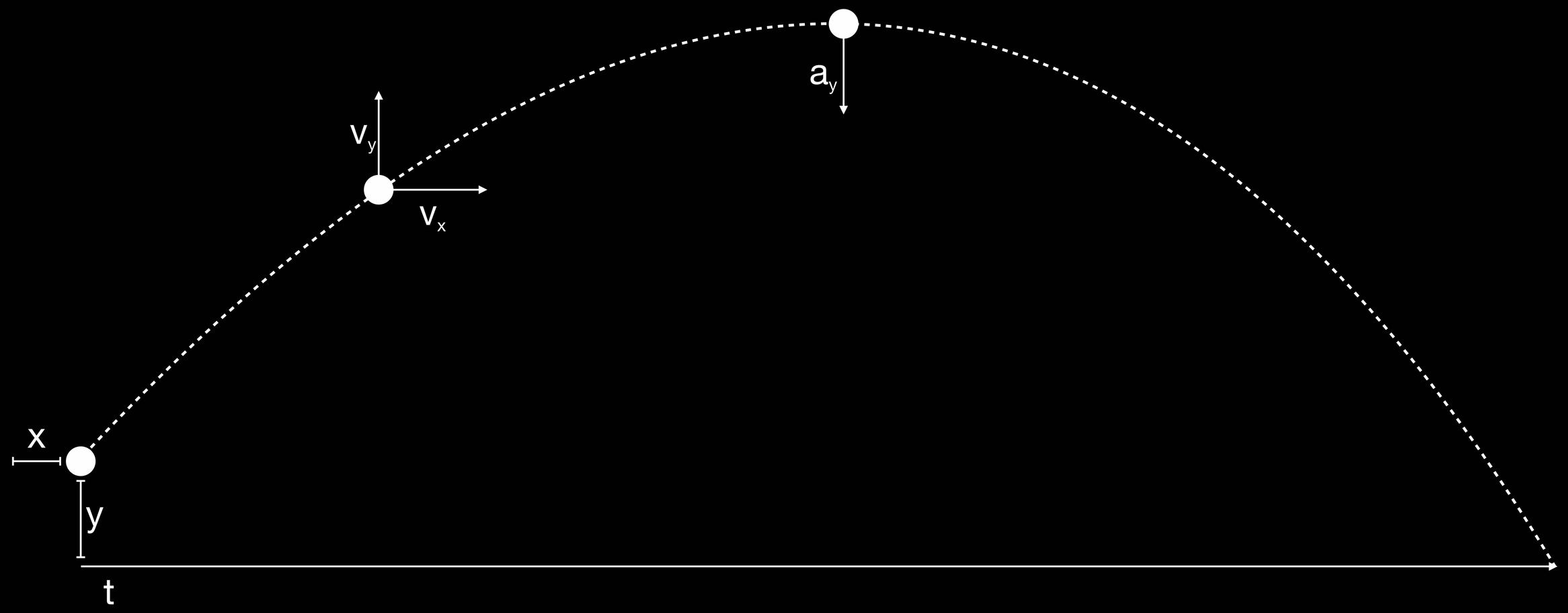




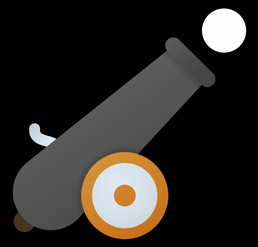

x
y


v_y
v_x
x
y


a_y
v_y
v_x
x
y


a_y
v_y
v_x
x
y
t

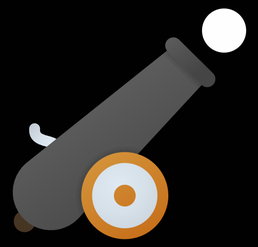
Concrete



Abstract

position
velocity
acceleration
time

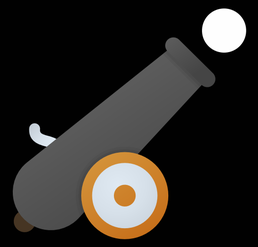
Concrete



Abstract

position
velocity
acceleration
time

Concrete



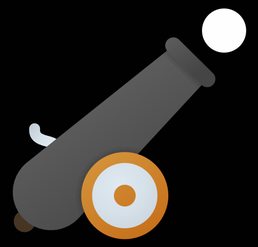
more information

Abstract

position
velocity
acceleration
time

less information

Concrete



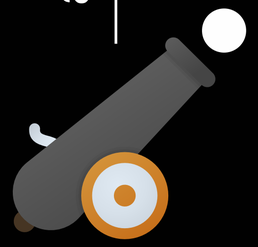
more information

Abstract

position
velocity
acceleration
time

less information

abstraction



Concrete

more information

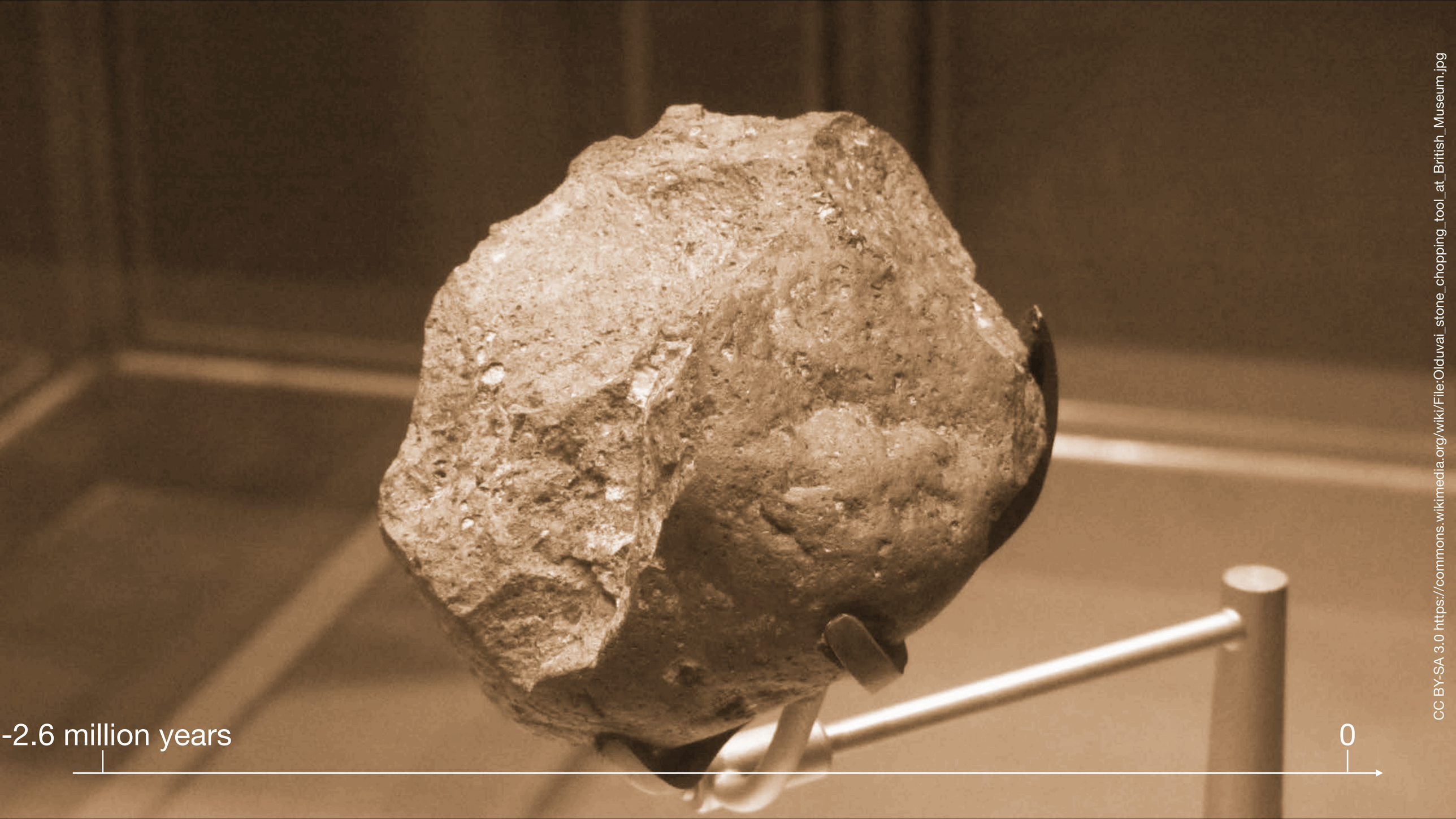
Model

abstraction

Domain

abstraction is a mapping from domain to model

Stone tools



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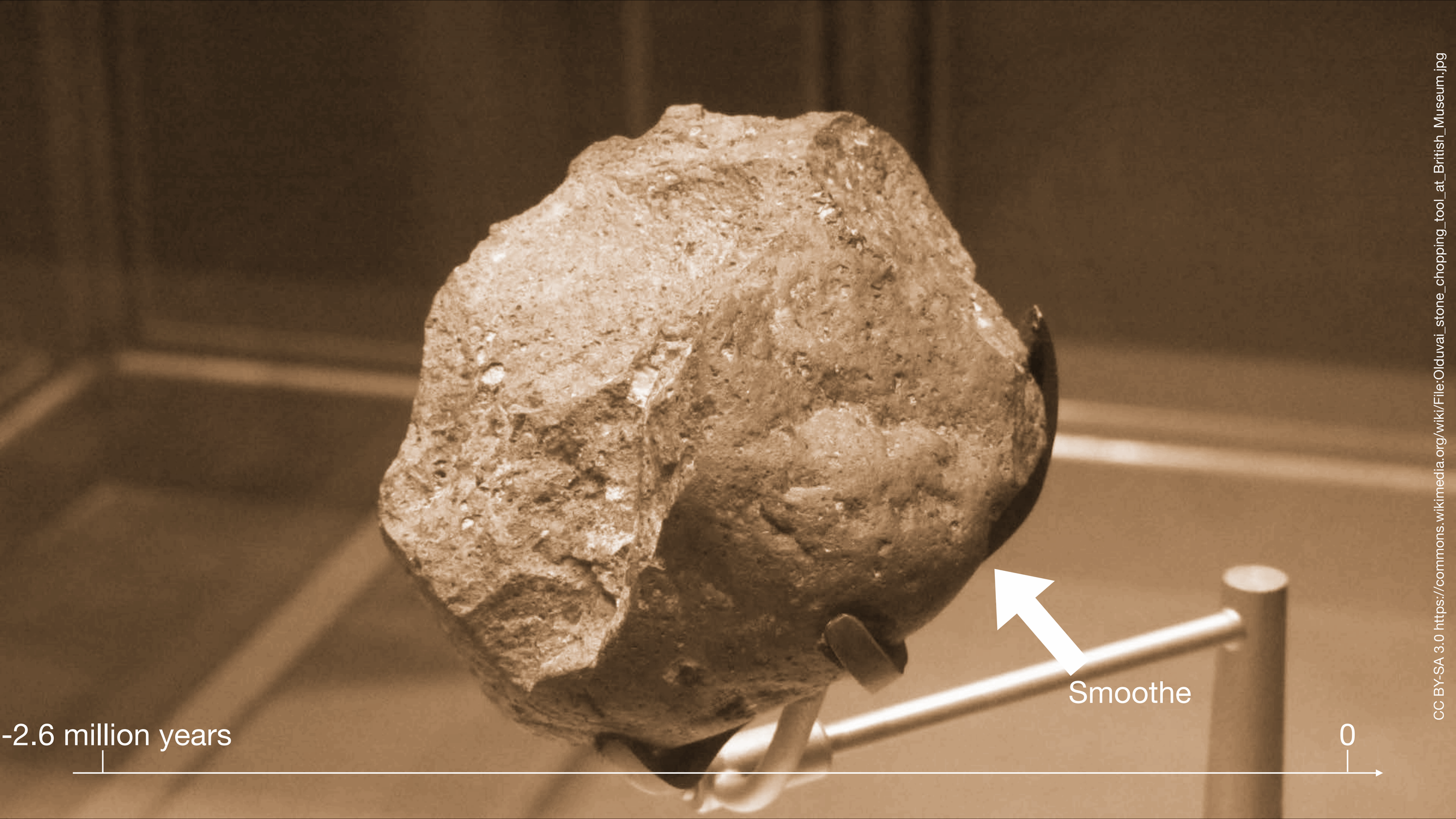

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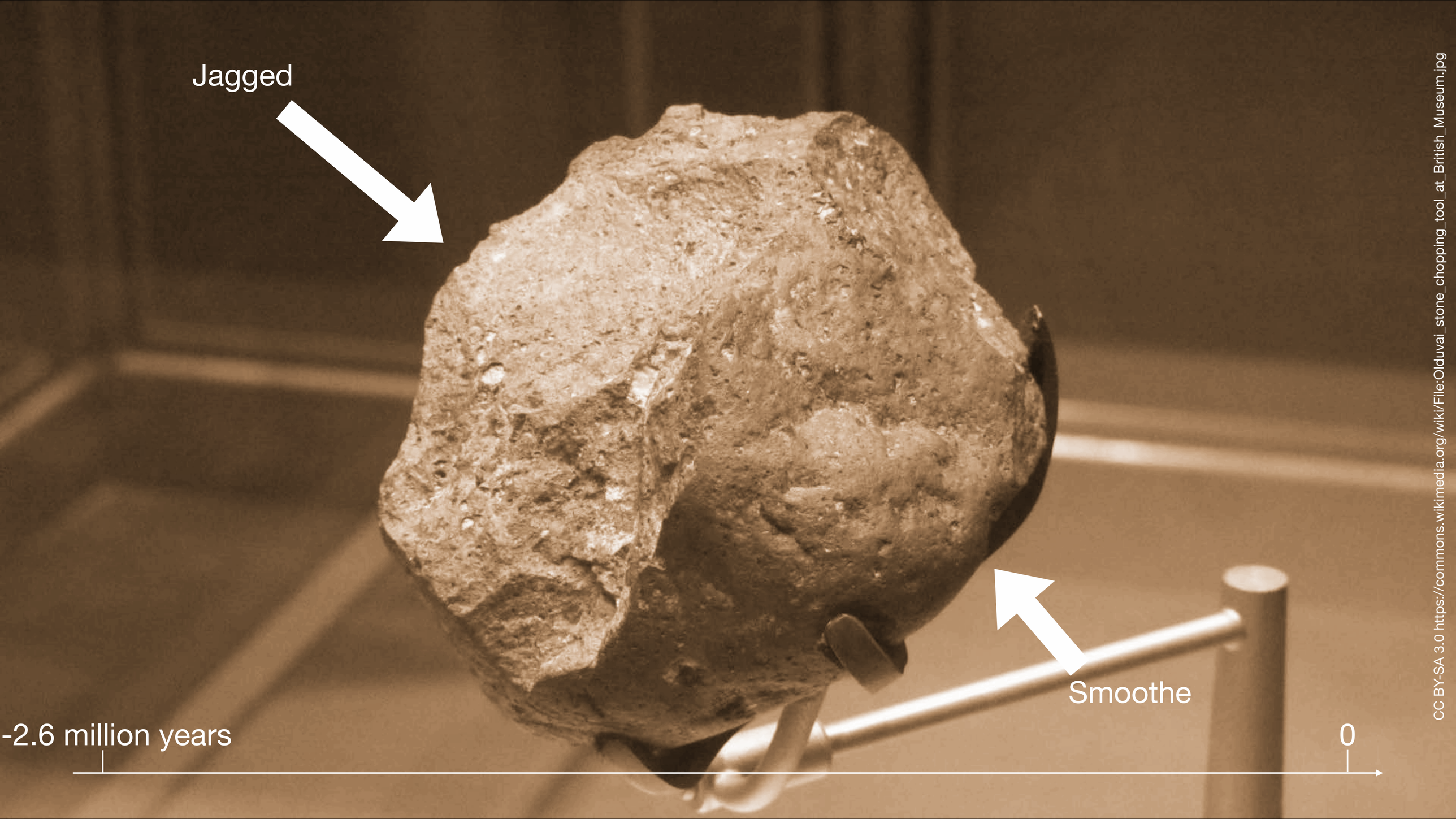
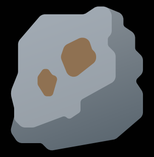


CC BY-SA 3.0 https://commons.wikimedia.org/wiki/File:Olduvai_stone_chopping_tool_at_British_Museum.jpg

Concrete



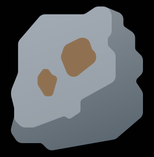
abstraction

Concrete

rock

abstraction

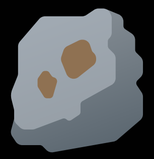
Concrete



Abstract rock

abstraction

Concrete



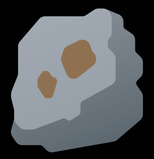
Abstract

rock

imagine

abstraction

Concrete



Abstract

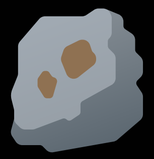
rock

imagine →

scraper

abstraction ↑

Concrete



Abstract

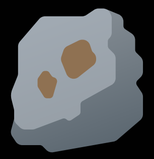
rock

imagine →

scraper

abstraction ↑

Concrete



bang →

Abstract

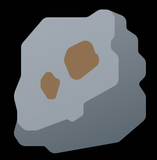
rock

imagine →

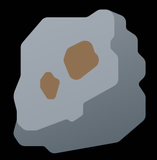
scraper

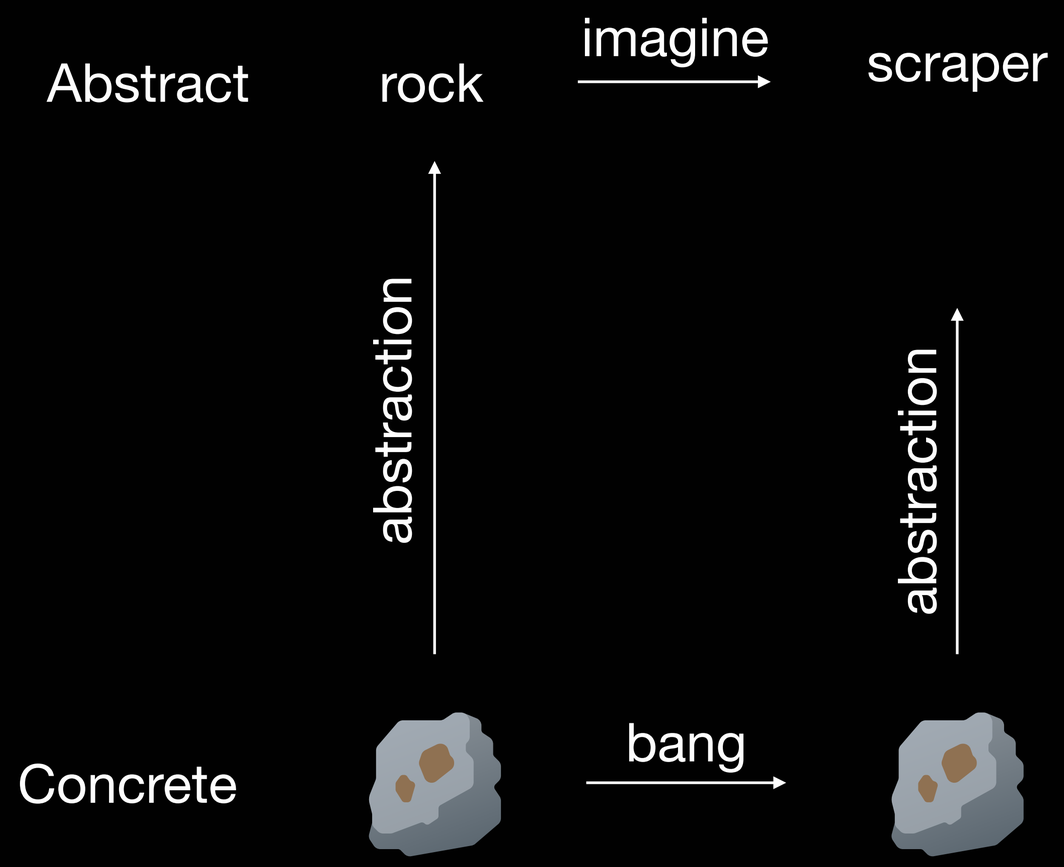
abstraction ↑

Concrete



bang →

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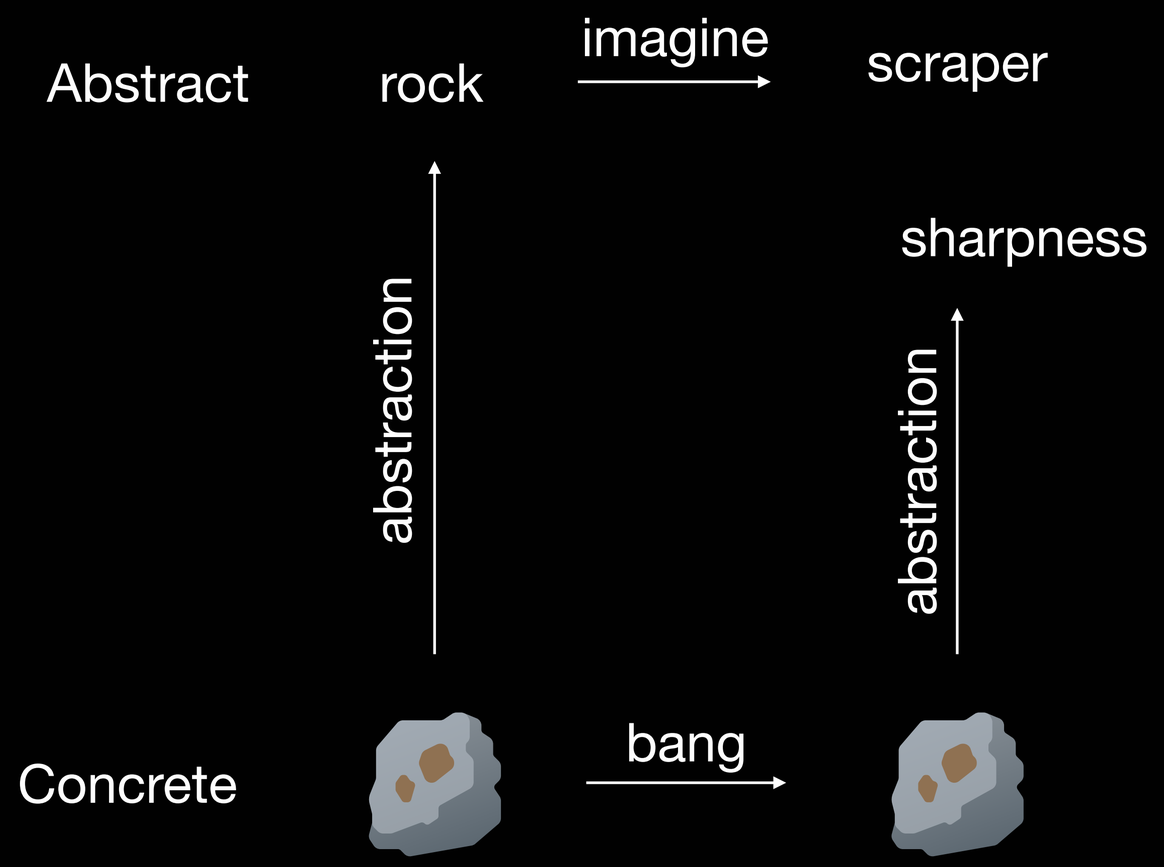
rock
imagine
scraper
abstraction
abstraction
Concrete
bang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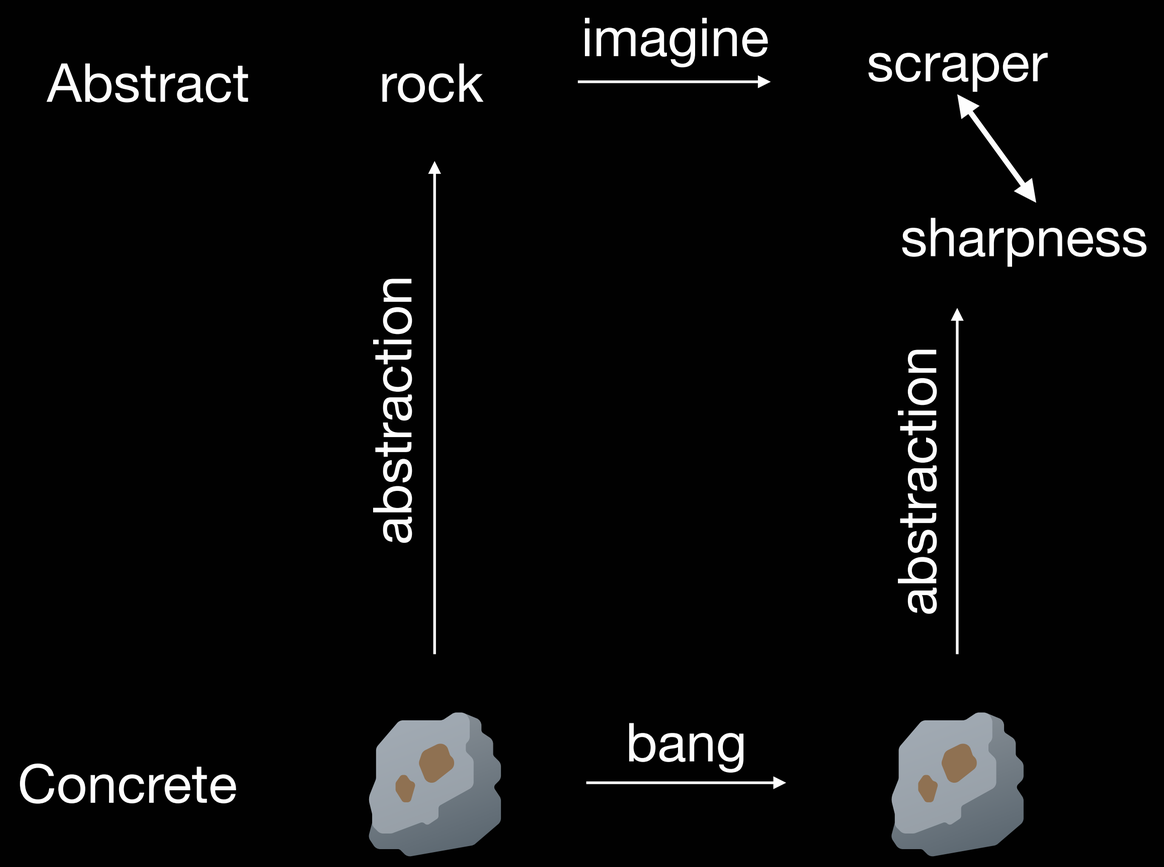
scraper
abstraction
sharpness
abstraction
Concrete
bang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rock
imagine
scraper
sharpness
abstraction
abstraction
Concrete
bang

