

# measuring and experimenting

digitalisierung und programmierung · prof. dr. nicolas meseth

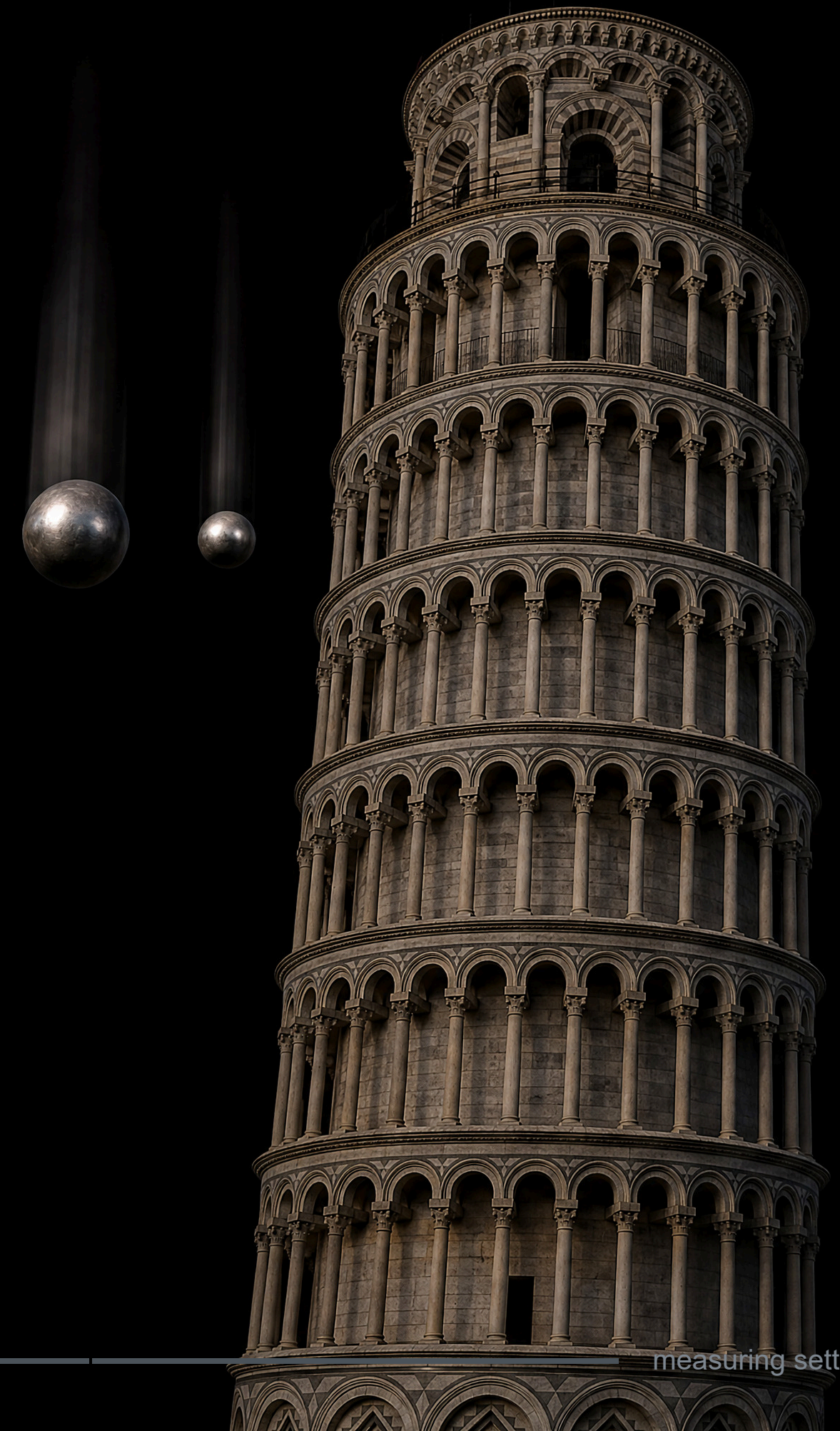
- 1 measuring settles it
- 2 know what you measure
- 3 one reading is a guess
- 4 build evidence

part 1

measuring settles it

which one  
lands first?

image: ai-generated (gpt-image-2)



measuring settles it

three ways to answer the same question

it sounds right

longer readings  
collect more light

three ways to answer the same question

it sounds right

longer readings  
collect more light

the assistant predicts it

double the  
integration time

## three ways to answer the same question

it sounds right

longer readings  
collect more light

the assistant predicts it

double the  
integration time

the series shows it

41 / 50 → 47 / 50  
recognised correctly



evidence from your setup

an explanation is a claim. a measurement can decide.

turn a claim into a test

question

does a longer window  
improve recognition?

turn a claim into a test

question

prediction

does a longer window  
improve recognition?

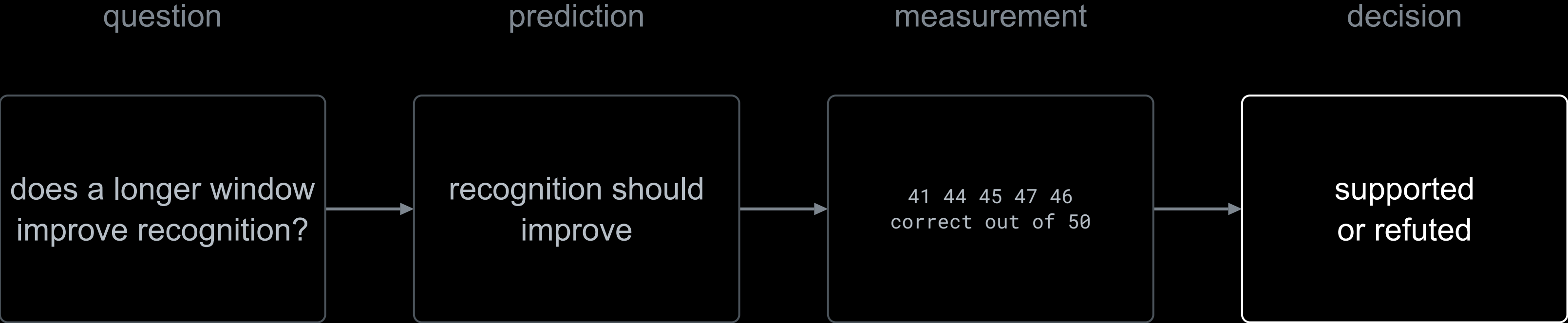


recognition should  
improve

turn a claim into a test



turn a claim into a test



write the expectation before you measure.

