

LECTURE 3

Oliver Knill, Harvard University

September 9 2020

PLAN

1. Poll

2. Average rate of change

4. Instantaneous rate of change

4. Running

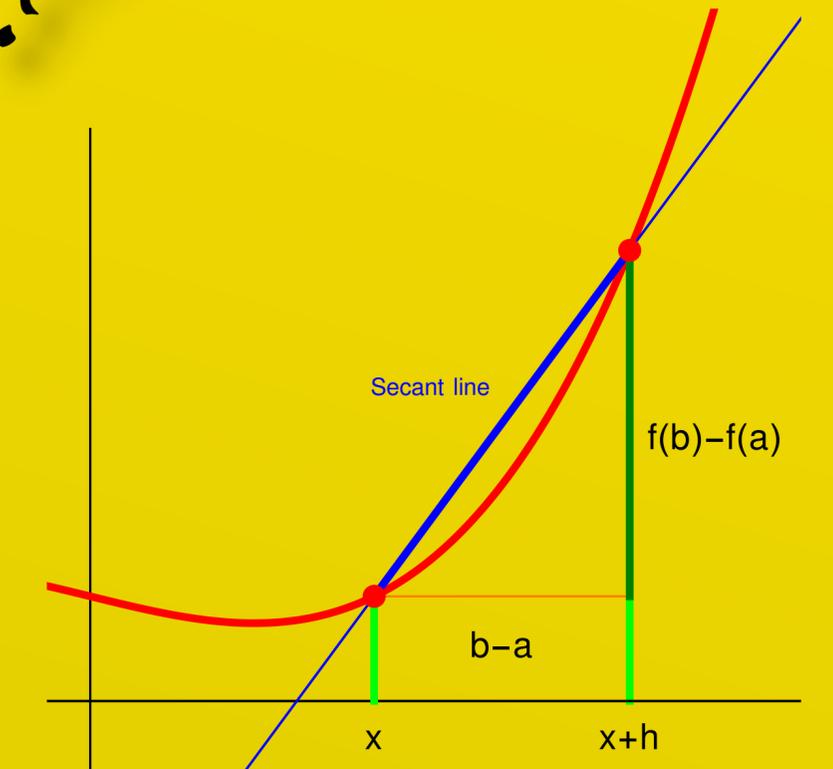
5. Zeno

6. Fish Speed

7. Project work

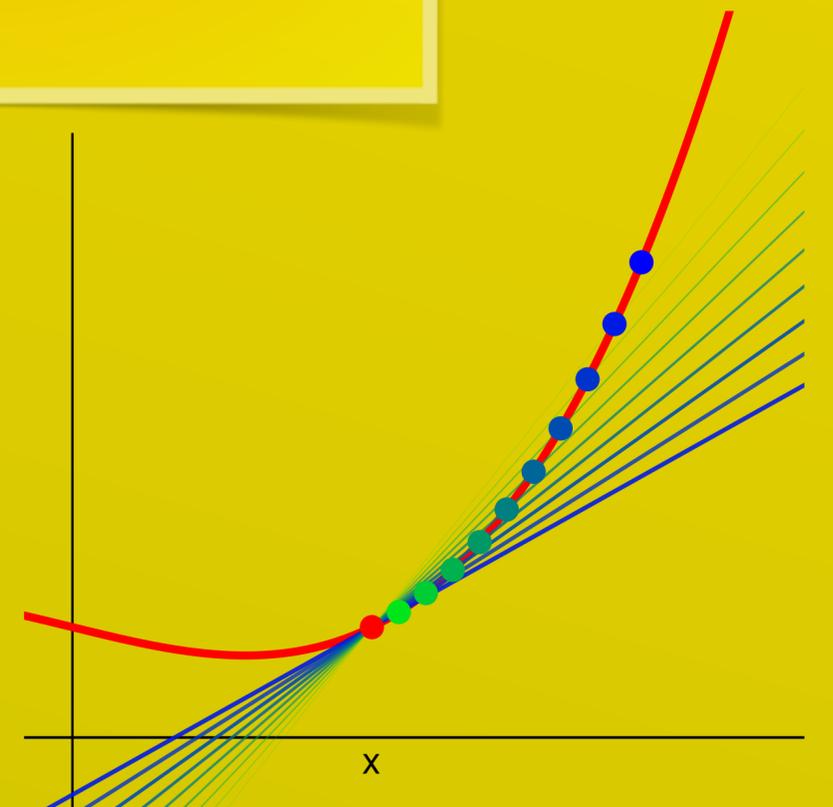
POLL: DID YOU GET IT?

