✓ - C.I of metrics — Non Gaussian to Gaussian — Param vs Non param

Today

Remedial Session: Statistics (3 more topics)

Regular Session: Linear Algebra & Co-ordinate Geometry

Geometric / intuitive

Application

ML concepts

Next Sessions (2 more)

Ops:

each section → chat (Q&A)

general / broad / out of the context → Q&A (30 mins)

Parametric vs Non-parametric tests

Parametric

- makes assumptions about the 'distb' of the data
- F-statistic
- ANOVA: each groups observations are sampled from a Gaussian distb

Non-parametric tests

- χ^2-test
- any distb. assumptions about the data?

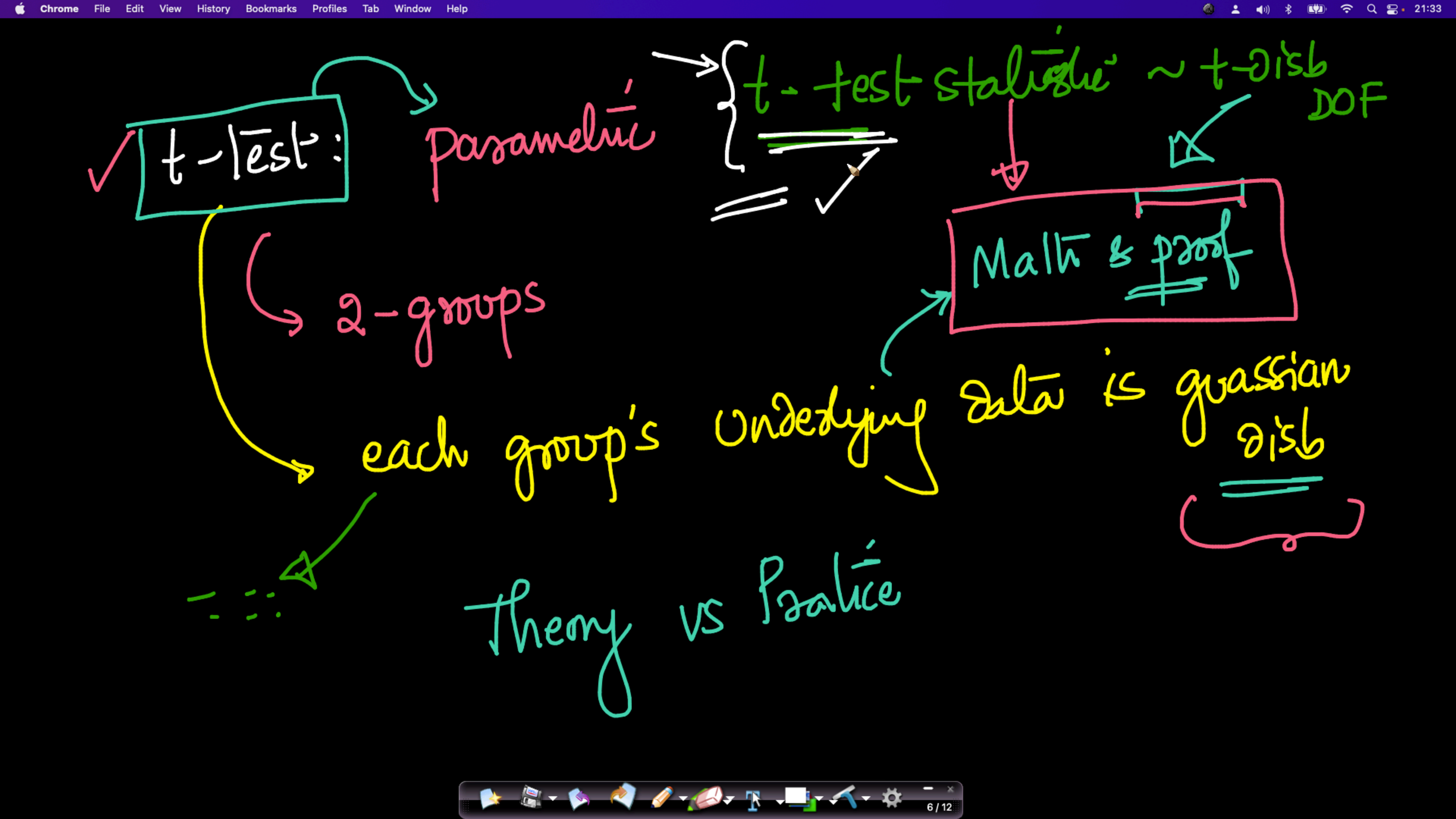
(Q) χ^2-test → No assumptions about underlying data

Common-Confusion

χ^2 test statistic $= \sum_{i=1}^{k} \frac{(O_i - E_i)^2}{E_i}$ ✓

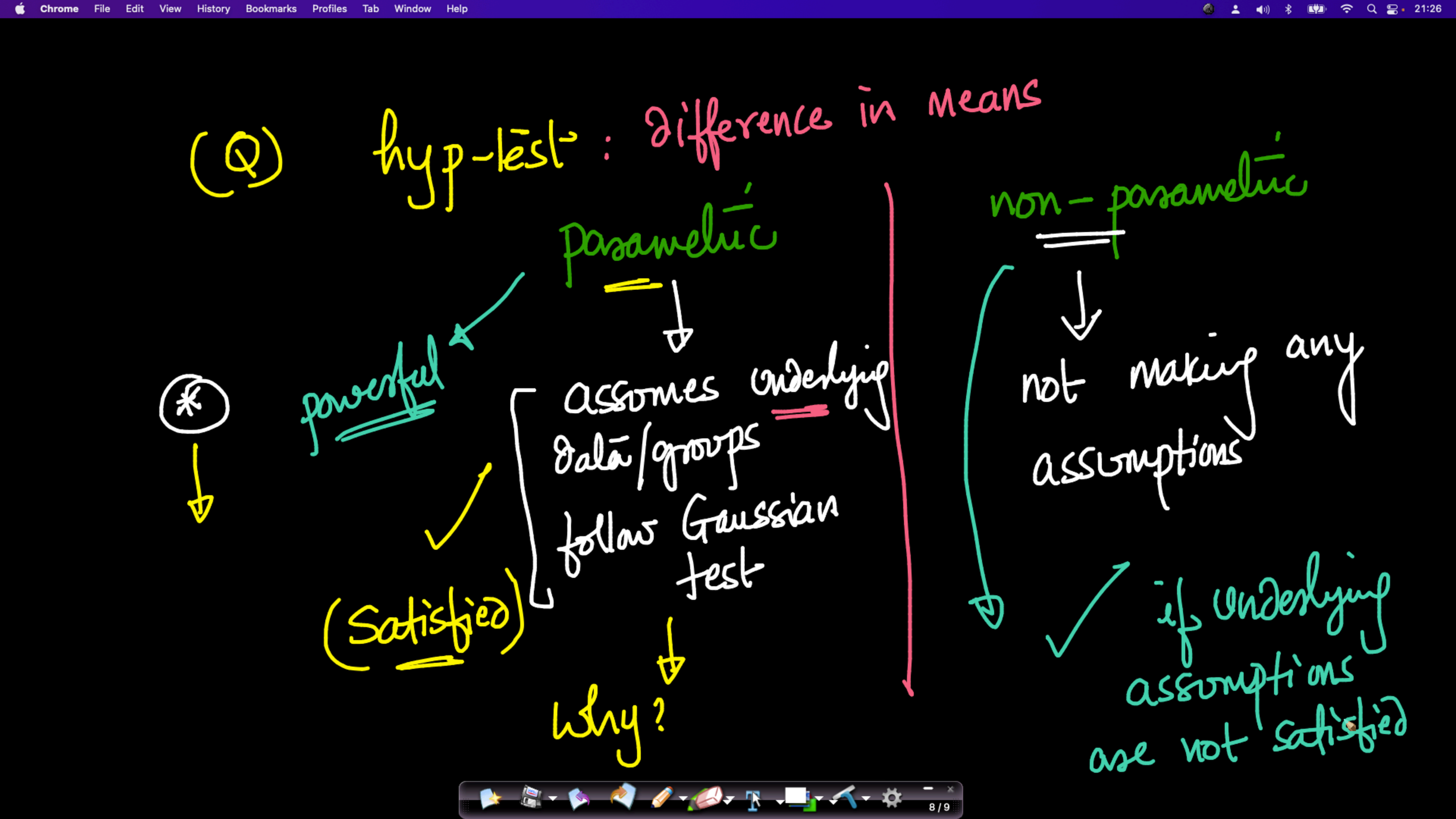
χ^2-distribution → p-value ✓

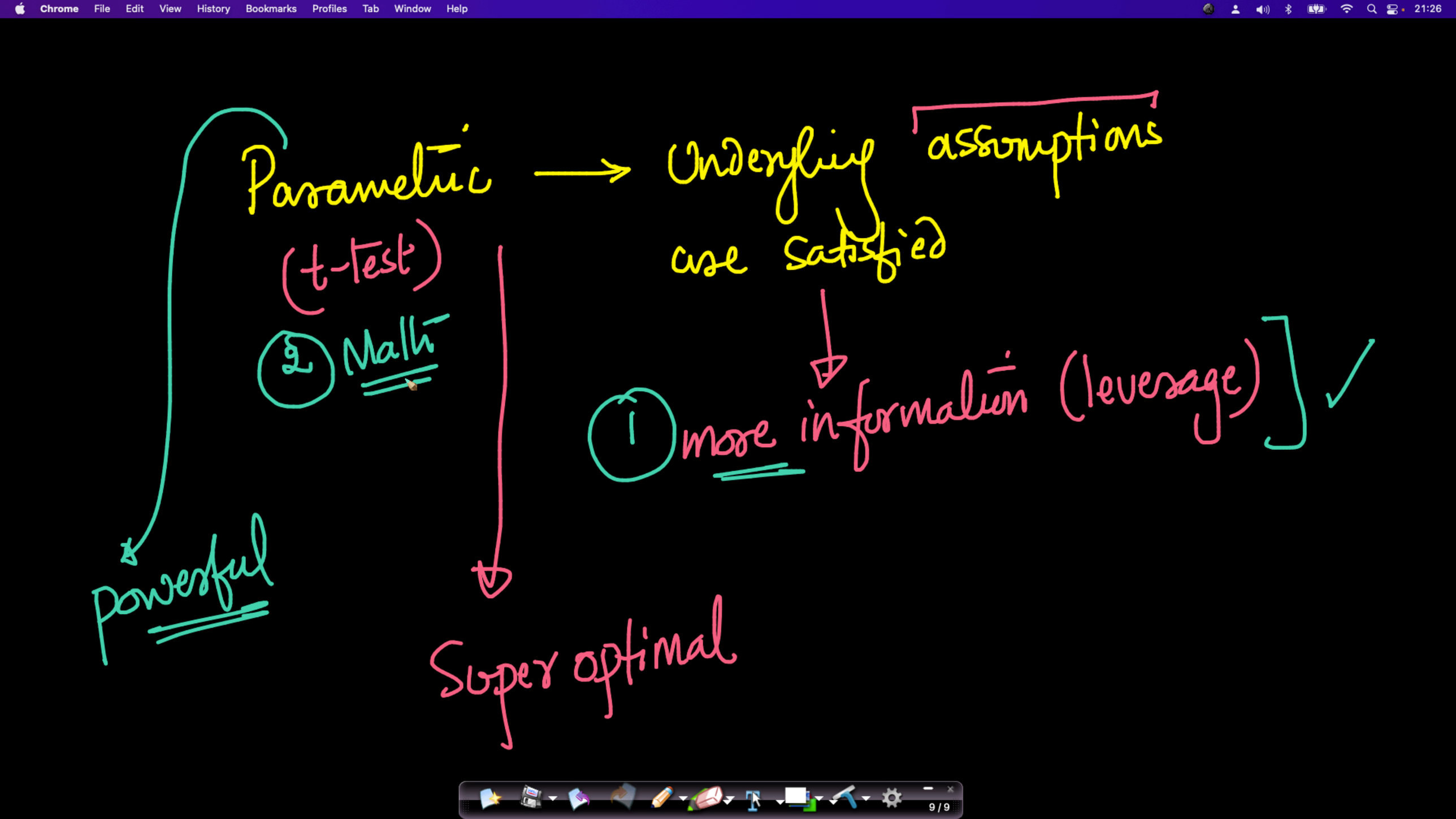
→ why is it non-parametric


t-test:
Parametric
t-test statistic ~ t-dist
DOF
2-groups
Math & proof
each group's Underlying data is gaussian dist
Theory vs Practice

✓ test.
t-statistic ~ t-dist^b

[underlying data ~ Gaussian (ideal-case)


(Q) hyp-test : difference in means
parametric
non-parametric
powerful
assumes underlying data/groups follow Gaussian test
(satisfied)
why?
not making any assumptions
if underlying assumptions are not satisfied
8 / 9


Parametric
(t-test)
2 Multi
Underlying assumptions
case satisfied
1 more information (leverage)
Powerful
Super optimal

(Q) 2-Sample z-test : parametric or non-param

- t-test → fewer sample size ; unknown σ
- z-test → larger sample size ; known σ

each groups underlying dist is Gaussian ✓

{ 100's of hyp. testing

↓ appropriate in the context ; param or non-param

→ 6-step framework

Underlying data

CLT: Sample-means ~ Gaussian dist ✓

Finite μ, σ

t-test → means of samples

Underlying data ≠ Gaussian

Can't prove

t-test statistic ~ t-dist DOF

Underlying data

Uniform-dist

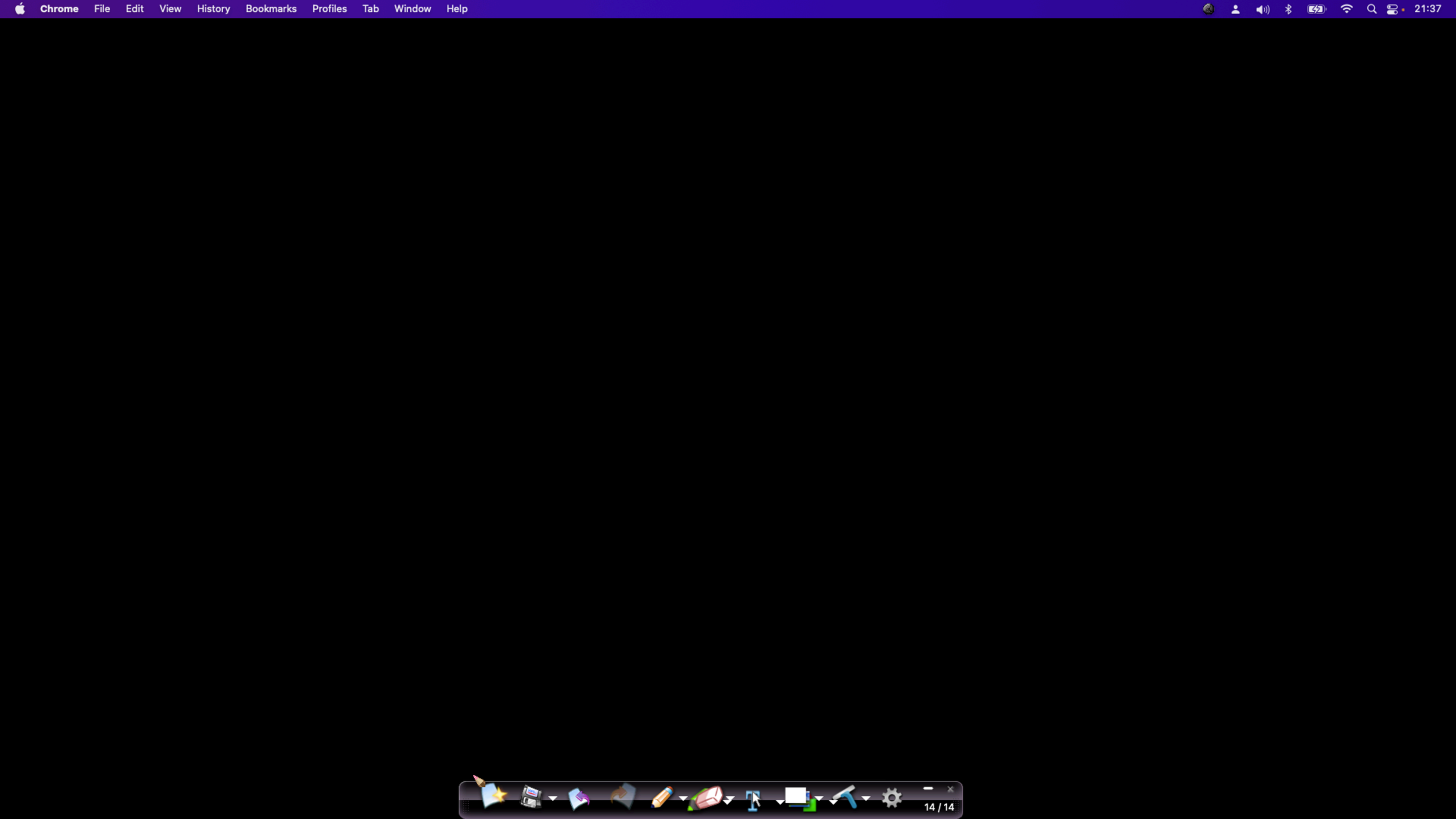
(finite μ, σ)

