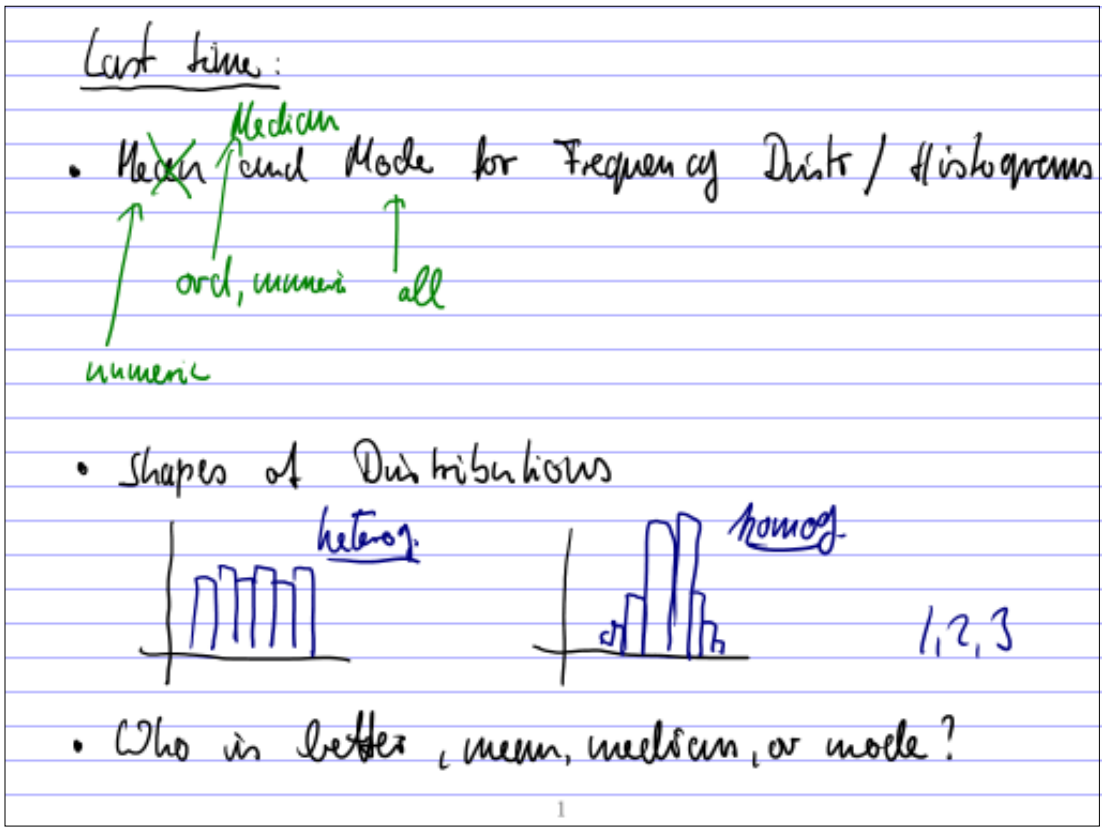
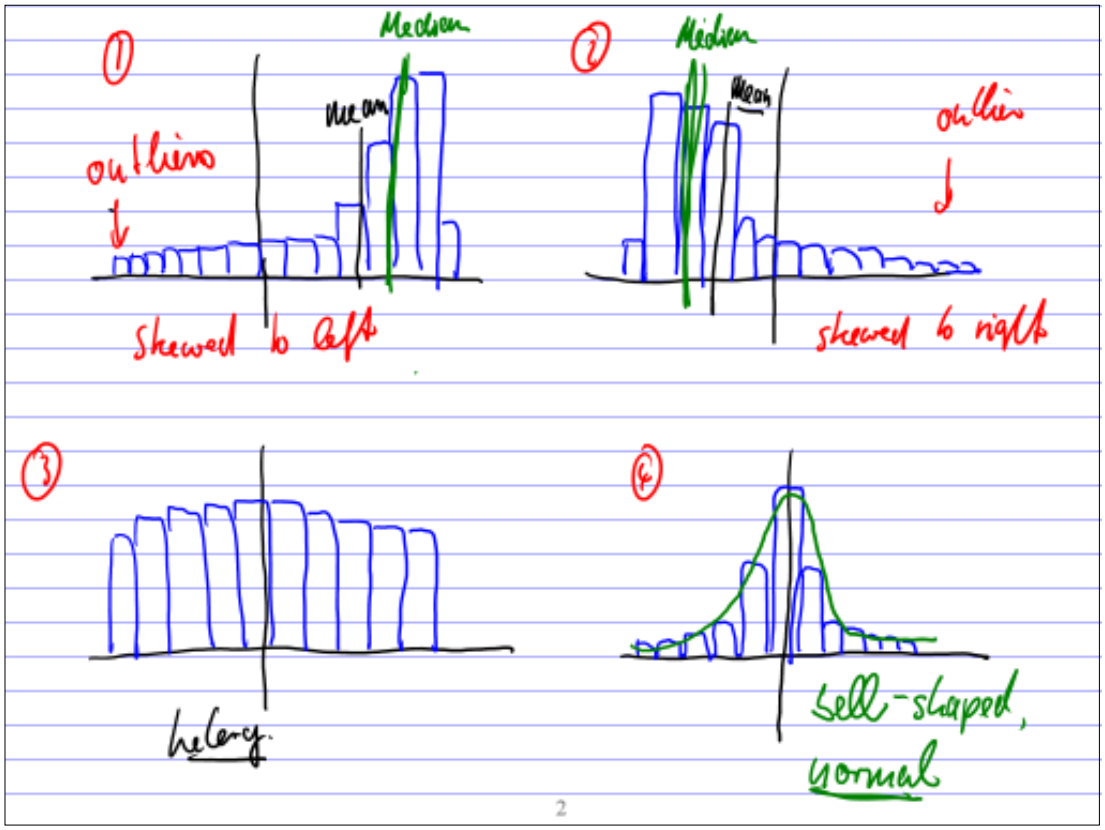
Panel 1