$$\frac{f(b) - f(a)}{b - a}$$



$$\frac{f(x + h) - f(x)}{h}$$

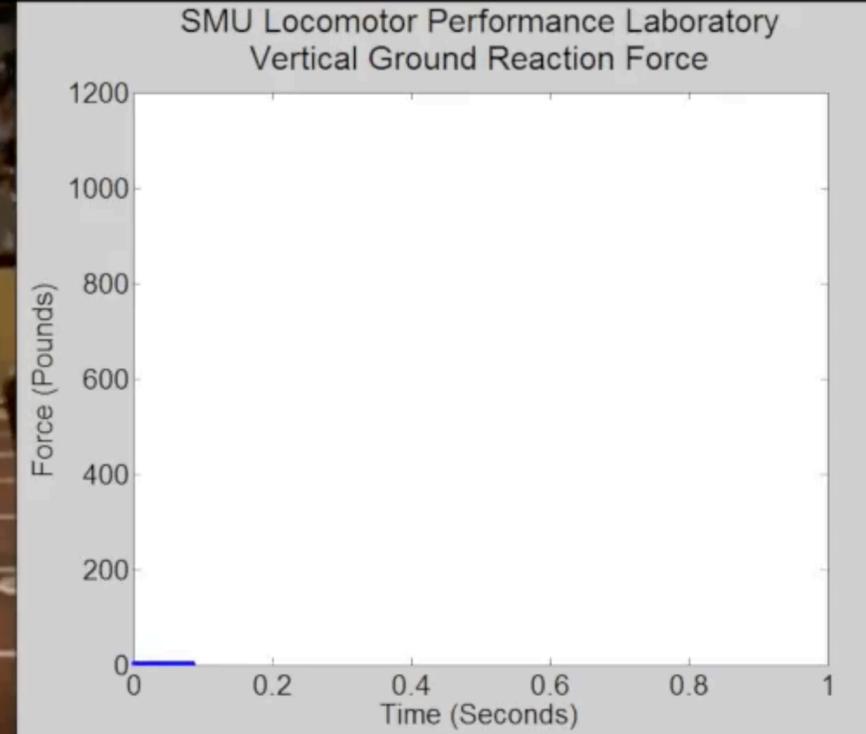
Limit of
when h goes