Sample-means ~ Gaussian

(CLT)

NOT converging

non-Gaussian to Gaussian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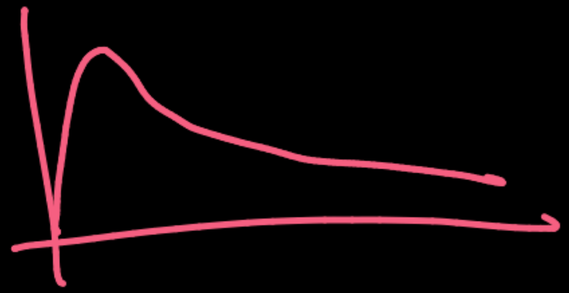
14 / 14

Non-Gaussian ⟶ Gaussian

$X \rightarrow \{x_1, x_2, \ldots\}$ observations



Q

e.g.: log-normal ⟶

$X \sim$ log-normal

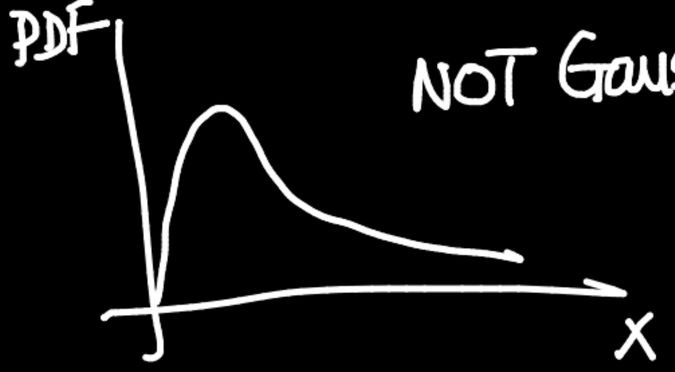
$\log_e(X) = \ln(X) \sim$ Gaussian-dist

Obs

$X \Rightarrow \{ x_1, x_2, x_3, \ldots x_n \}$

PDF

NOT Gaussian

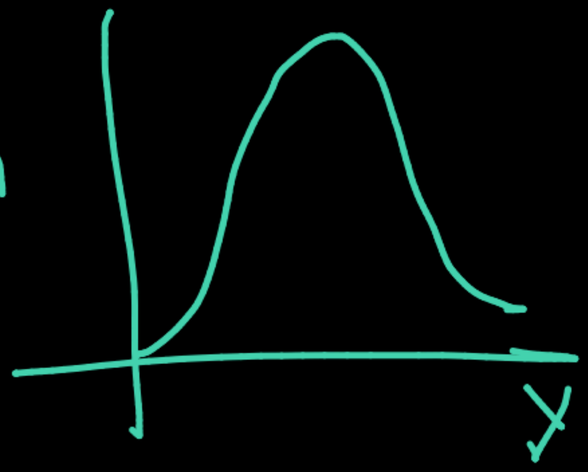


one transforming

$\ln(x)$: log transform

$Y = \{ \ln(x_1), \ln(x_2), \ln(x_3) \ldots \ln(x_n) \}$

$y_1 \quad y_2 \quad y_3 \quad \ldots \quad y_n$



why ?

analogy: cm → feet
°C → °F

10, 10

↳ Non-Gaussian (log-normal)

transforming → log

Gaussian

t-test

tampering

↳ X

123.6	→ 121.6
29.3	→ 213.45

Conclusions

hyp-testing: $H_0: M_1 = M_2$
$H_a: M_1 \neq M_2$

$$y = \ln(x)$$

$$x = e^{y} \Rightarrow \exp(y)$$

✓ Box-Cox :

X $\{x_1, x_2, \dots x_n\}$

non-Gaussian

box-cox (scipy)

λ

optimization

exp

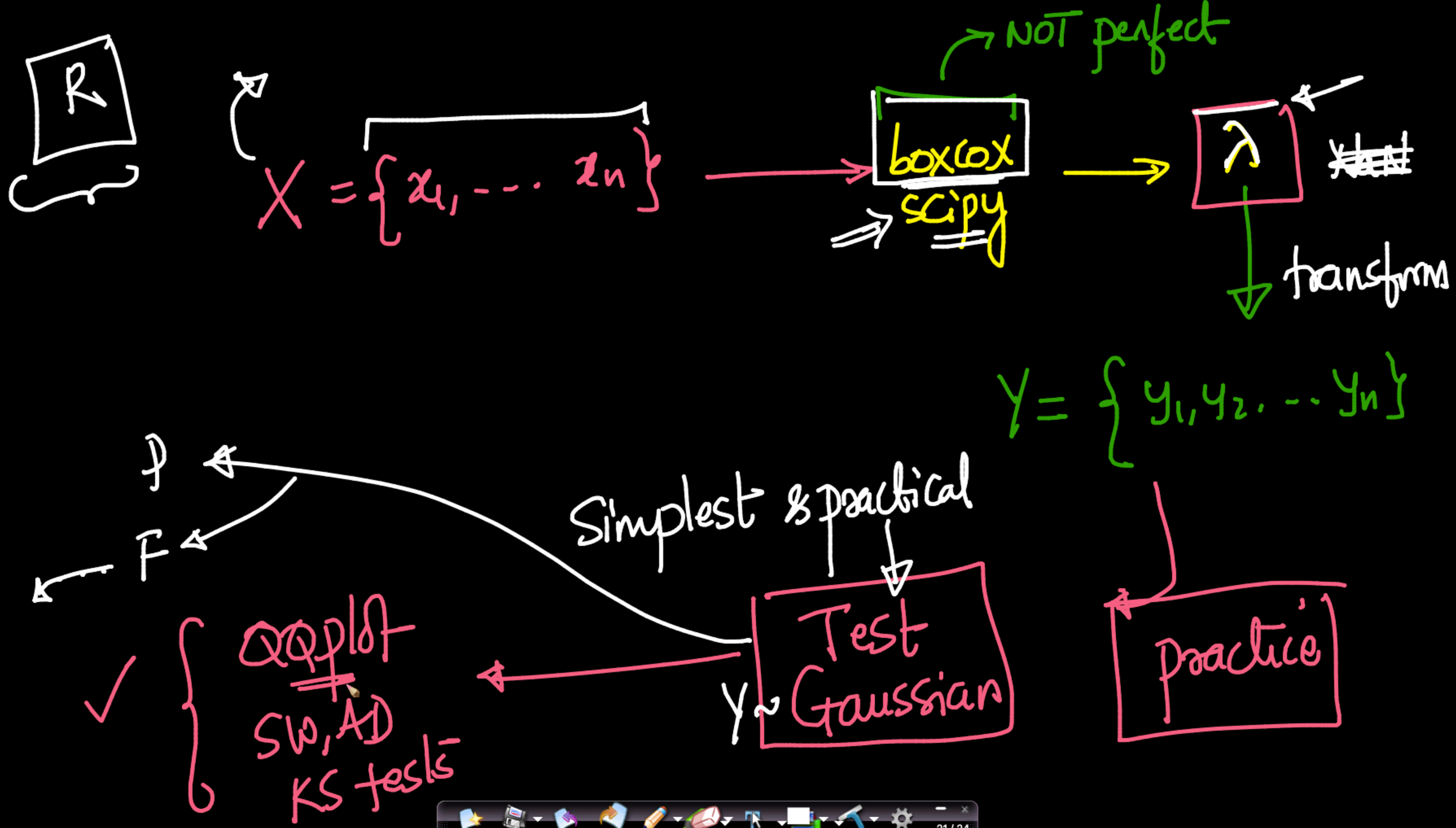
$$\text{Gaussian} \sim Y_i = \begin{cases} \dfrac{X_i^{\lambda} - 1}{\lambda} & \text{if } \lambda \neq 0 \\ \ln(X) & \text{if } \lambda = 0 \end{cases}$$

log

generalization of log-normal

any data → Gaussian [No]

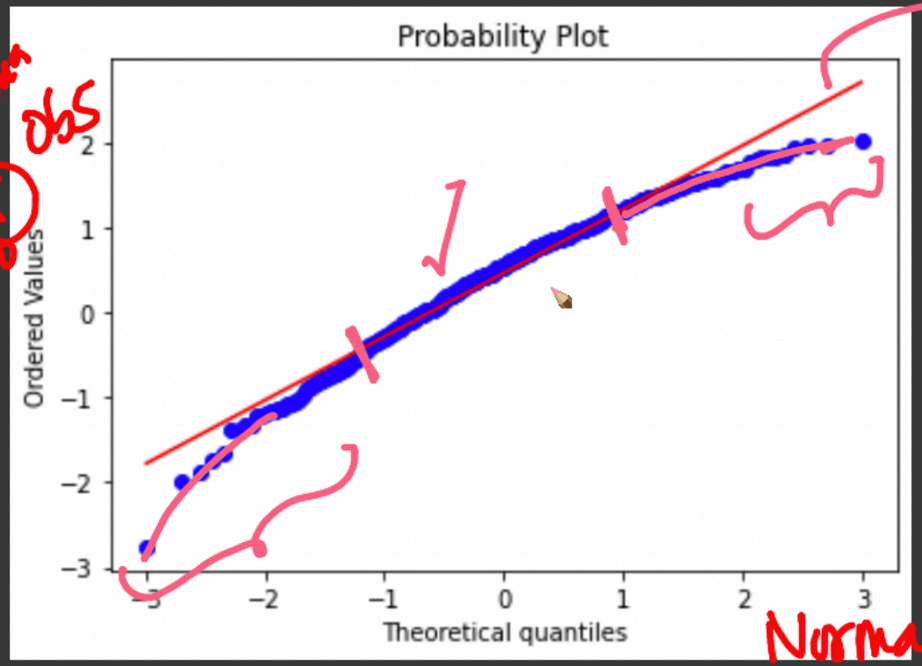
NO



[5]
0s

0s

```
# qq plot of x vs normal
fig, ax1 = plt.subplots()
prob = stats.probplot(x, dist='norm', plot=ax1)
```

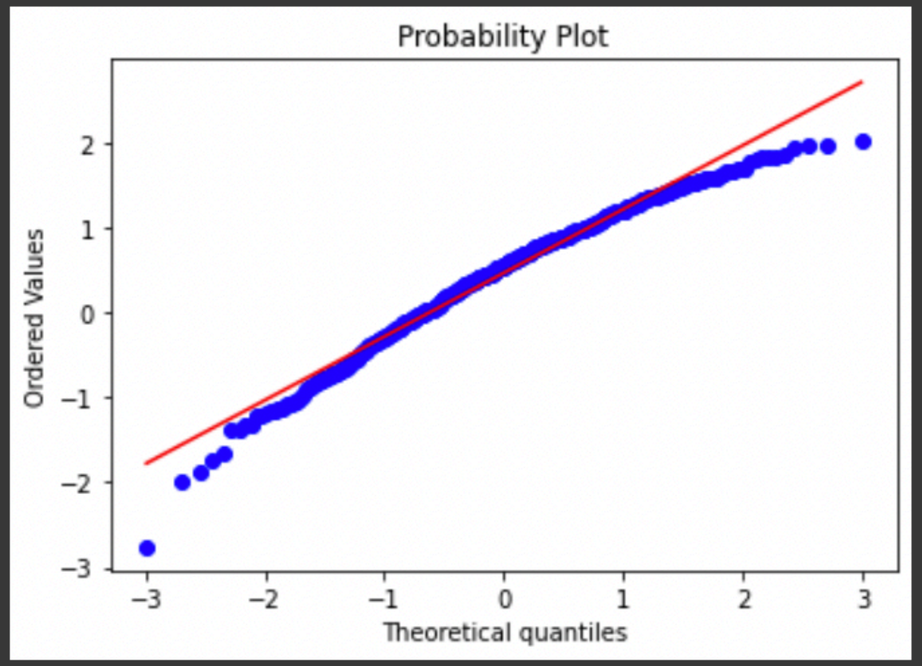


log-gamma
obs
45 degree line
if X ~ Normal
Normal-dist

[5]
0s

0s

```
# qq plot of x vs normal
fig, ax1 = plt.subplots()
prob = stats.probplot(x, dist='norm', plot=ax1)
```



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InterviewBit Software | Live | DSML Advan | dsml-course/Coordina | dsml-course/01-Scala | dsml-course/15-Hypo | Gamma distribution - | box-cox.ipynb - Colab | Untitled1.ipynb - Colab | scipy.stats.boxcox

colab.research.google.com/drive/1HBSL2rle-pokrz50QIhgWGuZiUaxAeUe#scrollTo=D6-0DIS2T_Pb

+ Code + Text

RAM Disk

Theoretical quantiles

abs →

```
# box cox transform
x1 = x+5
xt, l = stats.boxcox(x,); # returns x_trasnfomred and lambda
print("lambda :" + str(l))

# check if xt is gaussian or not using QQ-Plot
fig, ax2 = plt.subplots()
prob = stats.probplot(xt, dist='norm', plot=ax2)
```