Abstract

rock

imagine

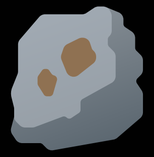
scraper

sharpness

abstraction

abstraction

Concrete



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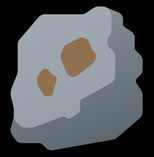

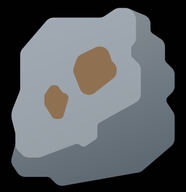

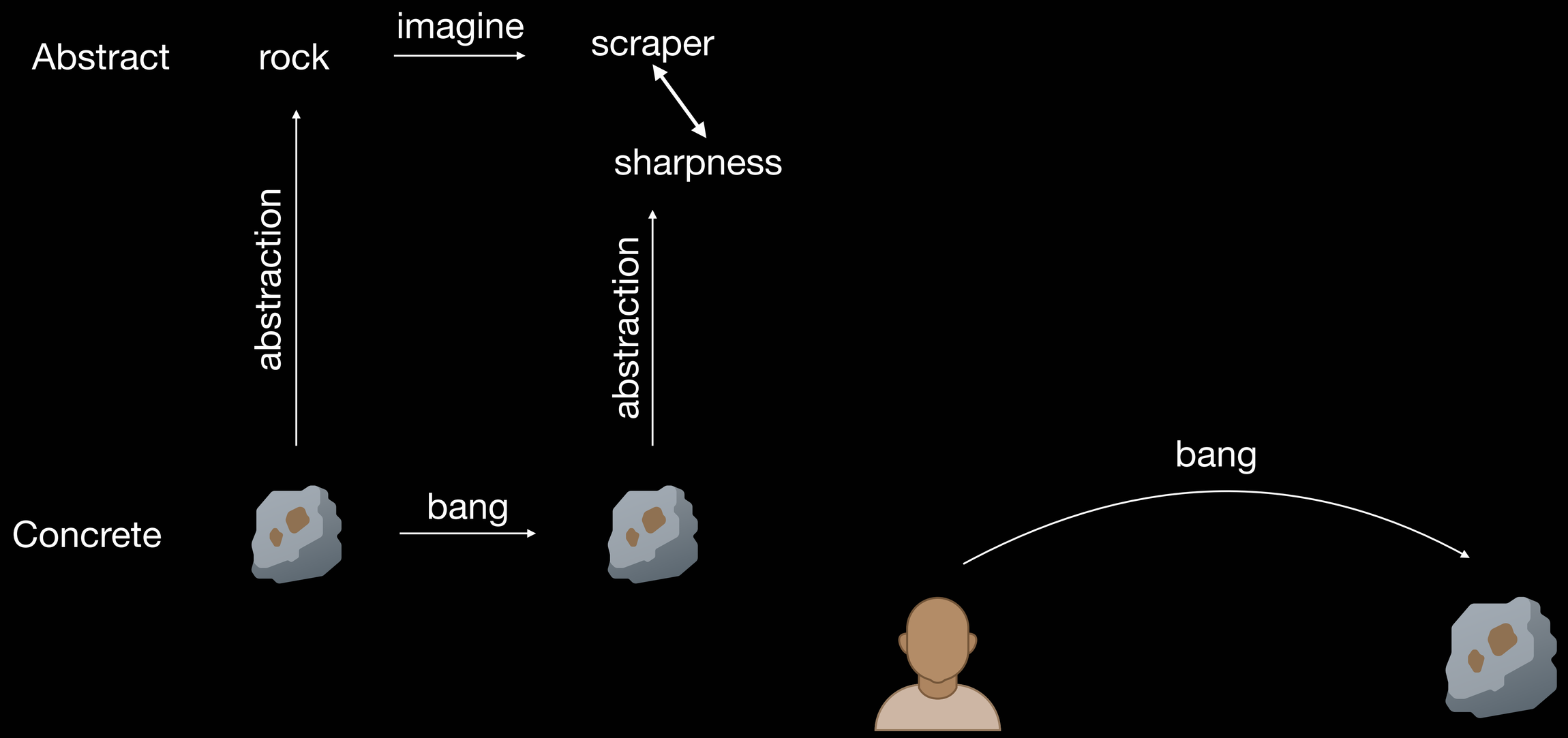
Abstract
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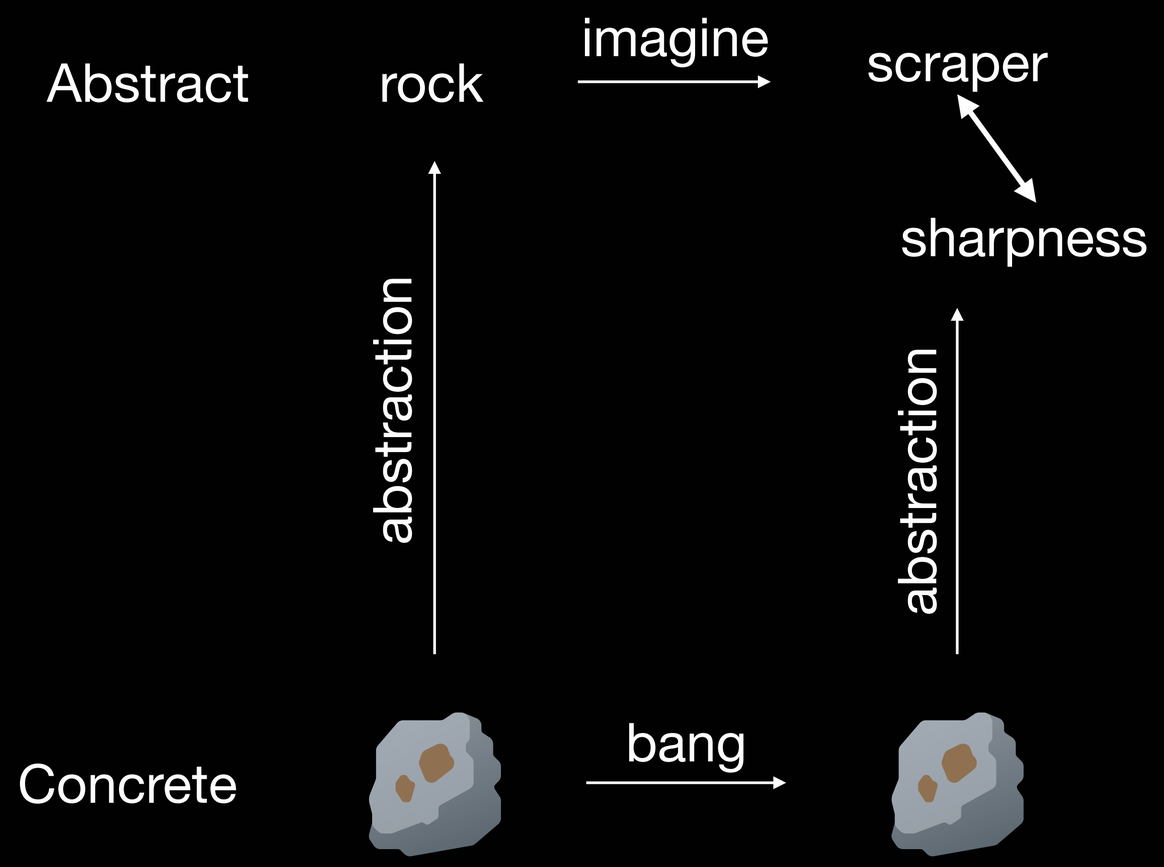
scraper
sharpness
abstraction
abstraction
Concrete
bang
bang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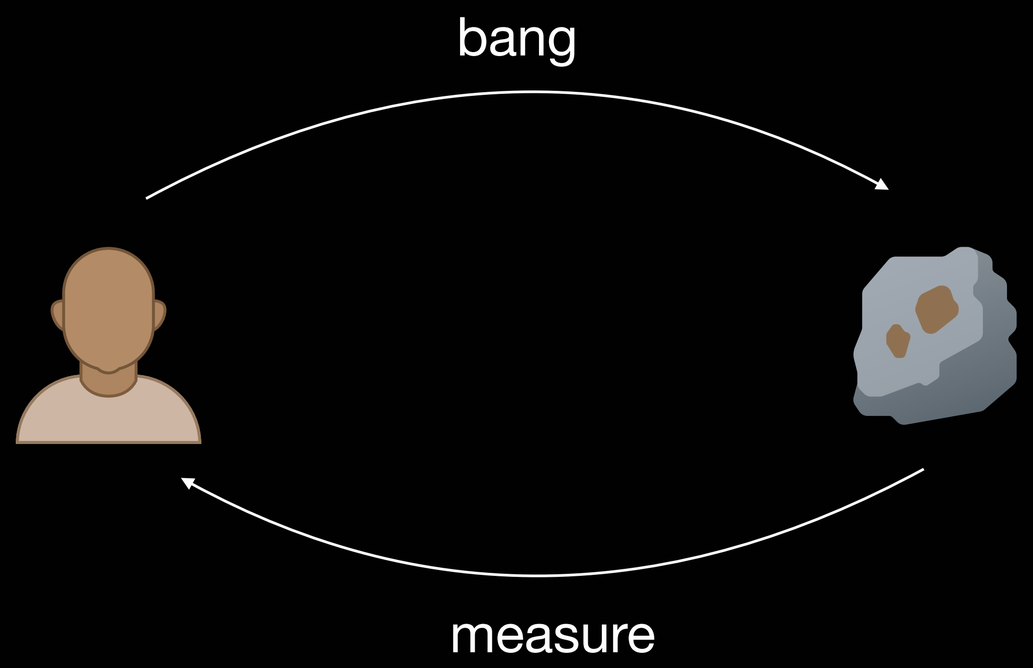
bang
measure

-1.4 million years

-2.6 million years

0

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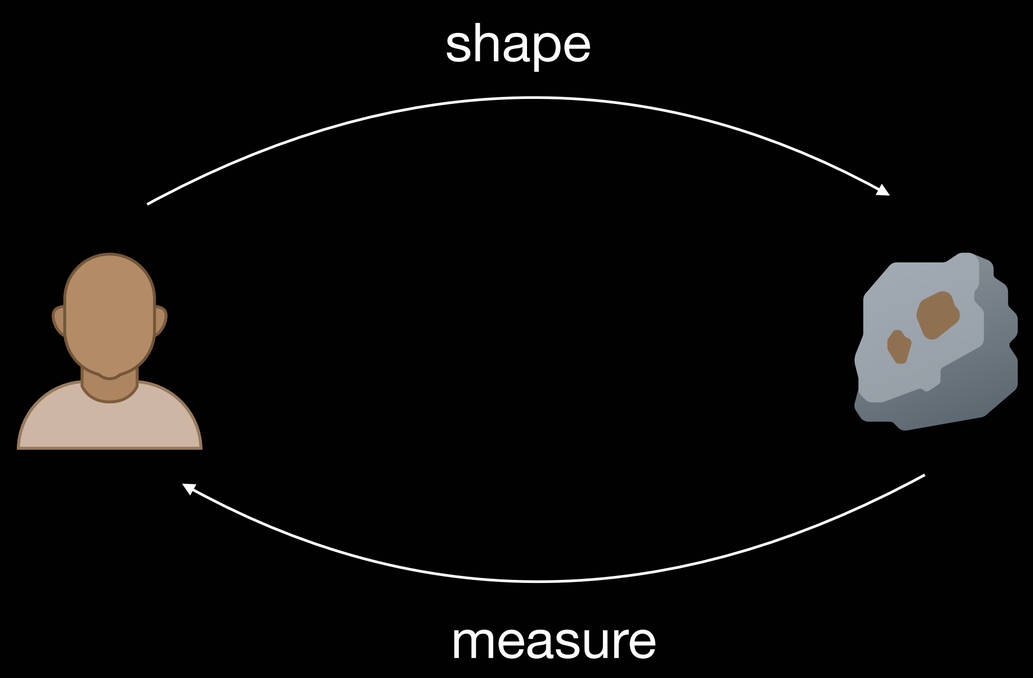
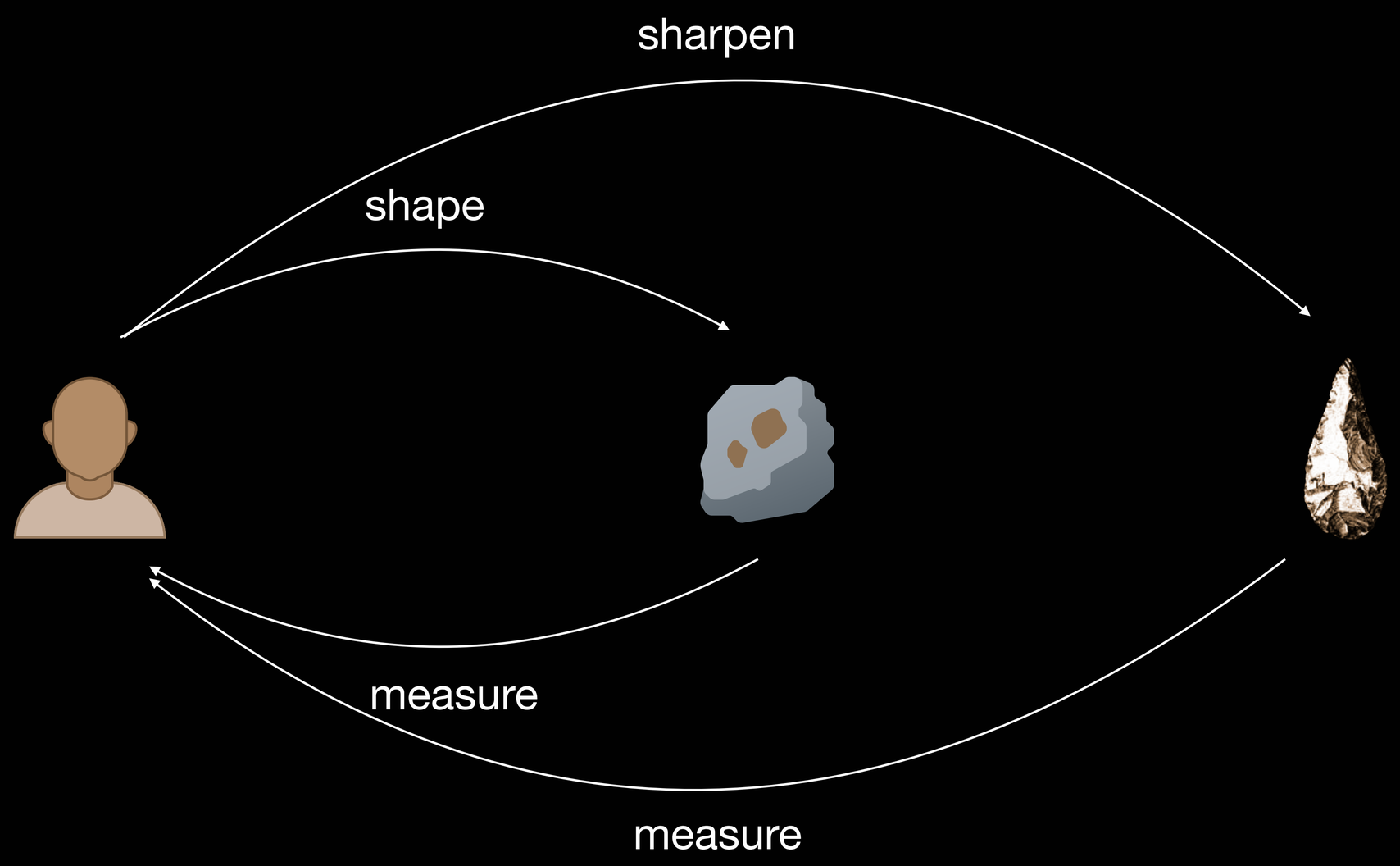
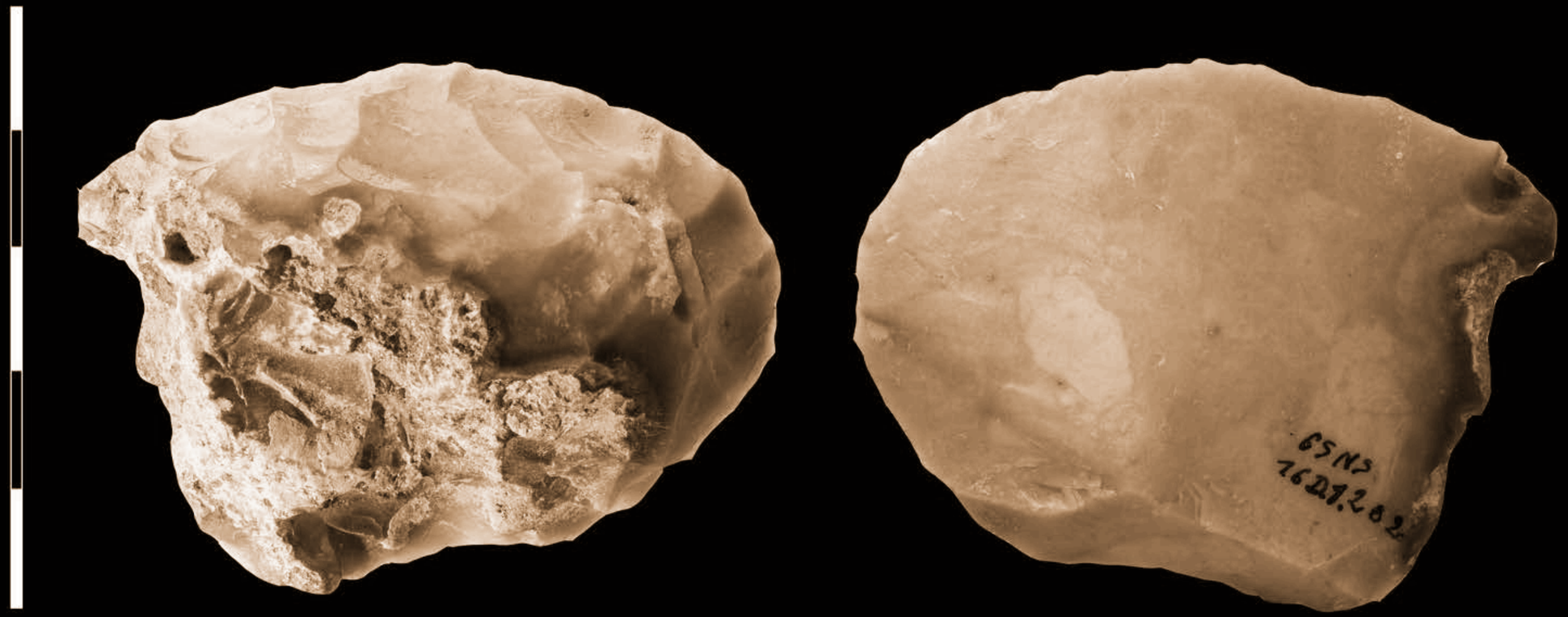
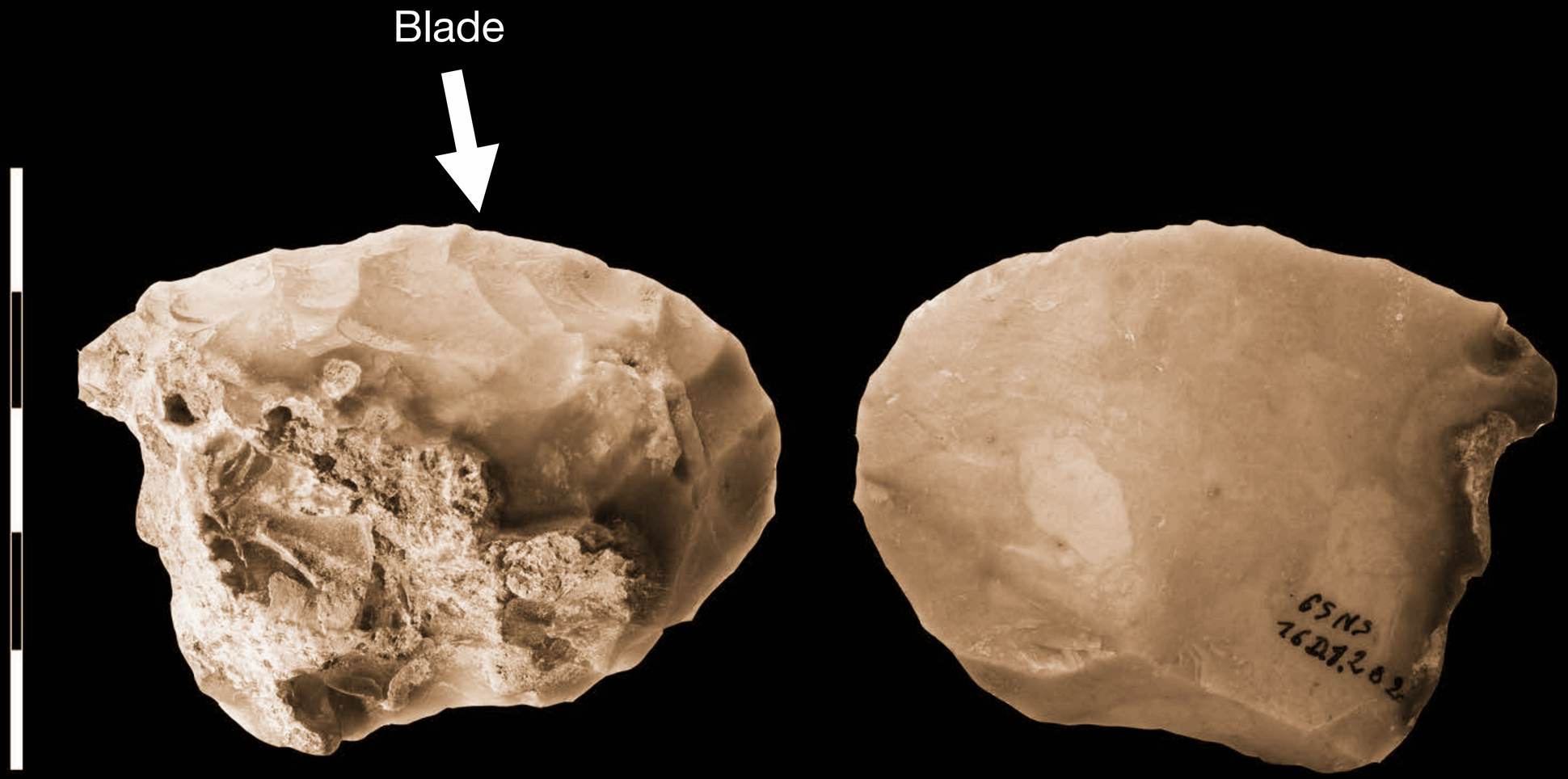

shape
measure


sharpen
shape
measure
measure



-2.6 million years -200 thousand years 0

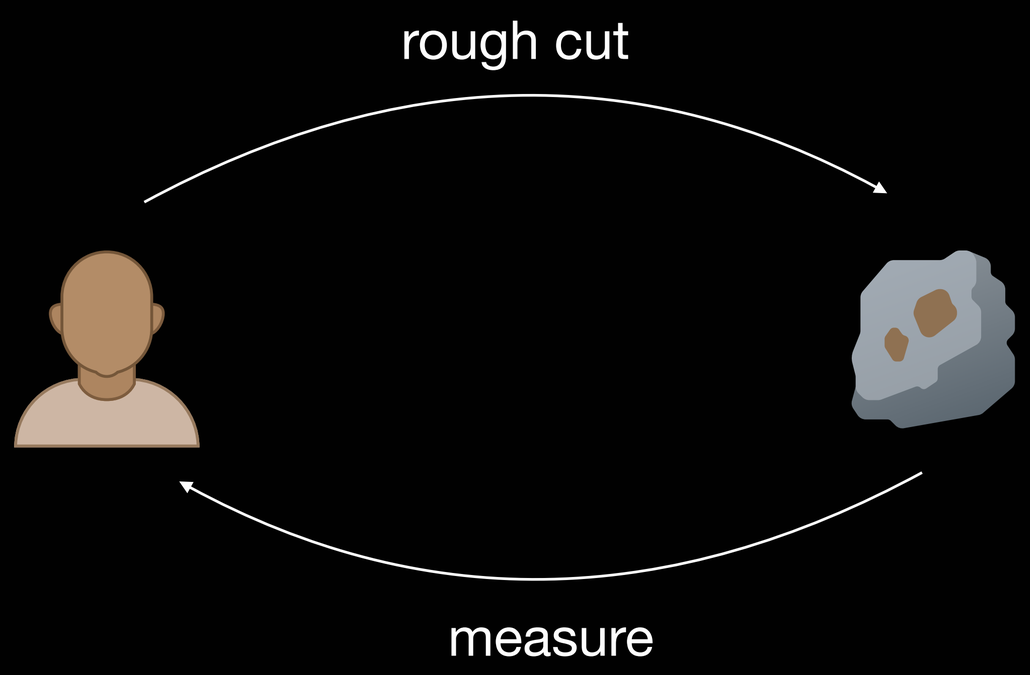
CC BY-SA 3.0 https://commons.wikimedia.org/wiki/File:Racloir_silex.jpg



