“New” Statistics Tutorial

Desmond Ong
24 January 2014

Outline

- Psych Science Guidelines: Effect Sizes and CIs
- (Robust methods, e.g. robust regressions)
- (Bayesian statistics)
- Bootstrapping and resampling (non-parametric methods)

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  - Report Effect Sizes (ES) and CIs

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    - Do not use p-values (NHST)
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    - Report Effect Sizes (ES) and CIs
- CI: Quick way: 1.96*SE

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  - ✗ Non-normal distributions (e.g. Poisson)
  - ✗ Error term depends on x (heteroscedasticity)
- These models are not "robust" against outliers,...
- Robust models: using a non-normal distribution (t, Cauchy...), sum of two normals, etc...

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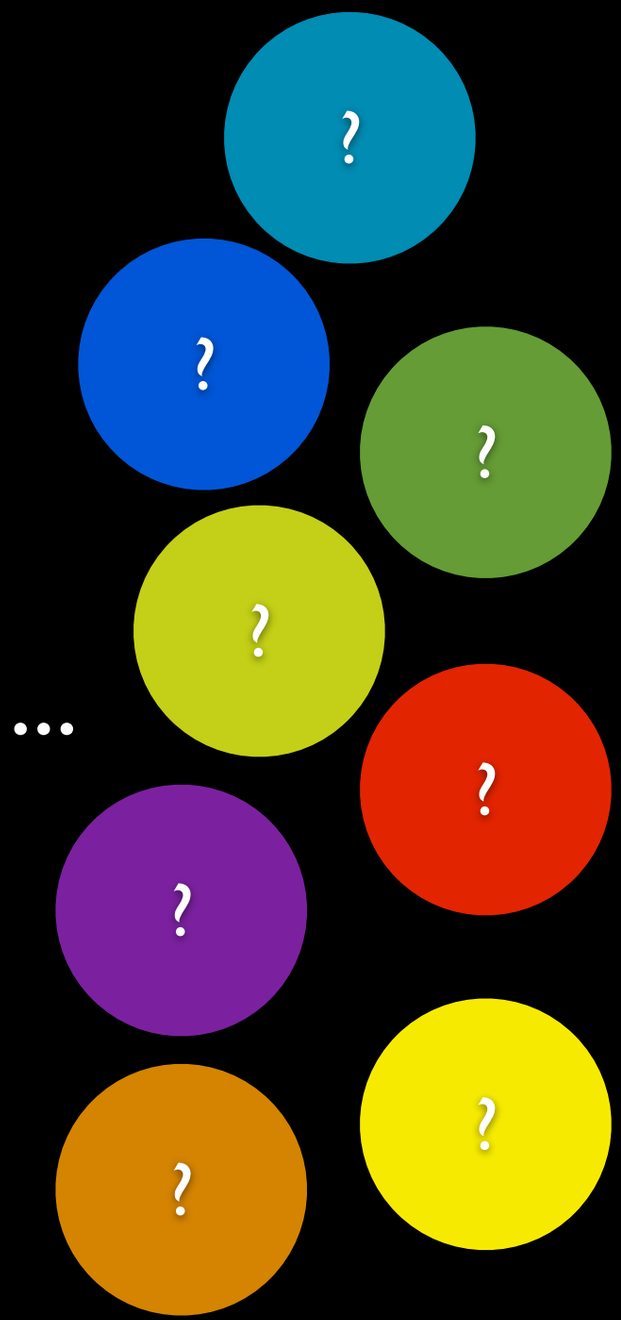
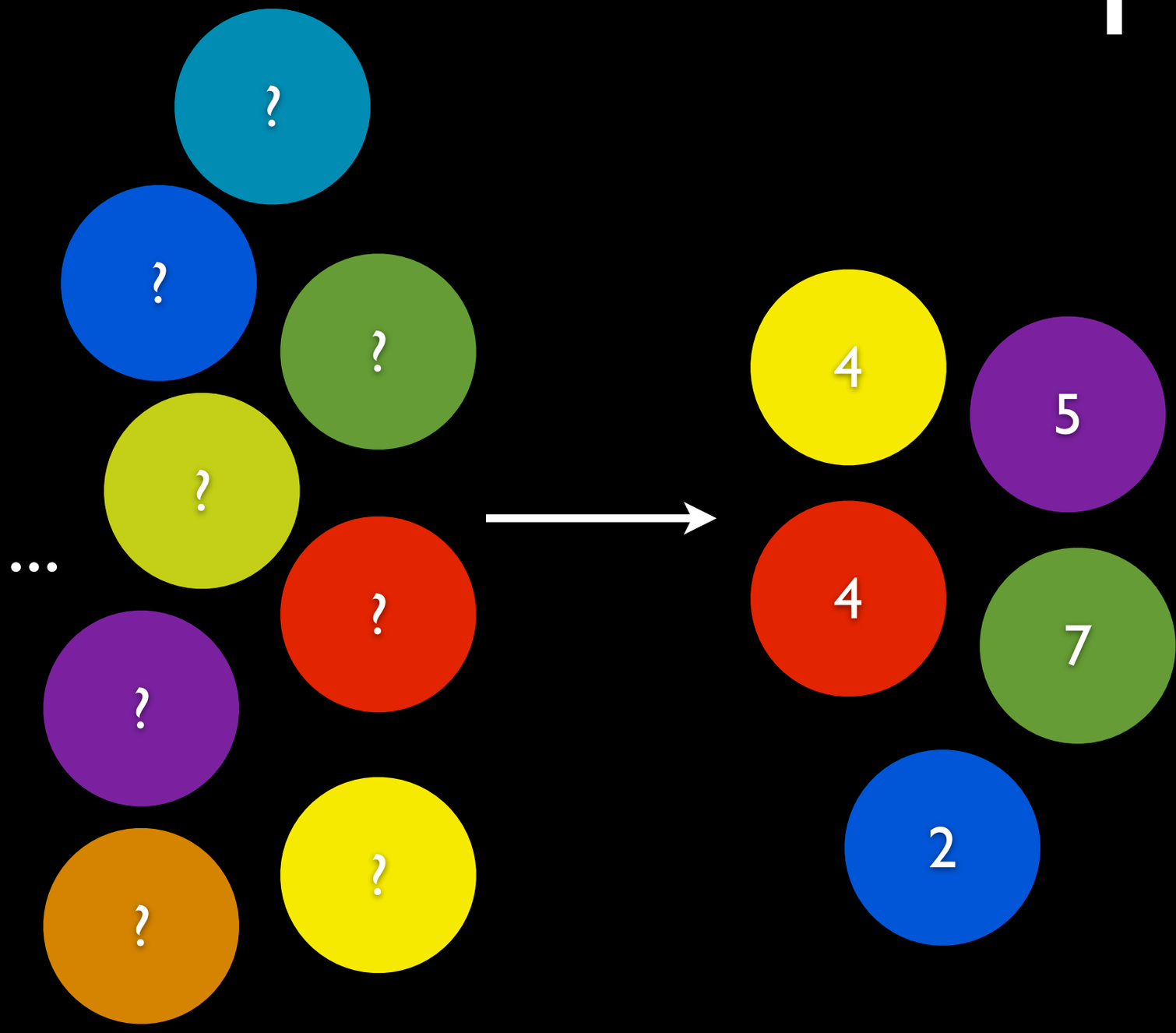
Bootstrapping