to 0



REVIEW RUNNING



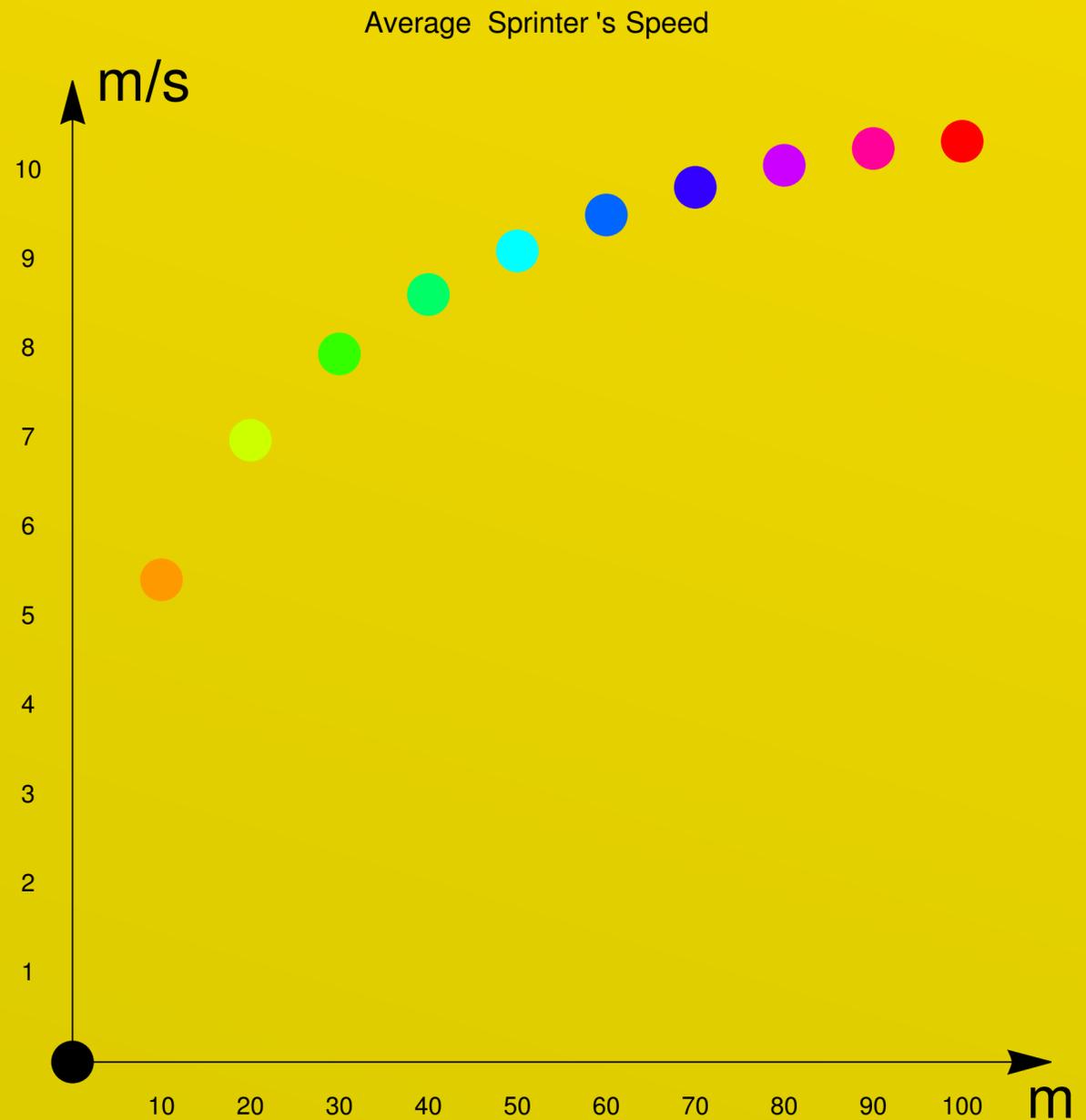
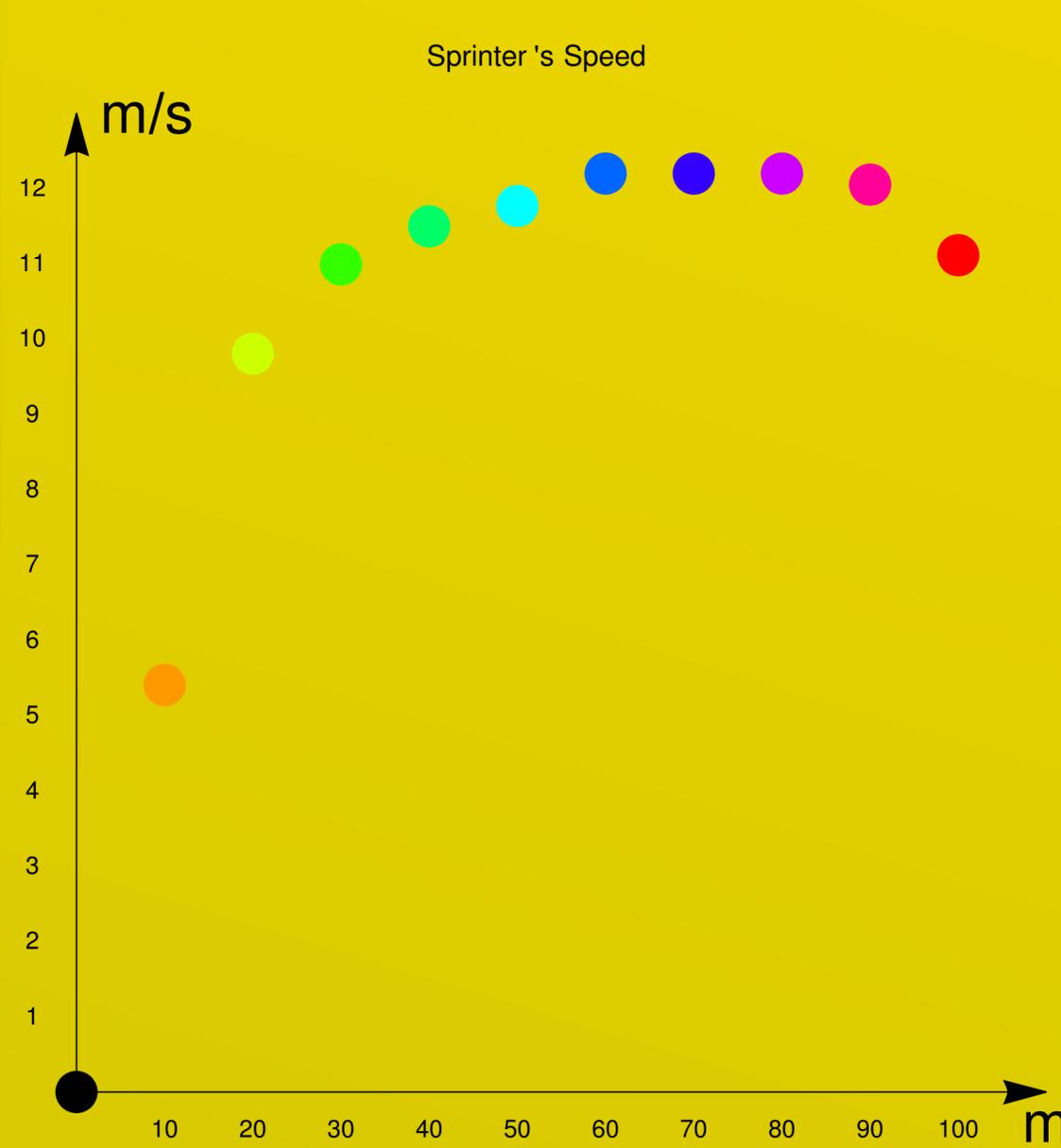
REVIEW RUNNING