2, -2

$x_1, x_2 \ldots x_{50}$

↓

+5

↓

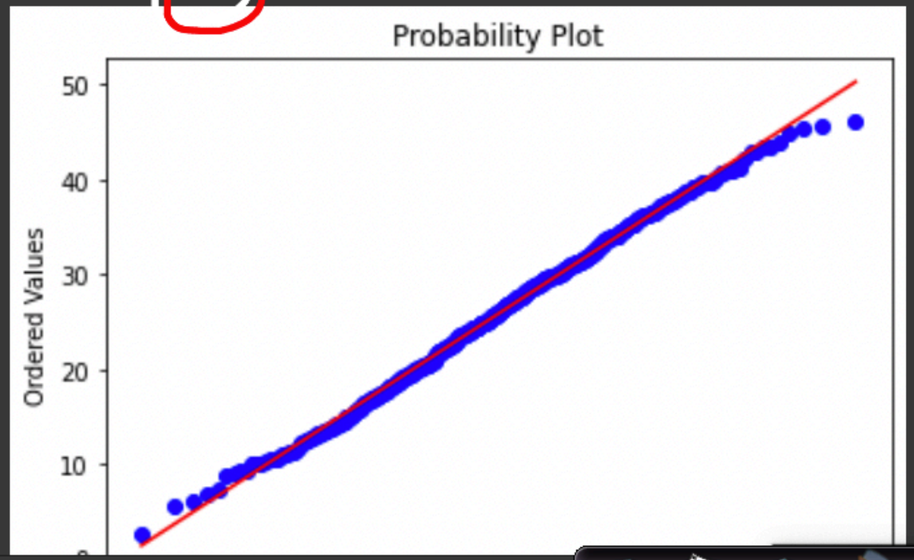
$x_1+5, x_2+5 \ldots x_{50}+5$

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
<ipython-input-10-1c3c724c108c> in <module>()
      1 # box cox transform
----> 2 xt, l = stats.boxcox(x); # returns x_trasnfomred and lambda
      3 print("lambda :" + str(l))
      4
      5 # check if xt is gaussian or not using QQ-Plot

/usr/local/lib/python3.7/dist-packages/scipy/stats/morestats.py in boxcox(x, lmbda, alpha)
   1043
   1044     if any(x <= 0):
-> 1045         raise ValueError("Data must be positive.")
   1046
   1047     if lmbda is not None:  # single transformation
```

24 / 24

```
# box cox transform
x1 = x+5
xt, l = stats.boxcox(x1,); # returns x_trasnfomred and lambda
print("lambda :" + str(l))

# check if xt is gaussian or not using QQ-Plot
fig, ax2 = plt.subplots()
prob = stats.probplot(xt, dist='norm', plot=ax2)
```

```
lambda :2.4288828199512202
```



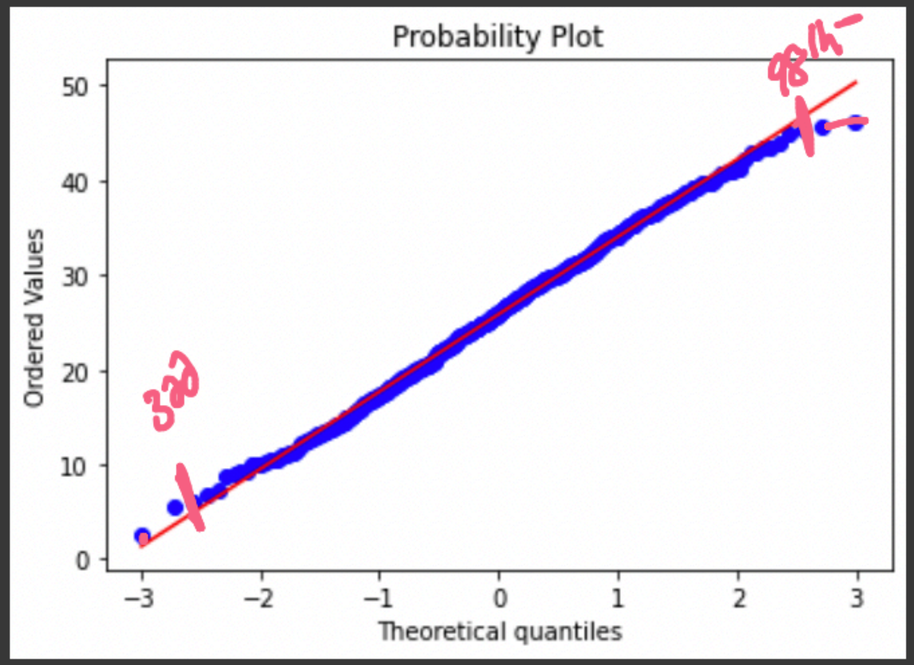
$$\text{box cox}\left(x_i + 5\right)$$

$$\lambda = 2.4 \neq 0$$

$$x_t = \frac{(x_i+5)^{2.42} - 1}{2.42}$$

```
xt, l = stats.boxcox(x1,); # returns x_trasnfomred and lambda
print("lambda :" + str(l))

# check if xt is gaussian or not using QQ-Plot
fig, ax2 = plt.subplots()
prob = stats.probplot(xt, dist='norm', plot=ax2)
```