-2.6 million years -200 thousand years 0

CC BY-SA 3.0 https://commons.wikimedia.org/wiki/File:Racloir_silex.jpg

CC By 4.0 https://wellcomecollection.org/works/up9n6r9j



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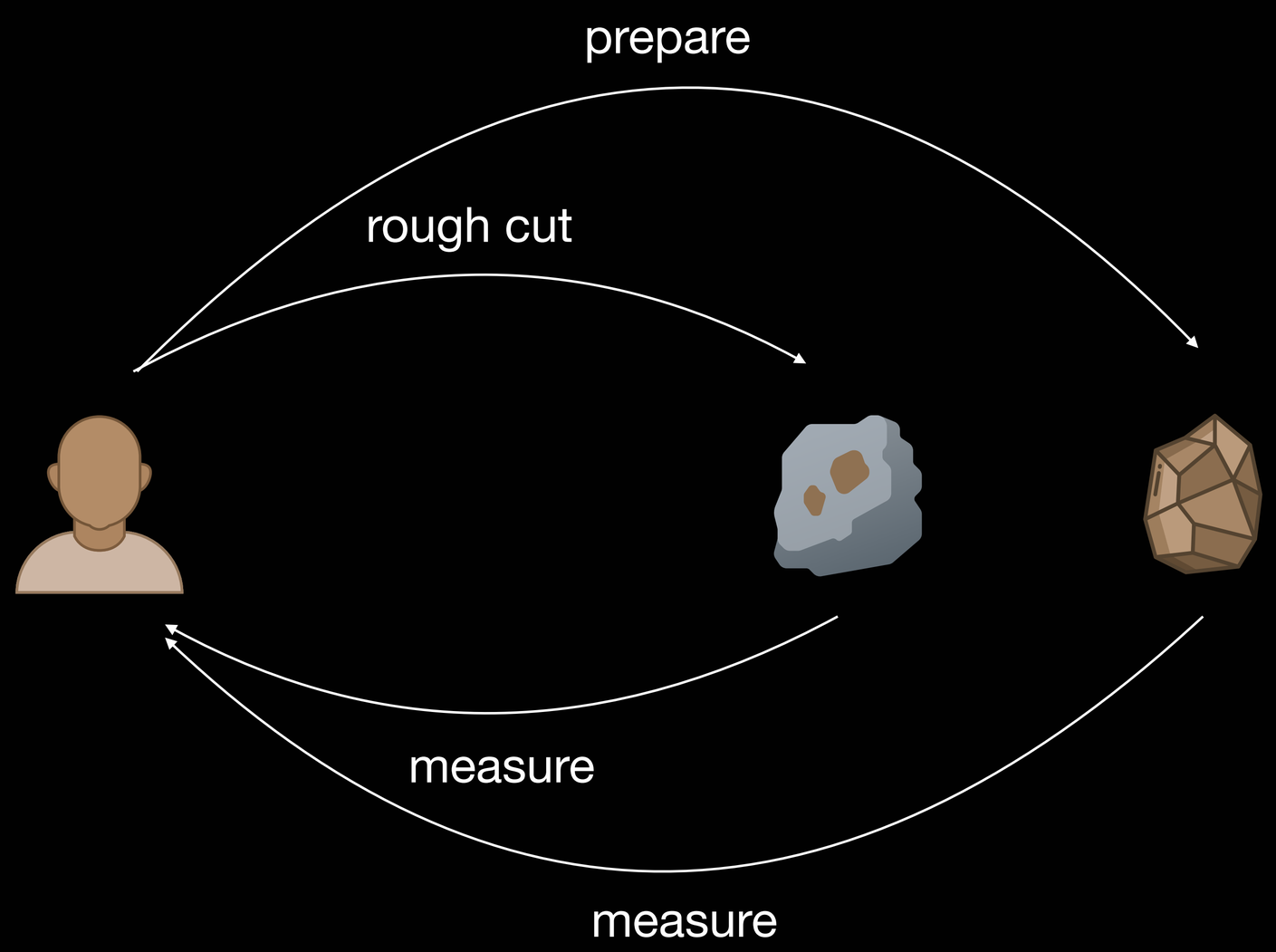

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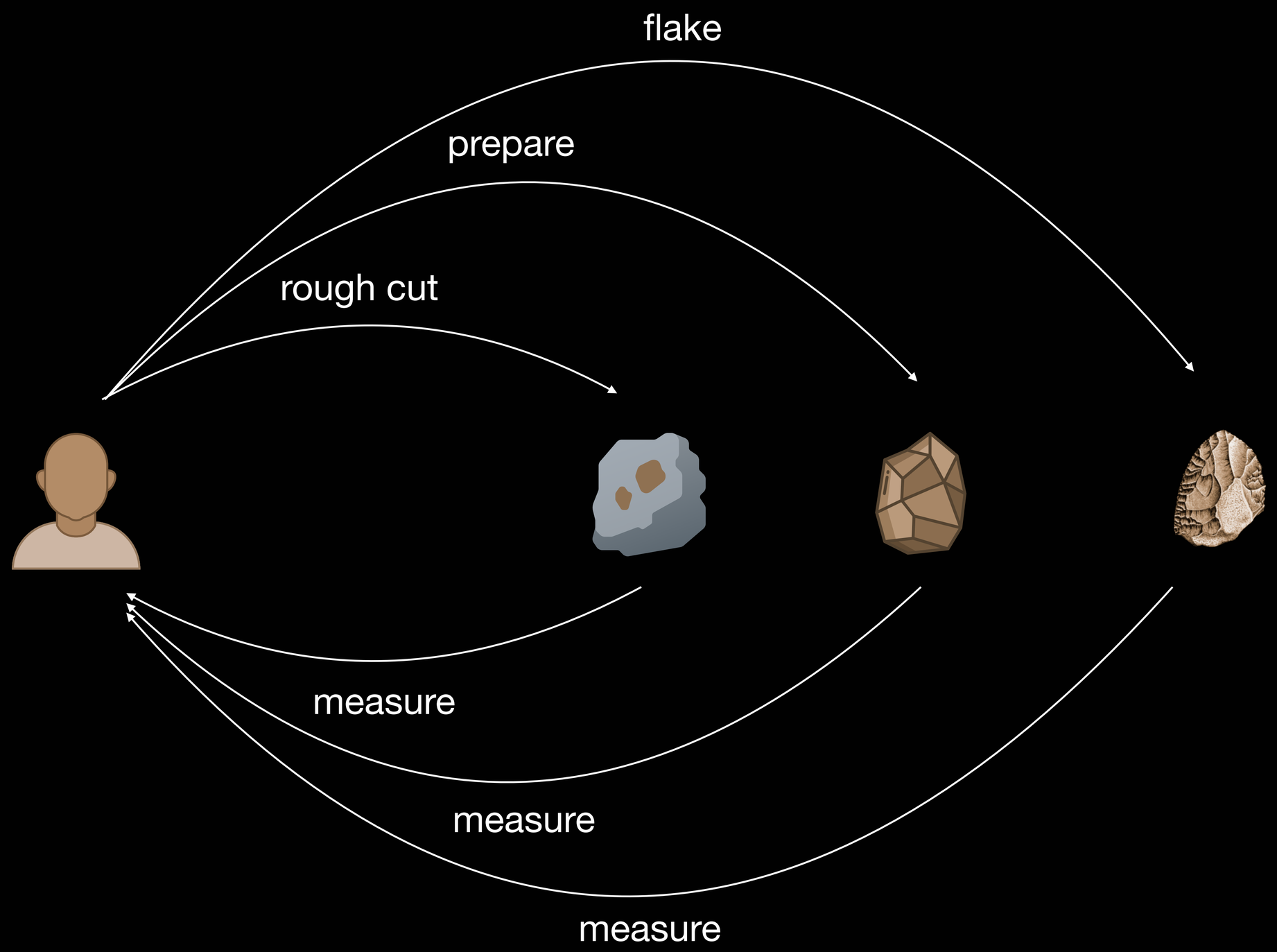

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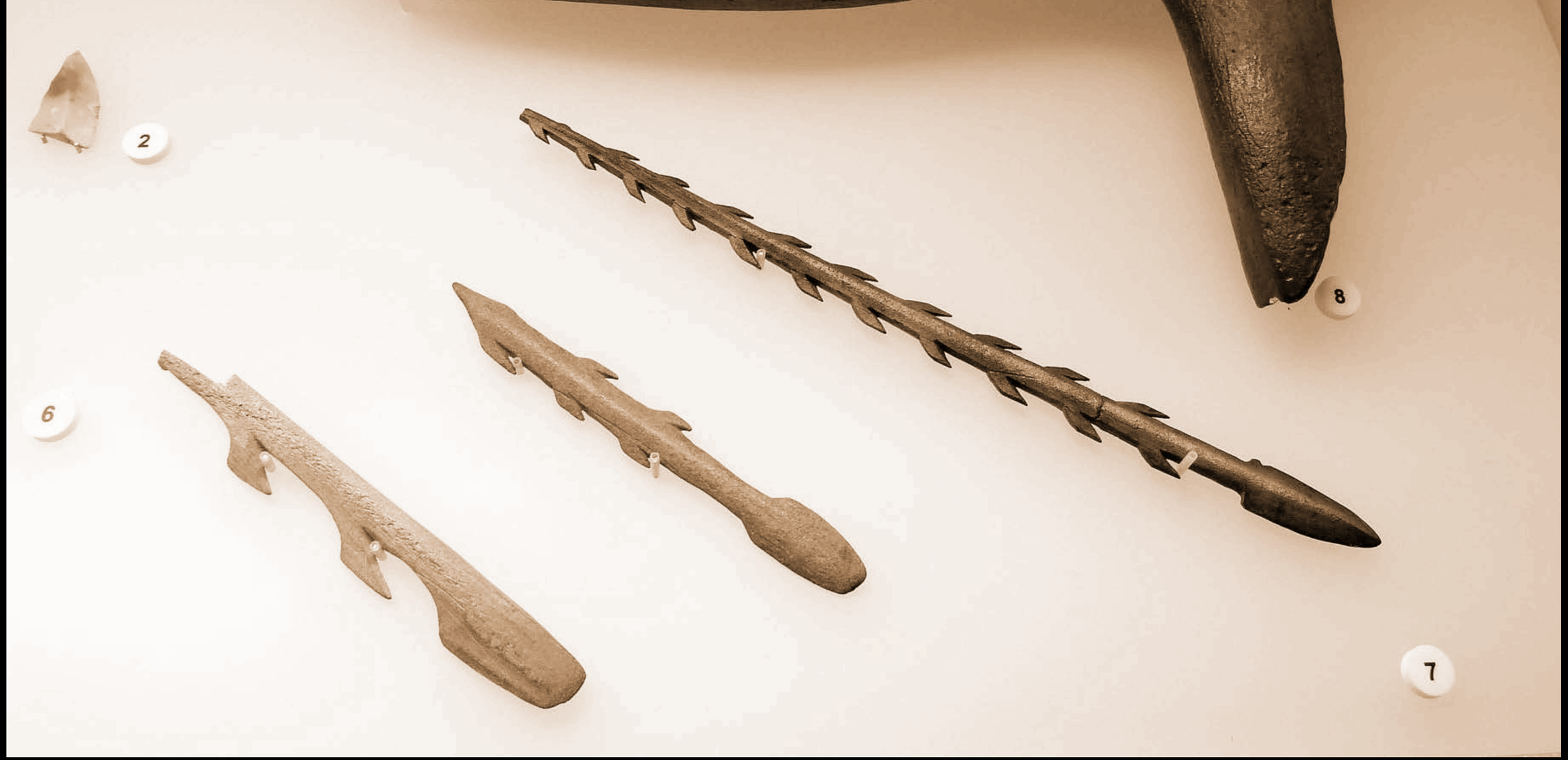

CC BY-SA 4.0 https://commons.wikimedia.org/wiki/File:ALB_-_Mesolithische_Harpunen_und_Lingby-Beil.jpg

-2.6 million years

-30 thousand years

0

feedback

planning

Arithmetic

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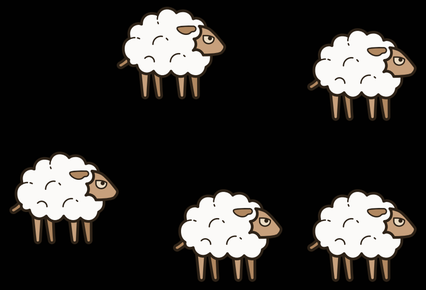
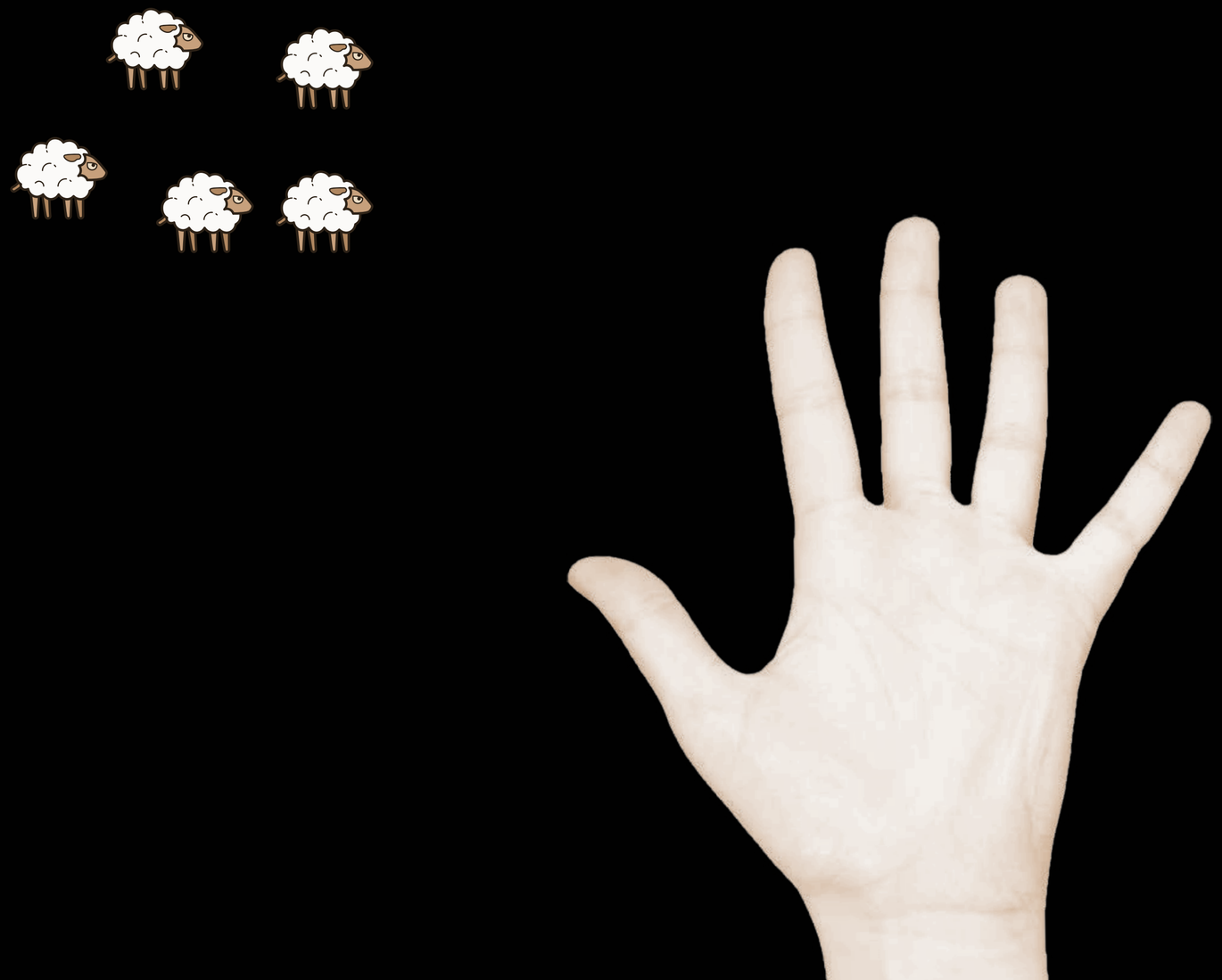
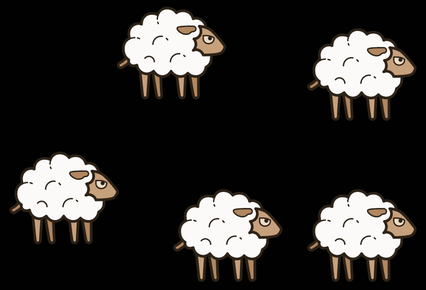
-2.6 million years

-20 thousand years

0







one two three four five ...

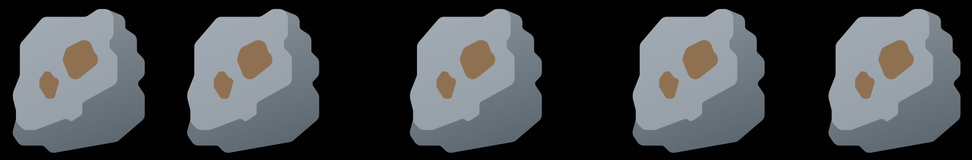
one two three four five ...

one two three four five ...

one two three four five ...