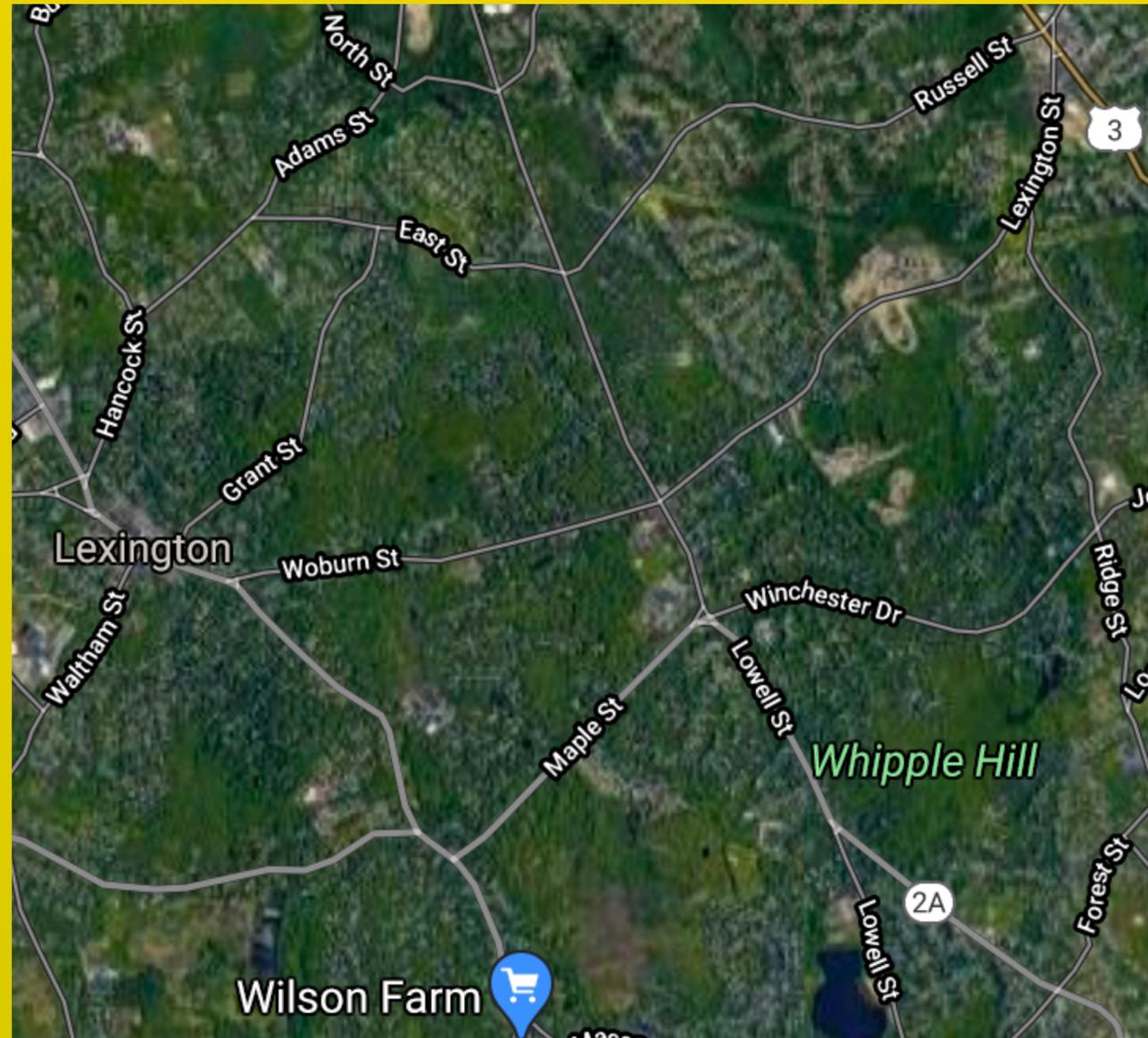
REVIEW RUNNING

Instantaneous speed

Average speed



WATCH



1:08



26:05.74

6'08" ROLLING
KM

6'02" AVERAGE
KM

4.30KM

19 M CURRENT
ELEV

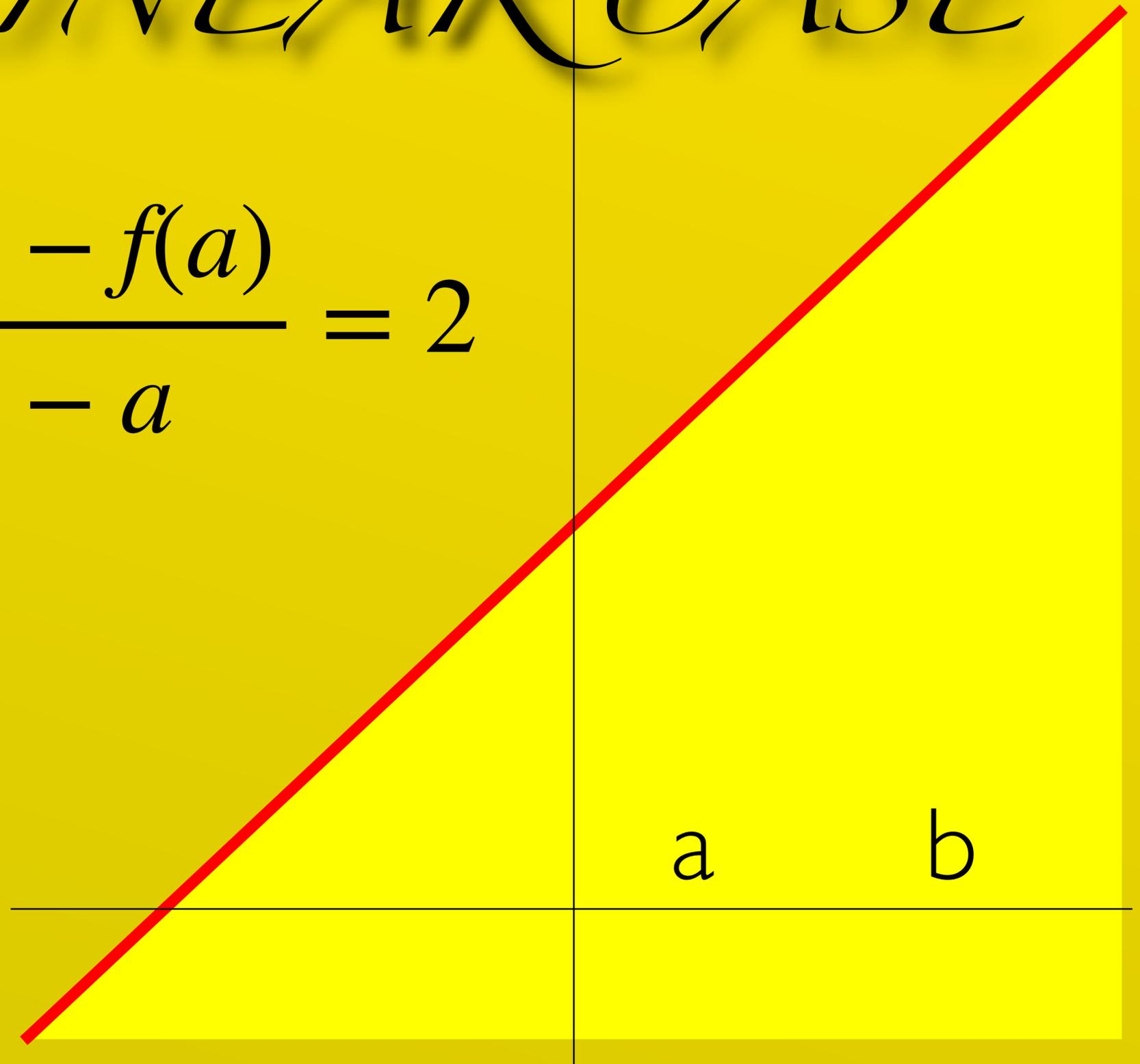
• • •

September 8, 2020

LINEAR CASE

$$\frac{f(b) - f(a)}{b - a} = 2$$

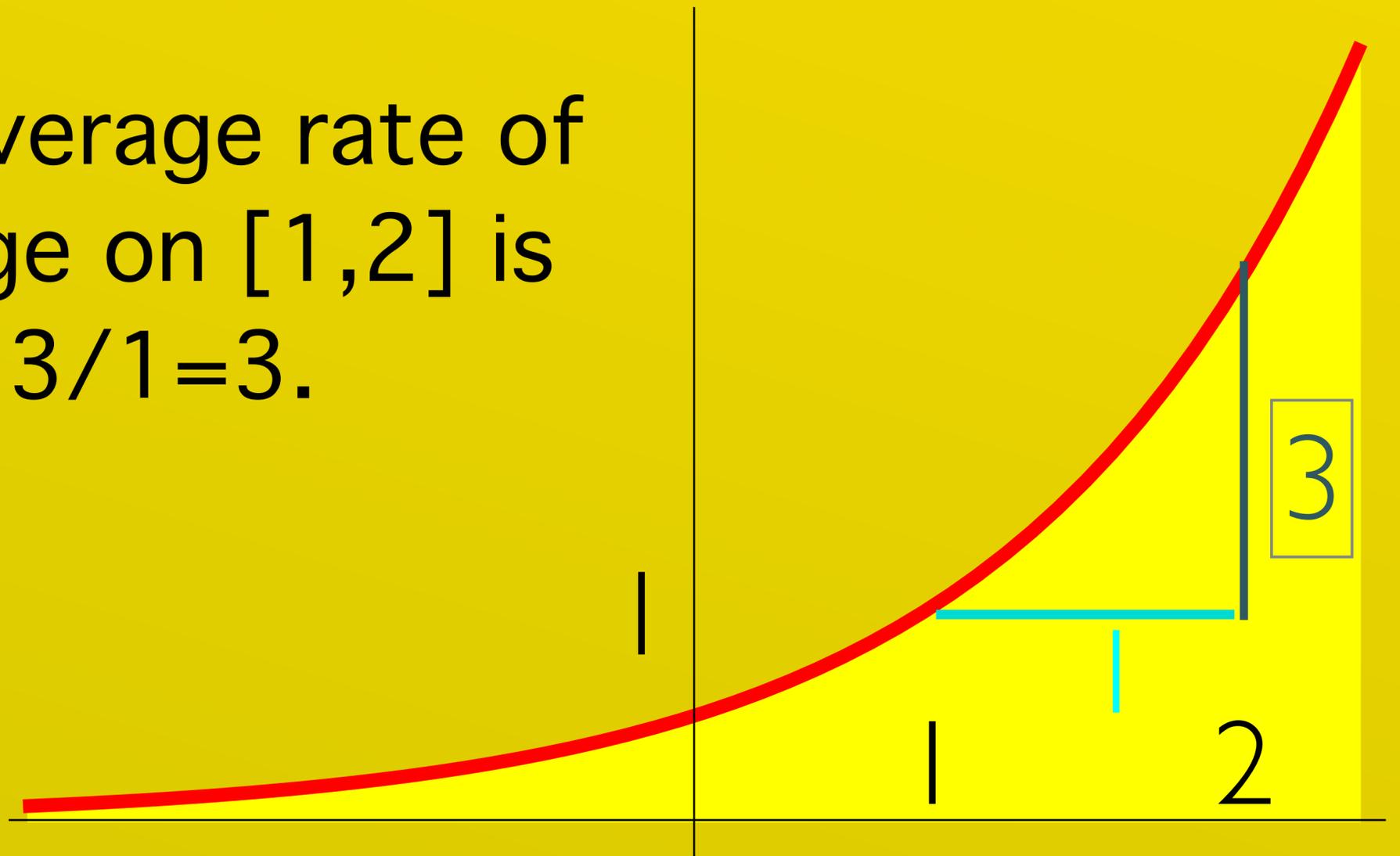
$$f(x) = 2x + 3$$