```
lambda :2.4268828199512202
```



better ~ Gaussian approx

Confidence Interval using bootstrapping

per-item-sale price

e.g:

$S \rightarrow \{S_1, S_2, S_3, \ldots S_{100}\}$ (n=100)

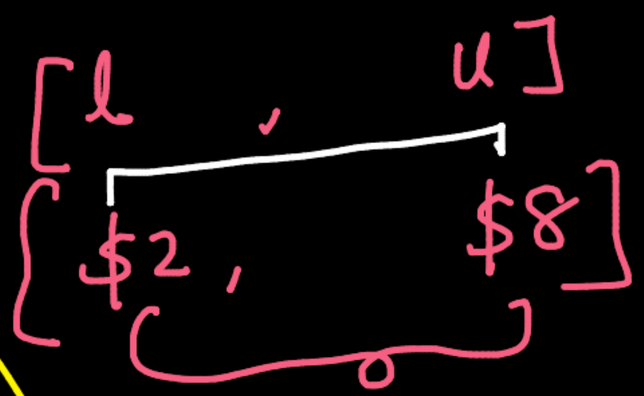
→ randomly sampling Millions

not gaussian dist

only data

(Q) find the 95% C.I of the median sale price @ Amazon (population)

→ bootstrapped samples



Gaussian μ ≈ median

95% C.I of the median of the population

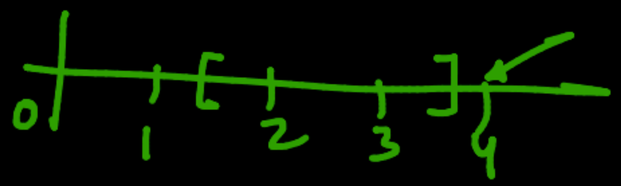
bootstrapped - Sampling

↓ all we have → random Sample of 100 obs

1

↓

≈ population



median → $4 = median(sample)

point estimate

Do Not populate

estimate population-median

[$2, $6] 95% C.I

[$4.5, $4.5] let

pop-median

drugs for COVID

median recovery time

population median

IS

1000

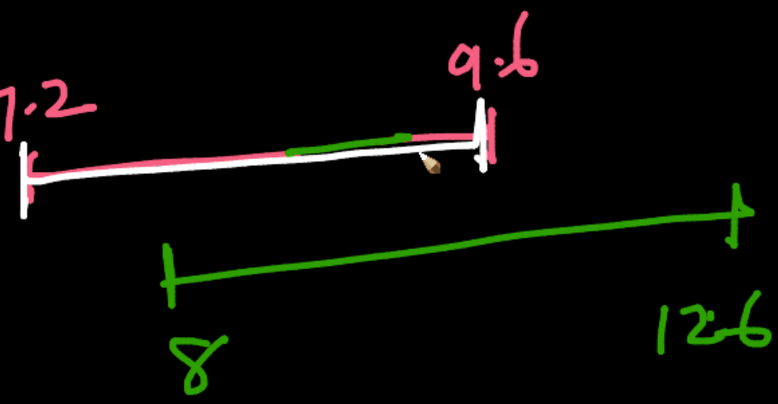
2000

d_1 → [7.2, 9.6]

d_2 → [8, 12.6]

d_3

d_4



Q

Sample-size is fixed

95% C.I

[2 , 3.2]

99% C.I

[1.2 4.6]

wider or narrower

$[-\infty \quad \infty]$

medians = [ ]

$S = \{s_1, s_2, \ldots s_{100}\}$

For i = 1 to 1000 # resampling

1. S_i ← sample 100 prices from S with replacement ✓ (50)
2. medians[i] = median(S_i)

Q why not without replacement

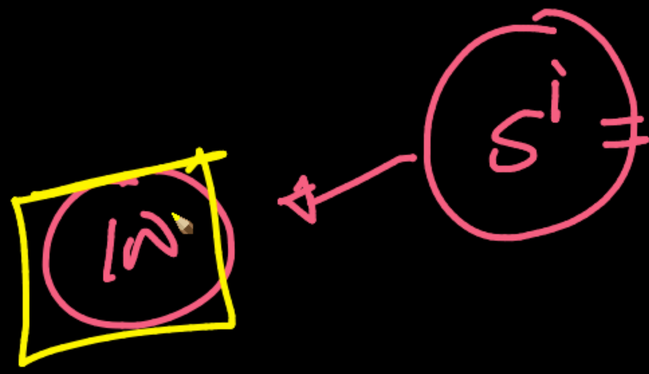
Sort medians

→

1000

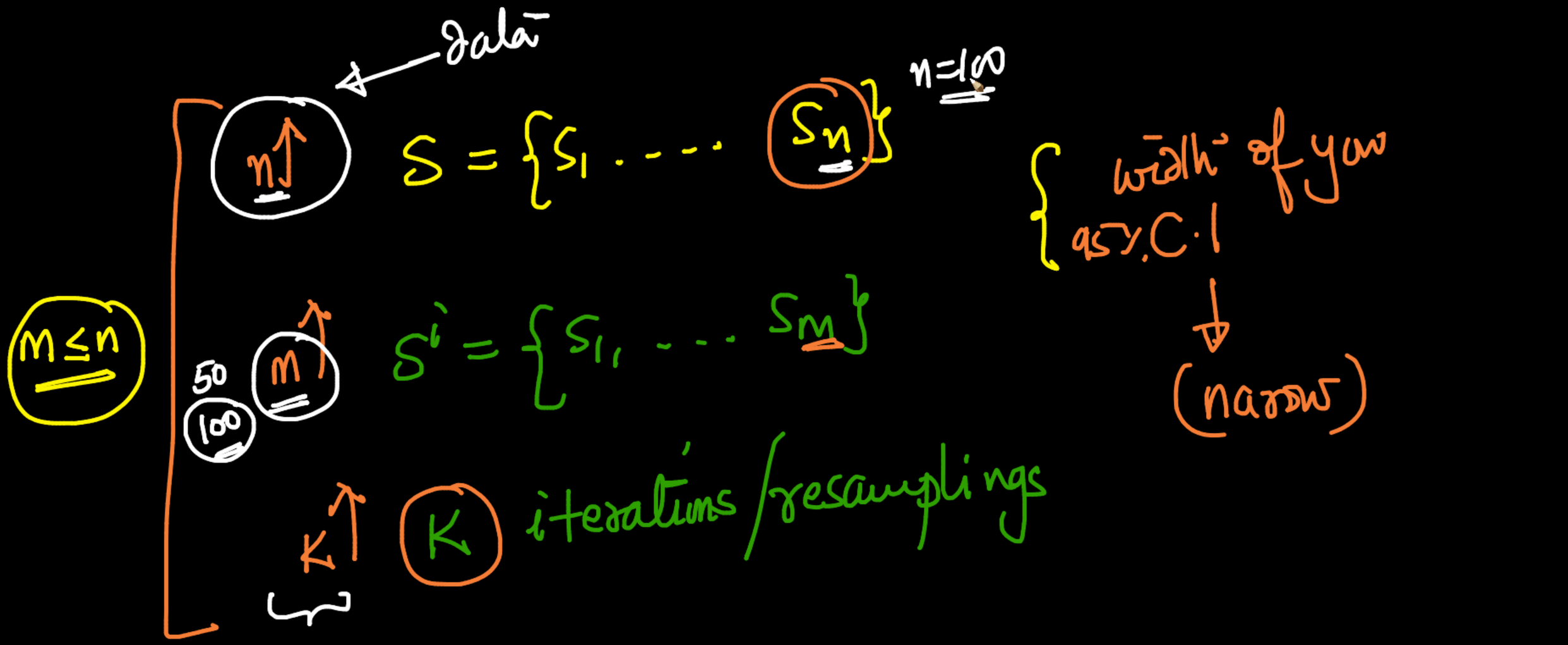