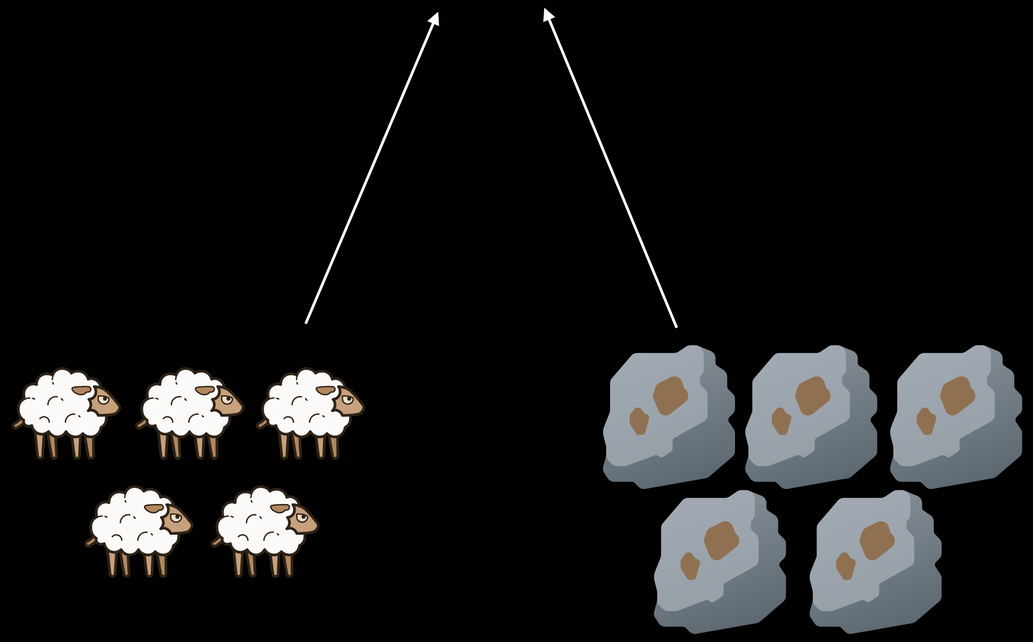
one two three four five …

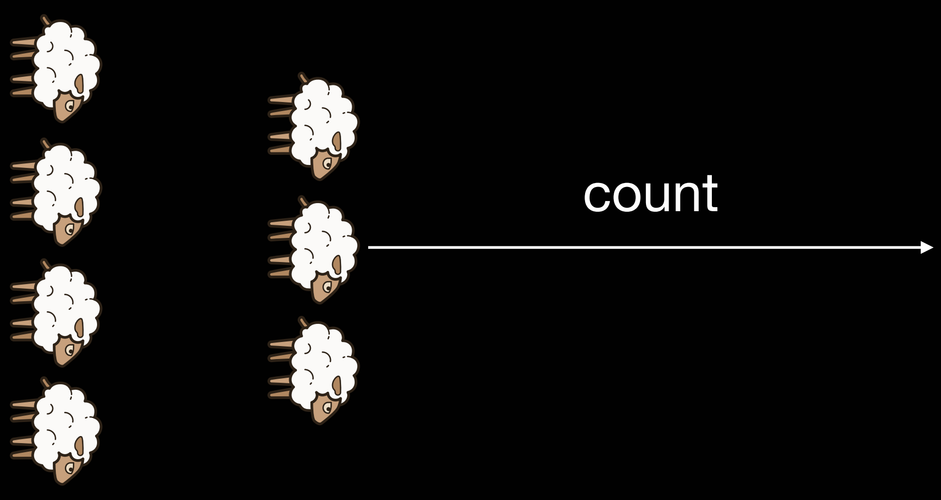
one two three four five …



one two three four five …

5




count

3

4

count

3

add

4

count

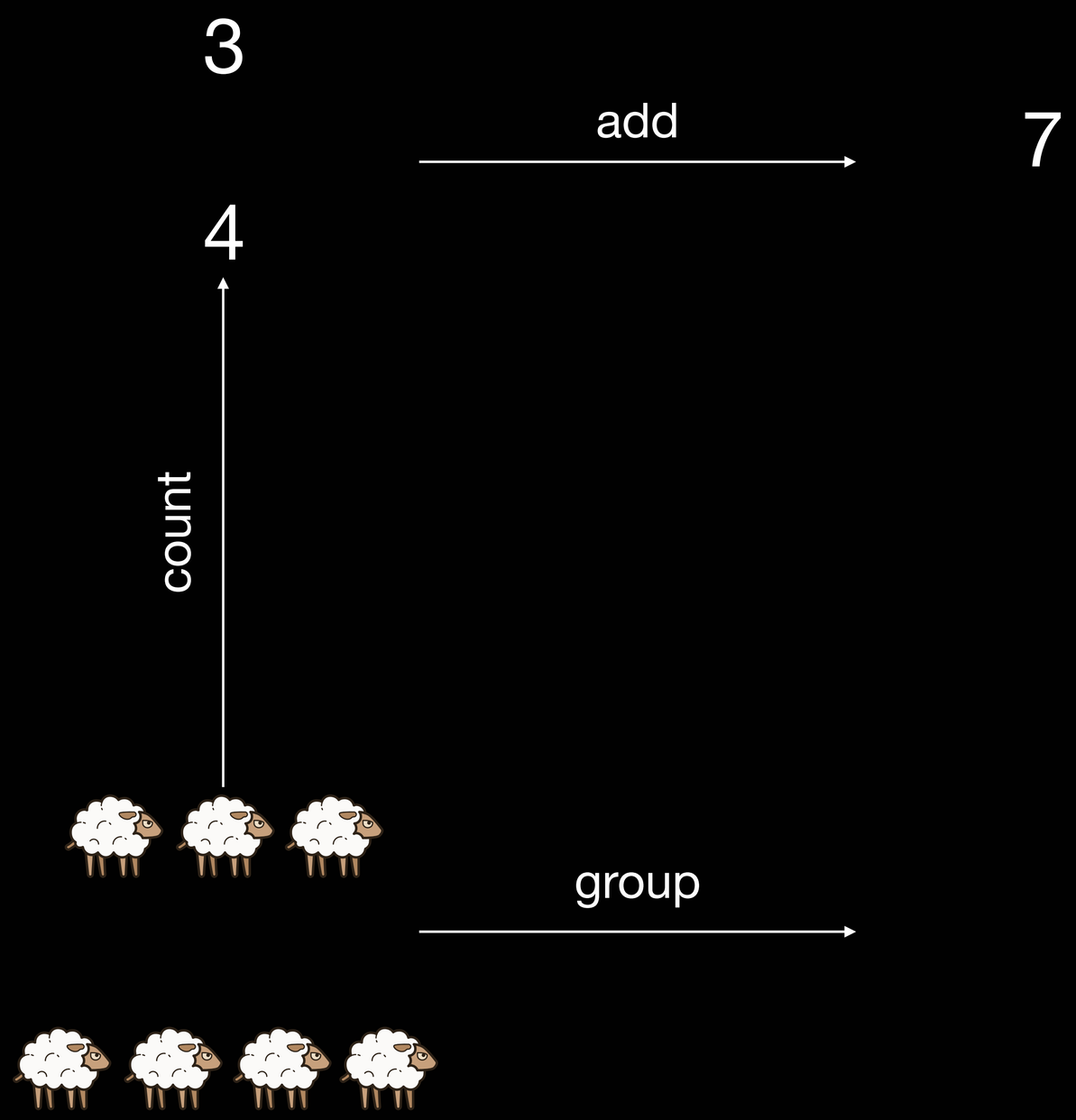
3

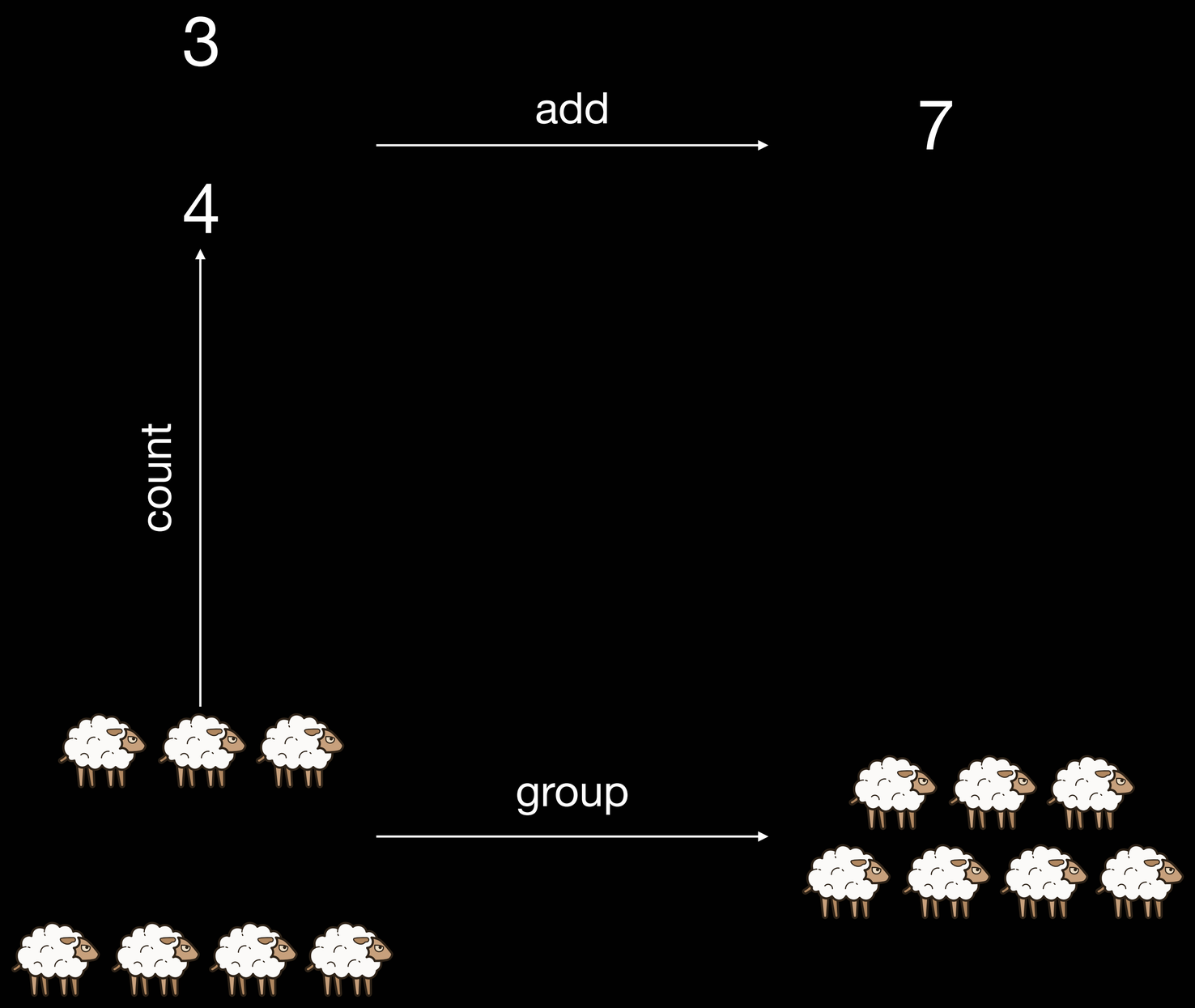
add

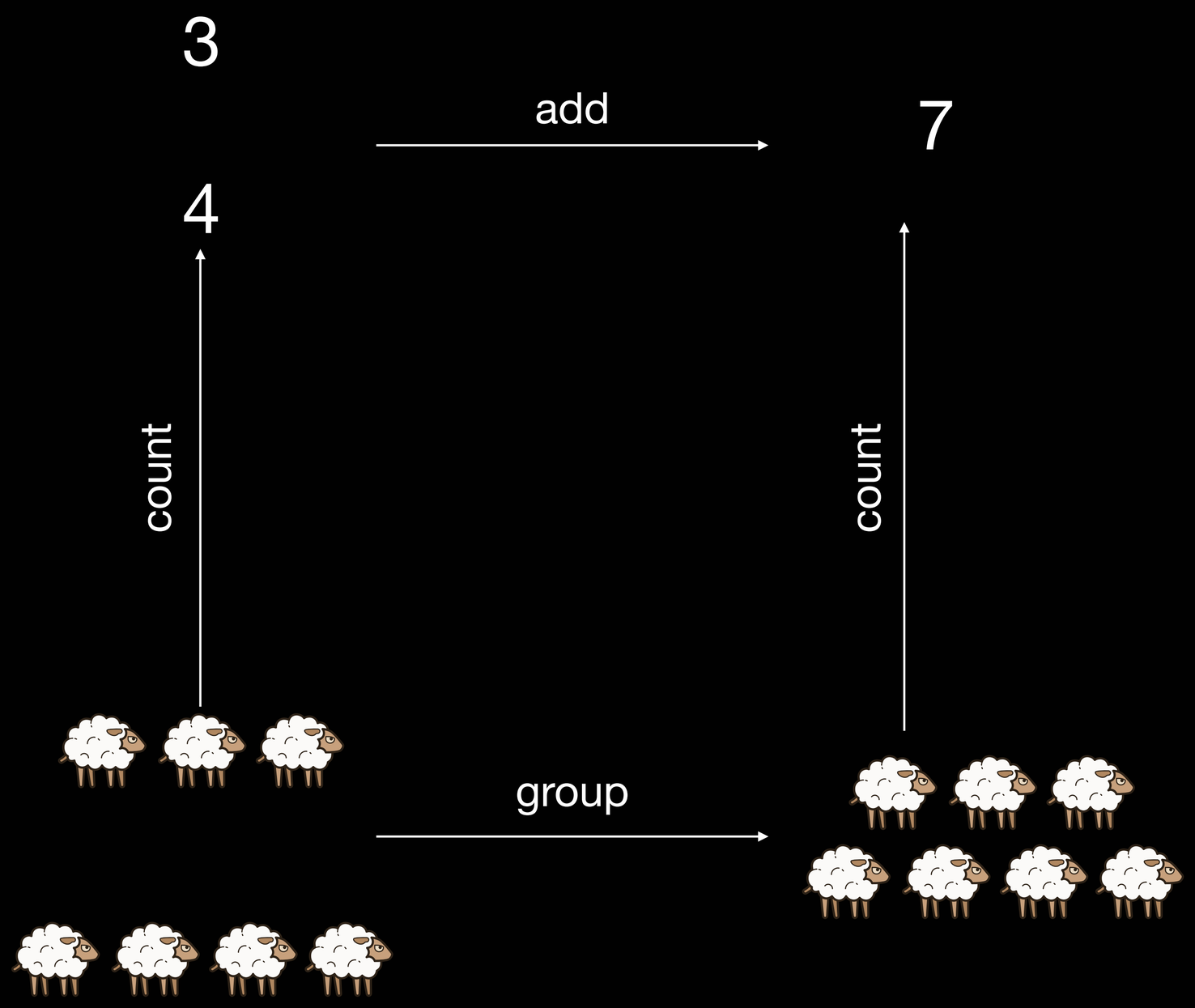
7

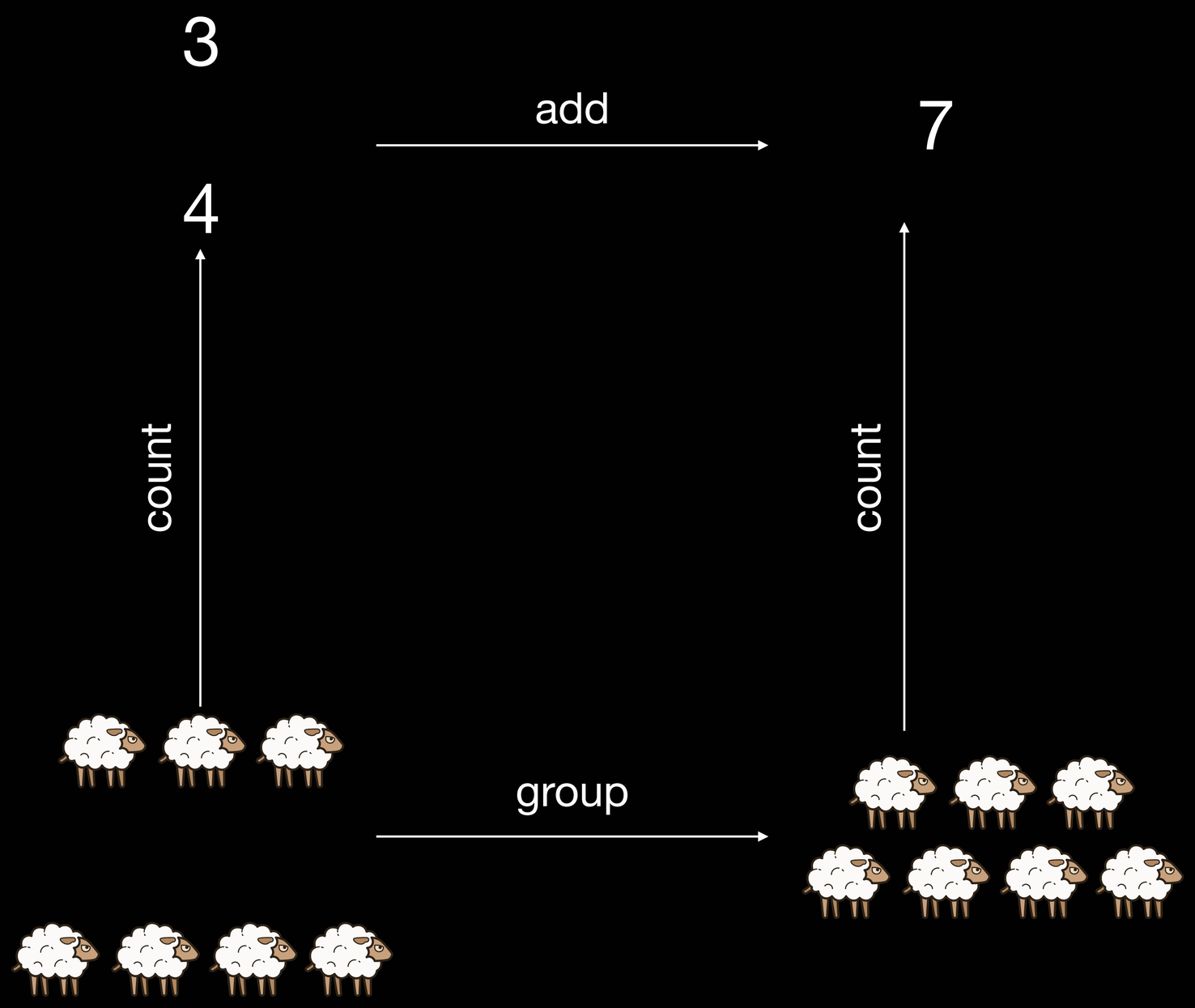
4

count

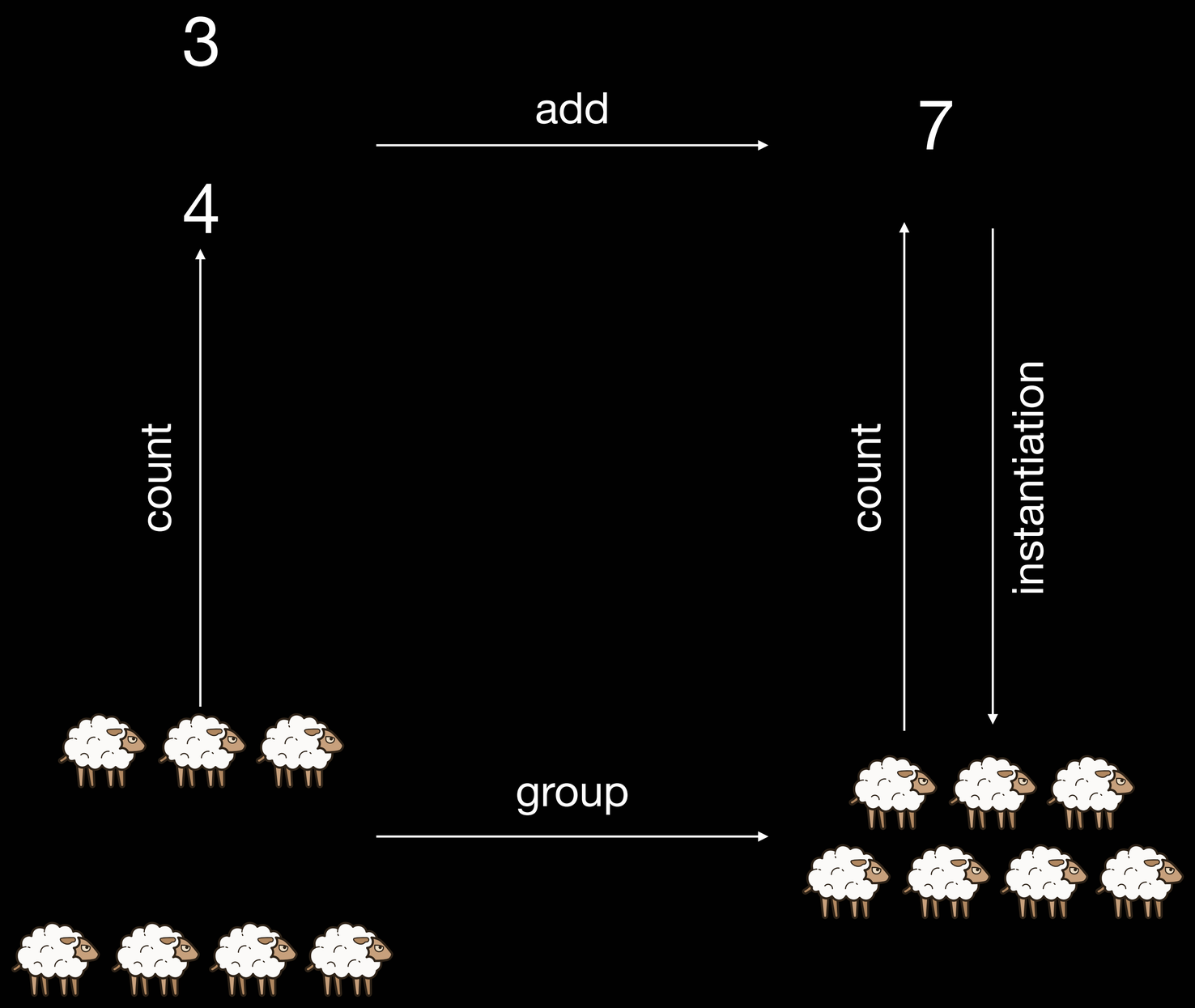

3
add
7
4
count
group


3
add
7
4
count
group

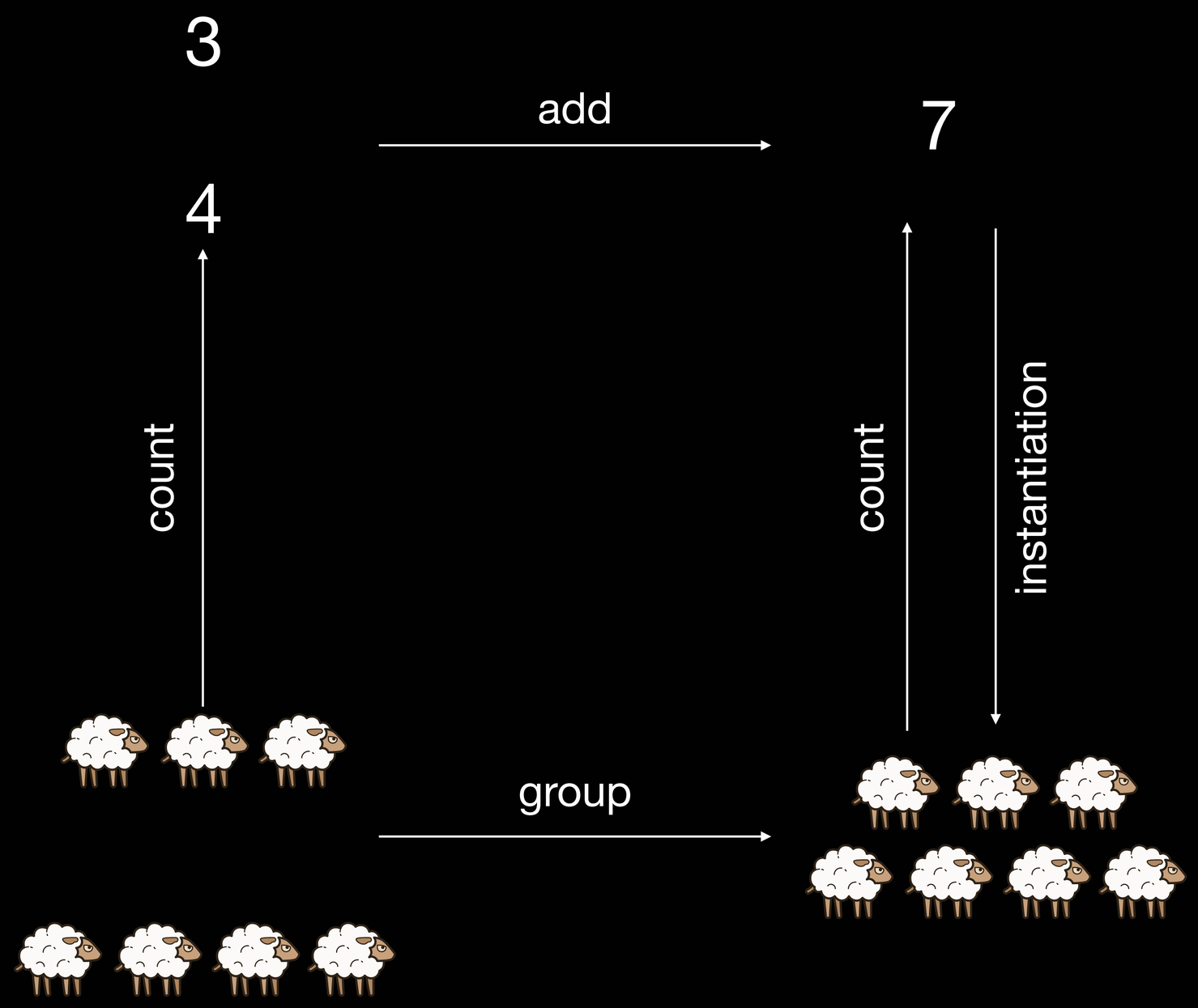

3
add
7
4
count
count
group



homomorphism

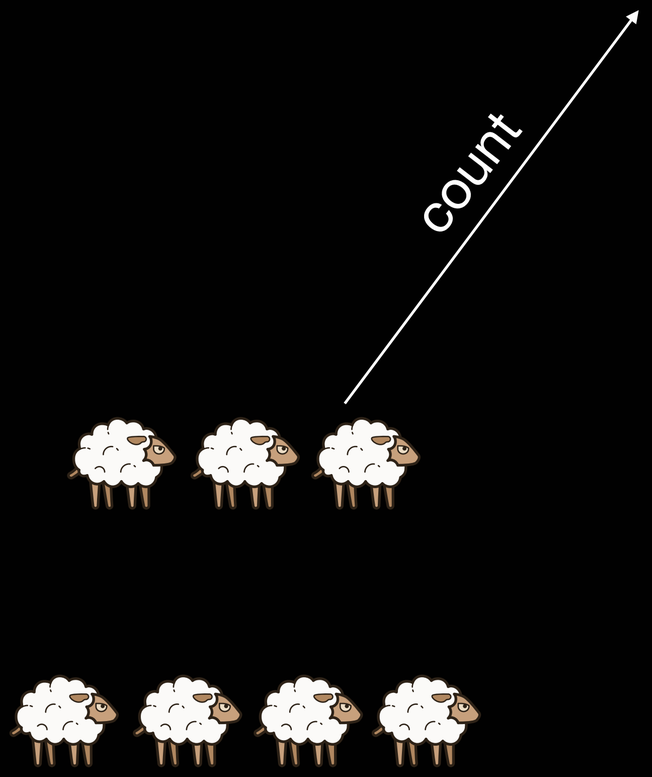


homomorphism



homomorphism

right inverse


count

3

4

count

3

4

count

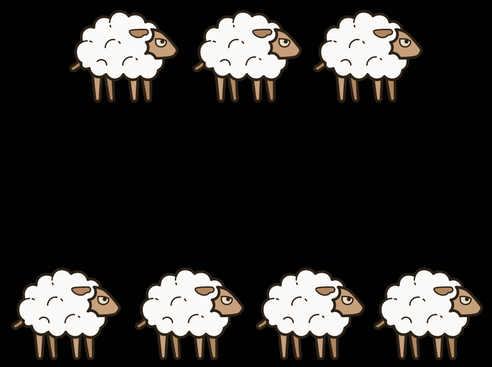
instantiate

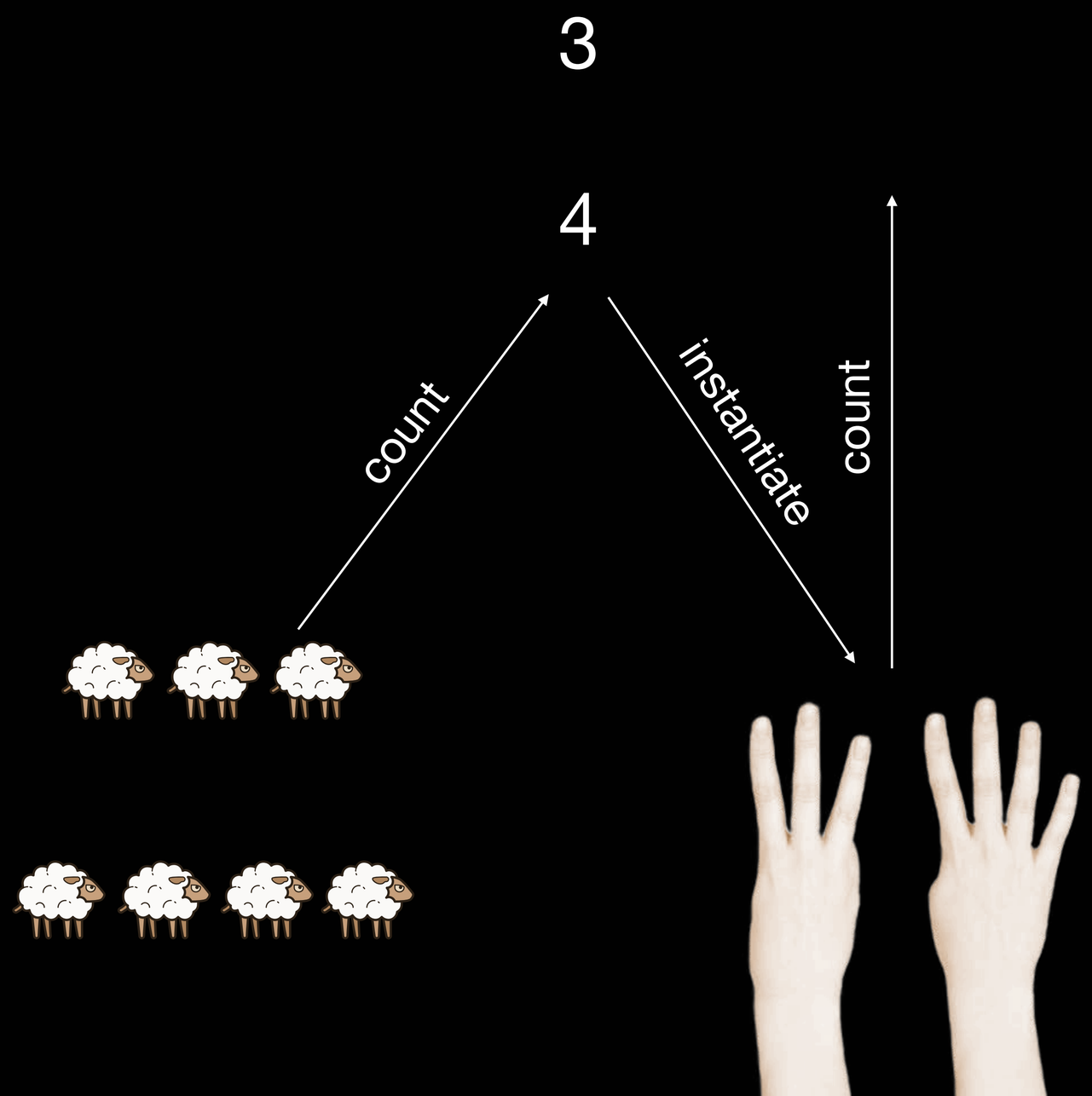
3

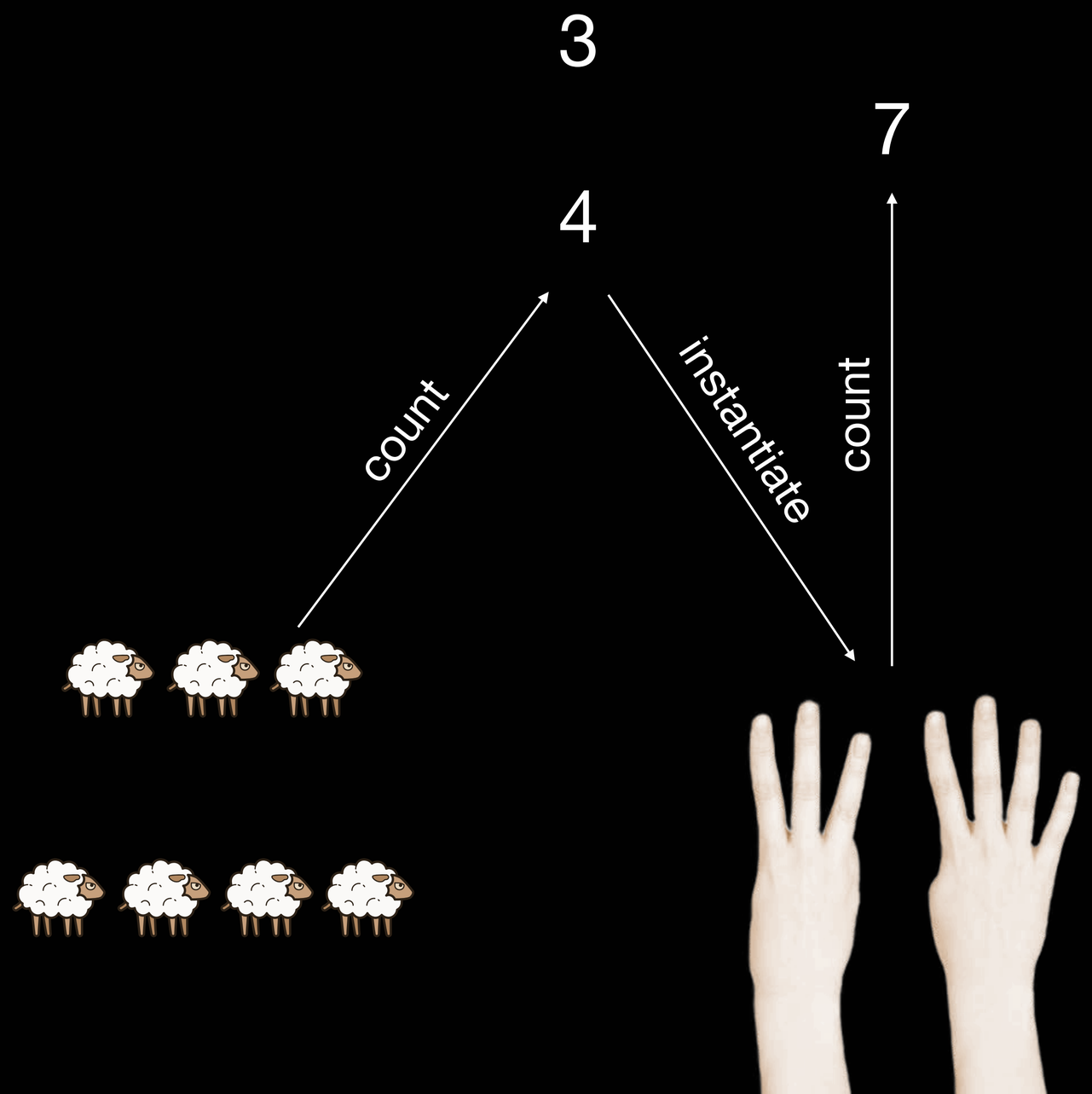
4

count

instantiate




3
4
count
instantiate
count


3
7
4
count
instantiate
count

homomorphism

right inverse

Geometry

Euclid

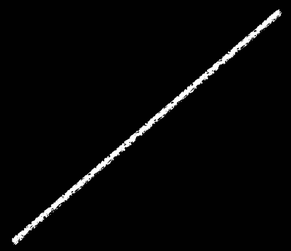
-2.6 million years

-2.3 thousand years

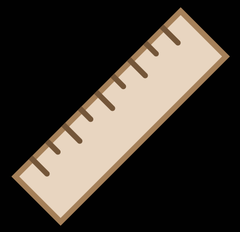
0

Tools

Definitions



Tools



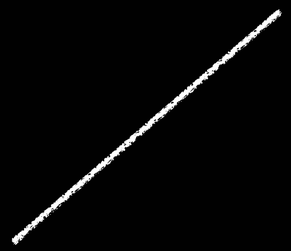
Axioms

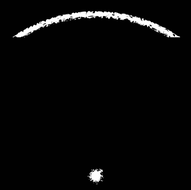
if $a = b$
and $b = c$
then $a = c$

if $a = b$
then $a + c = b + c$

if $a = b$
then $a - c = b - c$

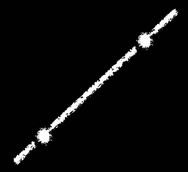
Definitions





Tools

Postulates



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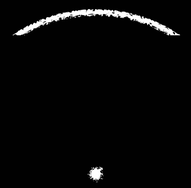
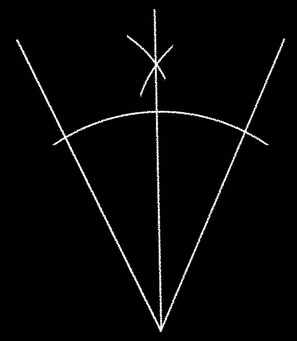
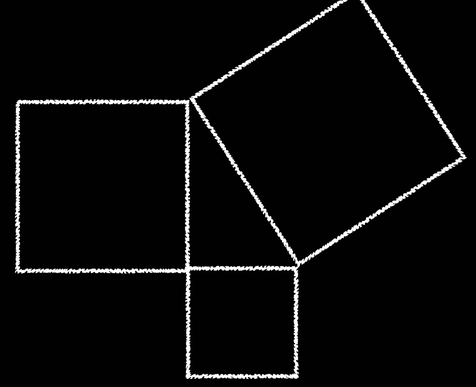