EXPONENTIAL FUNCTION

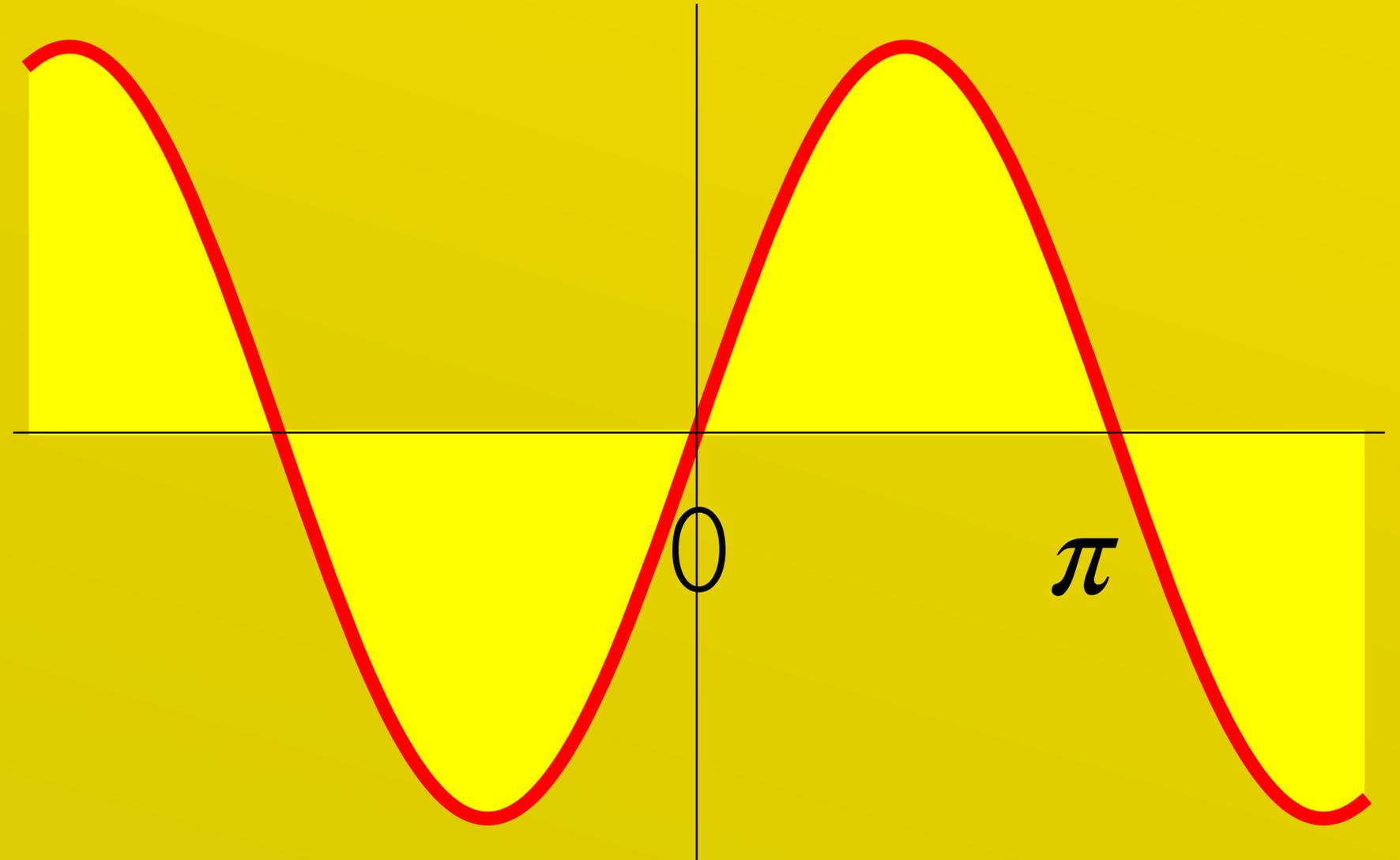
The average rate of
change on $[1,2]$ is
 $3/1=3$.

$$f(x) = 2^x$$



TRIG FUNCTIONS

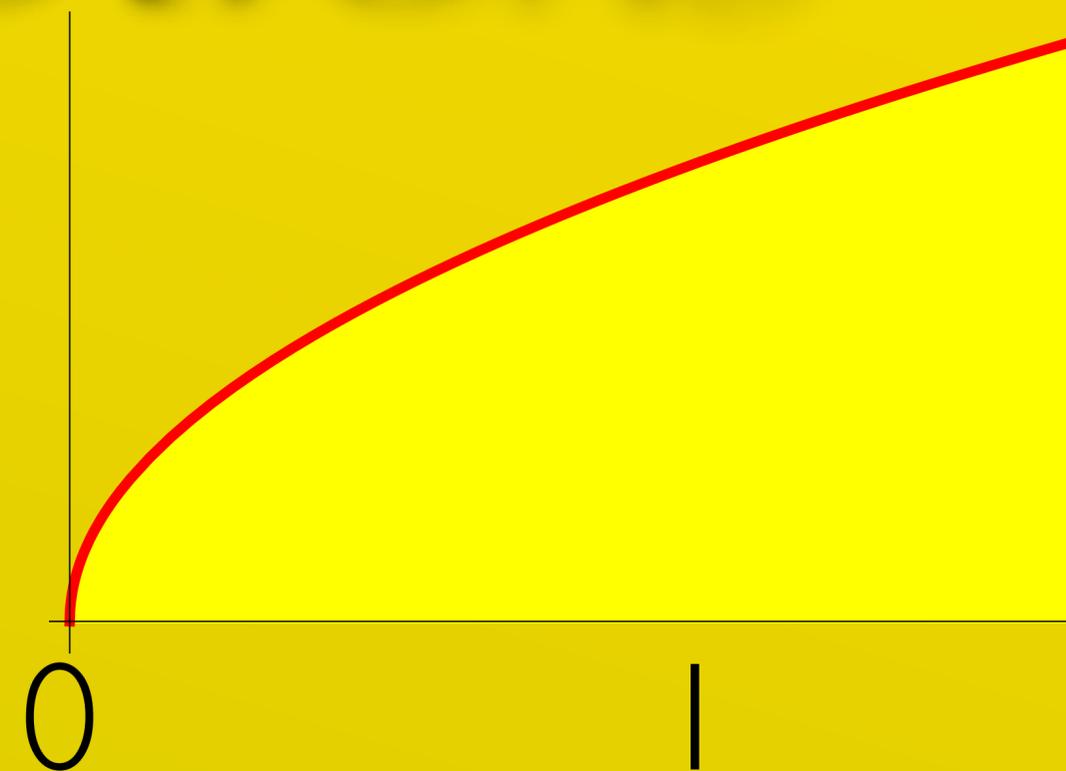
The average rate of change on $[0, \pi]$ is 0



$$f(x) = \sin(x)$$

INVERSE FUNCTIONS

$$y = \sqrt{x}$$



The average rate of change on $[0, 1]$ is 1

ZENO OF ELEA



"If everything when it occupies an equal space is at rest at that instant of time, and if that which is in locomotion is always occupying such a space at any moment, the flying arrow is therefore motionless at that instant of time and at the next instant of time but if both instants of time are taken as the same instant or continuous instant of time then it is in motion."