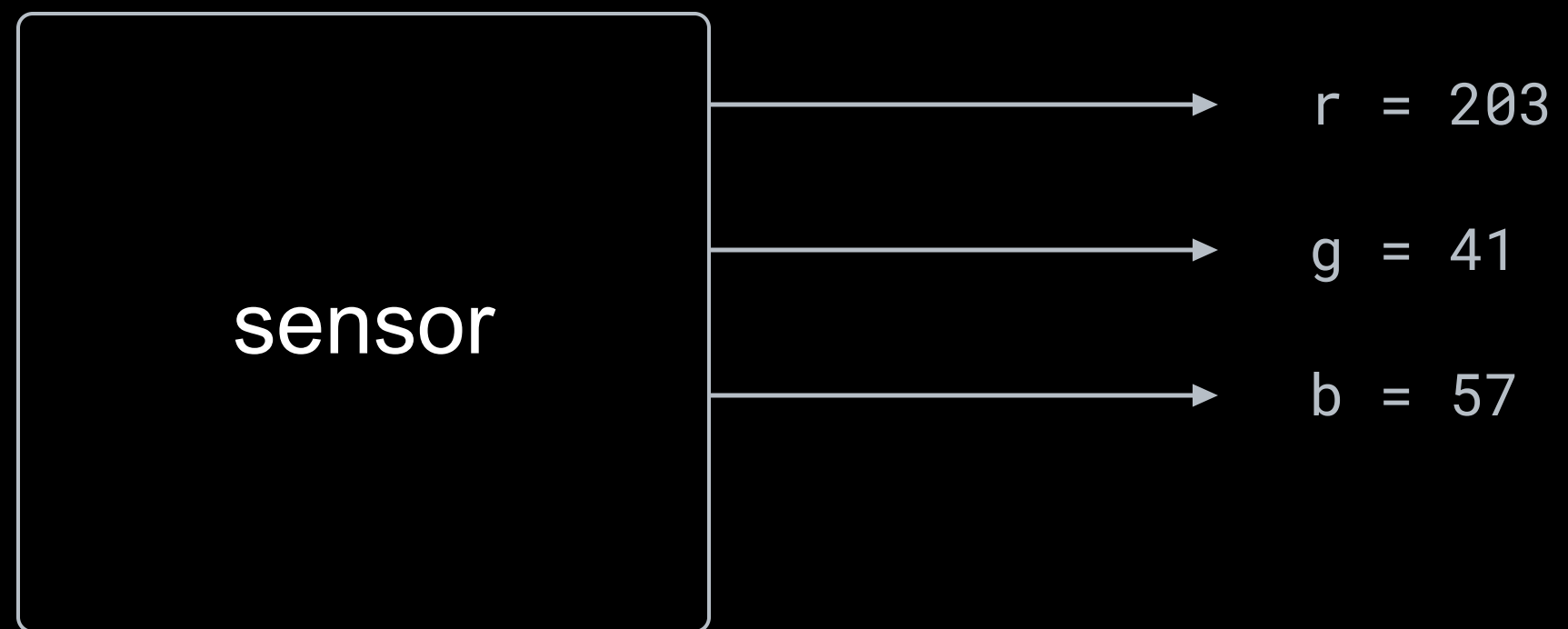
part 2

# know what you measure

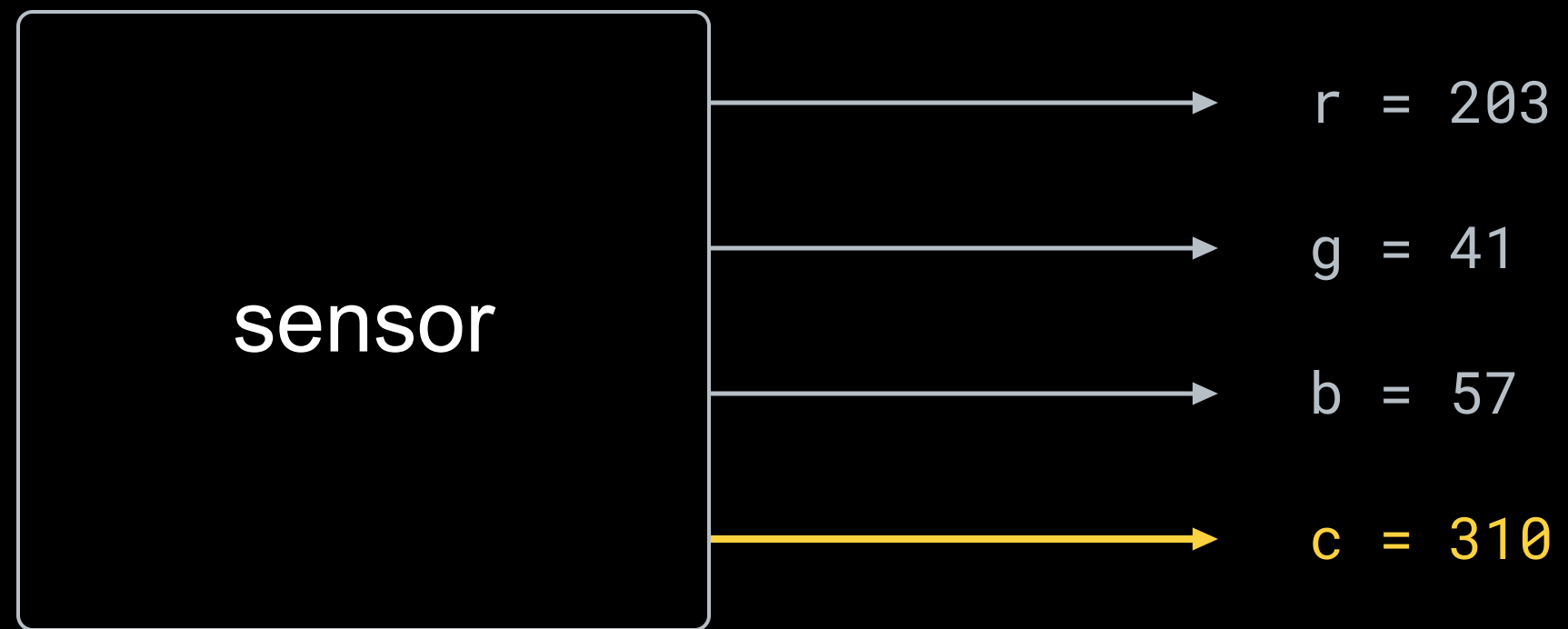
this concept lives at the input



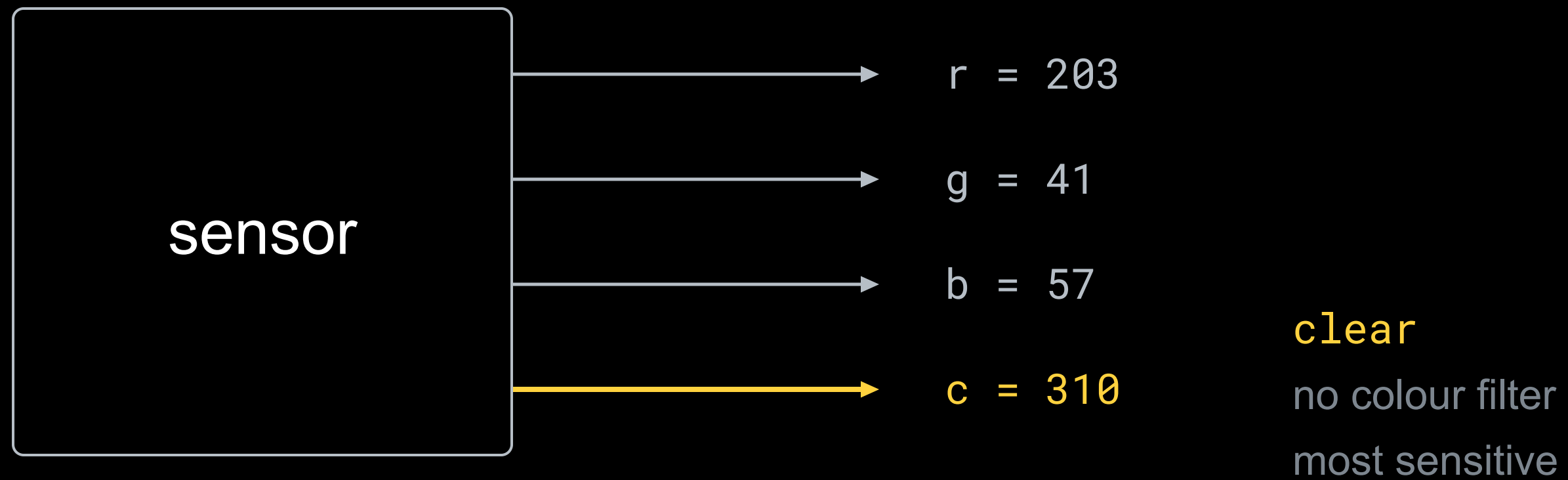
the sensor returns four numbers



the sensor returns four numbers



the sensor returns four numbers

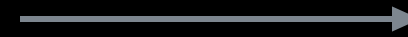


your eyes see a colour. the program sees four values.