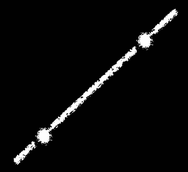
Tools

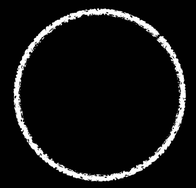
Theorems





Postulates





Axioms

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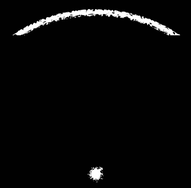
Definitions



Tools

small set of formal concepts

instruments

Algebra

Al-Khwarizmi

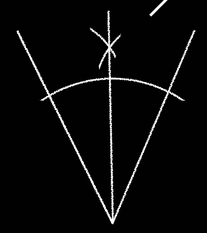
CC BY-SA 4.0 https://commons.wikimedia.org/wiki/File:الفيلسوف_العربي_(الخوارزمي).jpg

-2.6 million years

-1.2 thousand years

0

algebraic objects



$$\frac{2}{5}$$

$$\sqrt{2}$$

algebraic objects

properties

↑

algebraic objects

meta abstraction

Physics

Galileo

Newton

-2.6 million years

-400 years

0

Earth
Air
Fire
Water

Earth
Air
Fire
Water

Natural place

Earth
Air
Fire
Water

Natural place
Natural motion

Earth
Air
Fire
Water

Natural place
Natural motion
Unnatural motion

Earth
Air
Fire
Water

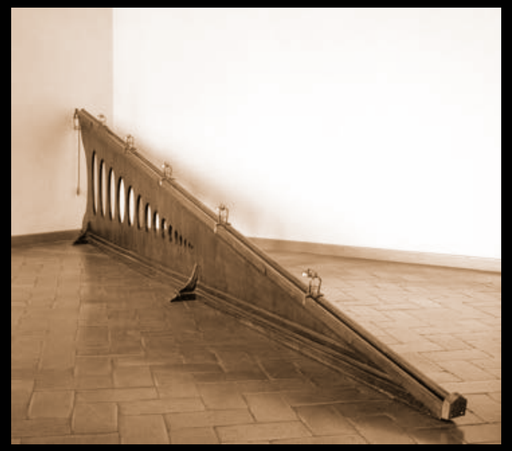
Natural place
Natural motion
Unnatural motion

reason

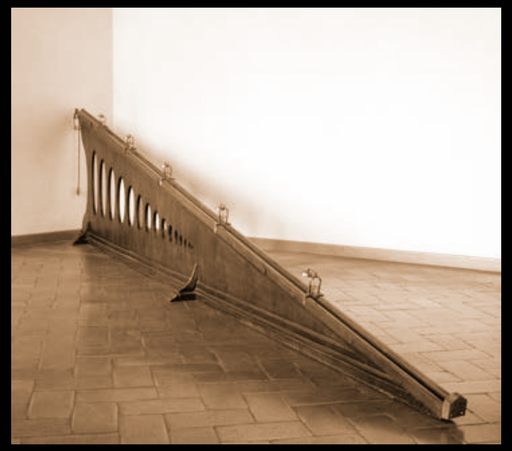
Earth
Air
Fire
Water

Natural place
Natural motion
Unnatural motion

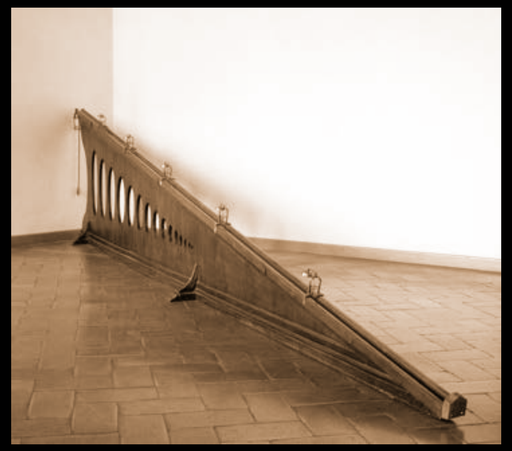
reason



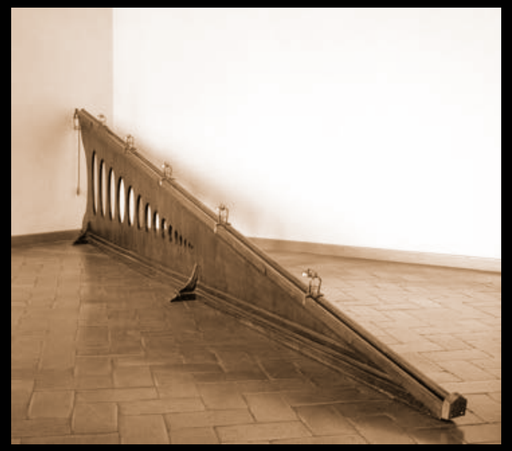
time
distance
horizontal/vertical



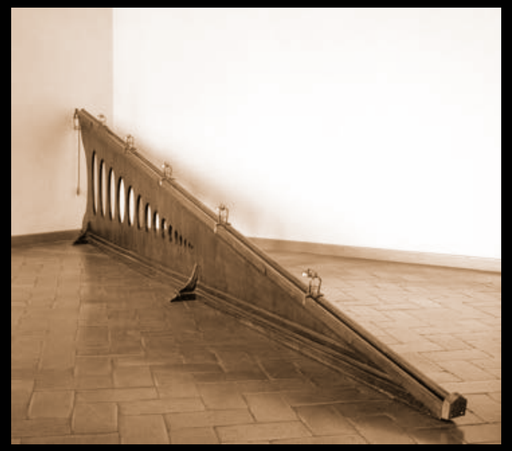
time
distance
horizontal/vertical



time
distance
horizontal/vertical



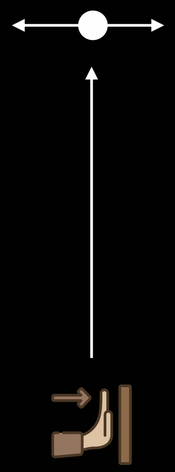
time
distance
horizontal/vertical



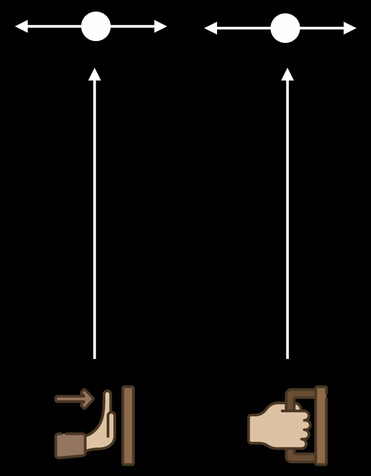
meta
iterative
refinement

forces

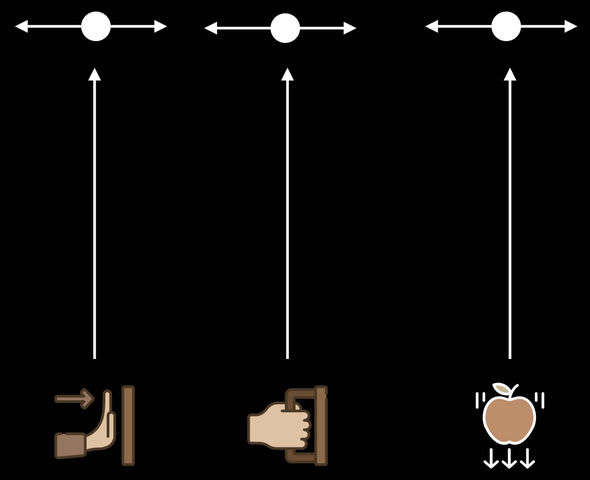
forces



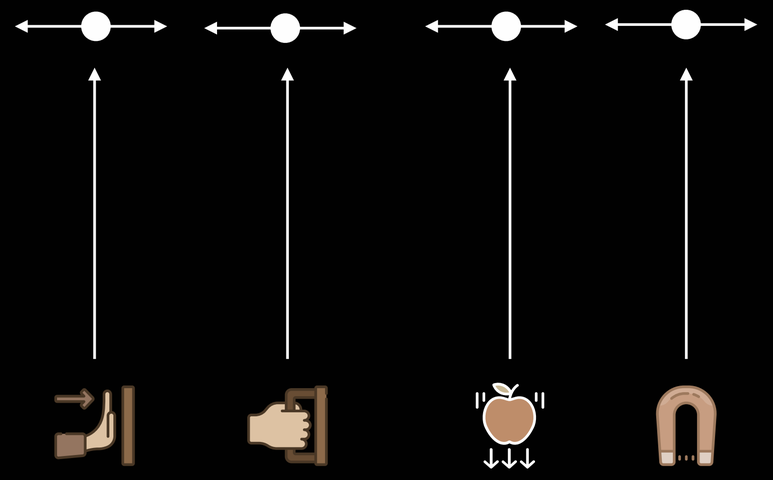
forces



forces



forces



Hypotheses non fingo

meta iterative refinement

scoped understanding

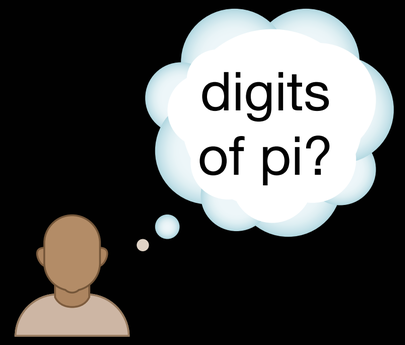
Computing

Turing

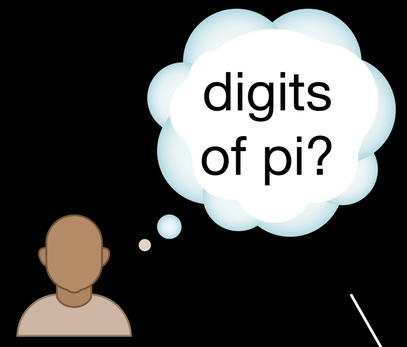
-2.6 million years

-80 years 0

Abstract



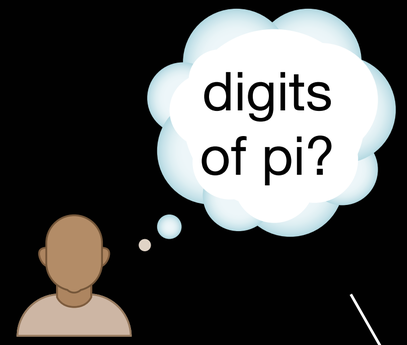
Abstract



Code

Concrete

Abstract



Code

Concrete

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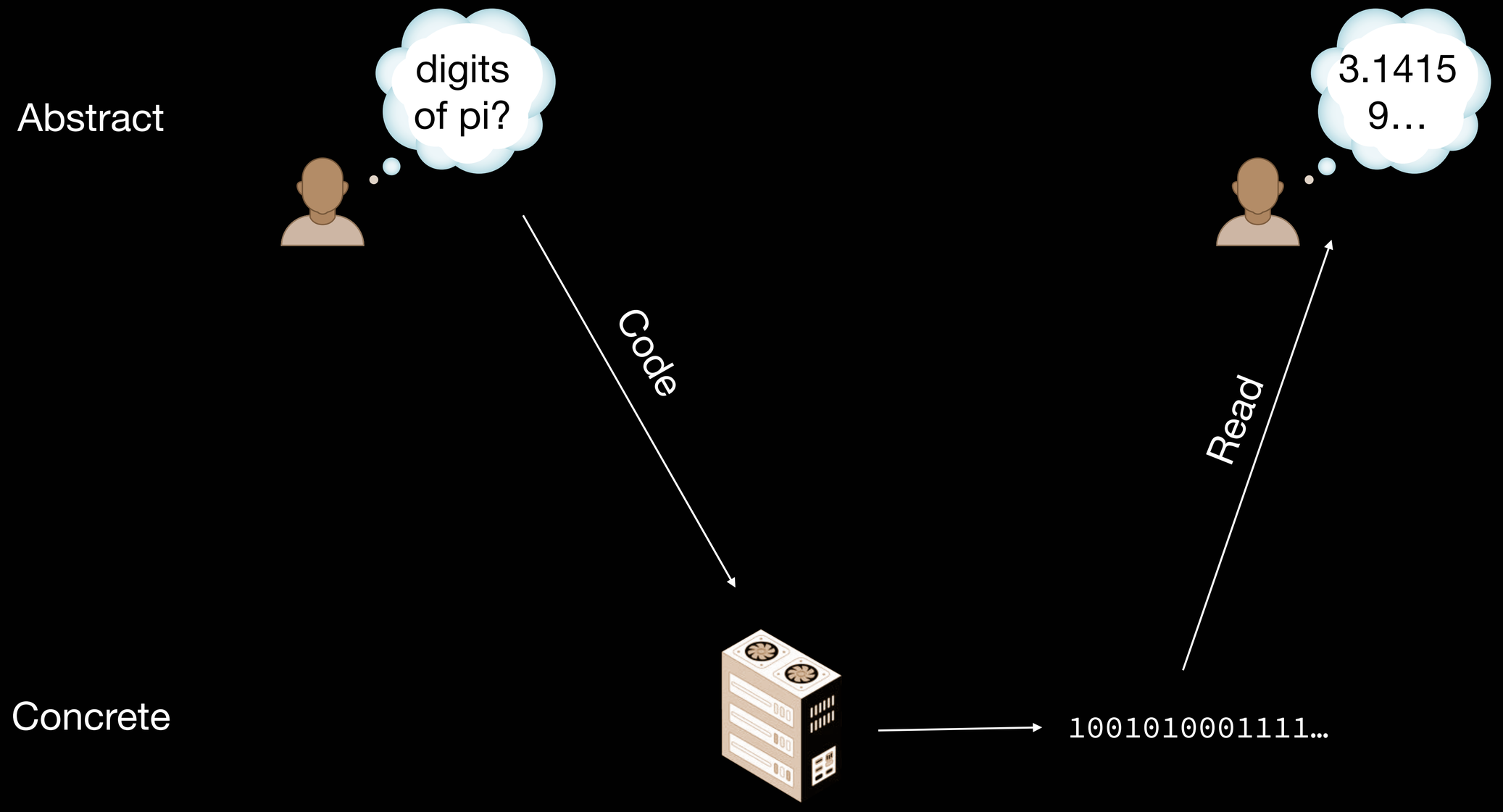
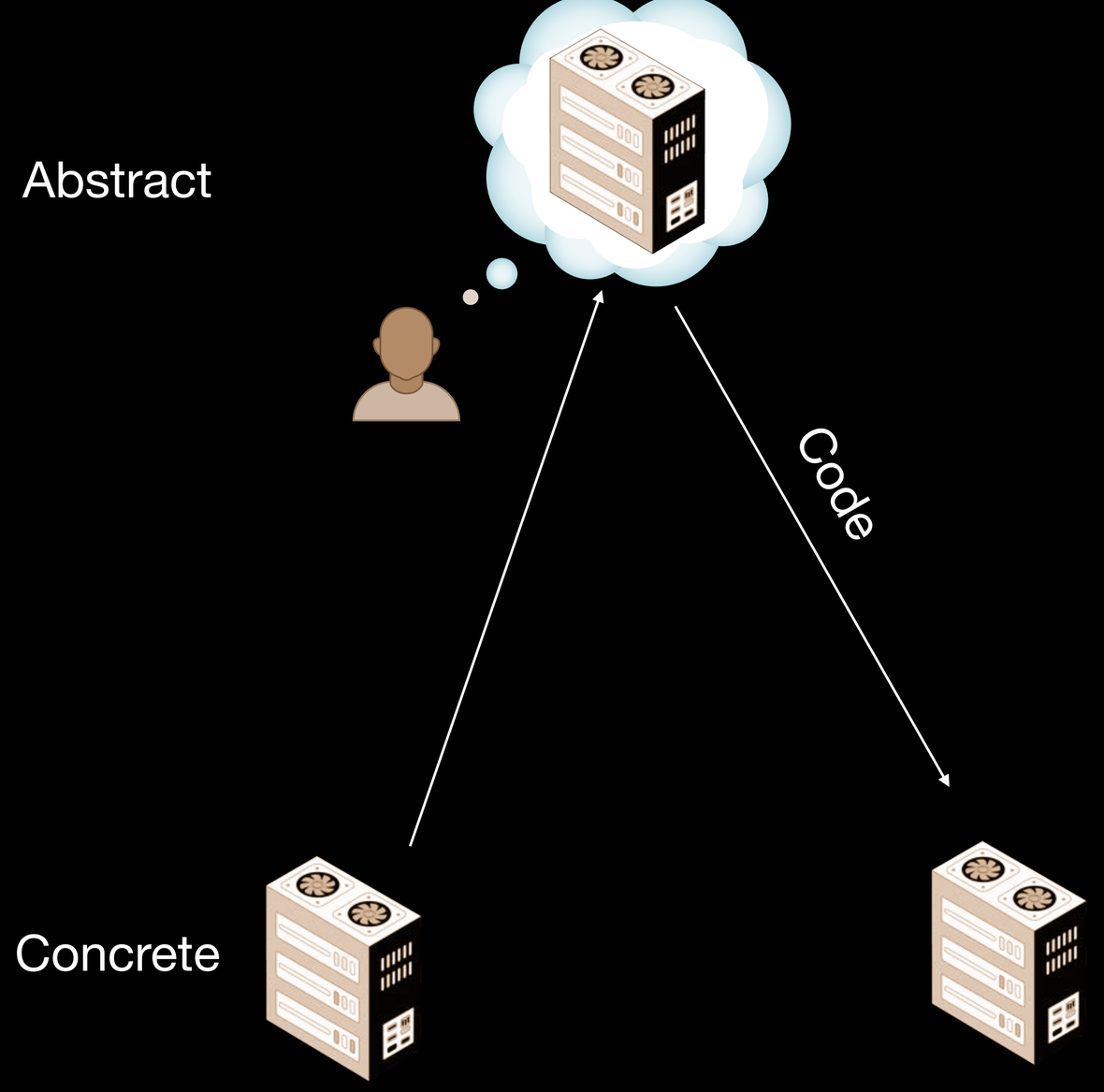
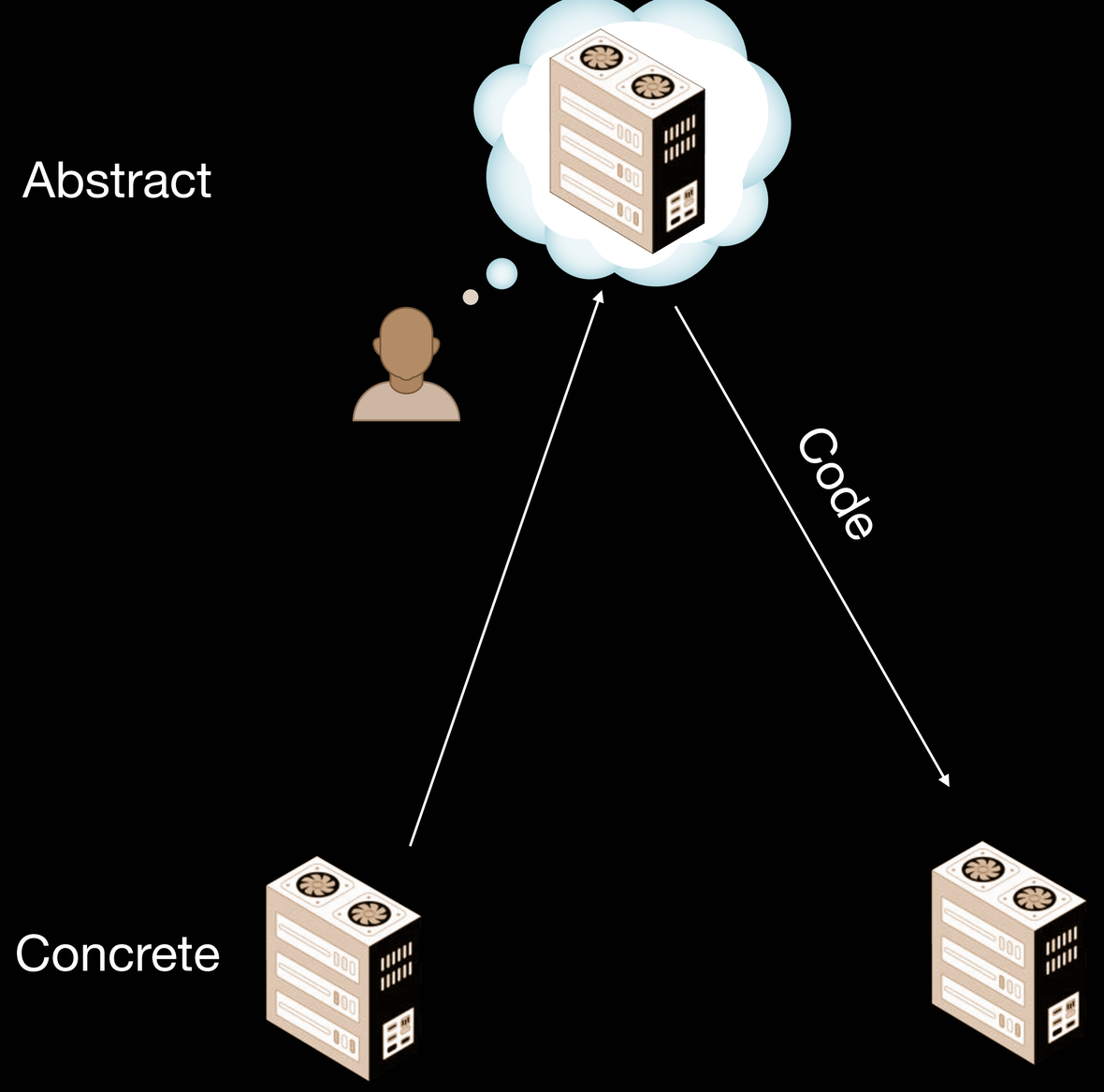
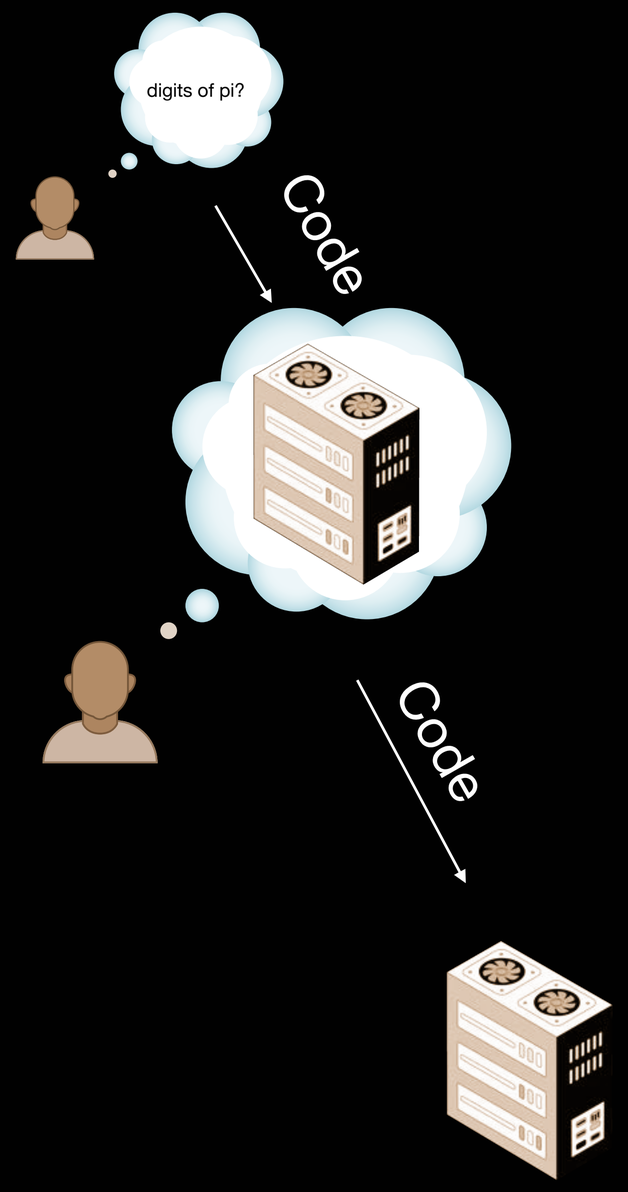