$S = \{s_1, s_2, \ldots s_N\}$

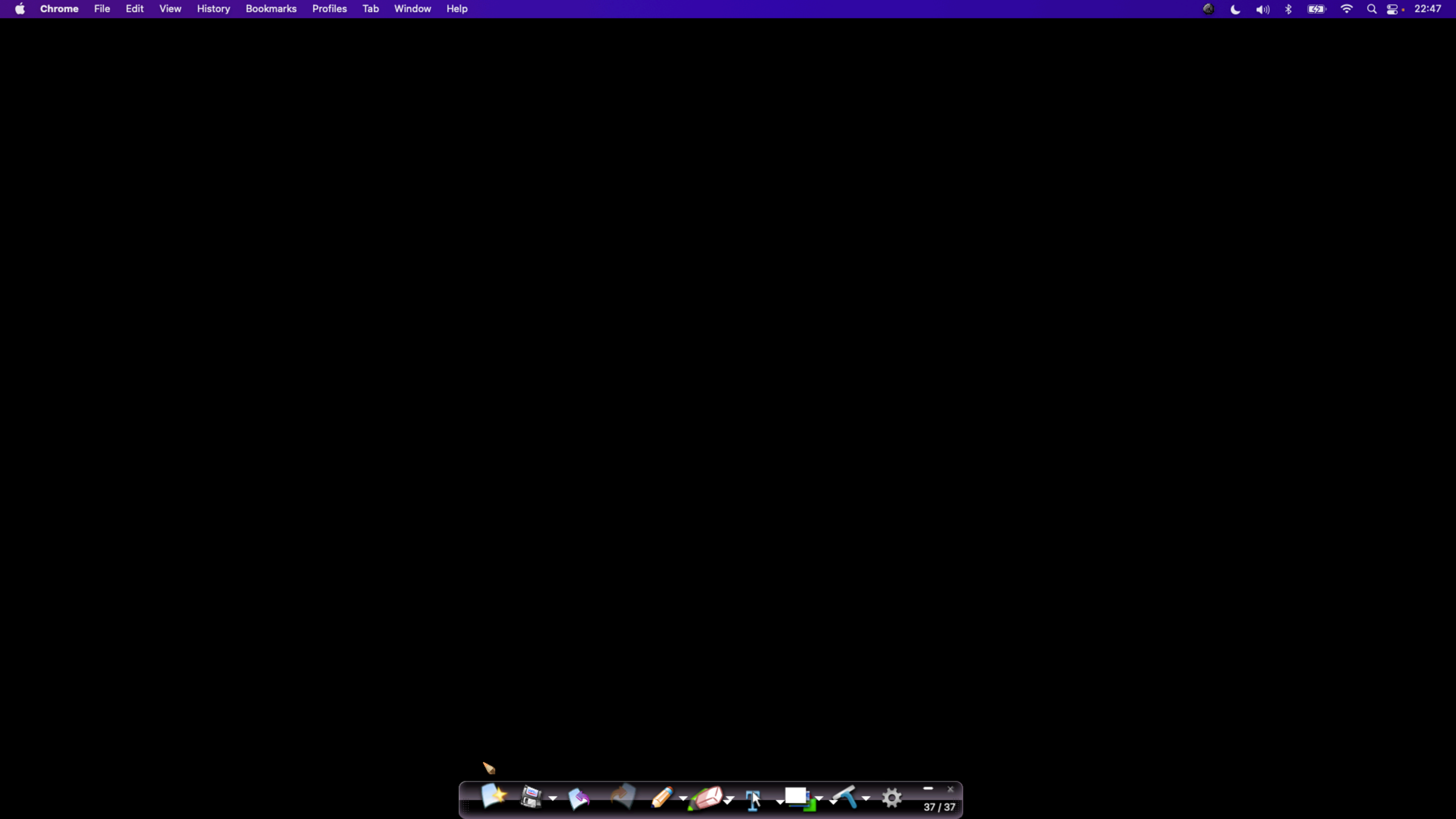
$S^1 = \{s_4,$



= randomly sample 100 obs from S without replacement

$S^1 = S^2 = S^3 = S^4 \ldots$


Jalan
n
S = {S1 .... Sn}
n=100
{ width of your
95% C.I
(narrow)
m ≤ n
50
100
m
S' = {S1, ... Sm}
K
K iterations / resamplings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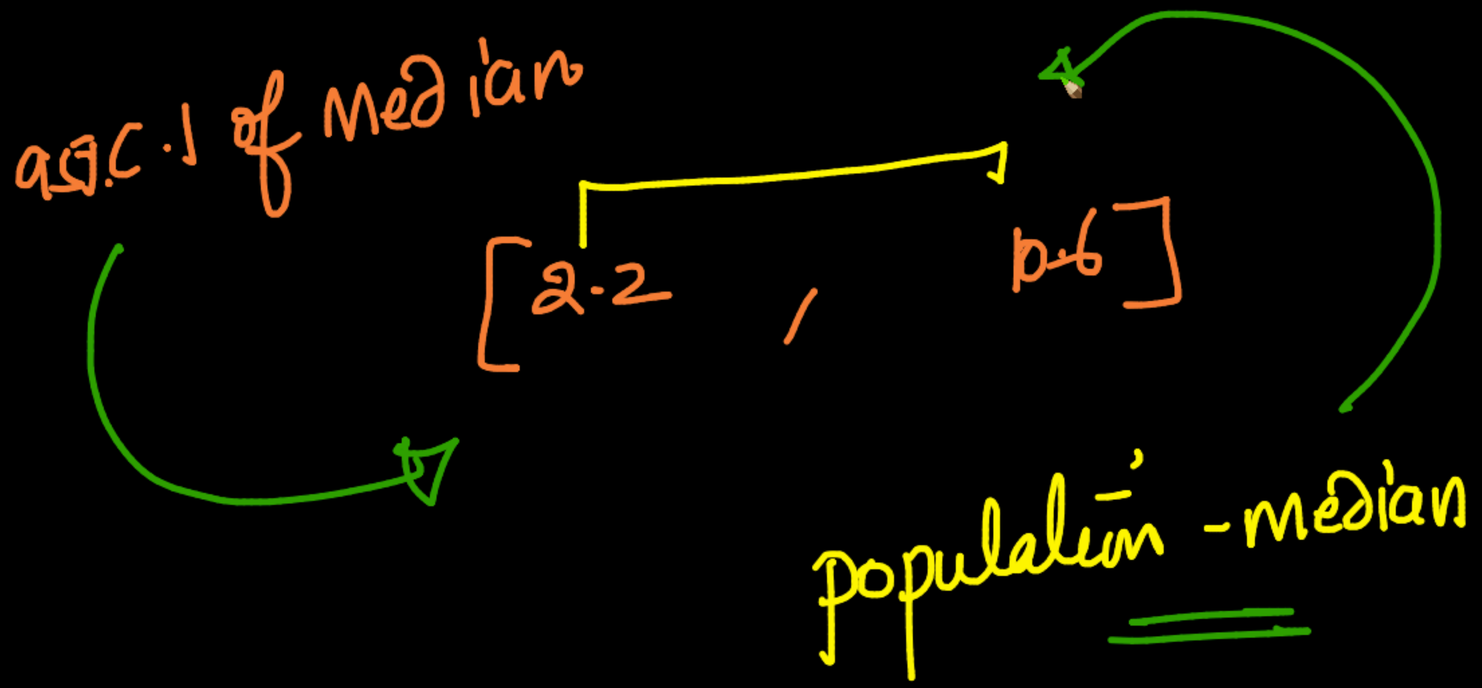
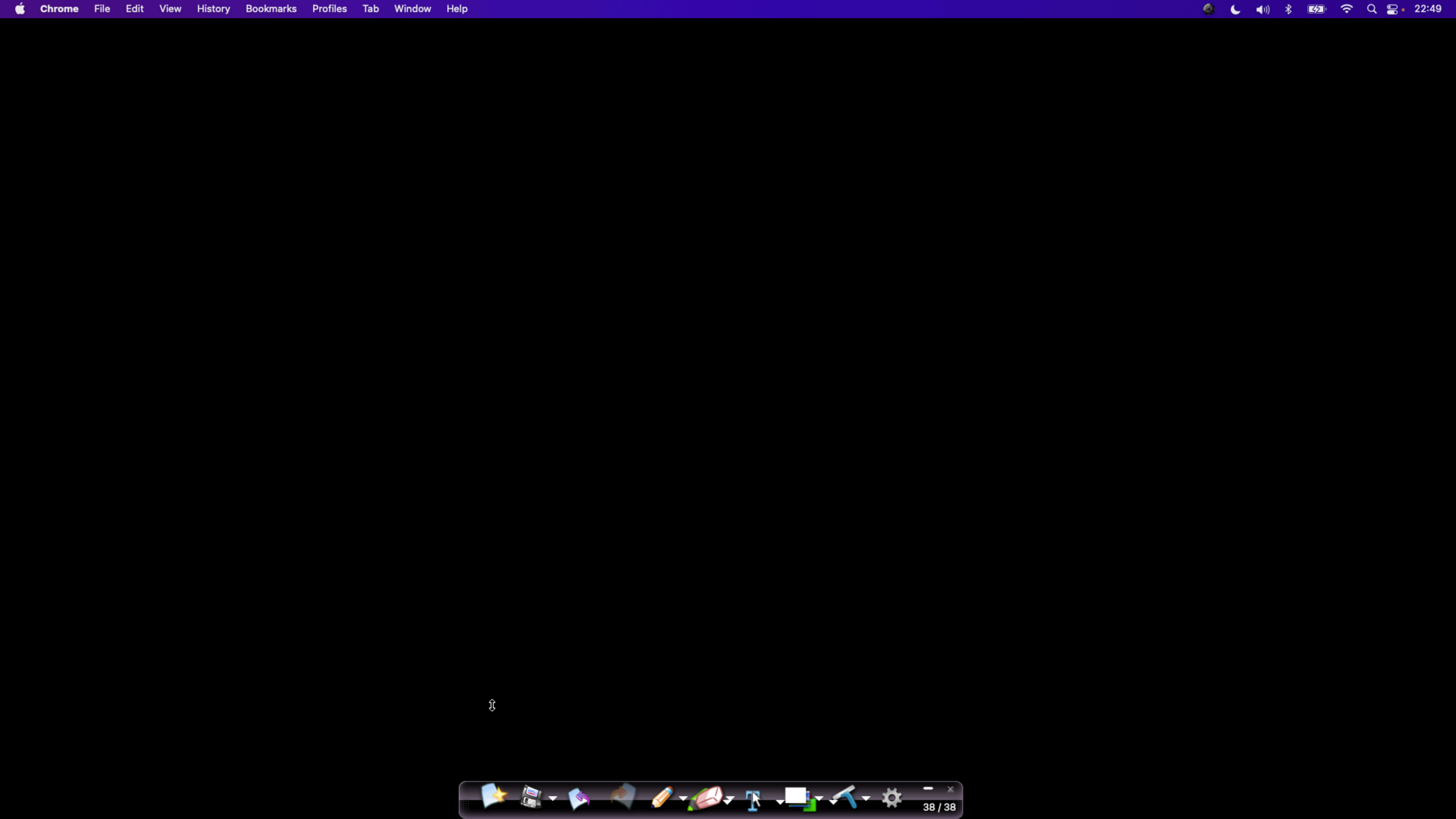
37 / 37

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22:49
38 / 38

$S^1 = S^2 = S^3 \ldots$ if sampling without replacement

$n = M$

$S_{i=5}$ = {1, 2, 3, 4, 5}

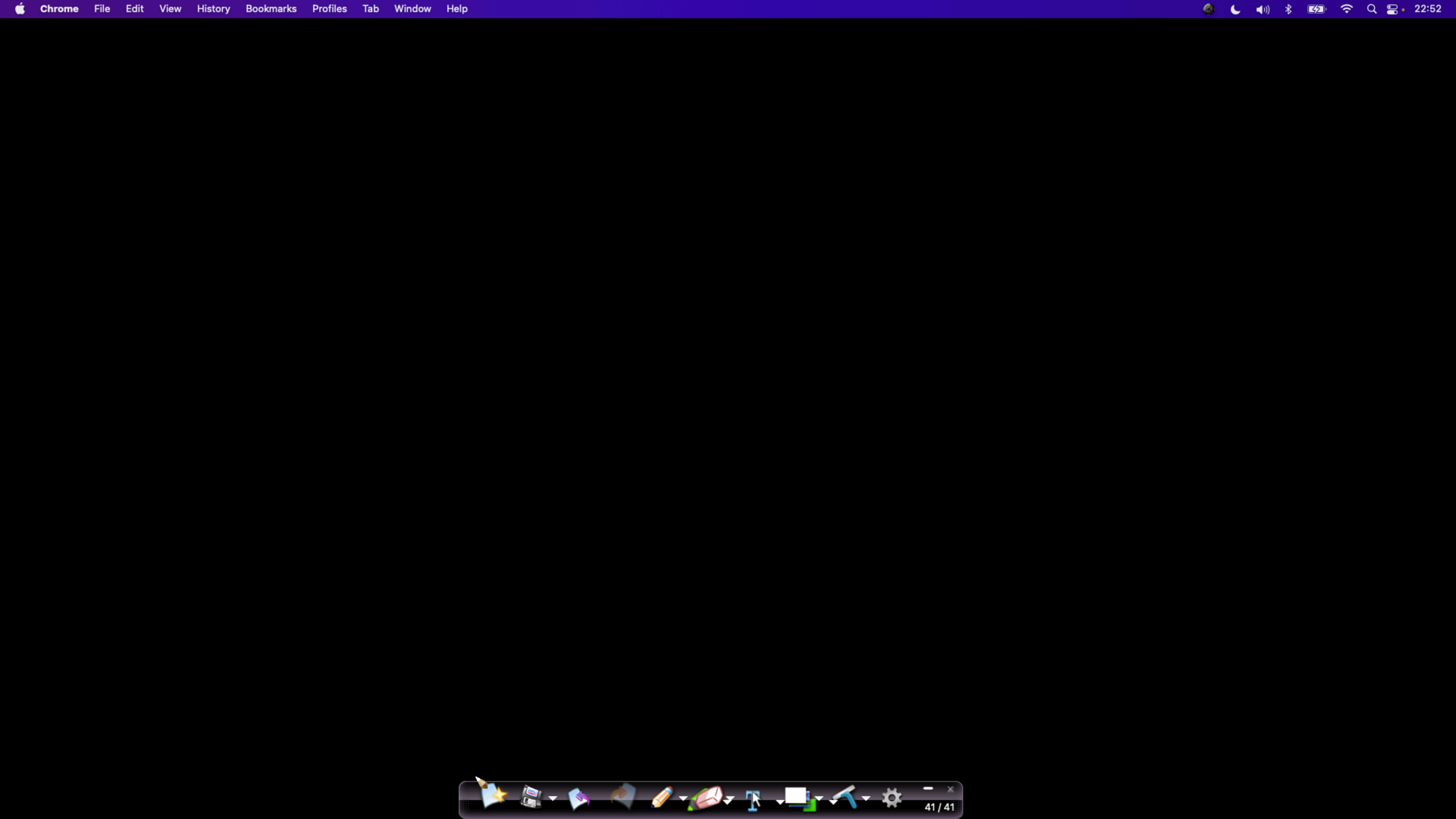
$S^1_{M=5}$ = {2, 3, 4, 5, 1}

with repl:

S = {1, 2, 3, 4, 5}

S^1 = {3, 4, 3, 5, 1}

✓ bootstrapping → Means
Medians
percentiles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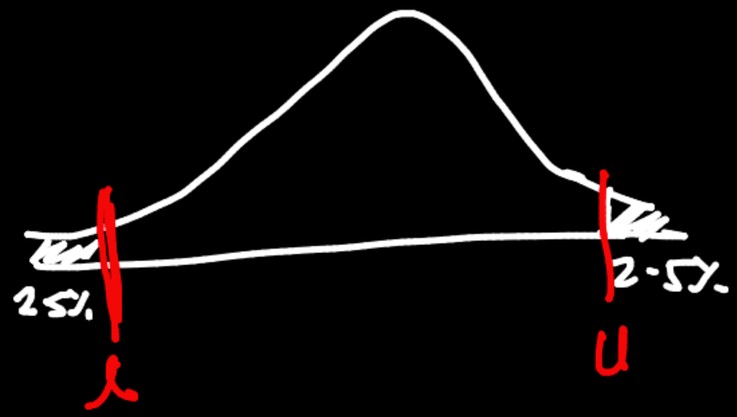
41 / 41

bootstrapped

1000 resamplings

Median



Sort them

2.5%

1 2 3

2.5%

2.5%

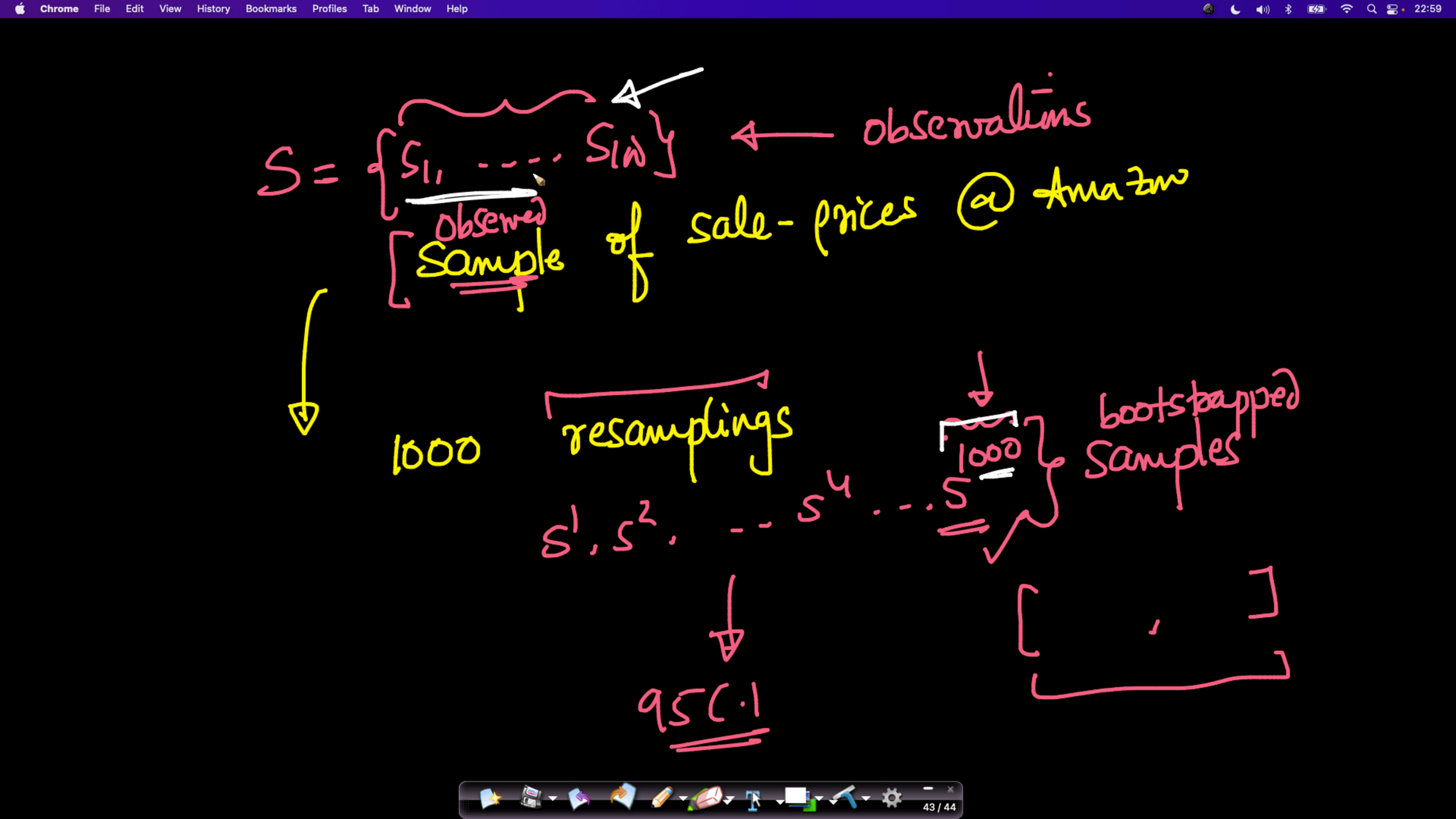
1000

2.5th

97.5th

non-parametric stat-tech

percentiles


S = {s1, ---- s1000}
observations
observed sample of sale-prices @ Amazon
1000 resamplings
s1, s2, -- s4 ... s1000
1000 bootstrapped samples
95C.I
[,]
43 / 44

{ CLT → means

96.231

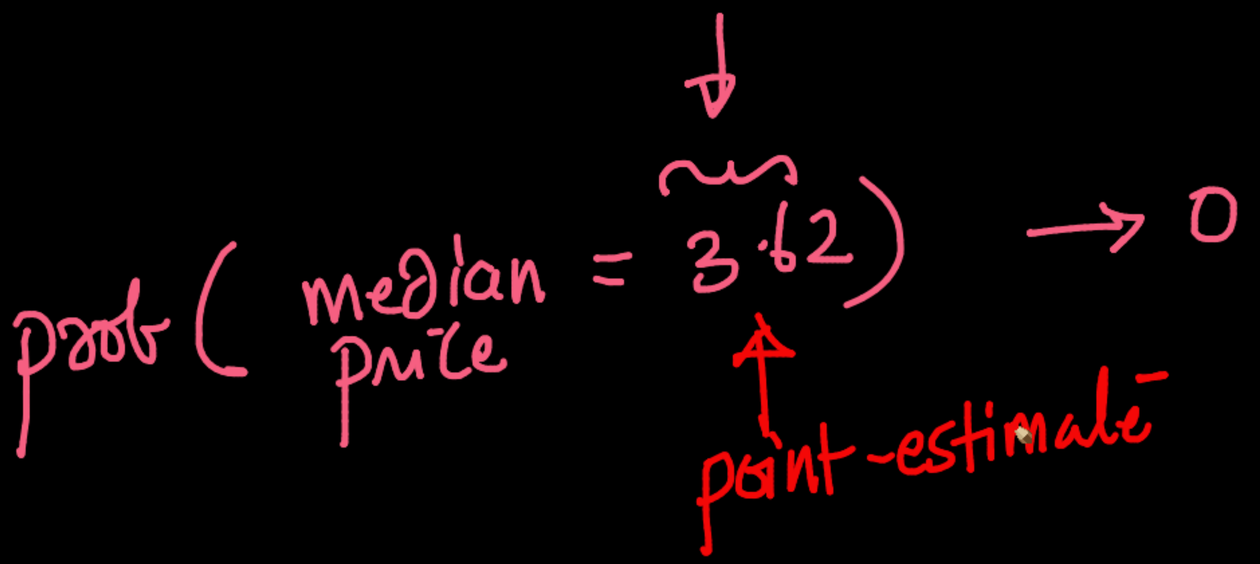
Prob(a person who weighs 96.23 kgs)