sent is not measured

what you send

$r = 255$   
 $g = 0$   
 $b = 0$



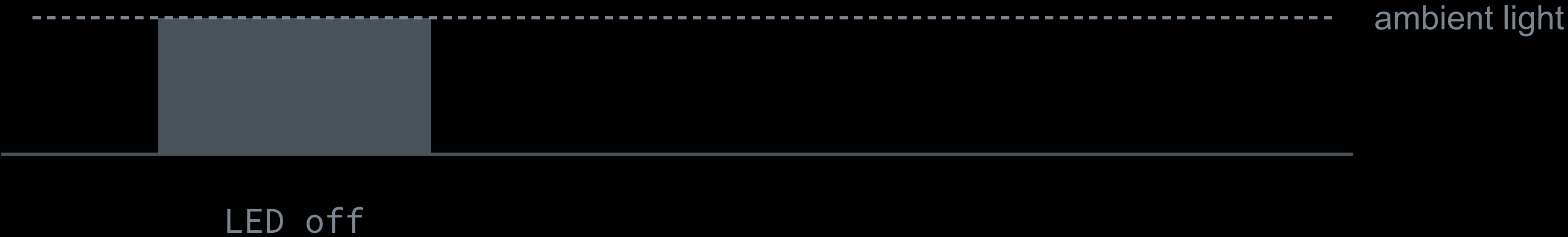
what arrives

$r = 203$   
 $g = 41$   
 $b = 57$   
 $c = 310$

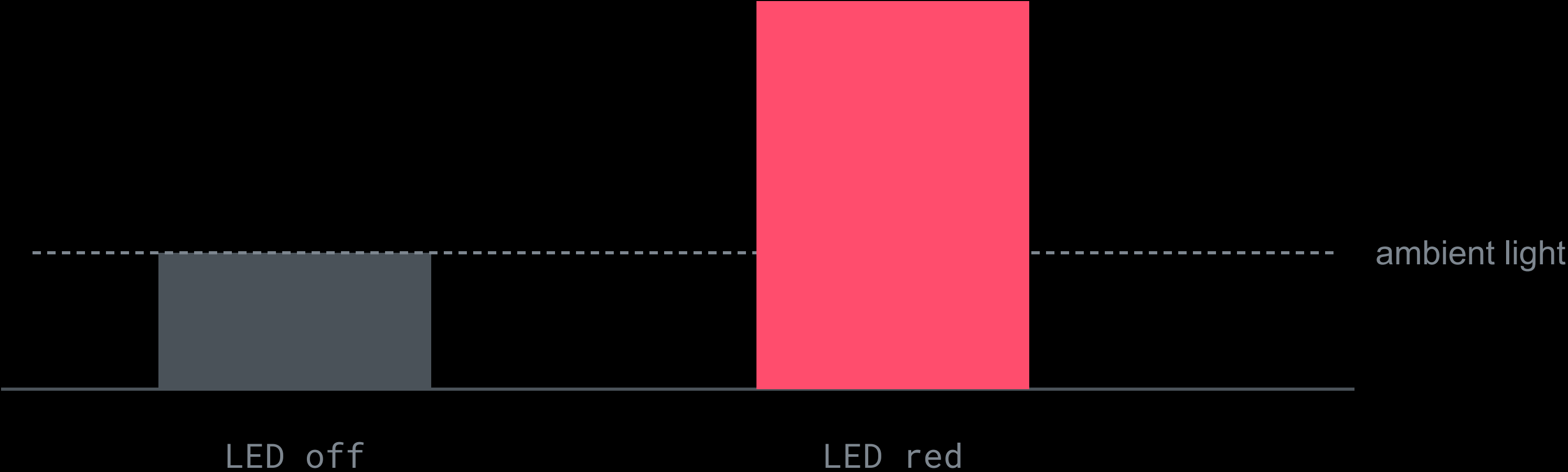
filters overlap · distance matters · the room measures with you

not broken. normal.

measure the dark first



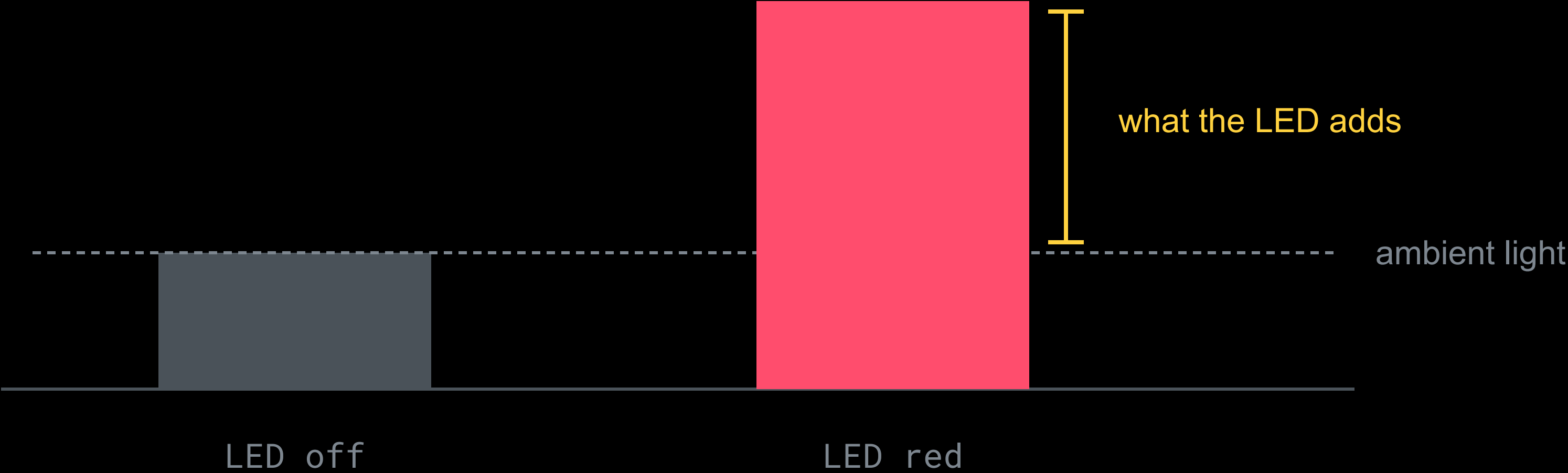
measure the dark first



measure the dark first



measure the dark first



reading = ambient + LED + noise

part 3

one reading is a guess

which value is true?

198

205

201

195

206

which value is true?

198

205

201

195

206

same LED · same settings · five readings



one reading is a guess

which value is true?