Abstract
digits of pi?
Code
3.1415 9…
Read
Concrete
1001010001111…


Abstract
Code
Concrete

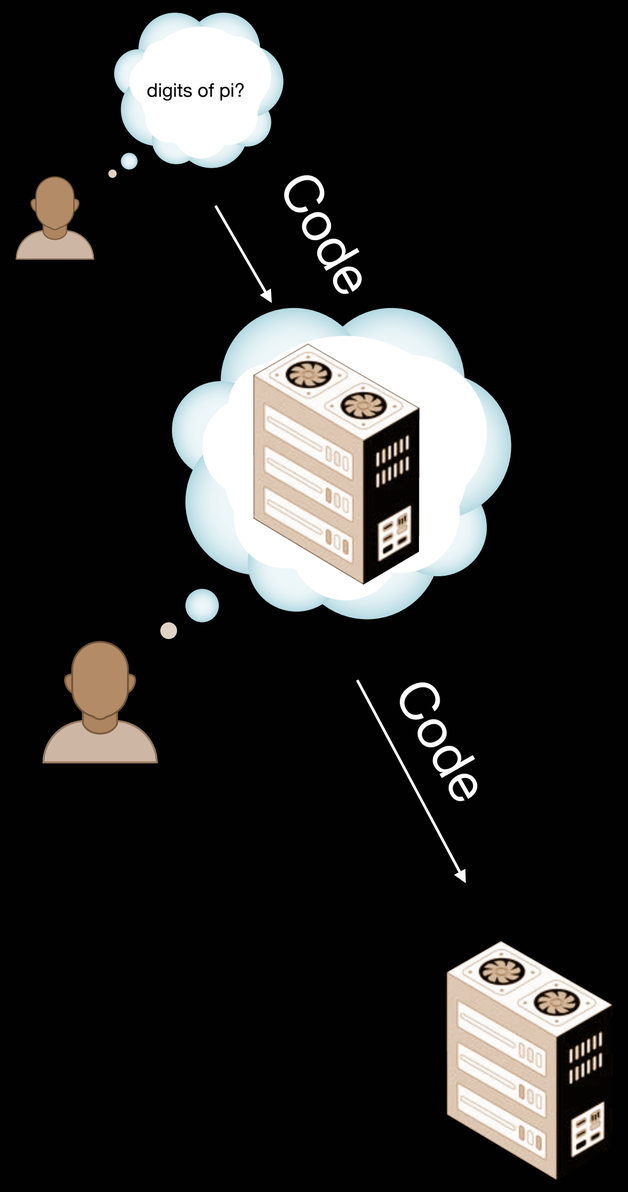

Abstract
Code
Concrete

Abstract



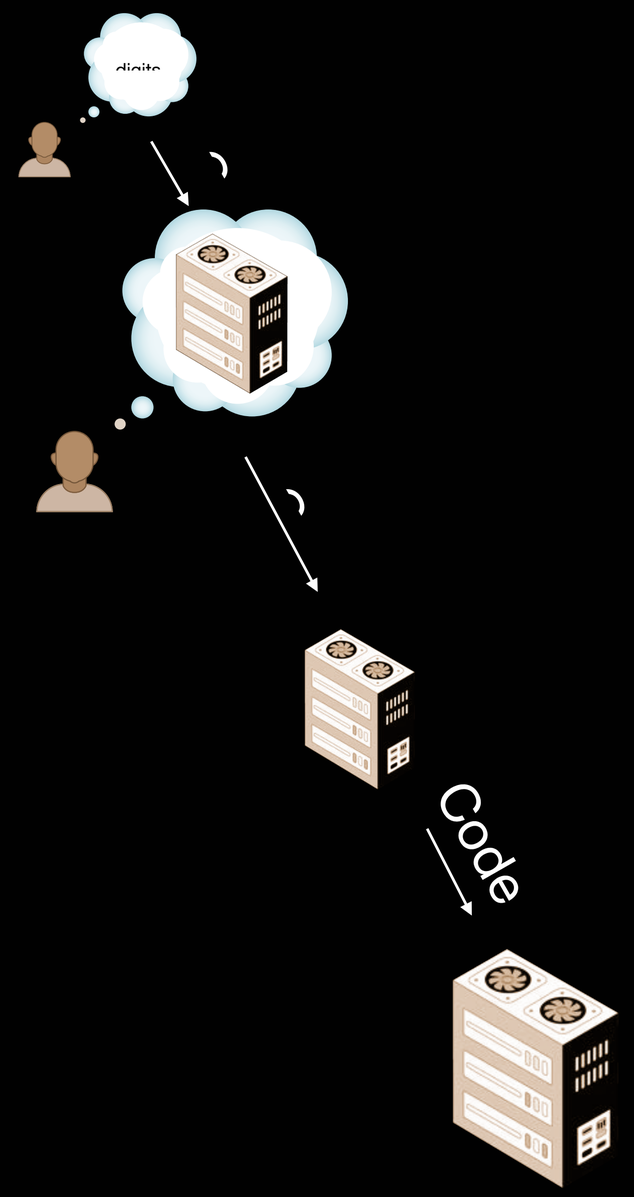
Concrete

Abstract



Concrete

Abstract



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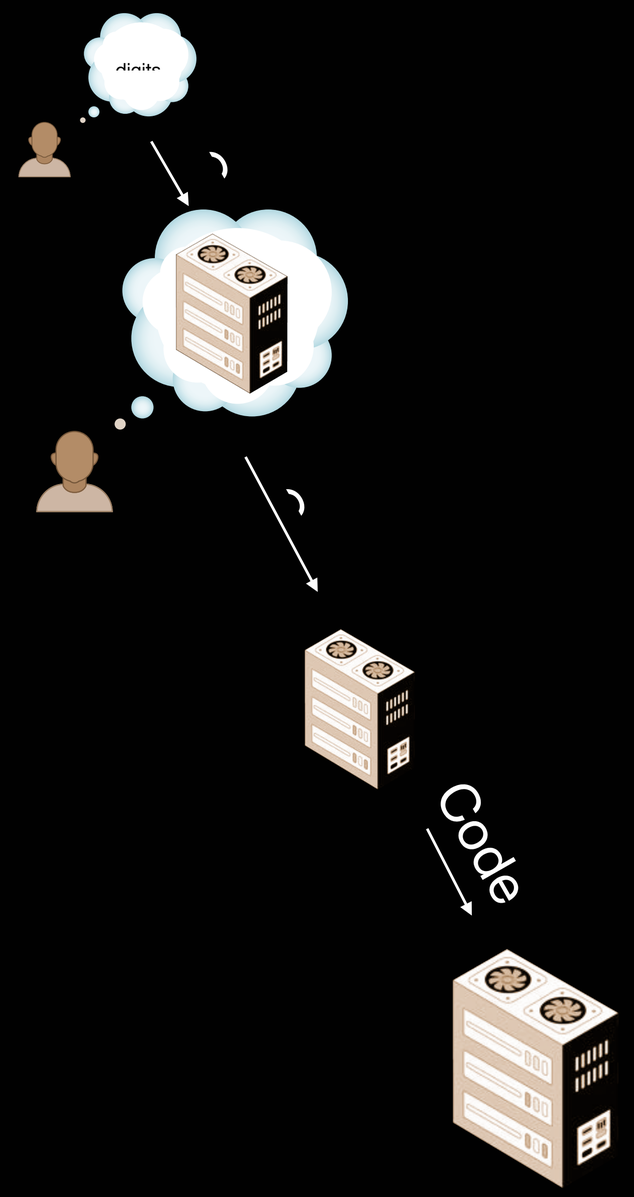
Abstract



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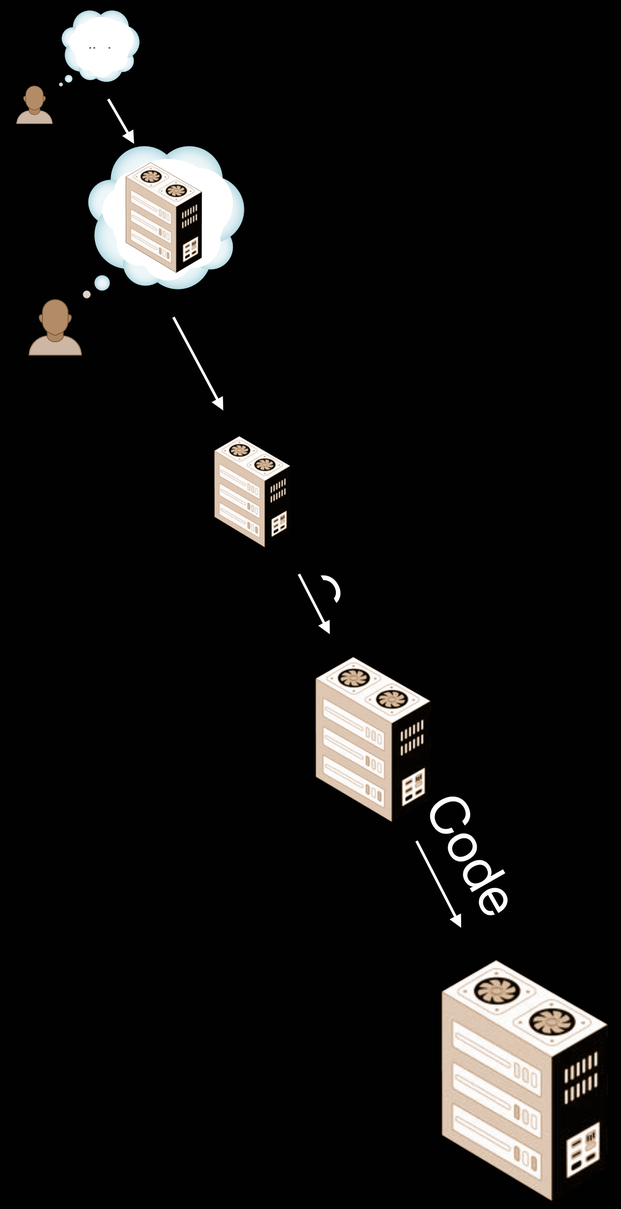
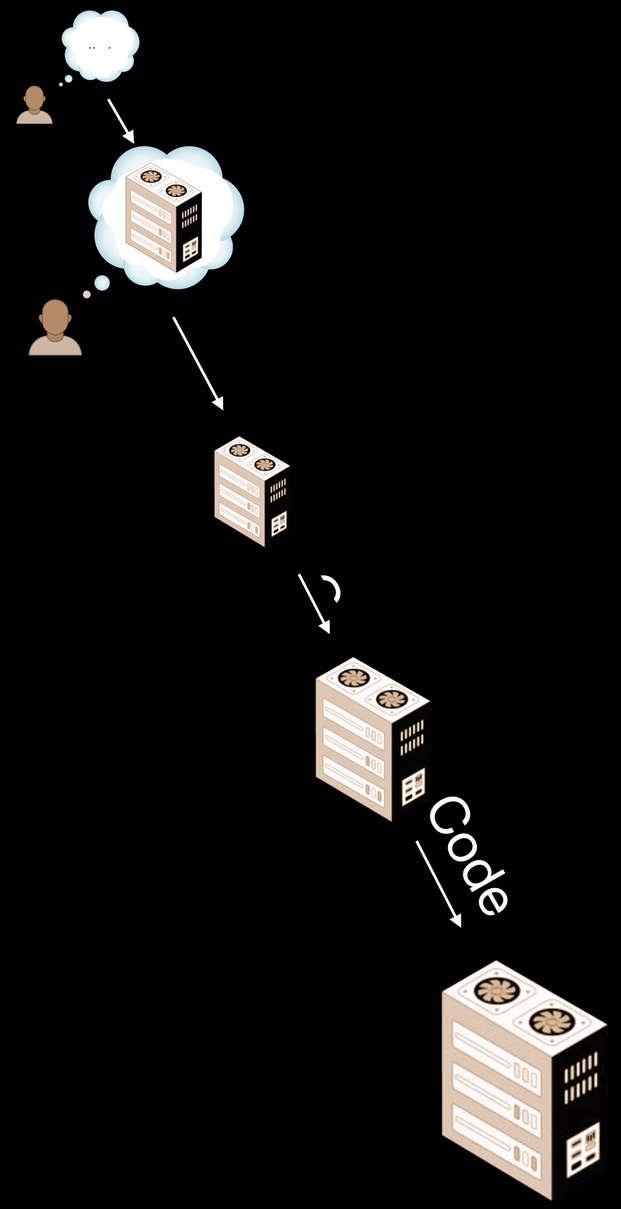
Abstract

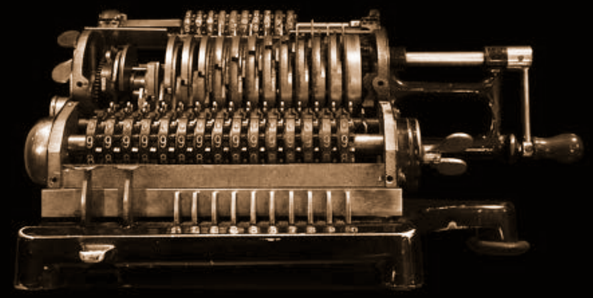


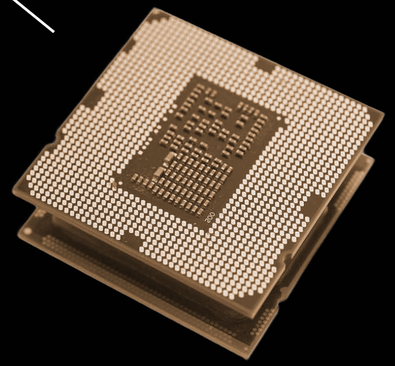
Concrete

Abstract



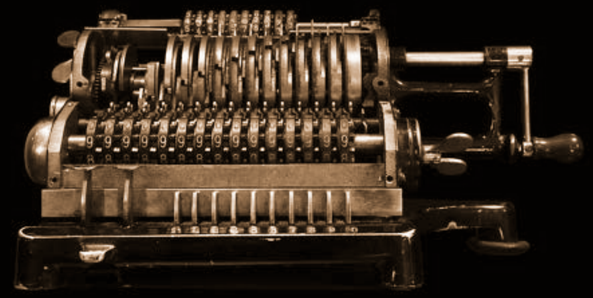
Concrete

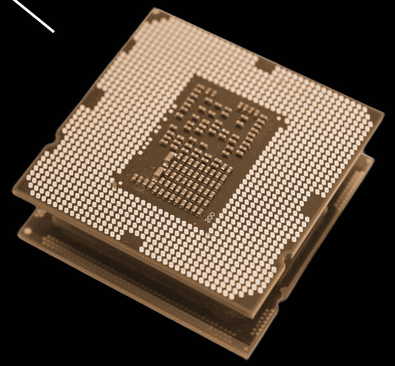




CC BY-SA 4.0 https://commons.wikimedia.org/wiki/File:UNIVAC_1_Recirculation_Chassis_Board_(1951).jpg

CC BY-SA 3.0 FR https://commons.wikimedia.org/wiki/File:Odhner_mechanical_computer-MHS_2445-IMG_9915-black.jpg





CC BY-SA 4.0 https://commons.wikimedia.org/wiki/File:UNIVAC_1_Recirculation_Chassis_Board_(1951).jpg

CC BY-SA 3.0 FR https://commons.wikimedia.org/wiki/File:Odhner_mechanical_computer-MHS_2445-IMG_9915-black.jpg

computer as abstraction

Automating Human Tasks

accounts
transactions
...

accounts
transactions
...

Code

accounts
transactions
...

Code

accounts
transactions
...

Code

accounts
transactions
...

Code

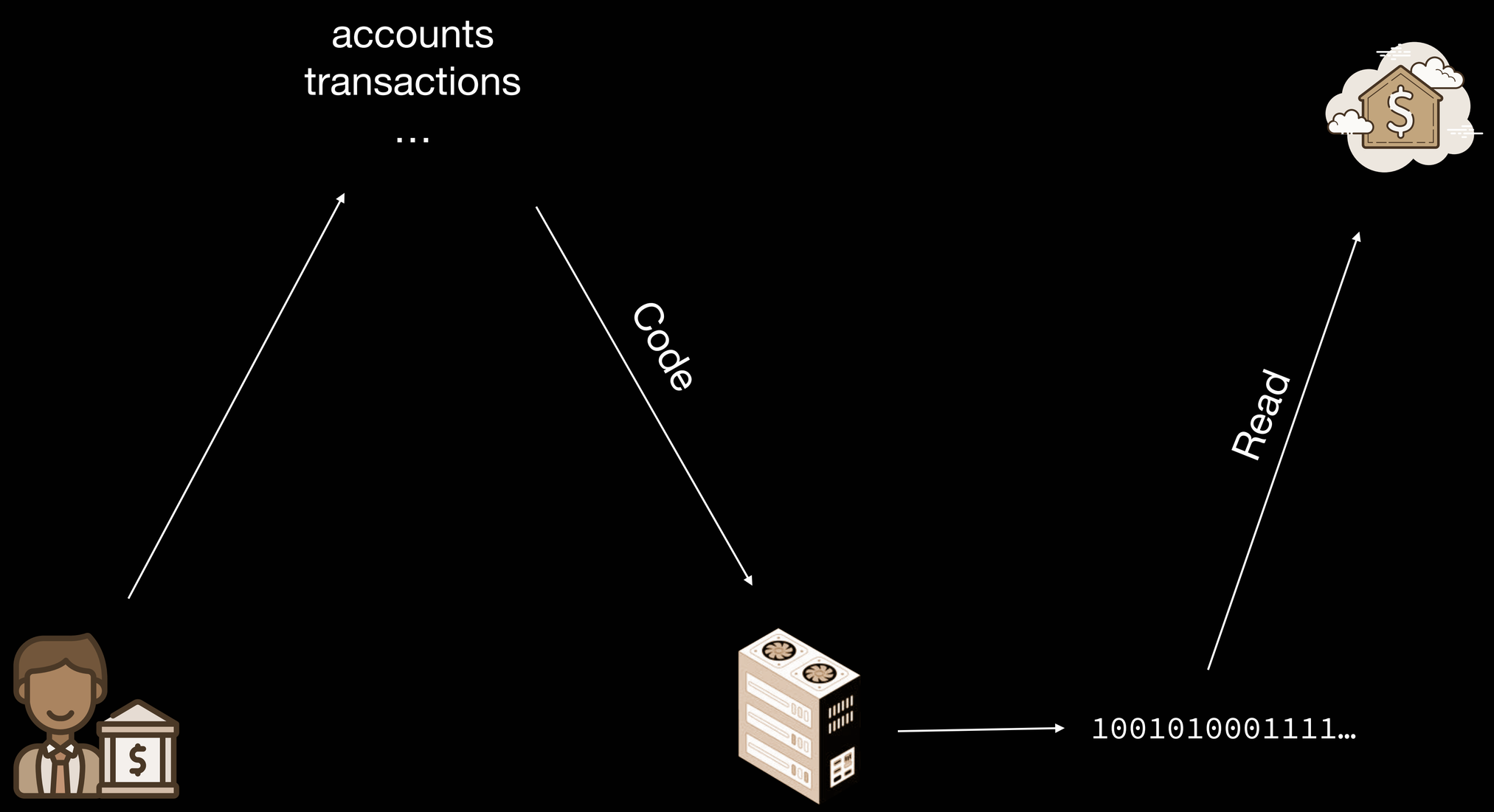
1001010001111...

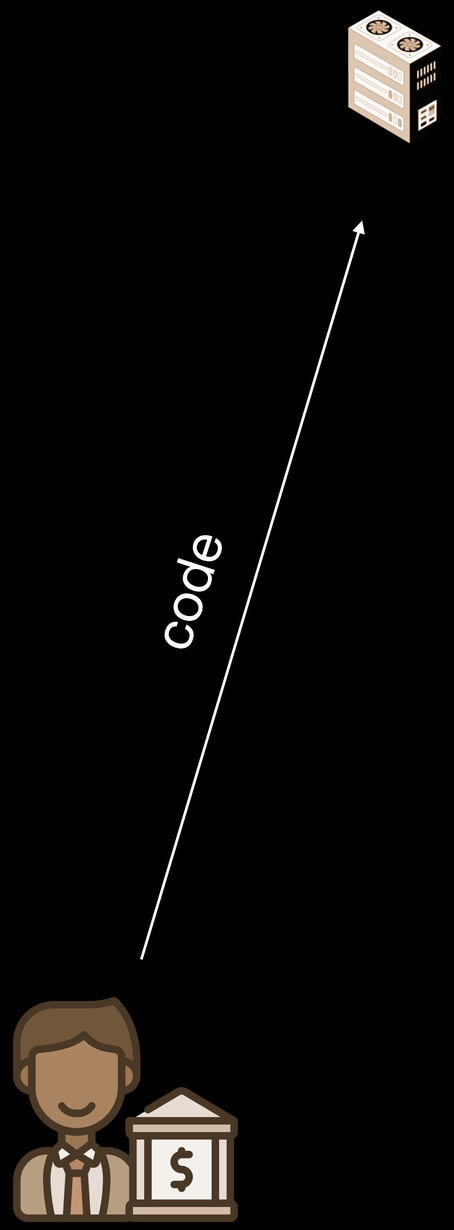
accounts
transactions
...