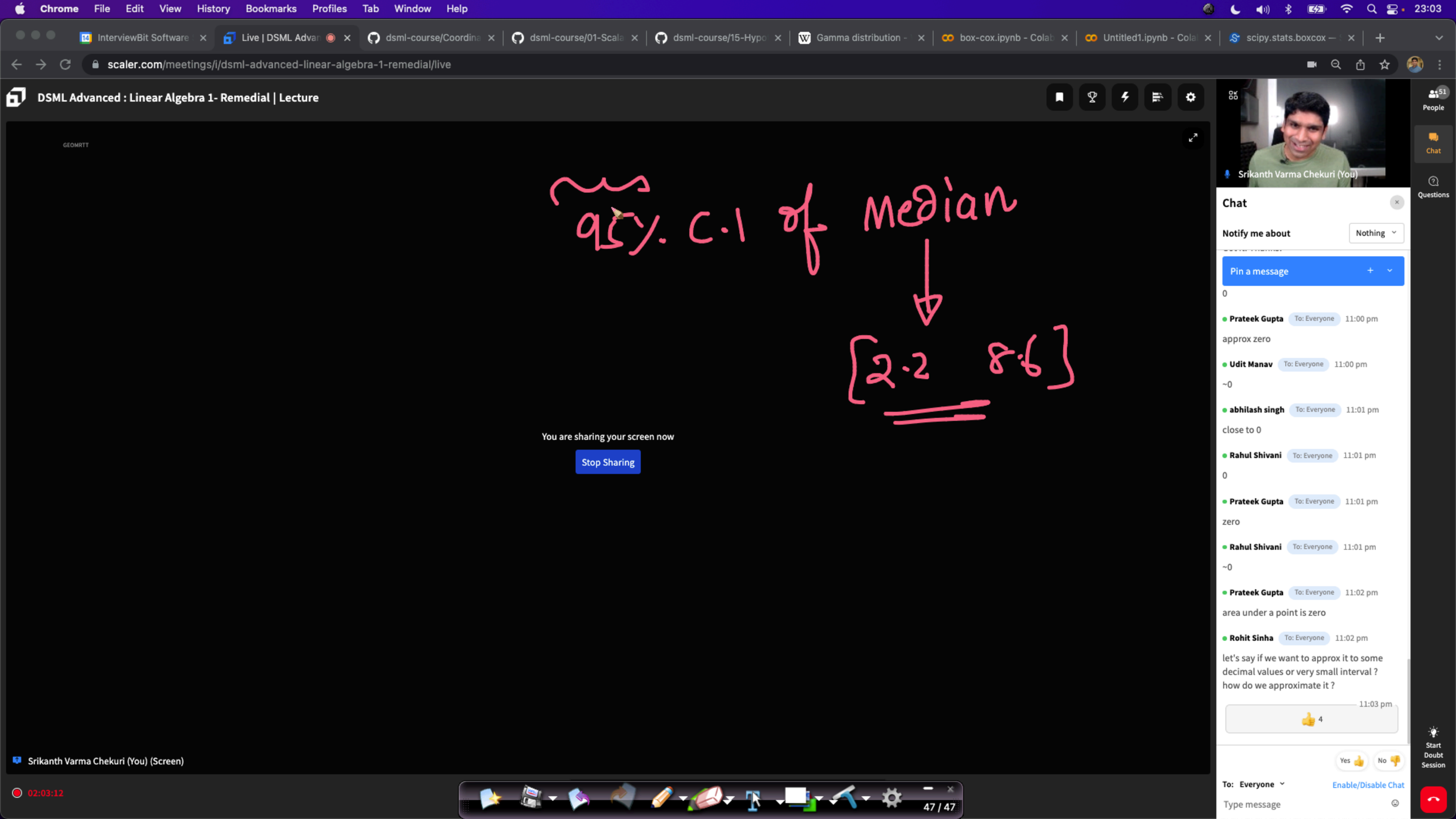
96.23000000...

Continous r.v

PDF

0


prob (median price = 3.62) → 0
point-estimate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23:03
InterviewBit Software
Live | DSML Advan
dsml-course/Coordina
dsml-course/01-Scala
dsml-course/15-Hypo
Gamma distribution -
box-cox.ipynb - Colab
Untitled1.ipynb - Cola
scipy.stats.boxcox —
scaler.com/meetings/i/dsml-advanced-linear-algebra-1-remedial/live
DSML Advanced : Linear Algebra 1- Remedial | Lecture
GEOMRTT
qty. c.1 of median
[2.2 8.6]
You are sharing your screen now
Stop Sharing
Srikanth Varma Chekuri (You) (Screen)
02:03:12
47 / 47
Srikanth Varma Chekuri (You)
People
Chat
Questions
Chat
Notify me about
Nothing
Pin a message
0
Prateek Gupta To: Everyone 11:00 pm
approx zero
Udit Manav To: Everyone 11:00 pm
~0
abhilash singh To: Everyone 11:01 pm
close to 0
Rahul Shivani To: Everyone 11:01 pm
0
Prateek Gupta To: Everyone 11:01 pm
zero
Rahul Shivani To: Everyone 11:01 pm
~0
Prateek Gupta To: Everyone 11:02 pm
area under a point is zero
Rohit Sinha To: Everyone 11:02 pm
let's say if we want to approx it to some decimal values or very small interval ? how do we approximate it ?
11:03 pm
4
Yes
No
To: Everyone
Enable/Disable Chat
Type message
Start Doubt Session