198

205

201

195

206

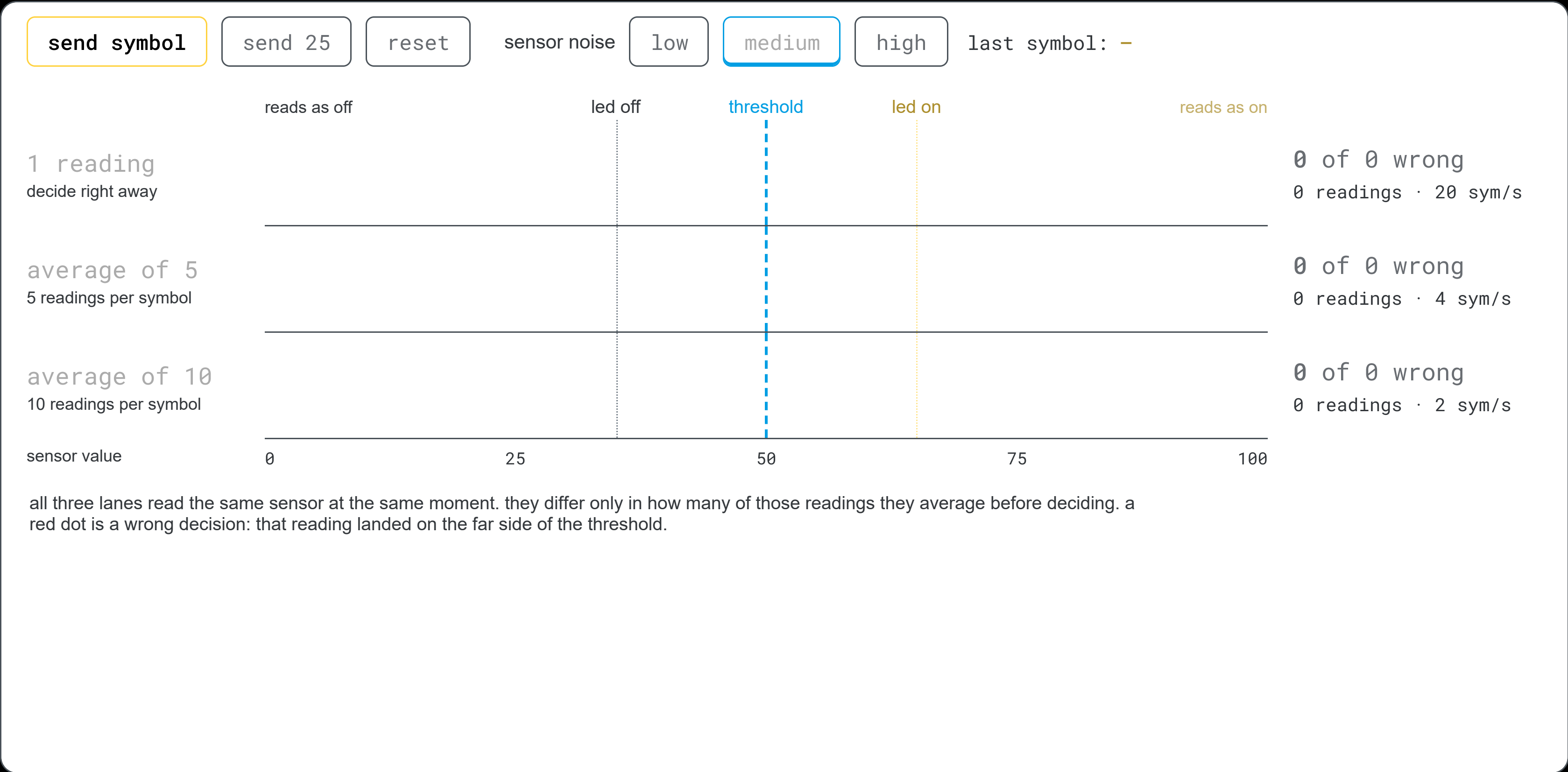
same LED · same settings · five readings

all of them are measurements

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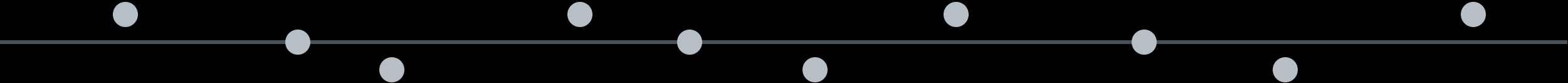
one reading is a guess

try it: how many readings per decision?