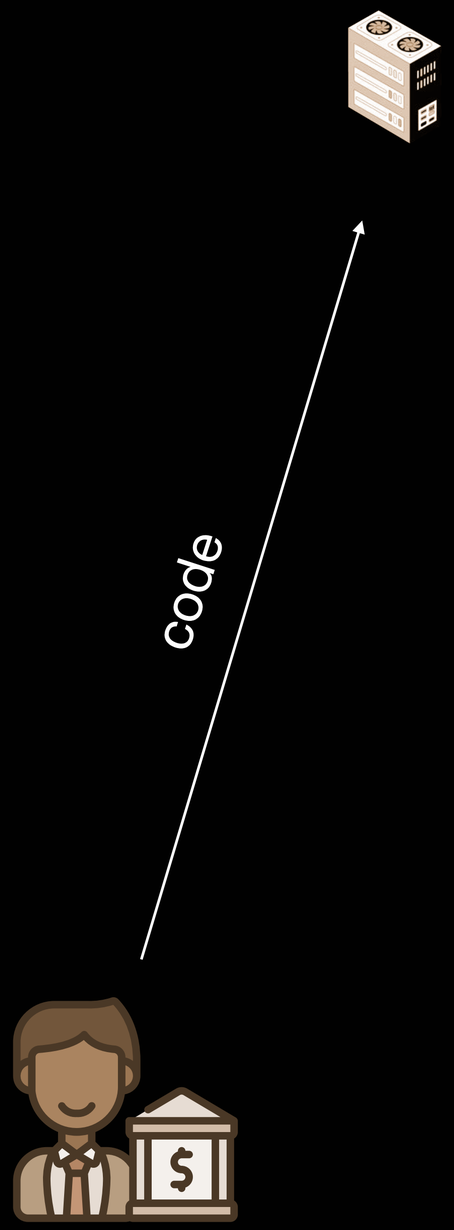
Code

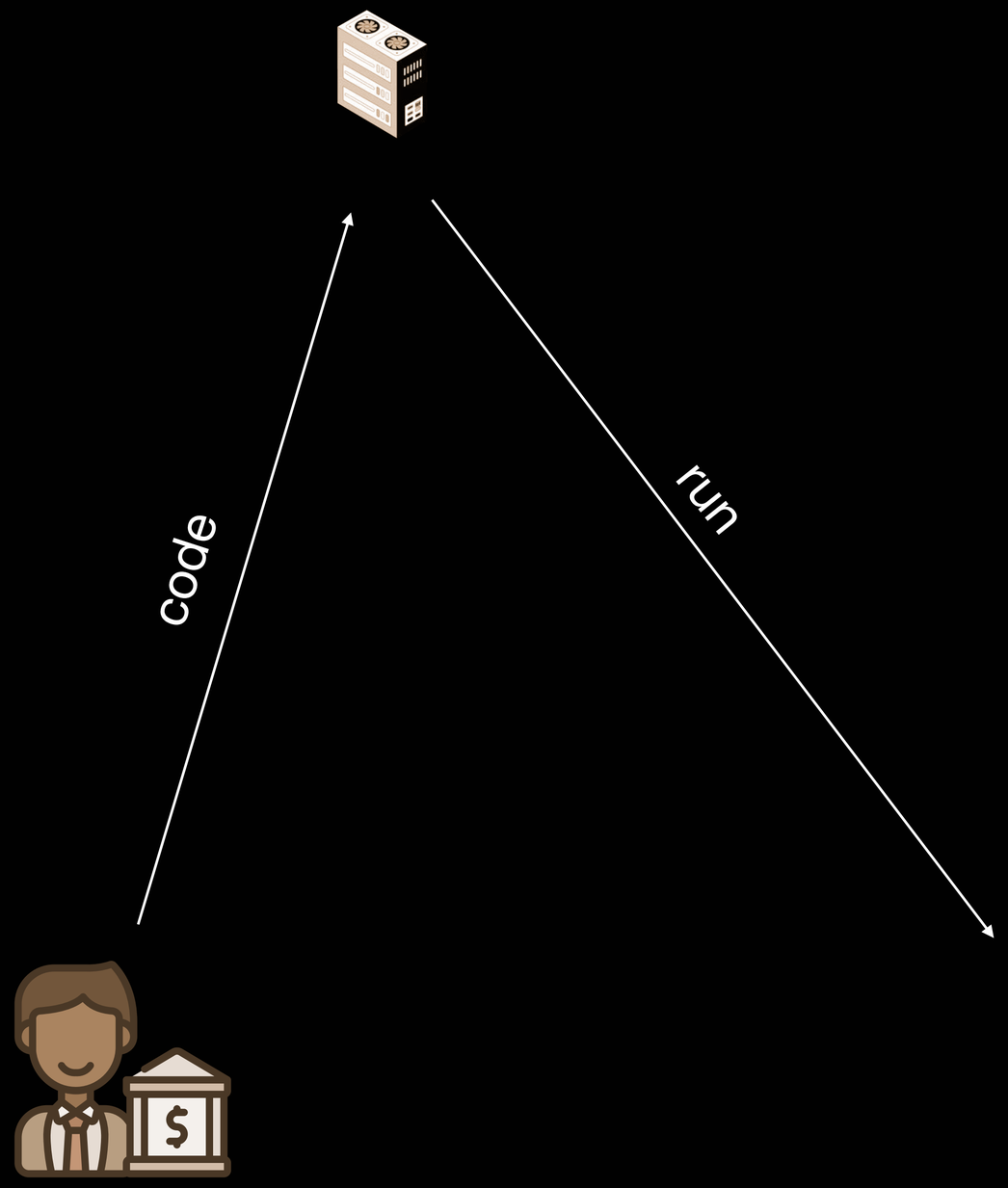
Read

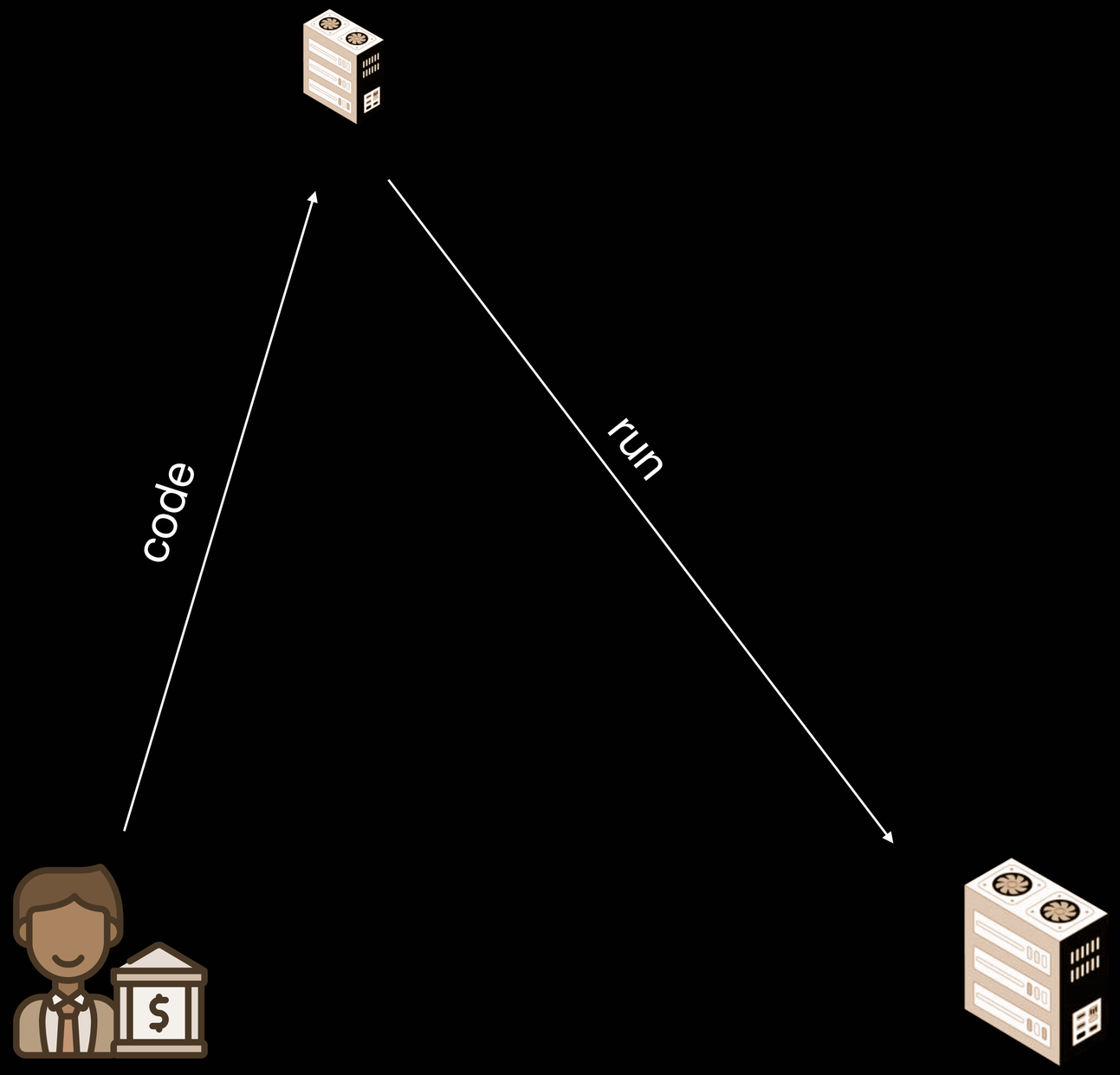
1001010001111...

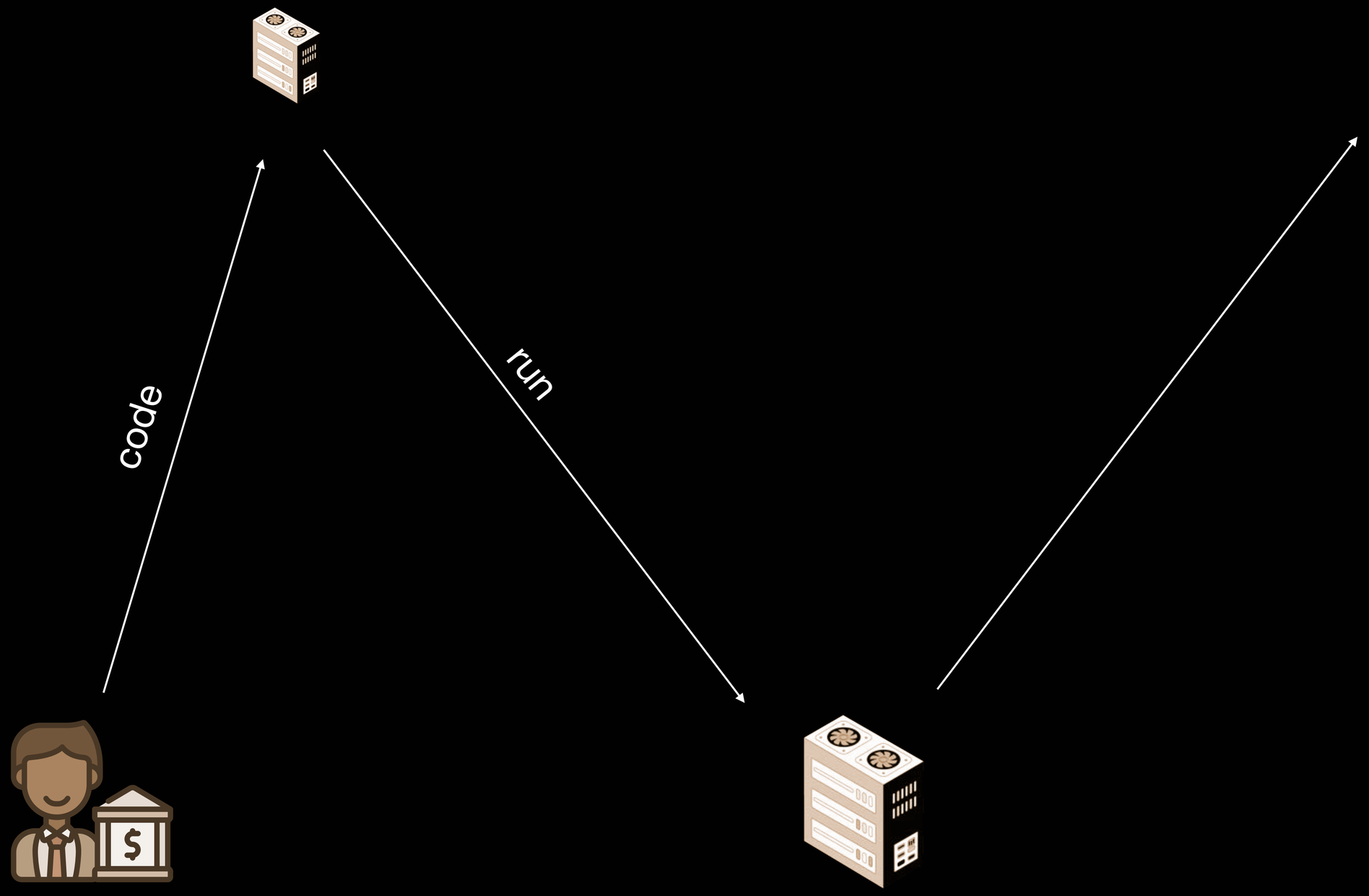

accounts
transactions
...
Code
Read
1001010001111...

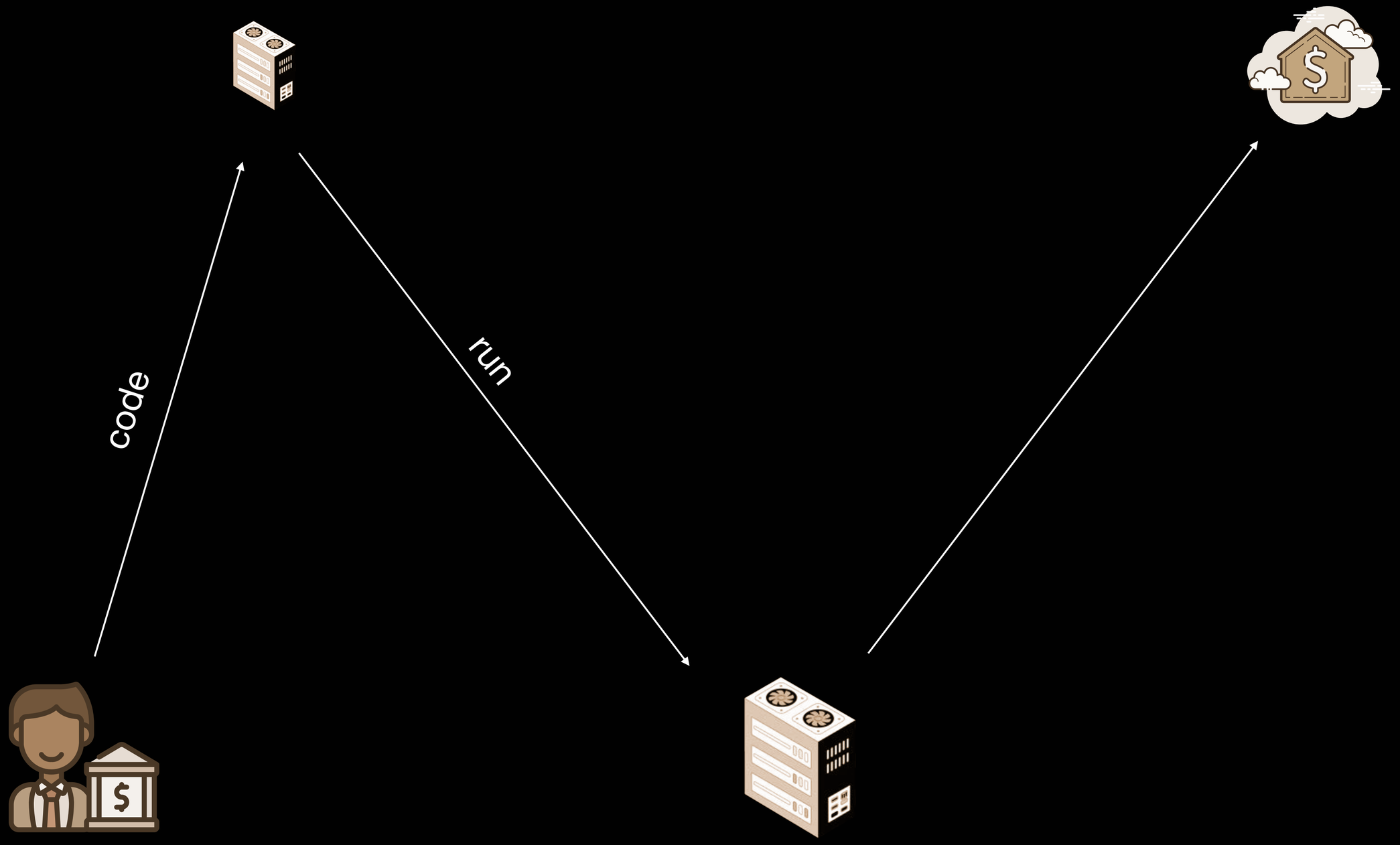

code

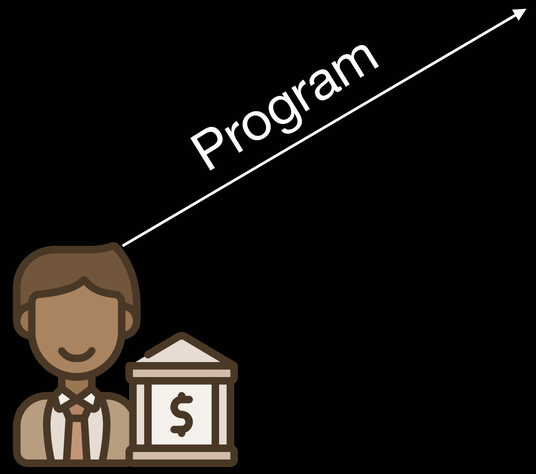

code

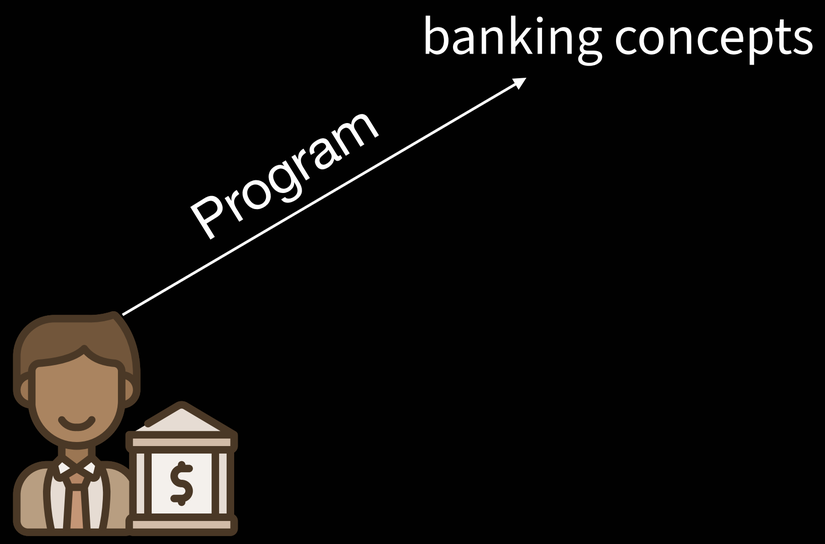

code
run

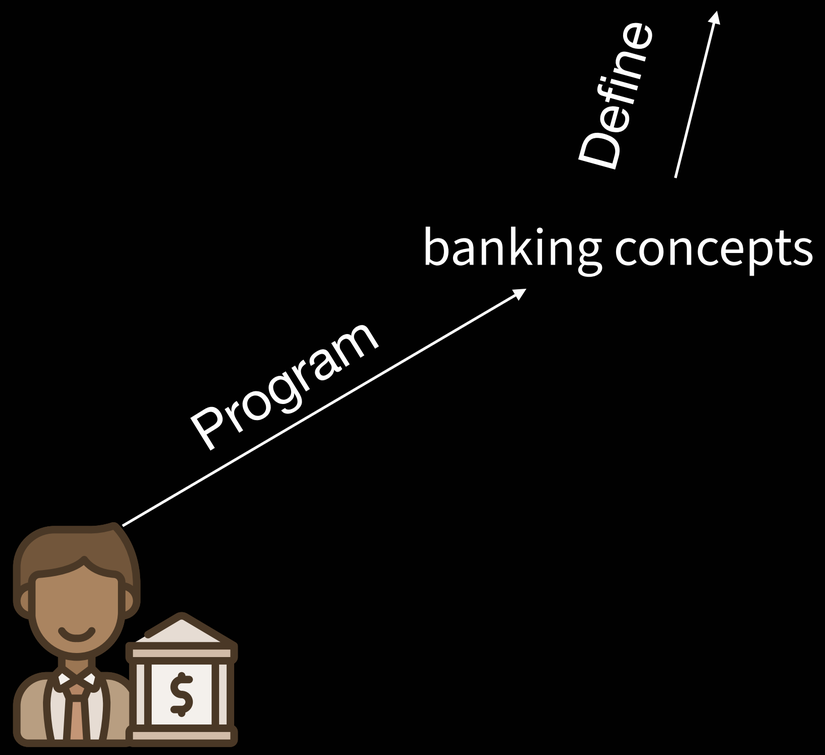

code
run


code
run


code
run


Program


banking concepts
Program

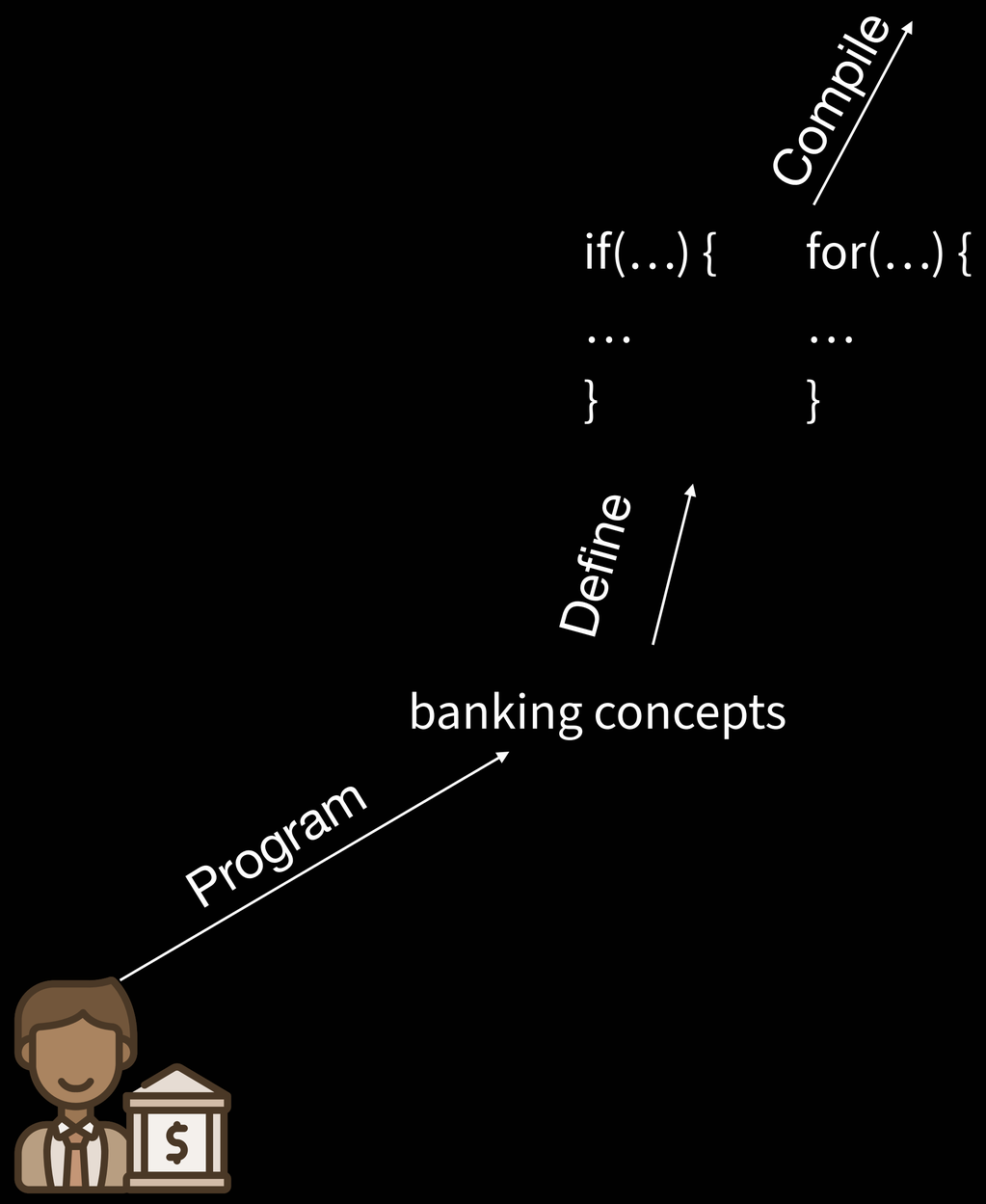

Define
banking concepts
Program

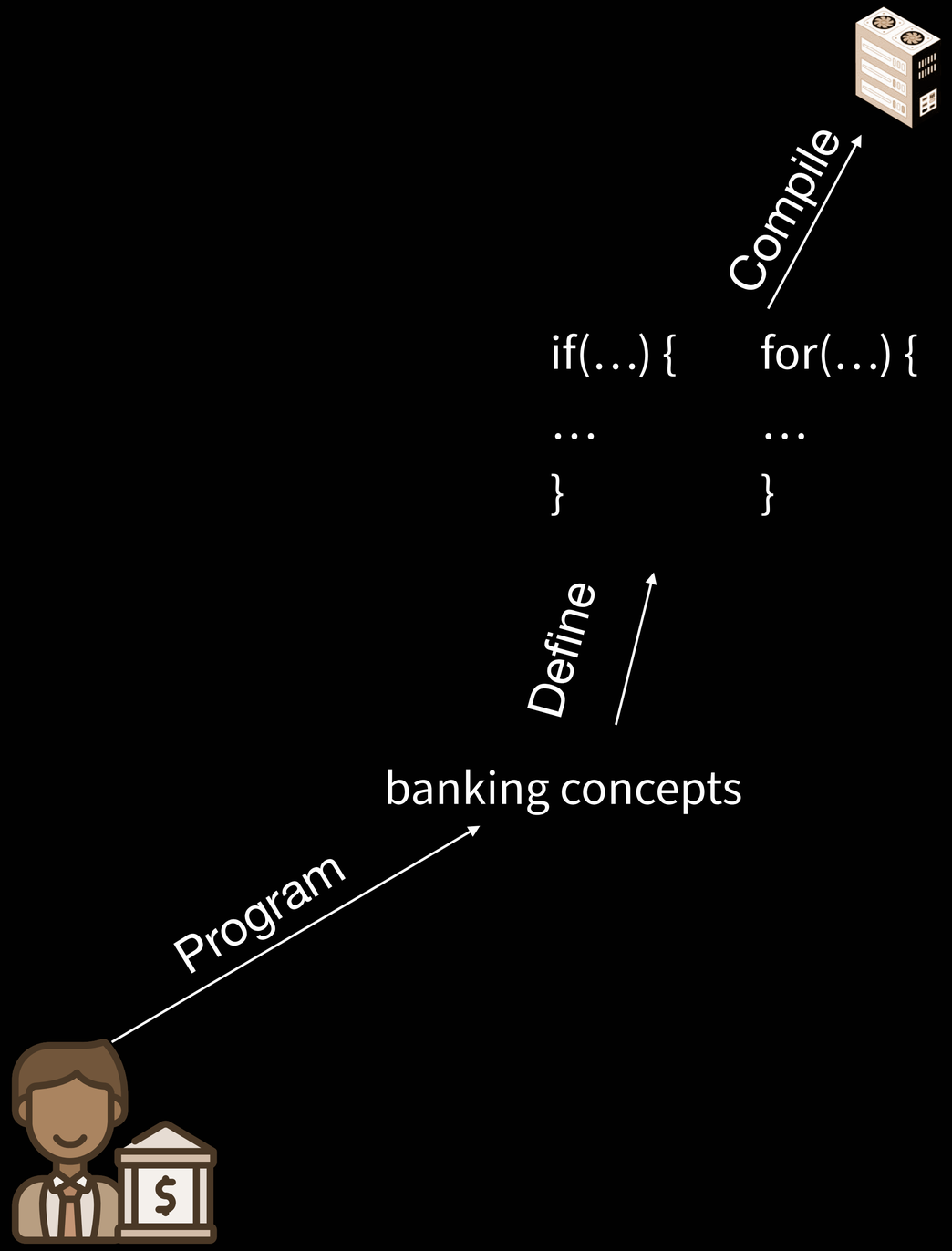
```
if(…) {      for(…) {
…            …
}            }
```