Panel 2



Panel 3

# Measures of Variability (Dispersion)

Want to say a machine that makes nails, 10 inch ones.

Machine A: 8, 9, 10, 11, 12 $\quad \bar{x} = 10$

Machine B: 2, 3, 10, 17, 19 $\quad \bar{x} = 10$

Want to come how close these nails are together ✓
how close to the avg. they are.

**Range:** max − min

A: range = 4

B: range = 16

3

Panel 4

Variance : is the avg distance of data to the mean.

→ $\frac{1}{n-1}\sum (x-\bar{x})^2$ is variance

Two symbols $s^2$ = sample variance

$\sigma^2$ = pop. variance (sigma)

(A)

| $x$ | $x-\bar{x}$ | $(x-\bar{x})^2$ |
|---|---|---|
| 8 | −2 | 4 |
| 9 | −1 | 0 |
| 10 | 0 | 1 |
| 11 | 1 | 4 |
| 12 | 2 | |
| | | 10 |

(B)

$\bar{x} = 10$

$s^2 = \frac{10}{4} = 2.5$

4

Panel 5

Data: 2, 3, 10, 17, 18

$\bar{x} = 10$

| $x$ | $x-\bar{x}$ | $(x-\bar{x})^2$ |
|---|---|---|
| 2 | -8 | 64 |
| 3 | -7 | 49 |
| 10 | 0 | 0 |
| 17 | +7 | 49 |
| 18 | 8 | 64 |
| | | 226 |

$\bar{x} = 10$

$s^2 = \frac{226}{4} = 56.5$

Machine B is better, because its variance is smaller, so units are more uniform.