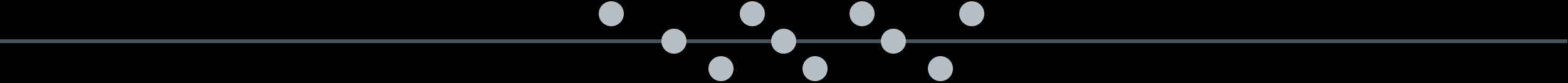


a series reveals what one reading hides

individual readings

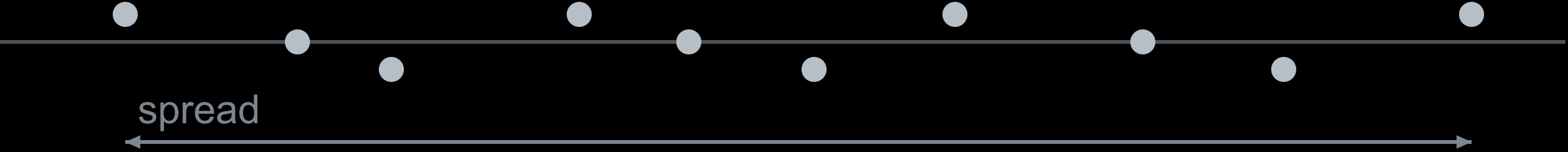


averages of five

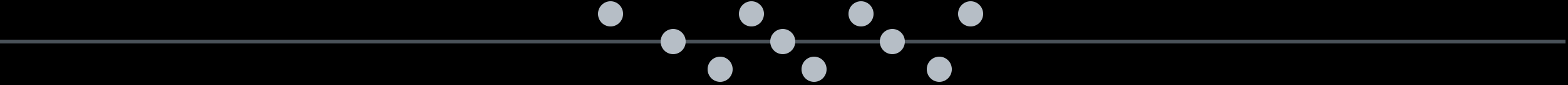


a series reveals what one reading hides

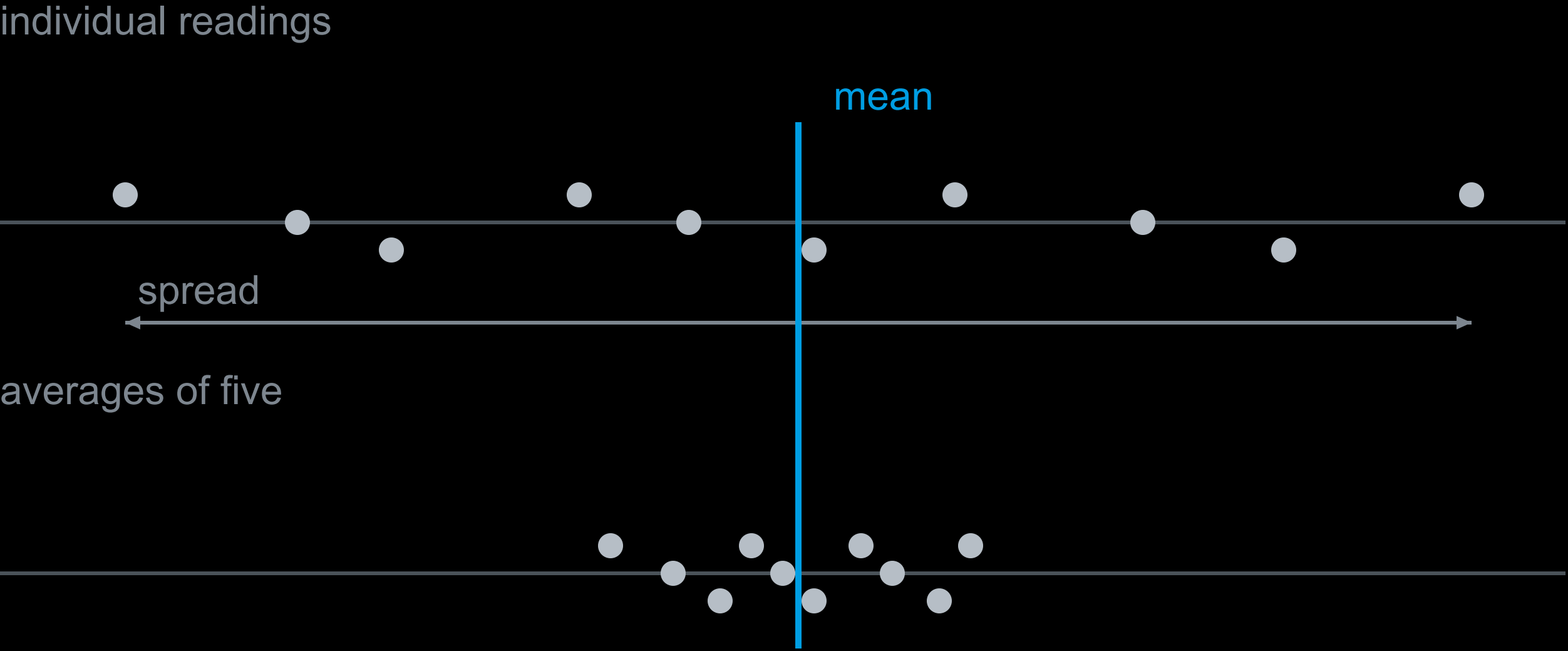
individual readings



averages of five



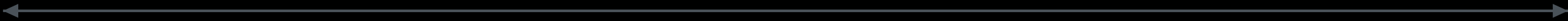
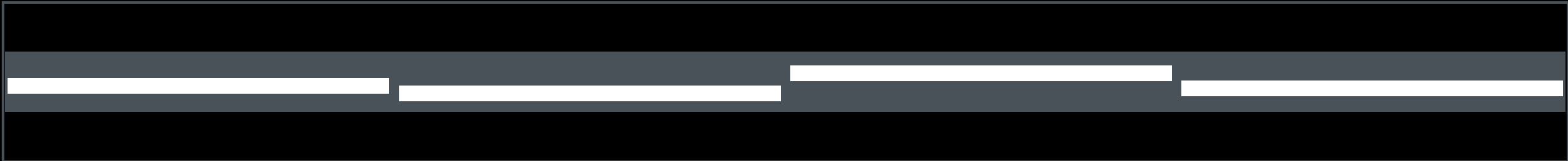
a series reveals what one reading hides



report the centre and the spread.