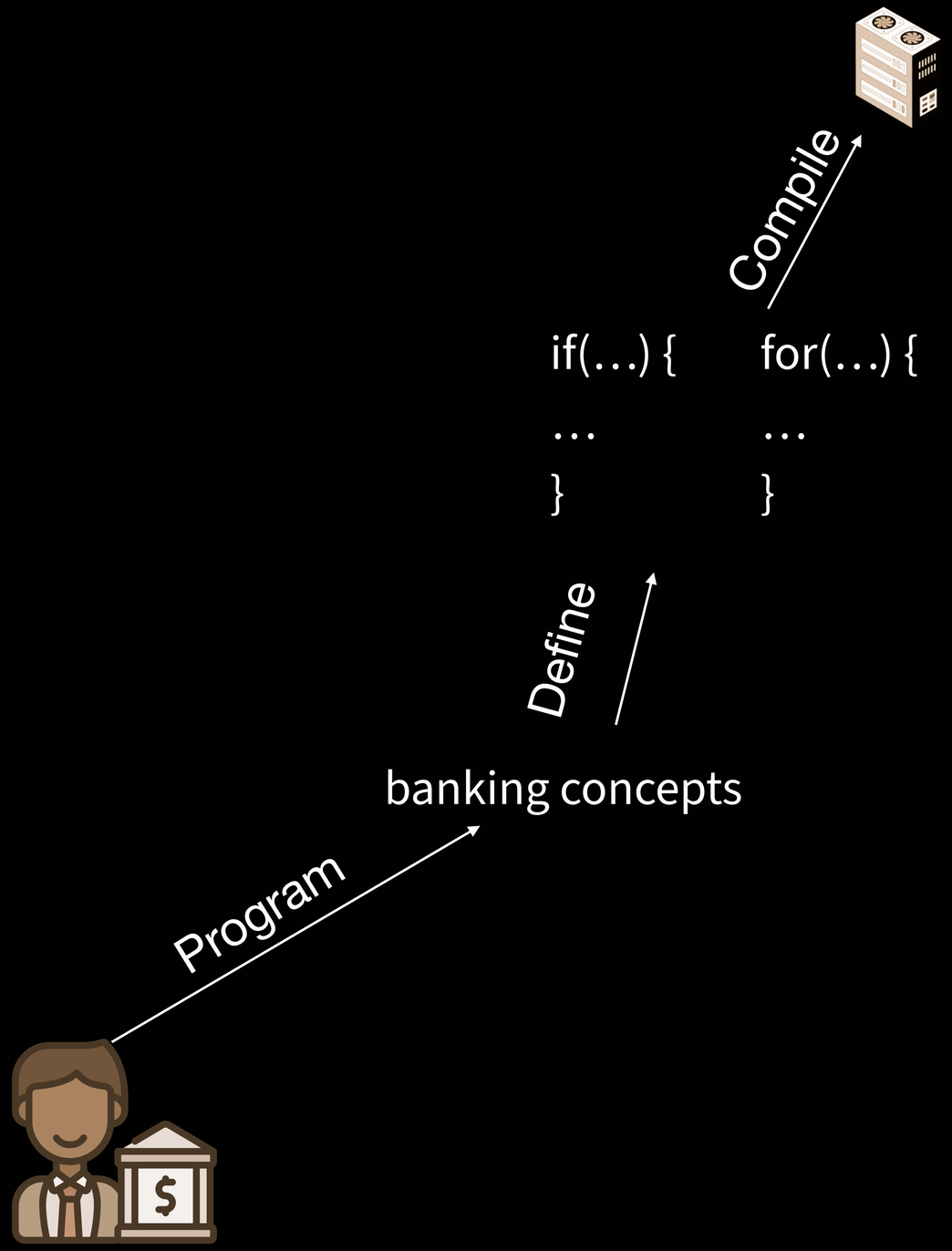
Define

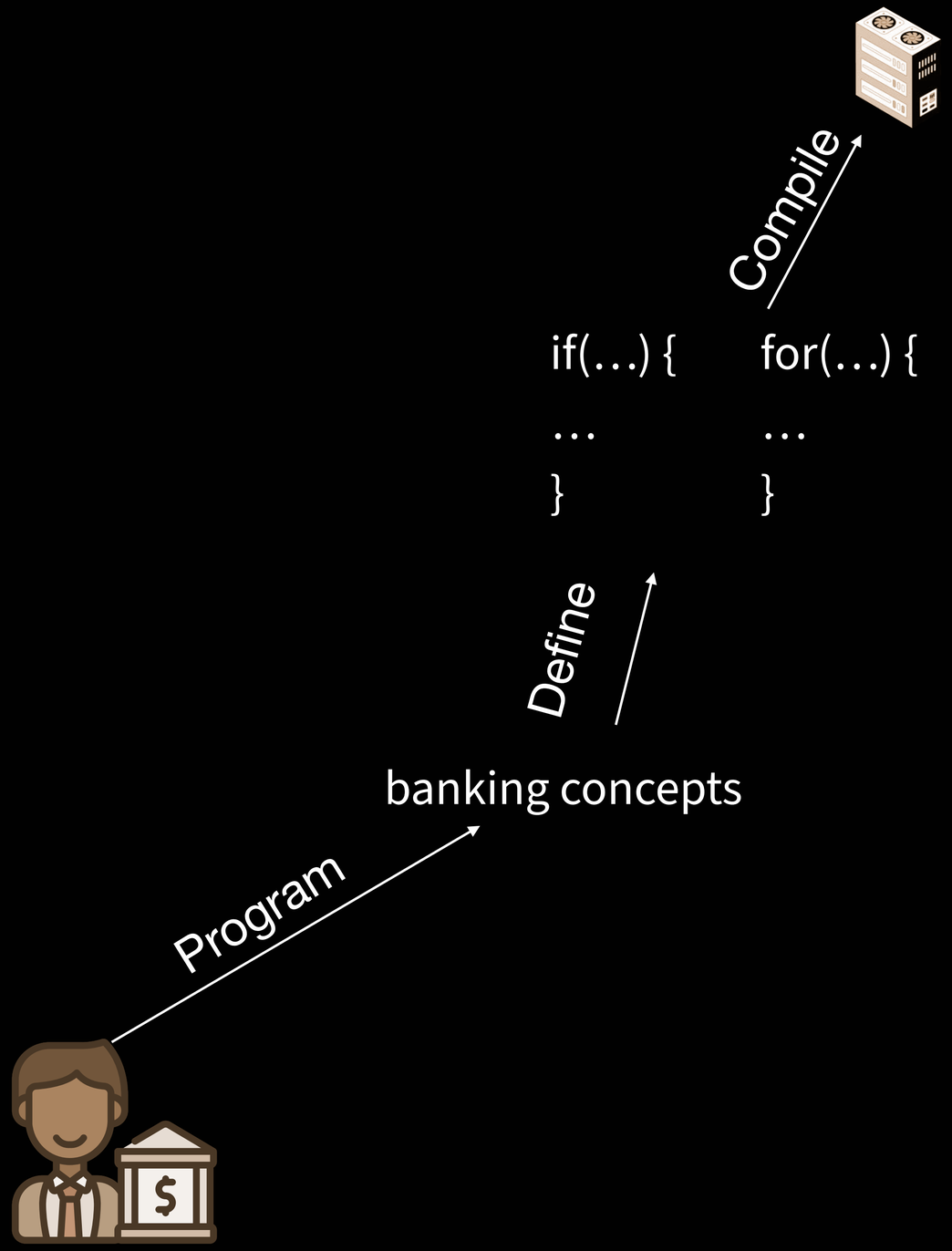
banking concepts

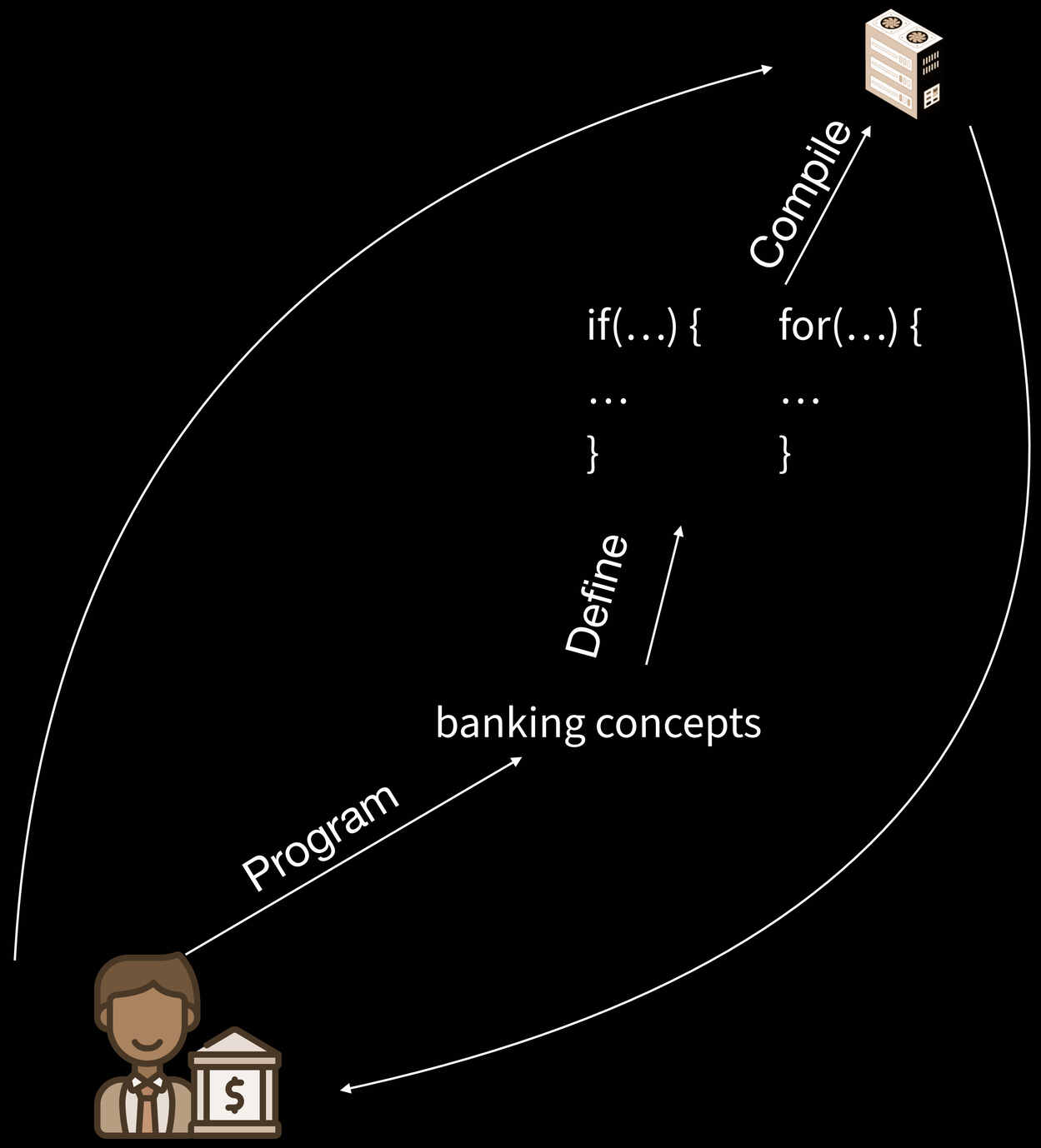
Program

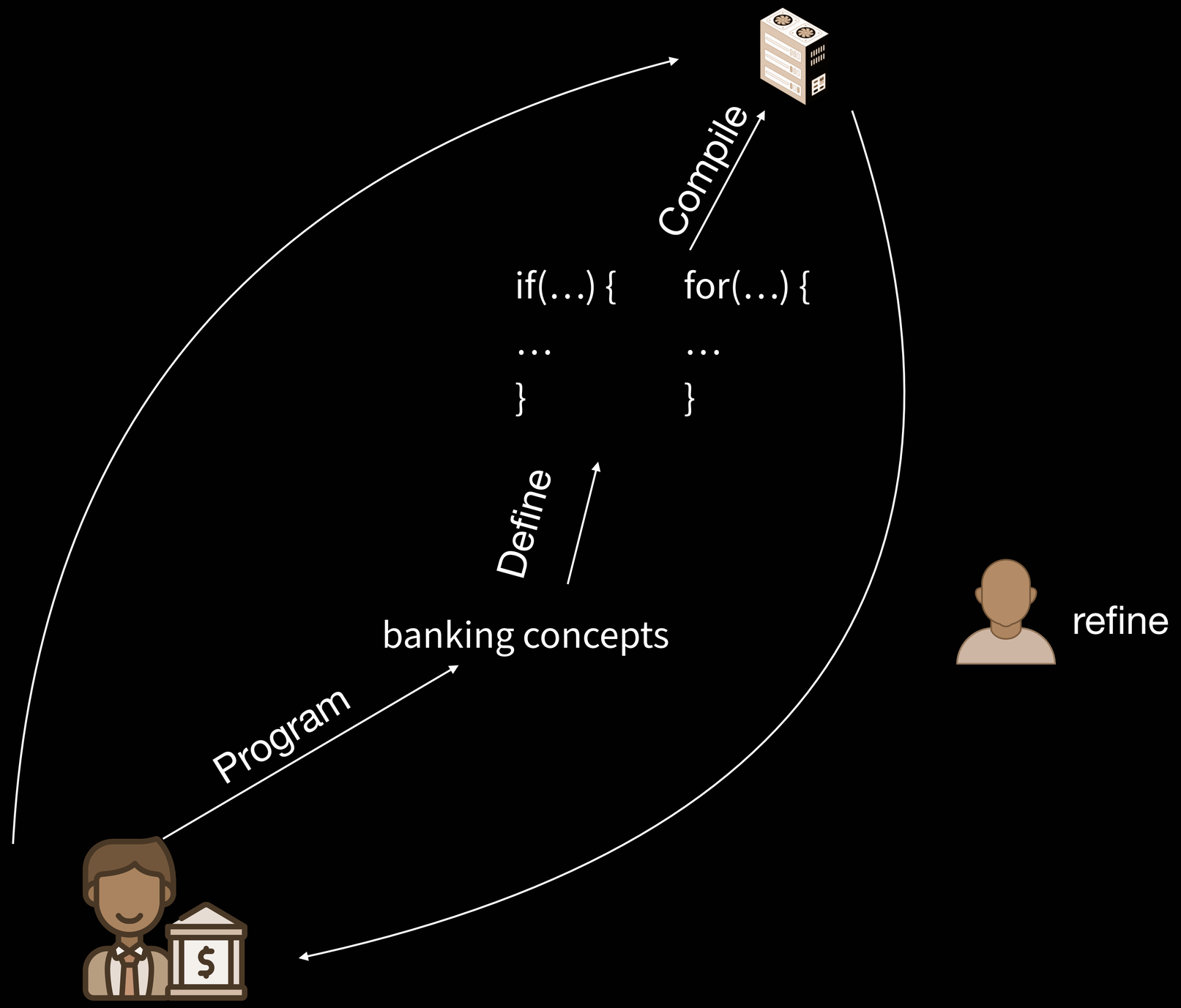

Compile
if(…) {
…
}
for(…) {
…
}
Define
banking concepts
Program

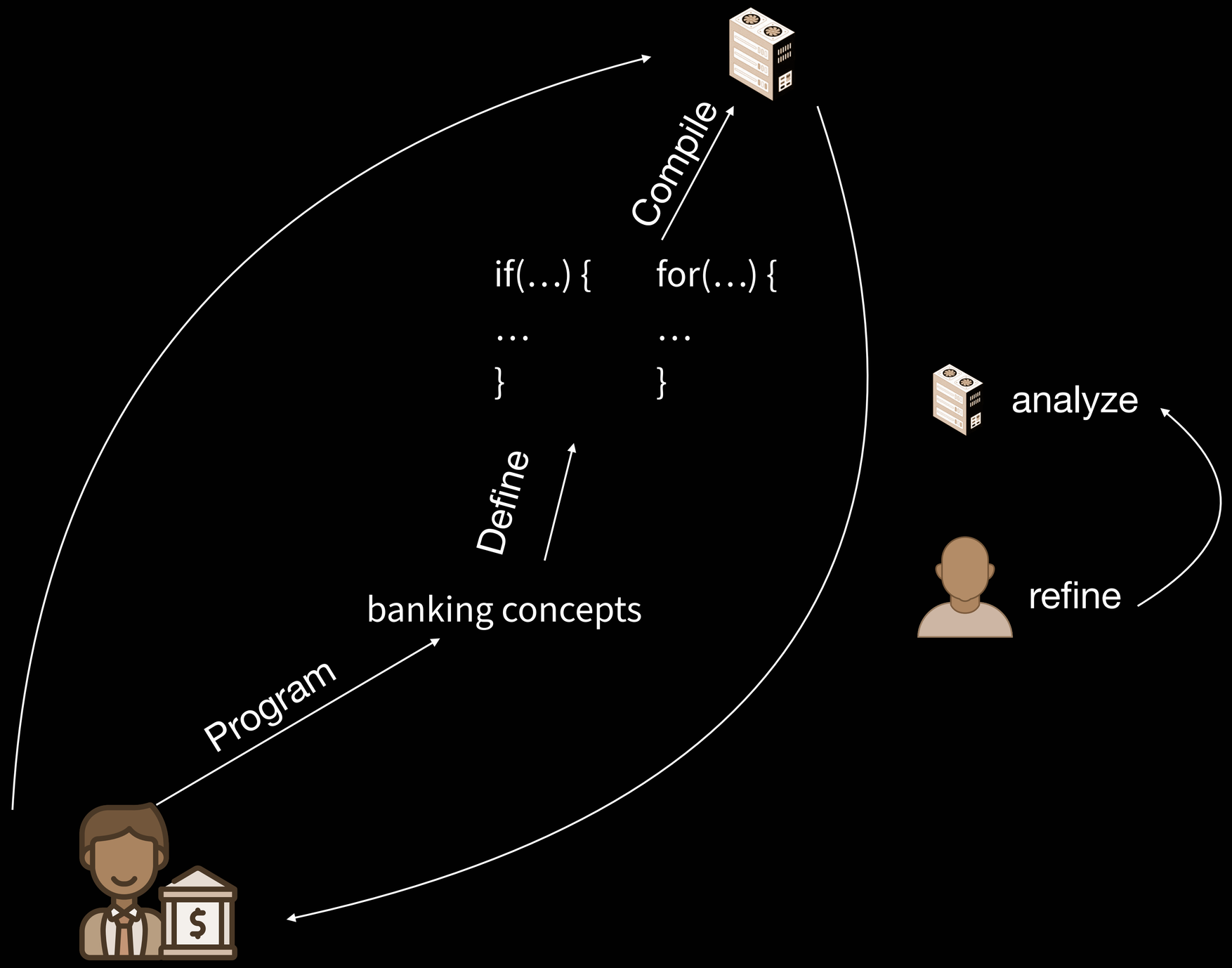

Compile
if(…) {
…
}
for(…) {
…
}
Define
banking concepts
Program

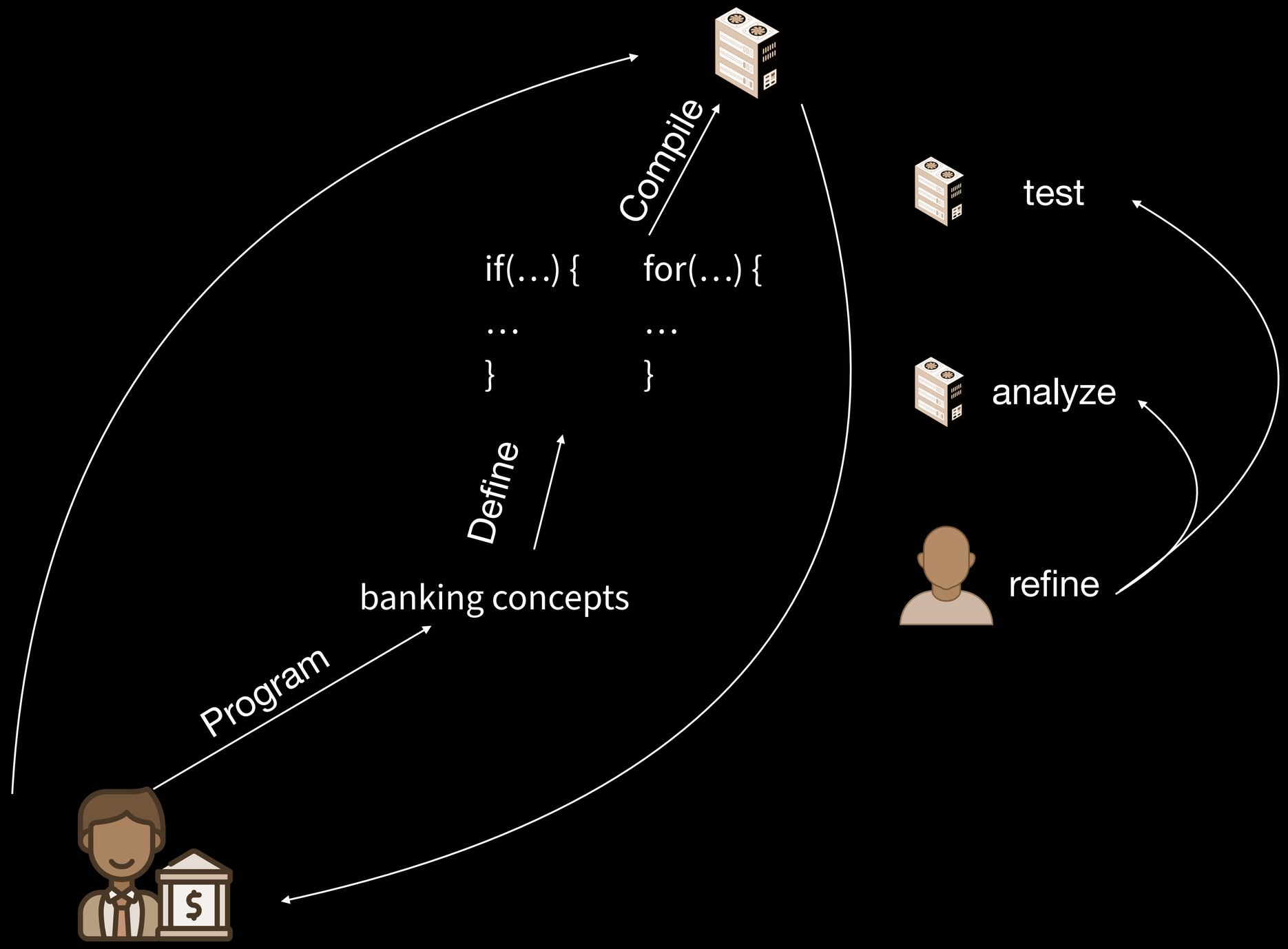

Compile
if(…) {
…
}
for(…) {
…
}
Define
banking concepts
Program


Compile
if(…) {
…
}
for(…) {
…
}
Define
banking concepts
Program


Compile
if(…) {
…
}
for(…) {
…
}
Define
banking concepts
Program


Compile
if(…) {
…
}
for(…) {
…
}
Define
banking concepts
Program
refine


Compile
if(…) {
…
}
for(…) {
…
}
Define
banking concepts
Program
analyze
refine


Compile
if(…) {
…
}
for(…) {
…
}
Define
banking concepts
Program
test
analyze
refine

feedback + planning

feedback + planning

homomorphism + right inverse

feedback + planning

homomorphism + right inverse

small set of formal concepts

feedback + planning

homomorphism + right inverse

small set of formal concepts

meta abstraction

feedback + planning

homomorphism + right inverse

small set of formal concepts

meta abstraction

meta iterative refinement

feedback + planning

homomorphism + right inverse

small set of formal concepts

meta abstraction

meta iterative refinement

scoped understanding

feedback + planning

homomorphism + right inverse

small set of formal concepts

meta abstraction

meta iterative refinement

scoped understanding

computer as instrument

Endowment

2.6 million years of evolution

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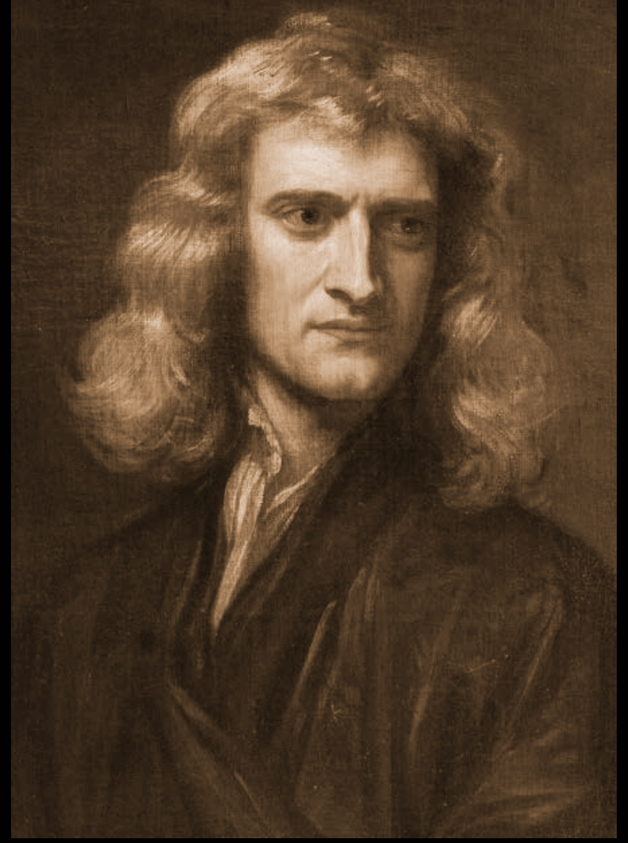
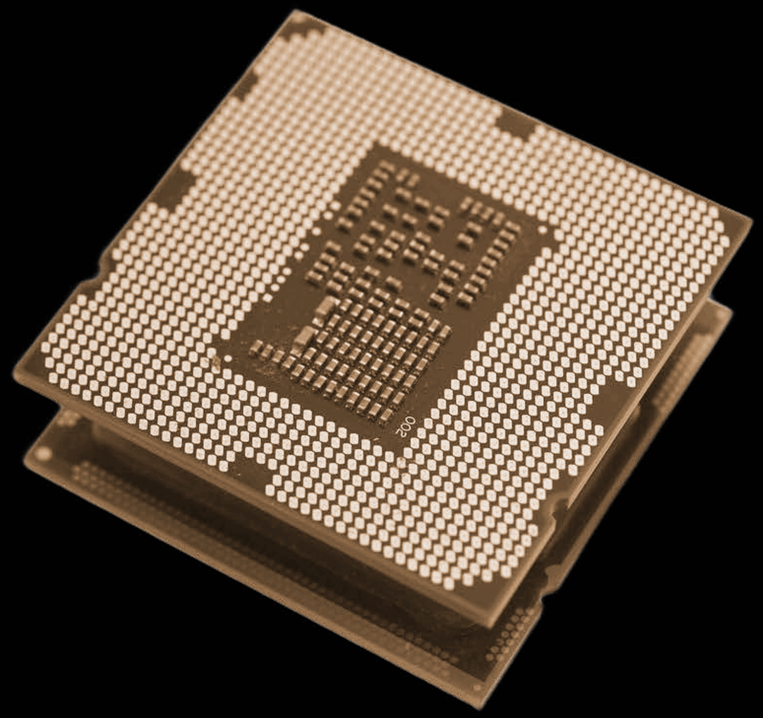


20 thousand years of accumulated knowledge

20+ years of education



The ultimate abstraction instrument

What are you going to do with it?