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Panel 6

Variance is hard to compute: need short cut

$$s^2 = \frac{1}{n-1}\left[\sum x^2 - \frac{(\sum x)^2}{n}\right] \qquad \frac{1}{n}\sum (x-\bar{x})^2$$

A:

| $x$ | $x^2$ |
|---|---|
| 8 | 64 |
| 9 | 81 |
| 10 | 100 |
| 11 | 121 |
| 12 | 144 |
| 50 | 510 |

$s^2 = \frac{1}{4}\left(510 - \frac{(50)^2}{5}\right) =$

$\left(\bar{x} = \frac{50}{5} = 10\right)$

$\frac{1}{4}(510 - 500) = \frac{10}{4} = 2.5$

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Panel 7

# Variance

variance → variance

variance tells how much a distr. is spread out around mean

Variance has wrong unit

**Def:** Standard Deviation is the square root of the variance:

$$s = \sqrt{s^2} \quad \text{or} \quad \sigma = \sqrt{\sigma^2}$$

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Panel 8

**Data:** 3, 4, 7, 1, 9, 8 Find std. dev. $s$.

| $x$ | $x^2$ |
|---|---|
| 3 | 9 |
| 4 | 16 |
| 7 | 49 |
| 1 | 1 |
| 9 | 81 |
| 8 | 64 |
| 32 | 220 |