the knob: integration time

few long readings



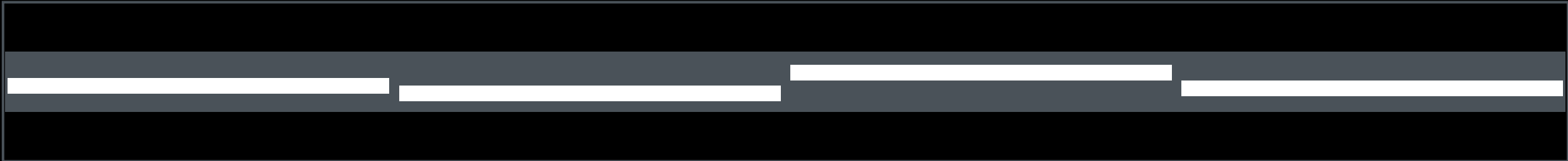
one second



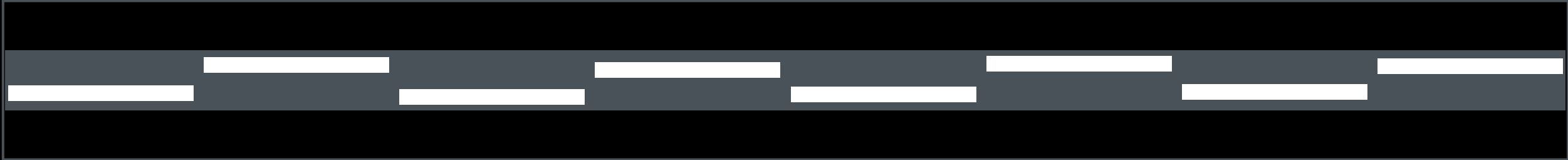
one reading is a guess

the knob: integration time

few long readings



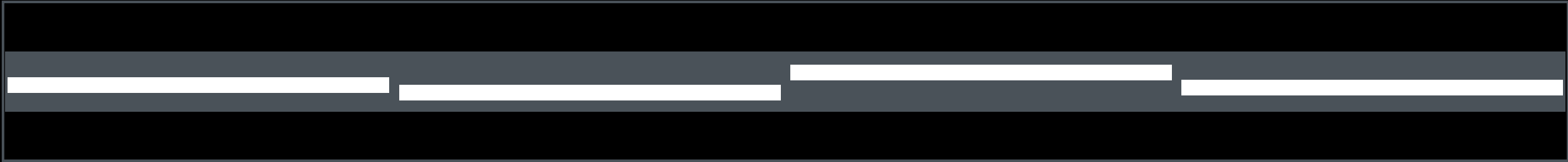
more, shorter readings



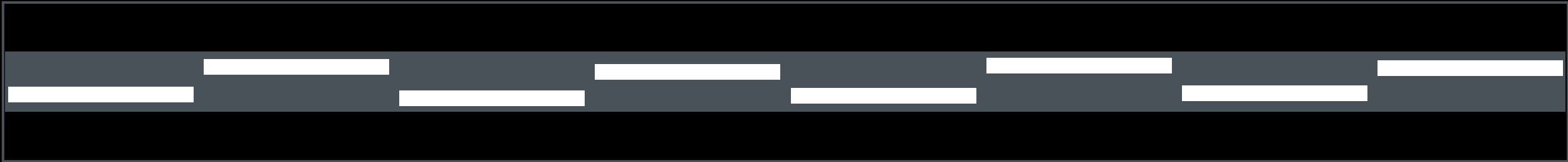
one second

the knob: integration time

few long readings

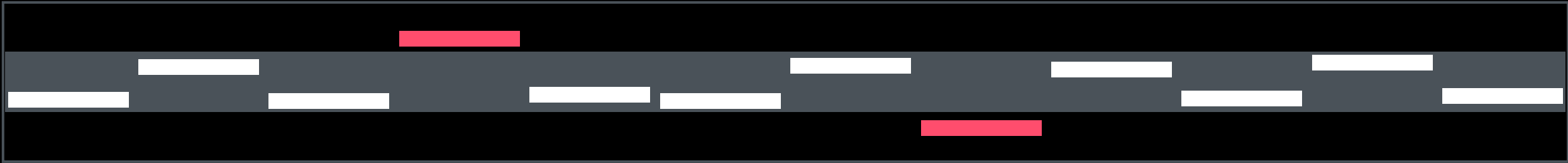


more, shorter readings

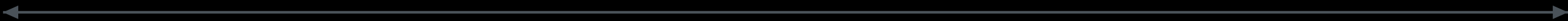


the band that still  
reads correctly

many short readings



these land in the  
wrong colour



one second

longer is calmer.  
shorter is faster.

where is your limit? measure it.

part 4

build evidence

two teams improve their result

team a

changed distance and  
integration time  
  
recognition improved

team b

changed only distance  
  
recognition improved

two teams improve their result

team a

changed distance and  
integration time

recognition improved



what caused it?

team b

changed only distance

recognition improved



distance

change one variable at a time.

what makes a measurement series

before

write conditions  
write the expectation

## what makes a measurement series

before

write conditions  
write the expectation



during

change one variable  
take a control reading  
repeat enough times

## what makes a measurement series

before

write conditions  
write the expectation



during

change one variable  
take a control reading  
repeat enough times



after

keep every value  
compare with expectation  
record the outcome

repeatable beats impressive.

luck or skill?

5 / 5

50 / 50

guessing succeeds about once in 32 attempts

luck or skill?

5 / 5

guessing succeeds about once in 32 attempts

50 / 50

guessing: about 1 in 1,125,899,906,842,624

luck or skill?