SALMON SPEED

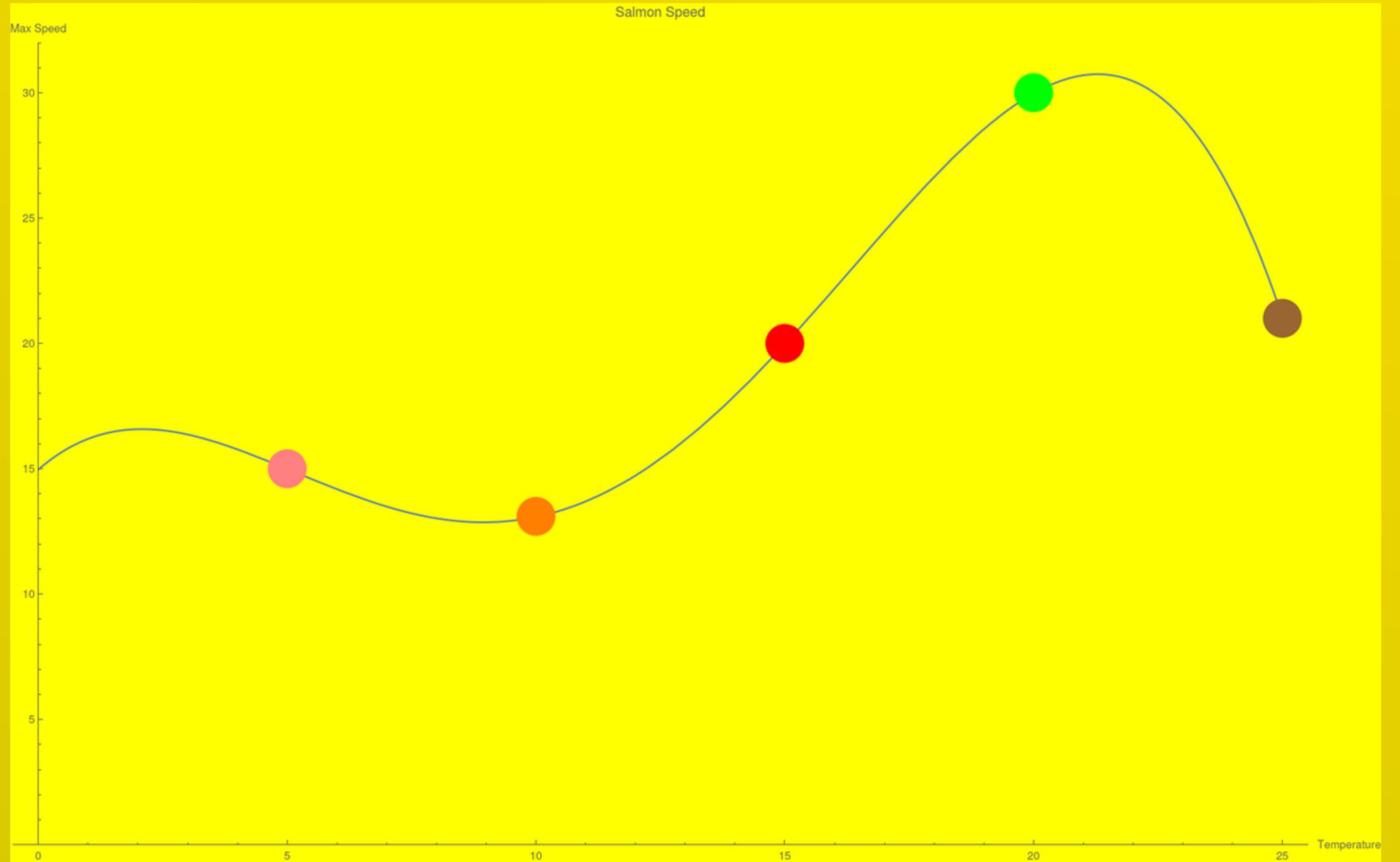


SWIMMING FISH

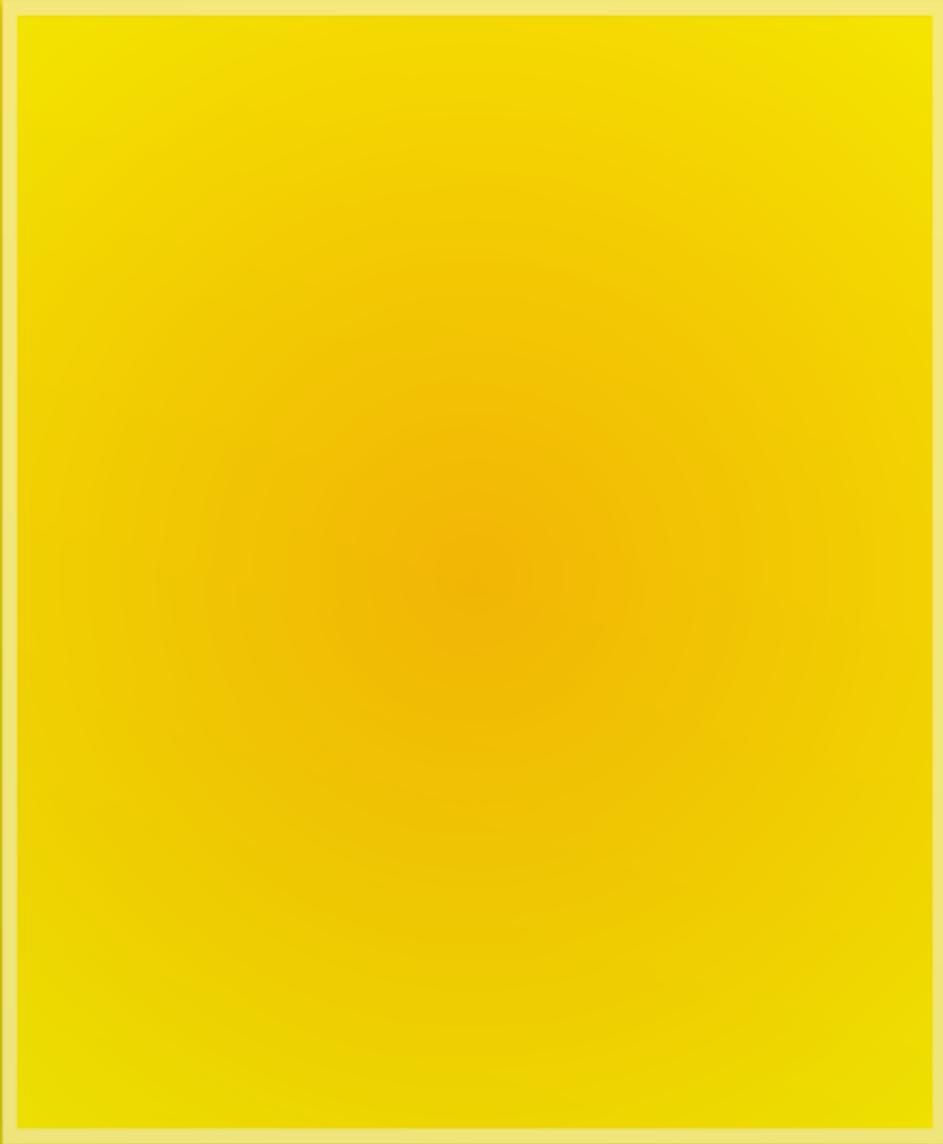