$$s^2 = \frac{1}{5}\left(220 - \frac{32^2}{6}\right) = \frac{49.33}{5} = 9.86$$

$$s = \sqrt{9.86} = 3.14$$

$$s^2 = \frac{1}{n-1}\left(\sum x^2 - \frac{(\sum x)^2}{n}\right)$$

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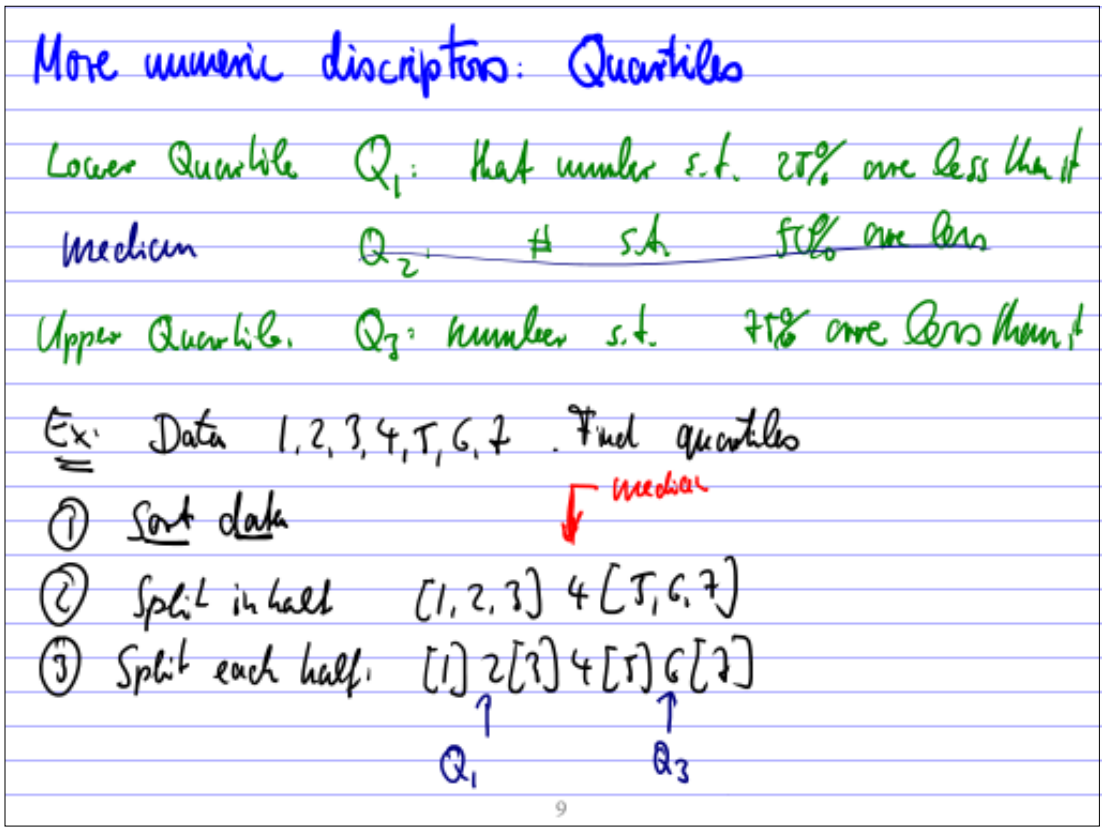
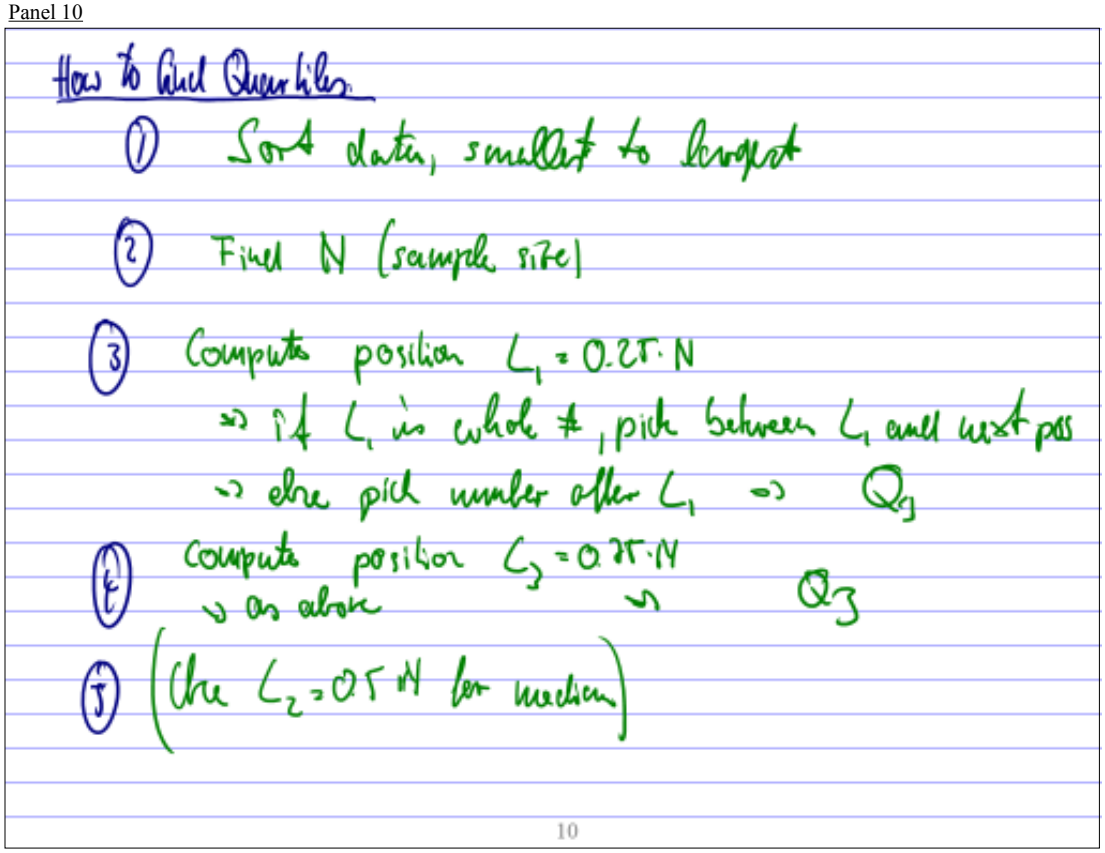
Panel 9




Panel 10



Panel 11

Ex: Data 1, 2, 3, 4, 5, 6 sorted, $N = 6$

$L_1 = 0.25 \cdot 6 = 1.5 \Rightarrow$ pick # at position 2 $\Rightarrow Q_1 = 2$

$L_3 = 0.75 \cdot 6 = 4.5 \Rightarrow$ pick # at position 5 $\Rightarrow Q_3 = 5$

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Panel 12

Data: 0, 87, 173, 253, 1, 103, 173, 265, 1, 112, 198

Sort: 0, 1, 1, 87, 103, 112, 173, 173, 198, 253, 265

$Q_1$: $L_1 = 0.25 \cdot 11 = 2.75$

$\Rightarrow$ look at position 3: $Q_1 = 1$

$Q_3$: $L_3 = 0.75 \cdot 11 = 8.25$

$\Rightarrow$ look at position 9: $Q_3 = 198$

(what if $L_1 = 3$ pick between 3rd and 4th: 44)

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