5 / 5



guessing succeeds about once in 32 attempts

50 / 50



guessing: about 1 in 1,125,899,906,842,624

evidence

calibrate, then classify



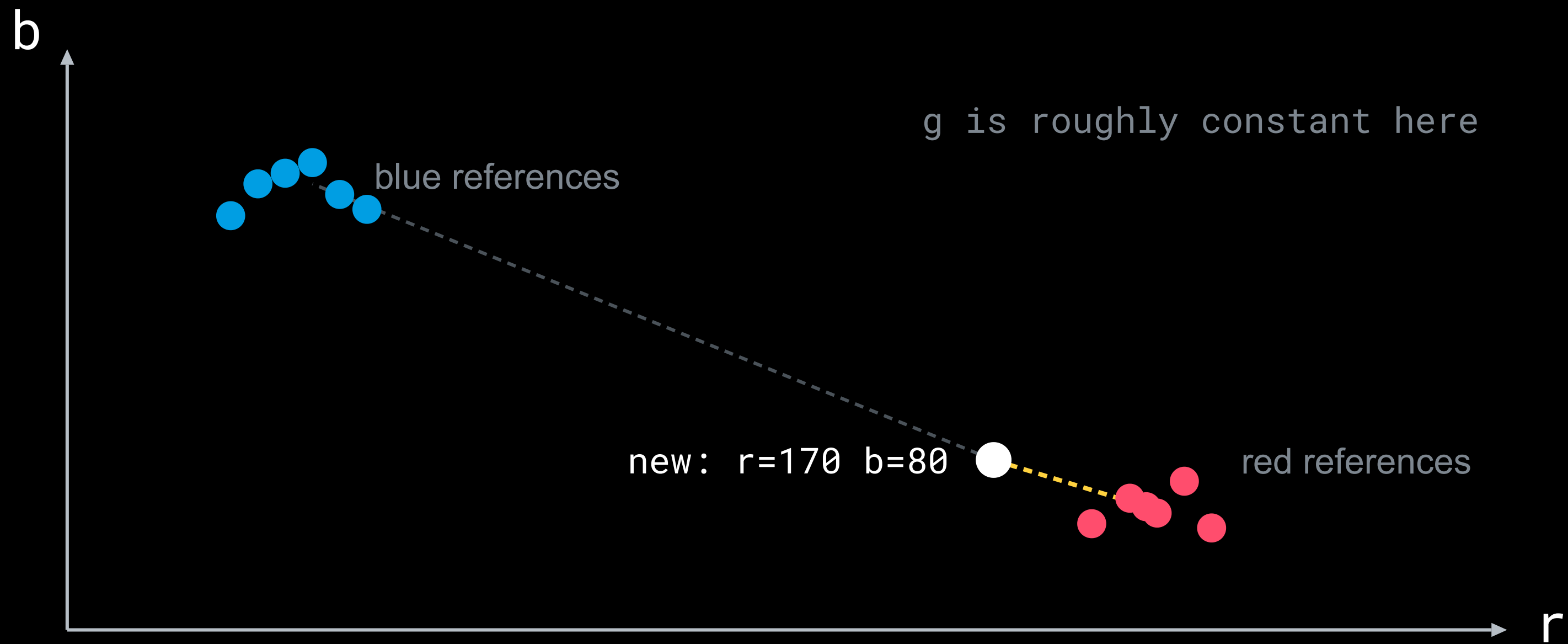
measure known colours many times

calibrate, then classify



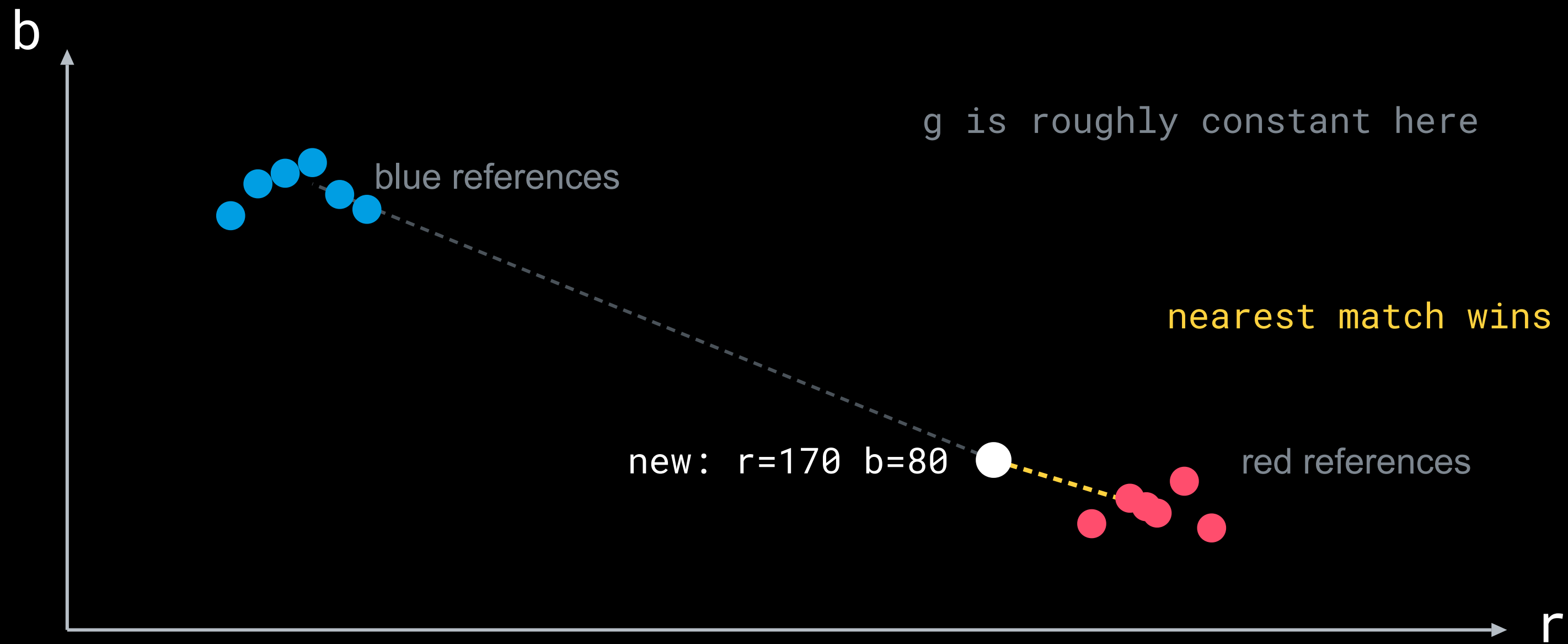
measure known colours many times

calibrate, then classify



measure known colours many times

calibrate, then classify



measure known colours many times

when the assistant and the data disagree

assistant suggestion

"increase the gain —  
recognition will improve"

your measurement series

gain ↑  
recognition: 94% → 82%

when the assistant and the data disagree

assistant suggestion

"increase the gain —  
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your measurement series

gain ↑  
recognition: 94% → 82%

✓ one variable

✓ enough repetitions

✓ control reading

when the assistant and the data disagree

assistant suggestion

"increase the gain —  
recognition will improve"



your measurement series

gain ↑  
recognition: 94% → 82%



✓ one variable

✓ enough repetitions

✓ control reading

ground truth for your setup

when the assistant and the data disagree

assistant suggestion

"increase the gain —  
recognition will improve"



your measurement series

gain ↑  
recognition: 94% → 82%



✓ one variable    ✓ enough repetitions    ✓ control reading

ground truth for your setup

log of  
mistakes



if you did not measure it,  
you do not know it.

one reading is not a measurement series.