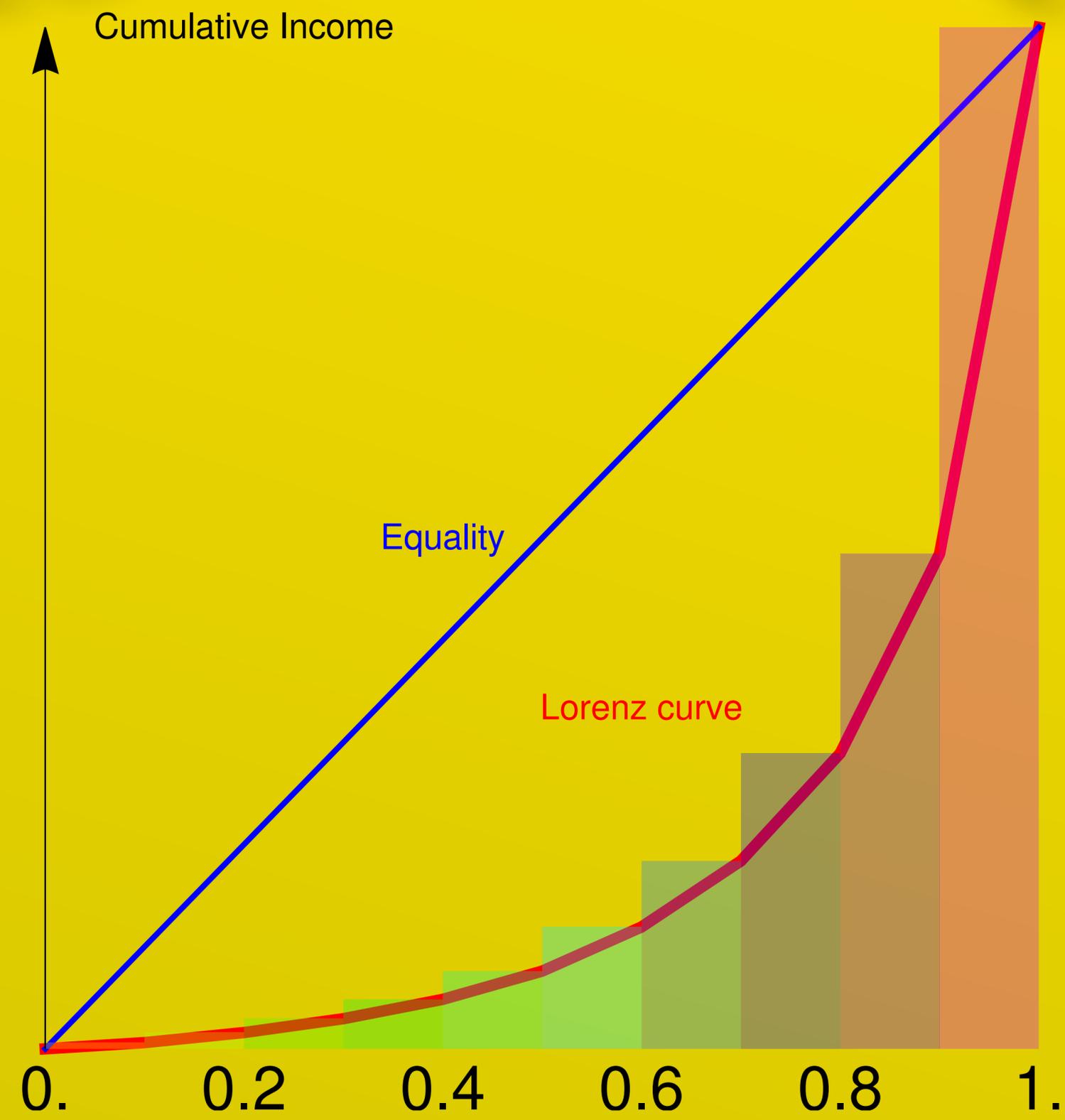


-> Jamboard

SALMON SPEED



PROJECT WORK



THE END