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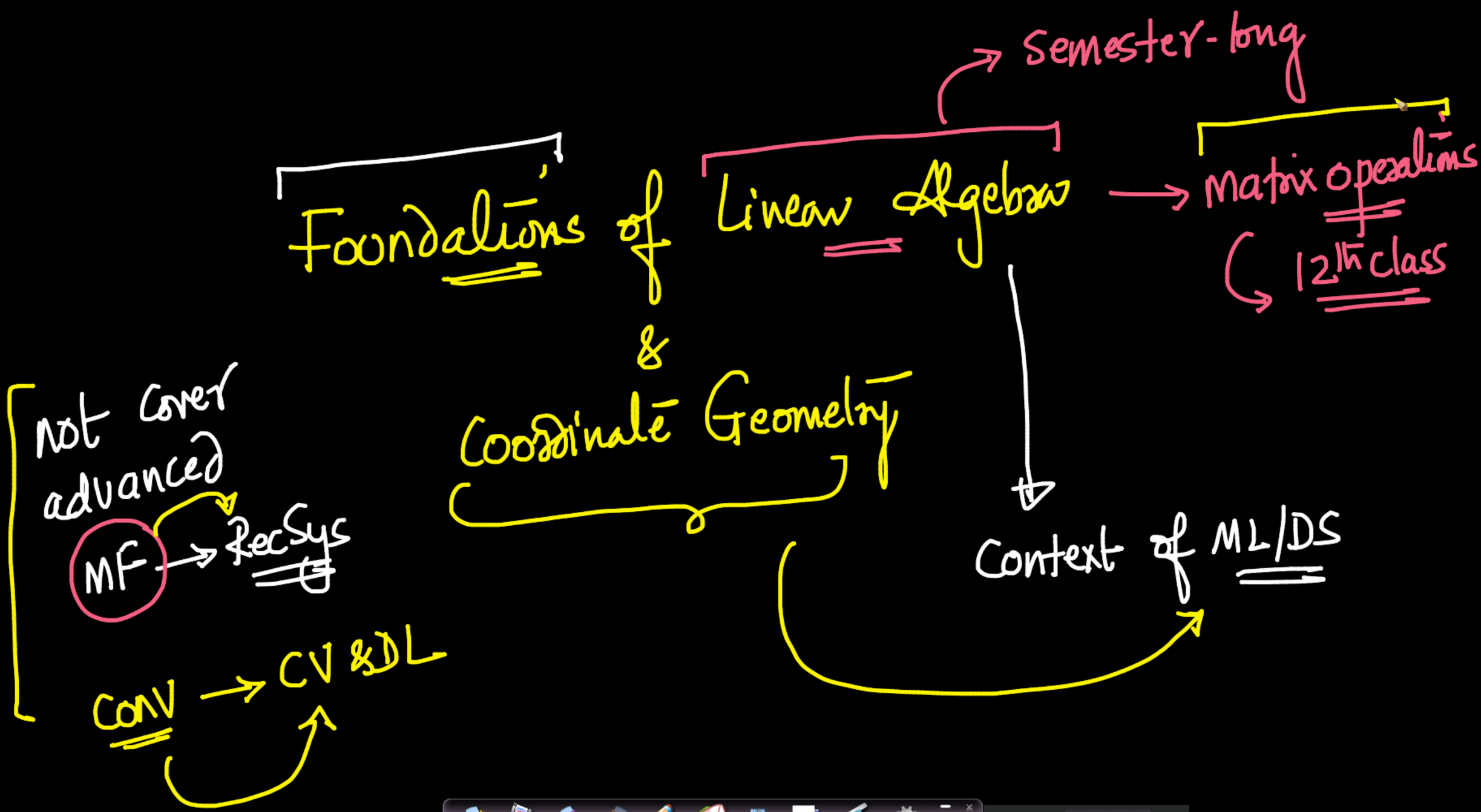
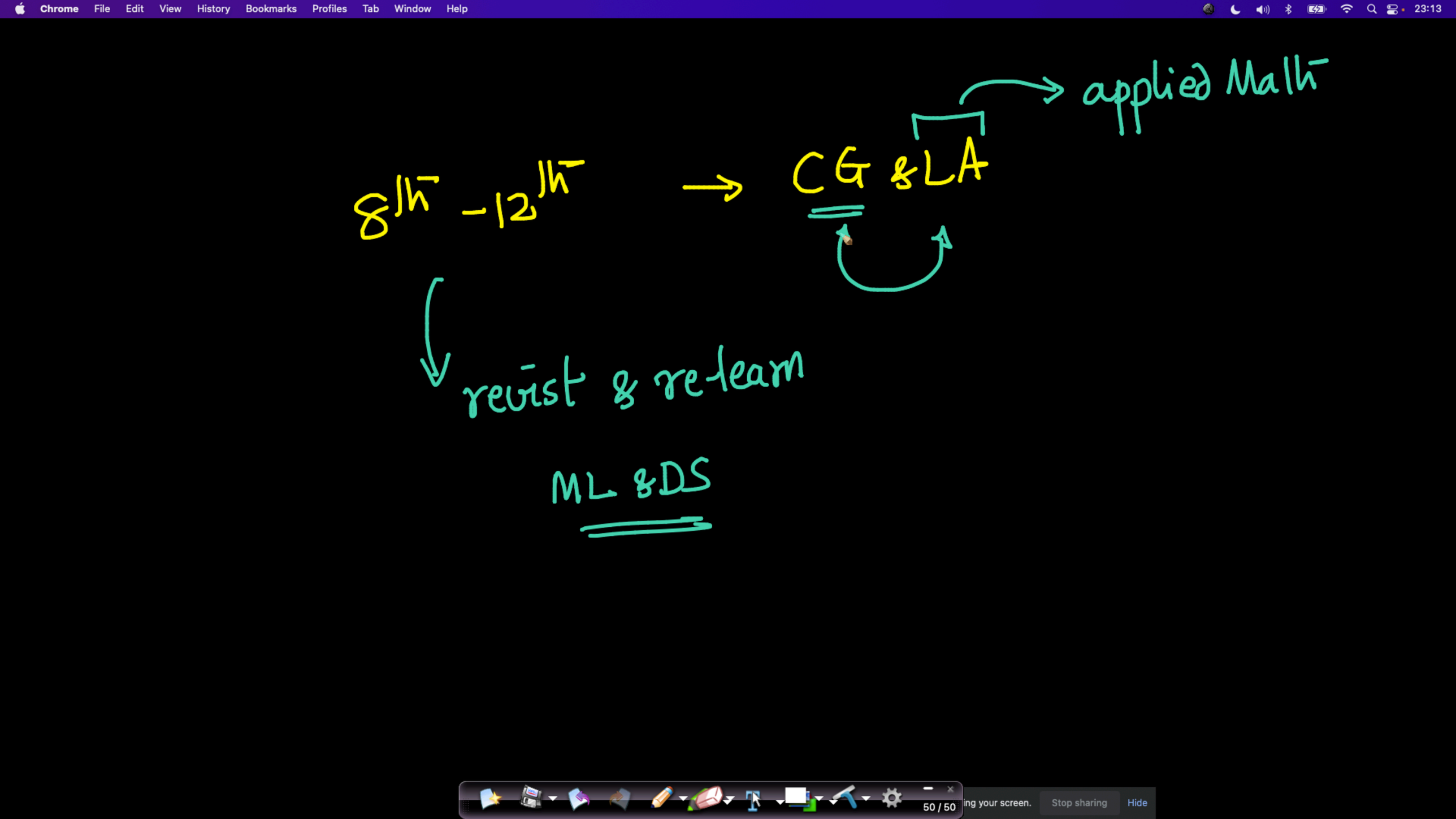
Break:

23:07

48 / 49




8 lh - 12 lh
CG & LA
applied Malh
revist & relearn
ML & DS

Lines, plane → high-school & college

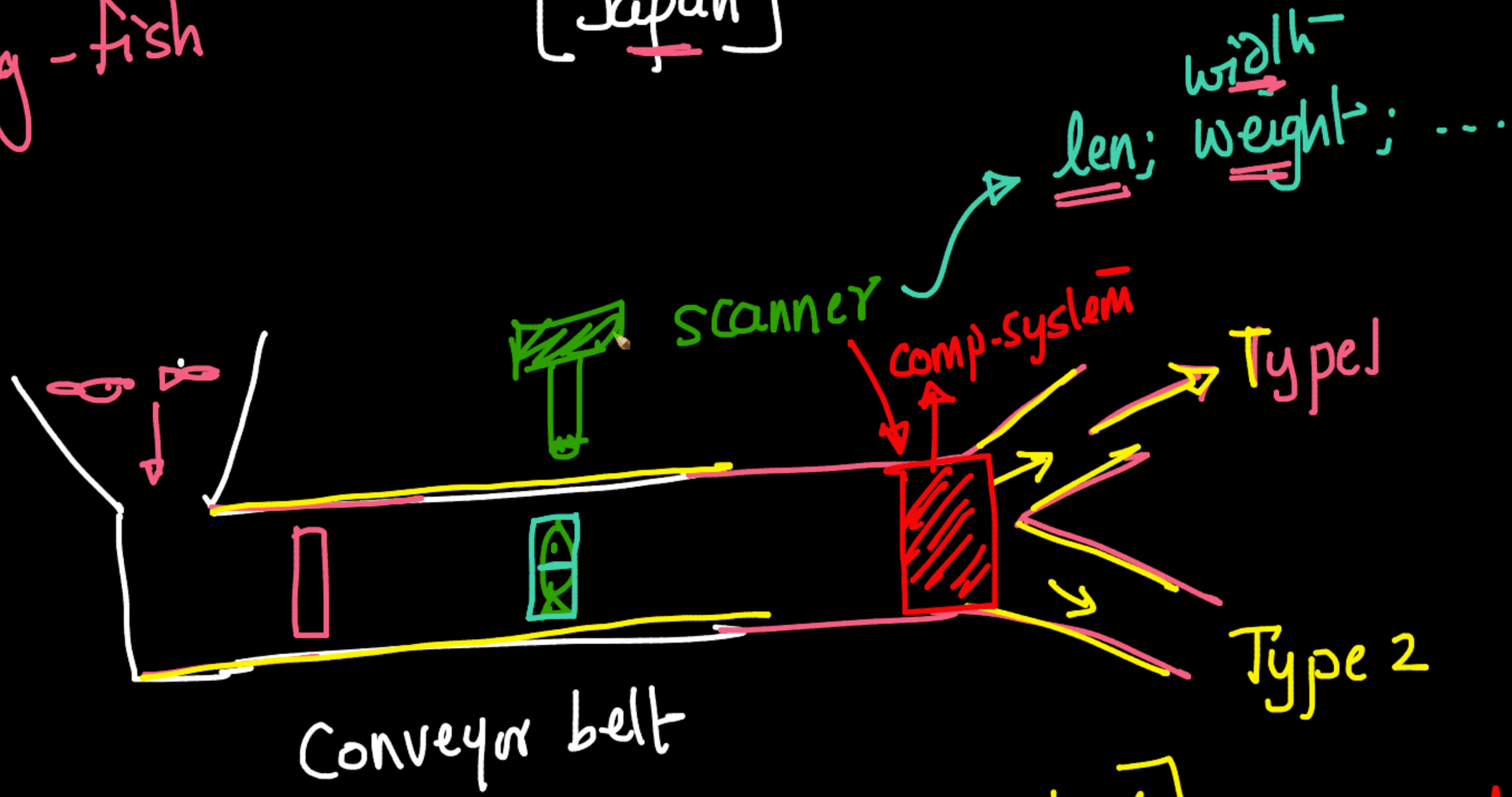
Vectors; matrices; dot-product → Physics X

real-world

circle; ellipses; spheres

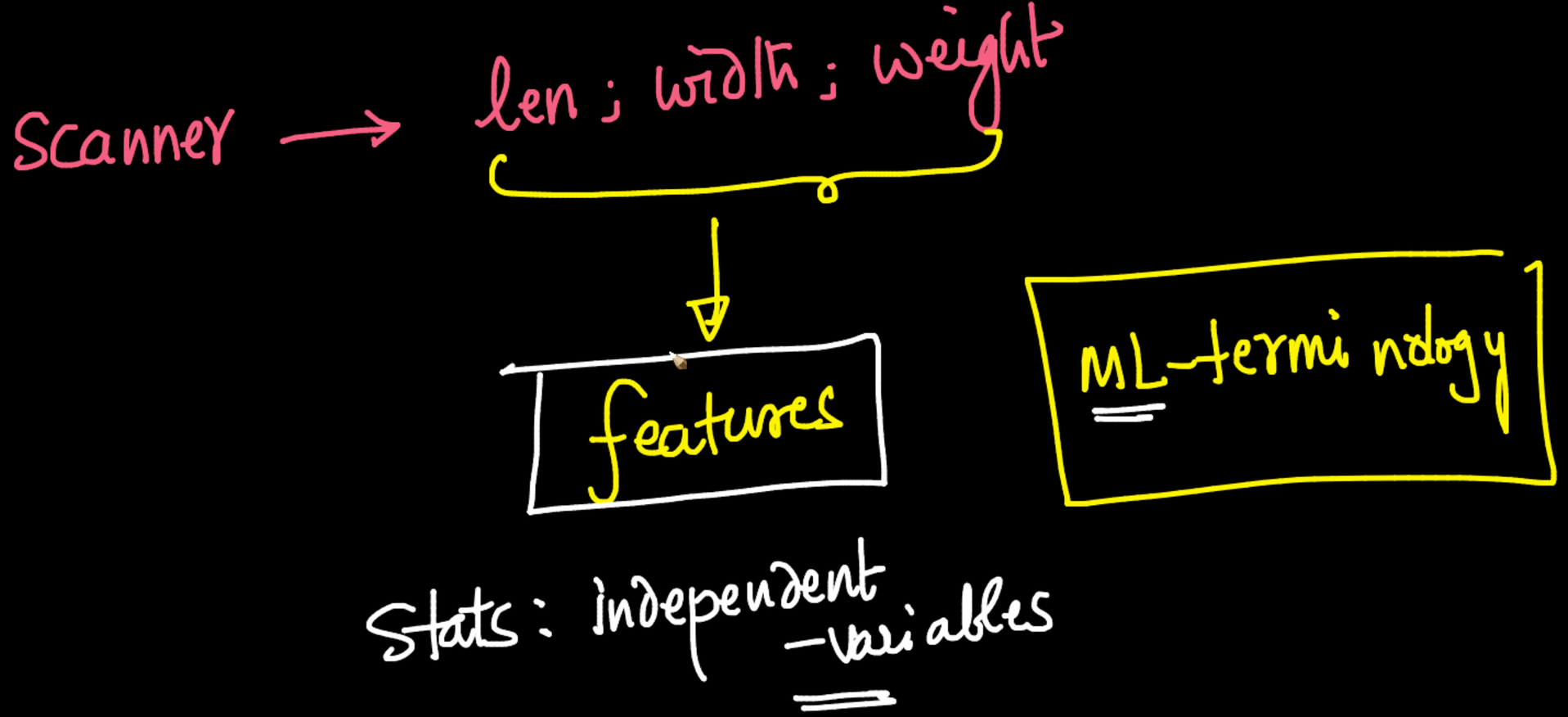
Sorting - fish

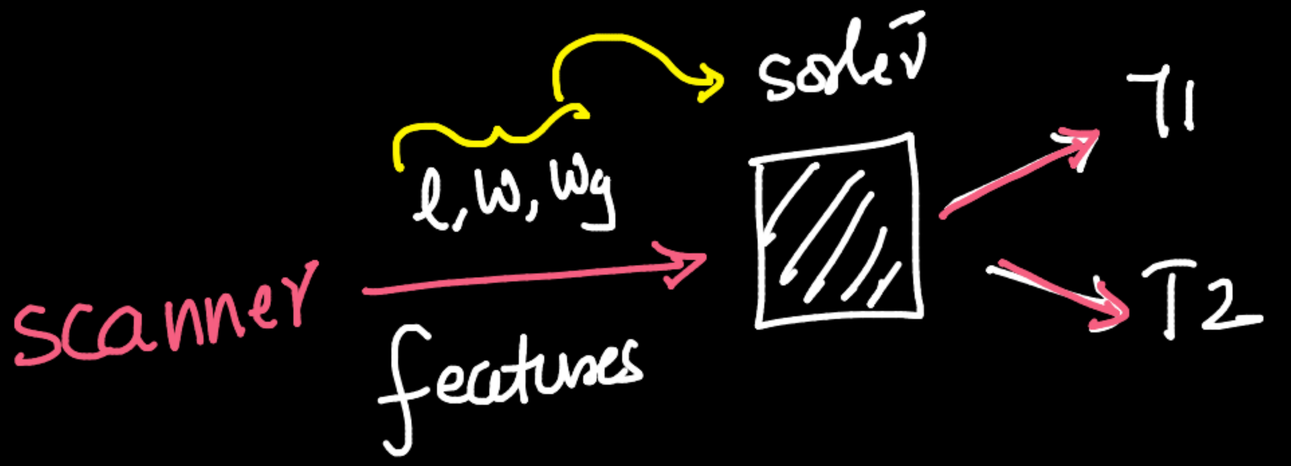
[Japan]



[Credits: Duda - hart]

automated sorter



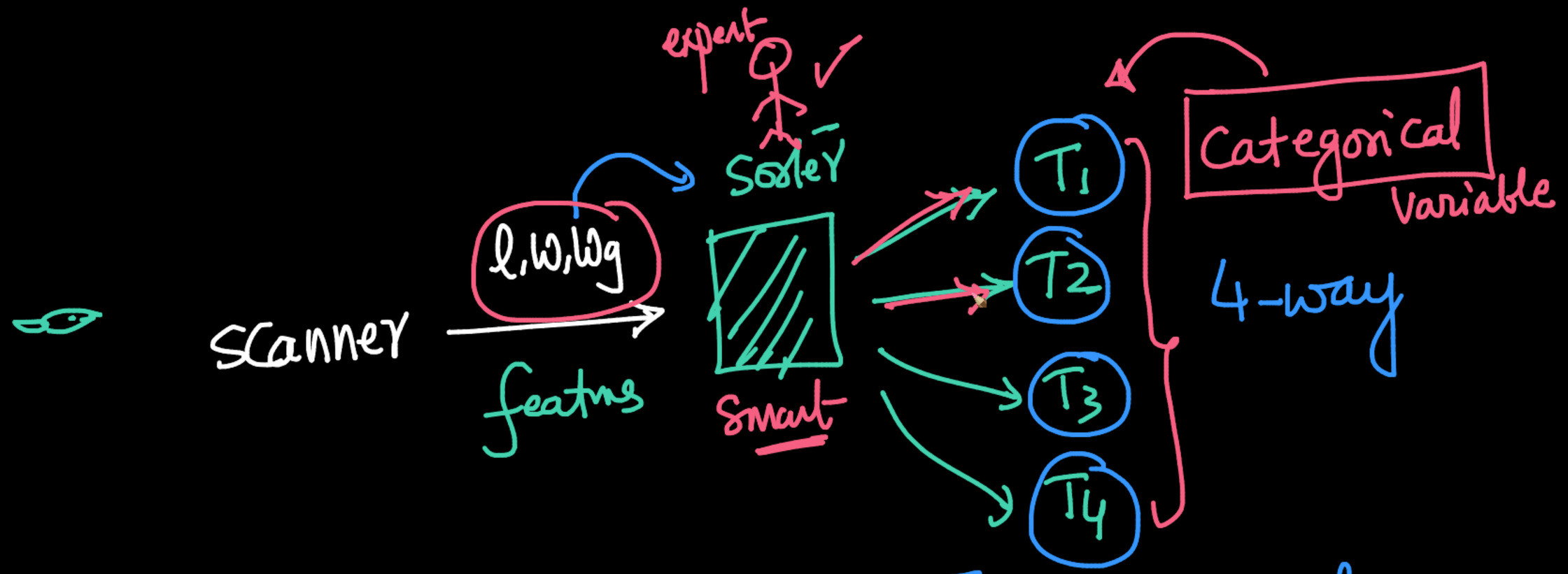


binary

categorical

classifying

[Binary - classification]



multi-class Classification

> 2 classes

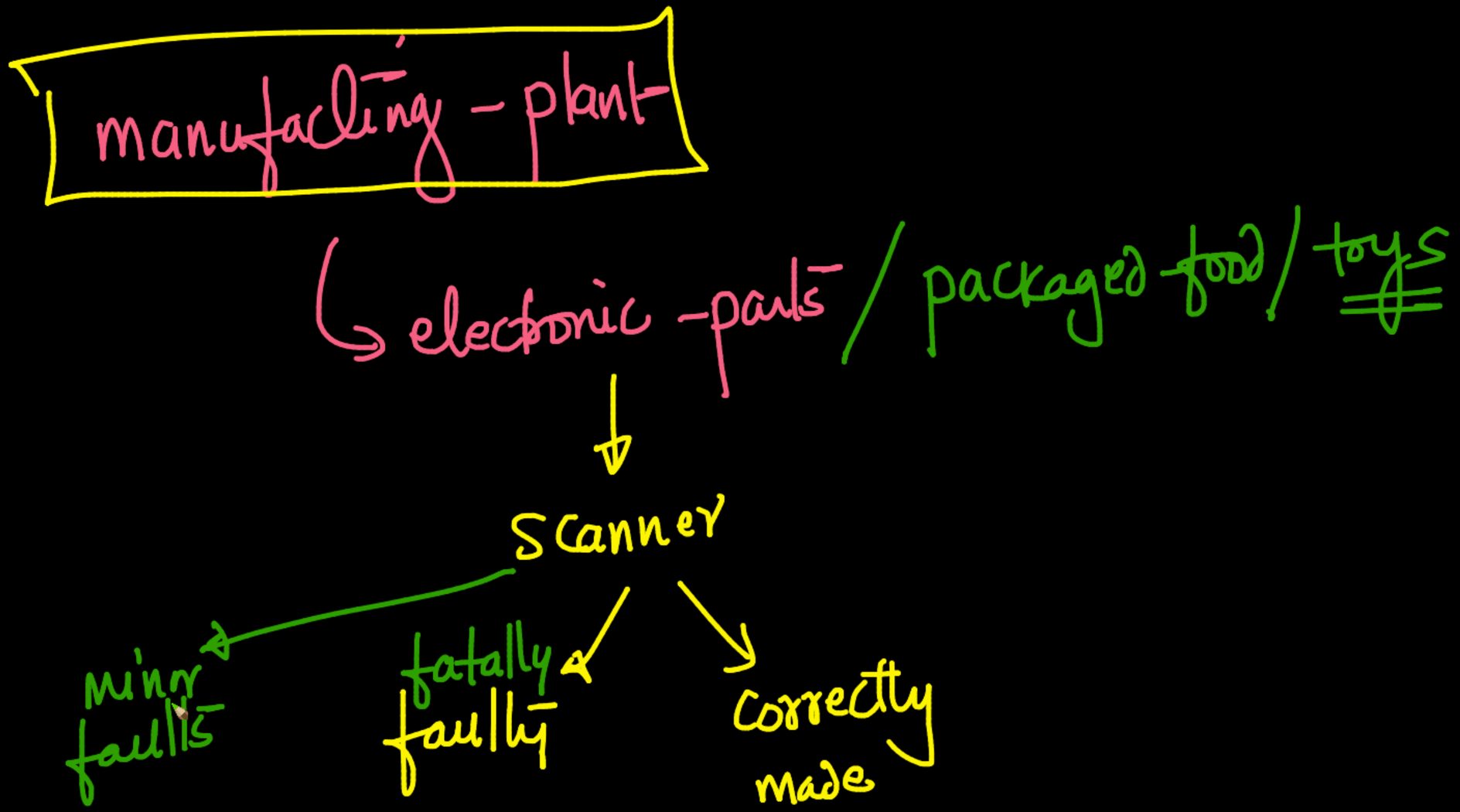
natural ordering amongst classes?

Predict age of fish using l, w, wg

↓

numerical

regression



Sorting fish ⟶ Linear Alg & Co-ordinate

(Q) predict Marks = {1, 2, 3, 4 - - 100} → discrete ; features

regression or multi-class classification

practical →

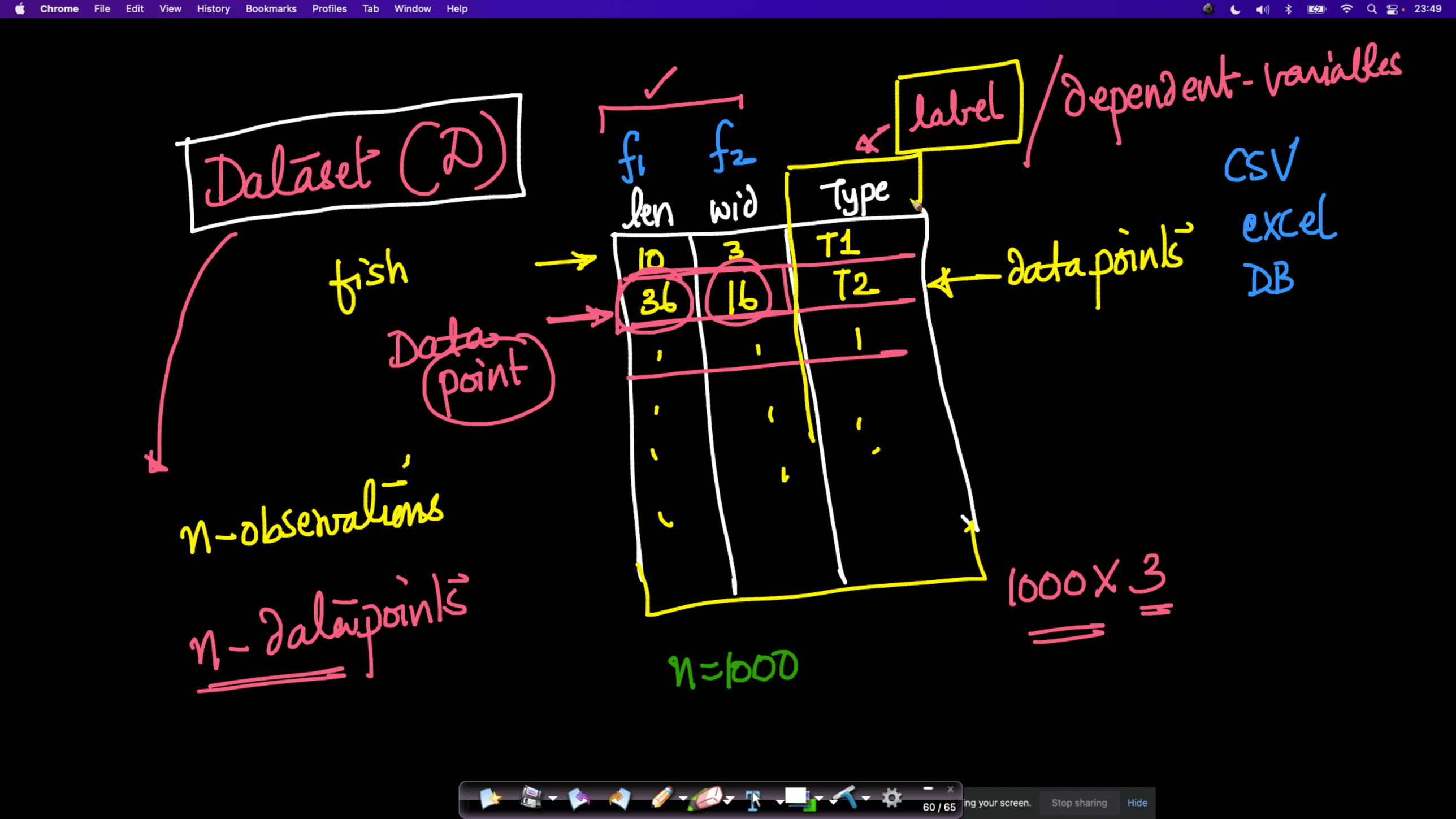
natural ordering

no-ordering amongst the classes

round (3.2)

3.2

3

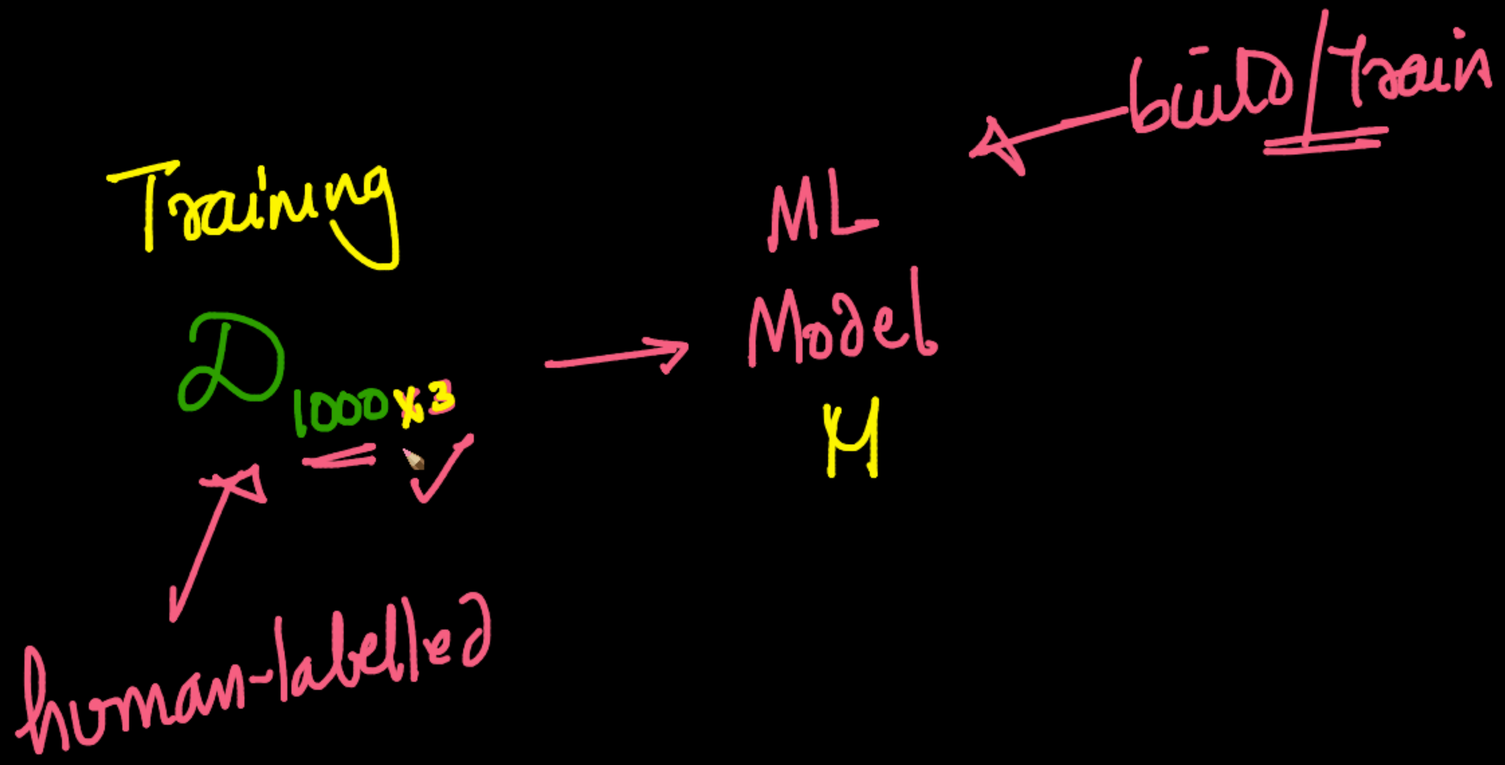

Dataset (D)
fish
Data point
n-observations
n-datapoints
f1
f2
len
wid
Type
label
dependent-variables
10
3
T1
36
16
T2
datapoints
CSV
excel
DB
n=1000
1000 X 3

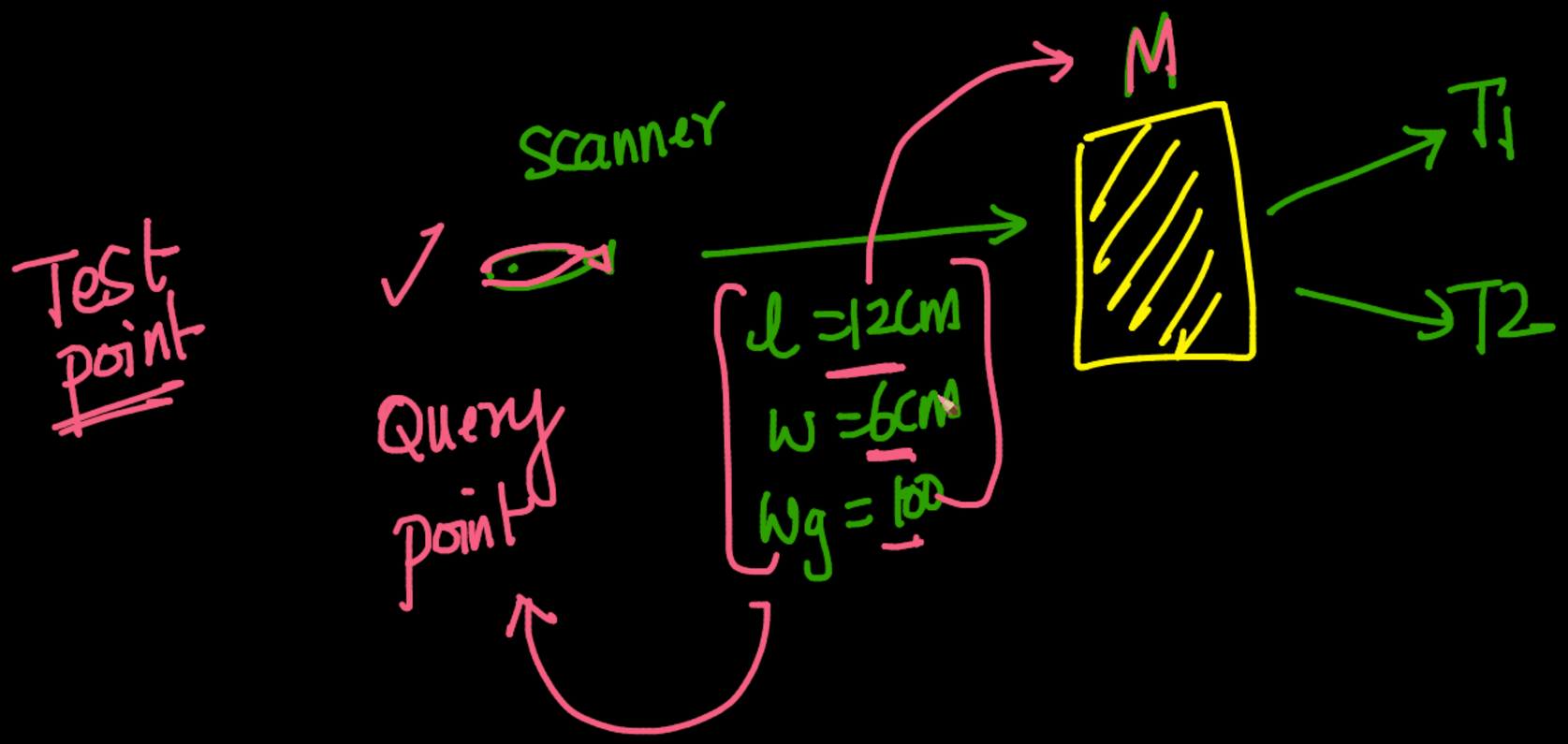
(Q) How do we get the data ?

↳ Sensors : $f_1, f_2, \ldots$; label → human expert

f_1, f_2 : l, w

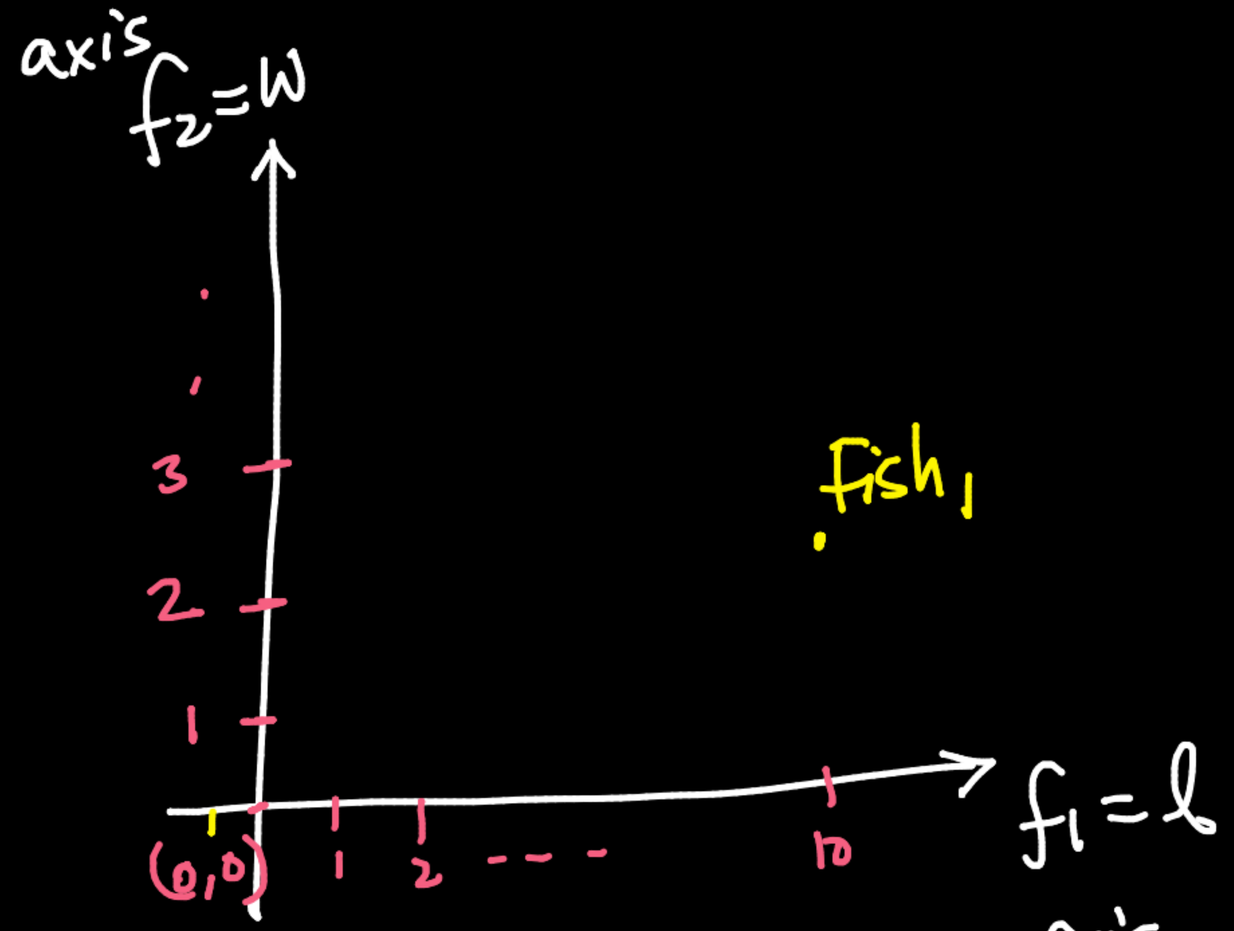
human-labelled (annotated-data)





data - point

data - vector



Fish$_1$

2D - geometry

Fish$_1$ = [10cm$_l$, 2cm$_w$]

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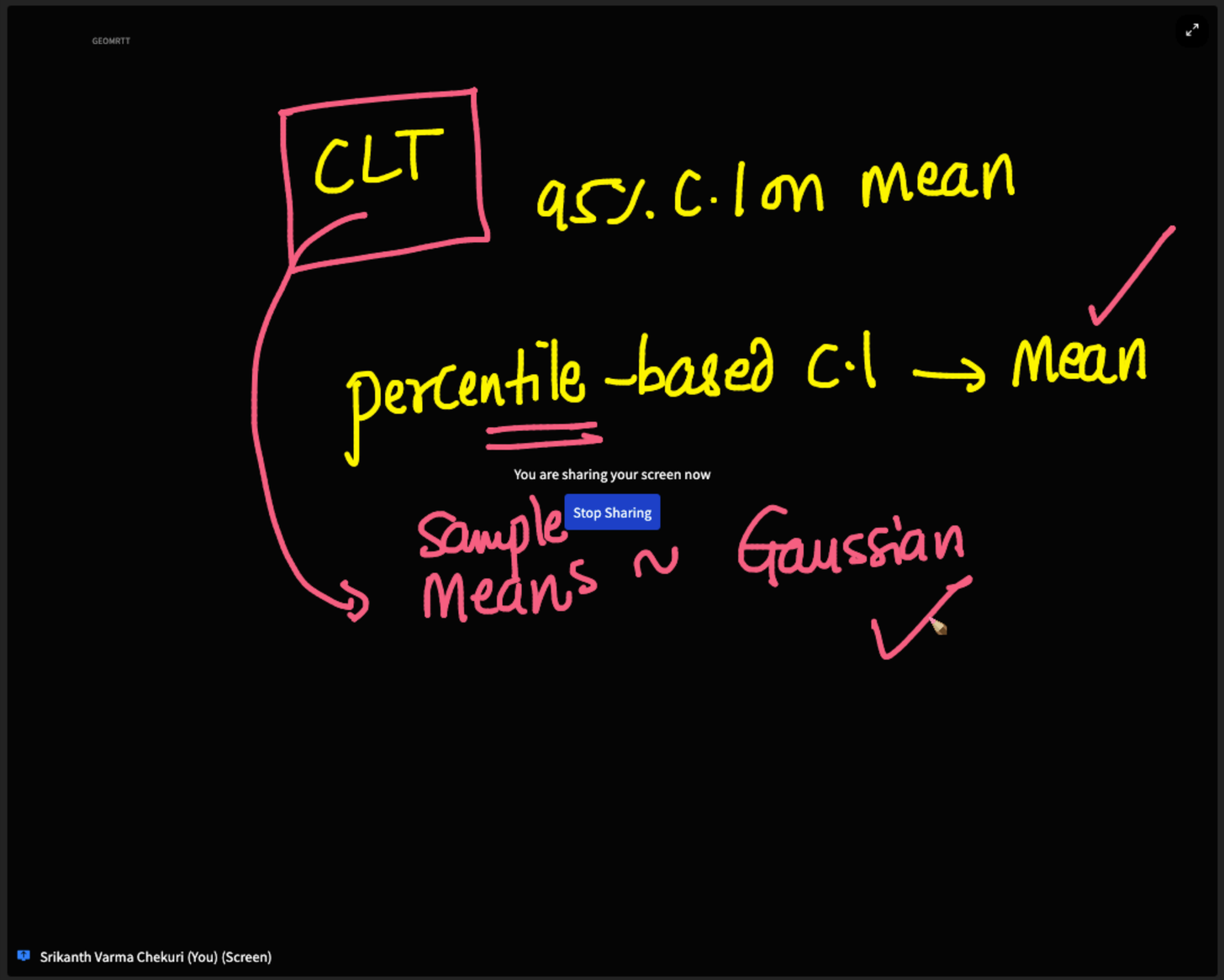

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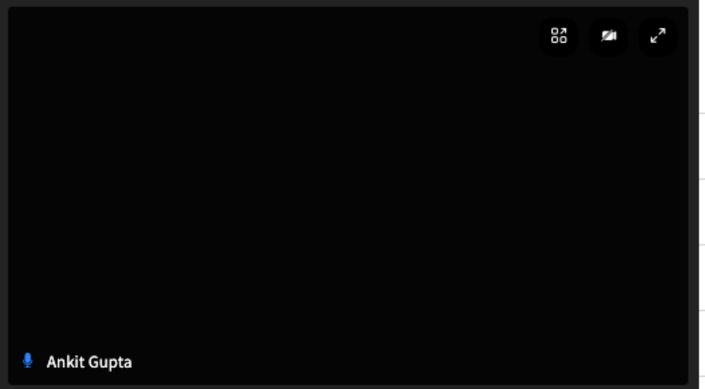

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People 30 | Chat 1 | Questions | Start Doubt Session

02:59:05

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large
k-resamplings → Median

CLT ≈ percentile based ✓

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Sample-Size = n = 100

Size of bootstrap sample = M = 1MM

Sameer Udgirkar has raised hand Unmute

Ankit Gupta

Srikanth Varma Chekuri (You)

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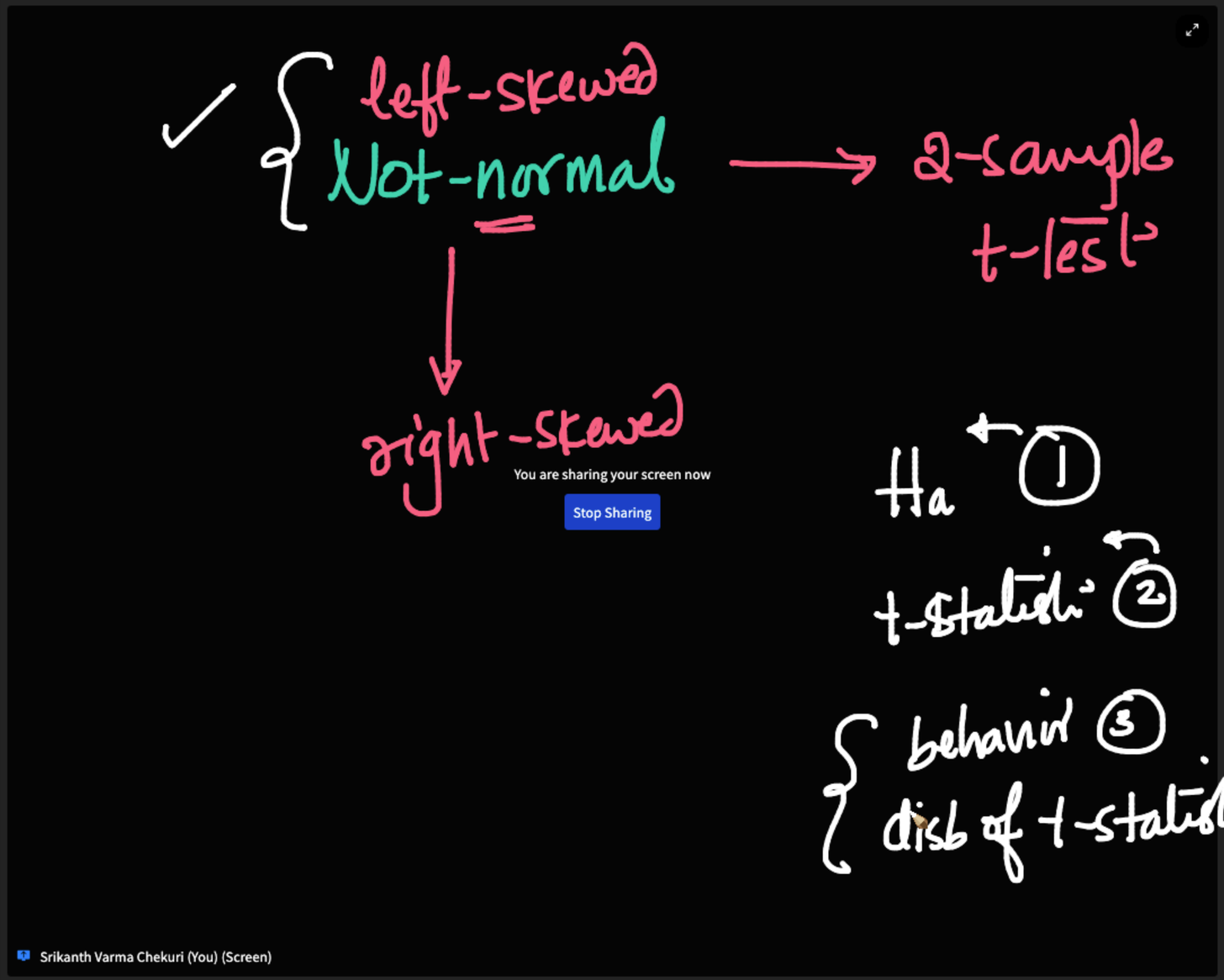

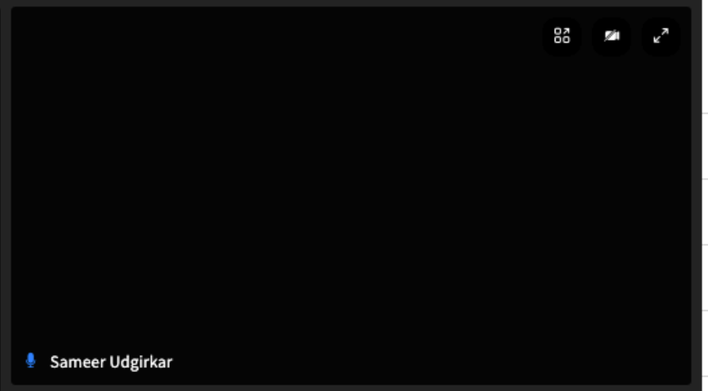

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03:03:48

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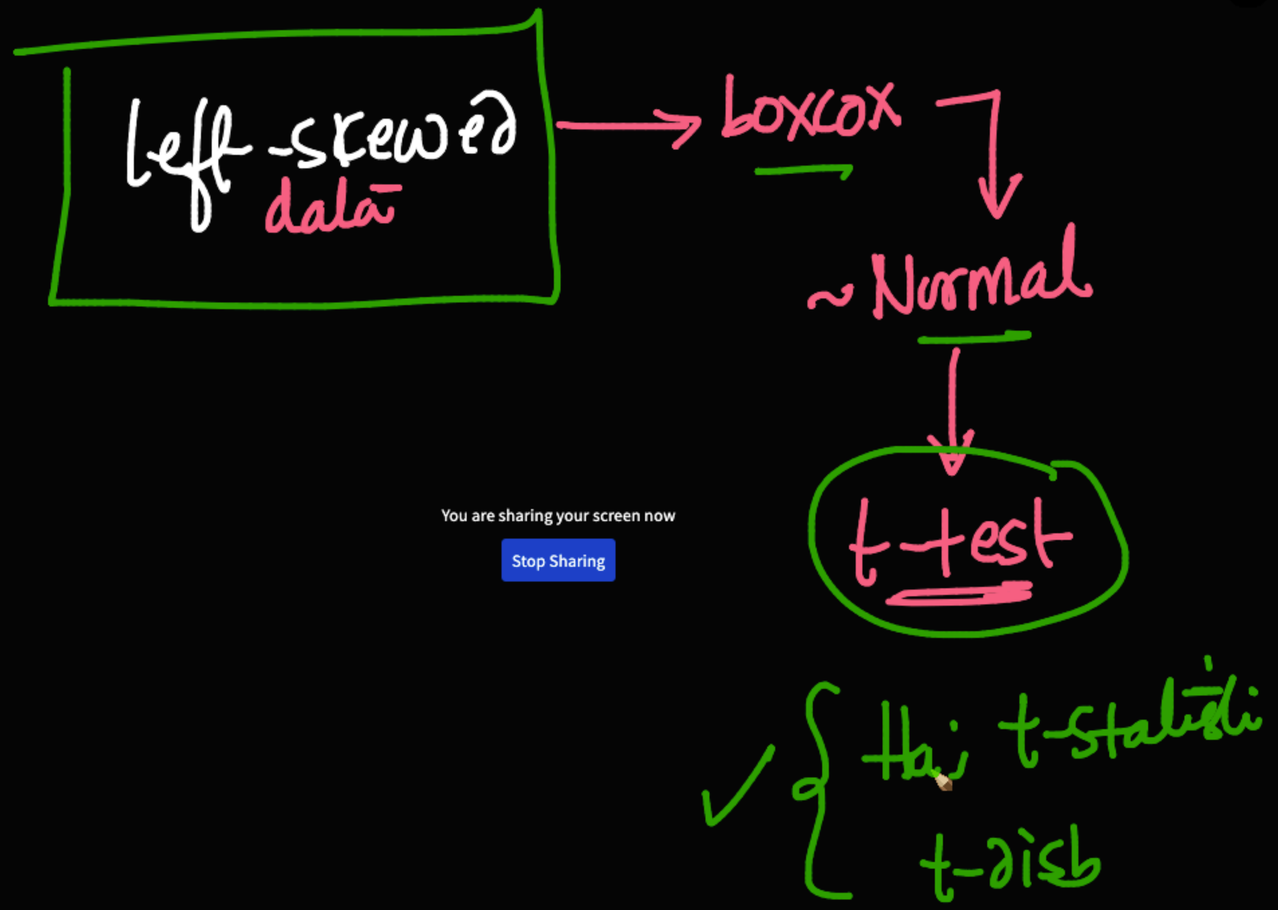

Sameer Udgirkar

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03:05:25

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