Population

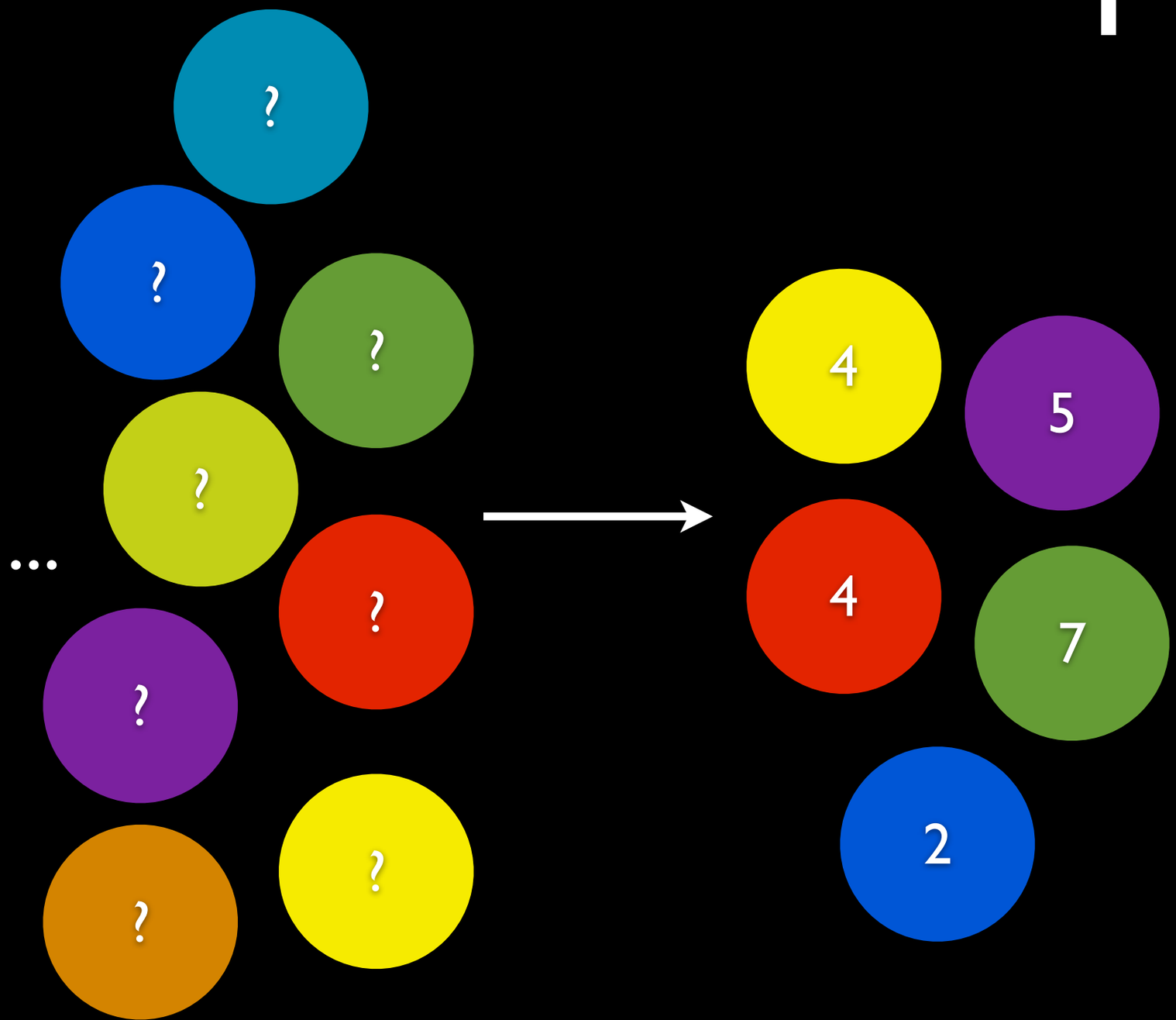
Bootstrapping



Population

Sample (n=5)

Bootstrapping



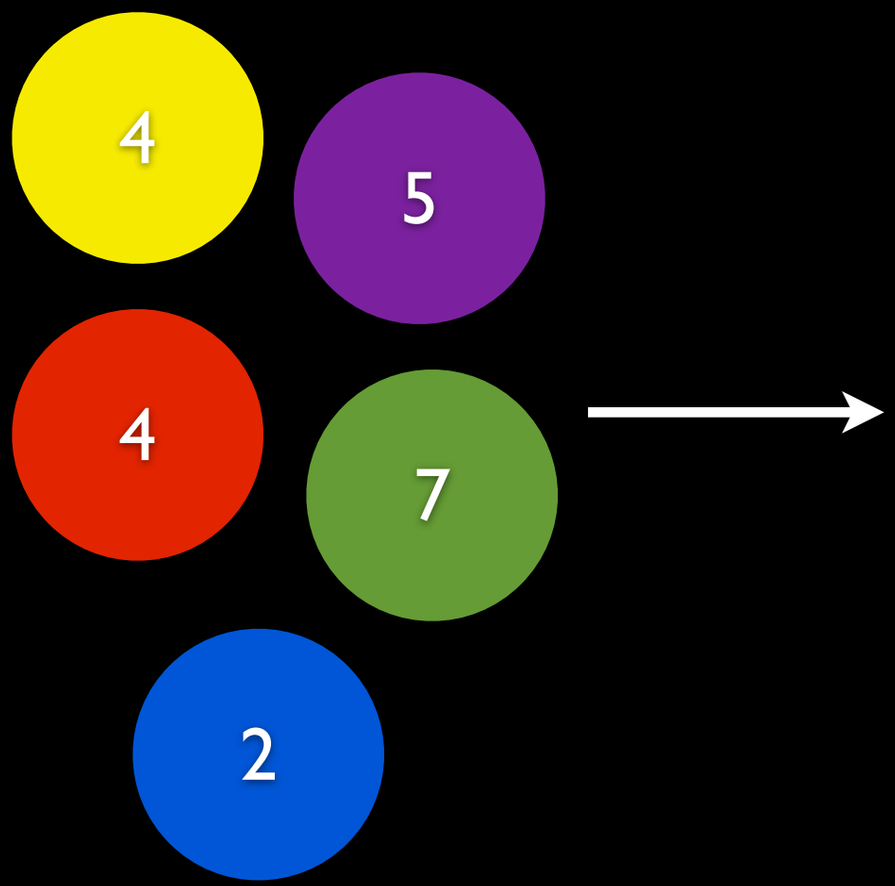
Sample
Mean = 4.4
SD = 1.82
SE = 0.812
CI = 1.59

Mean = 4.4 [2.81, 5.99]

Population

Sample (n=5)

Bootstrapping



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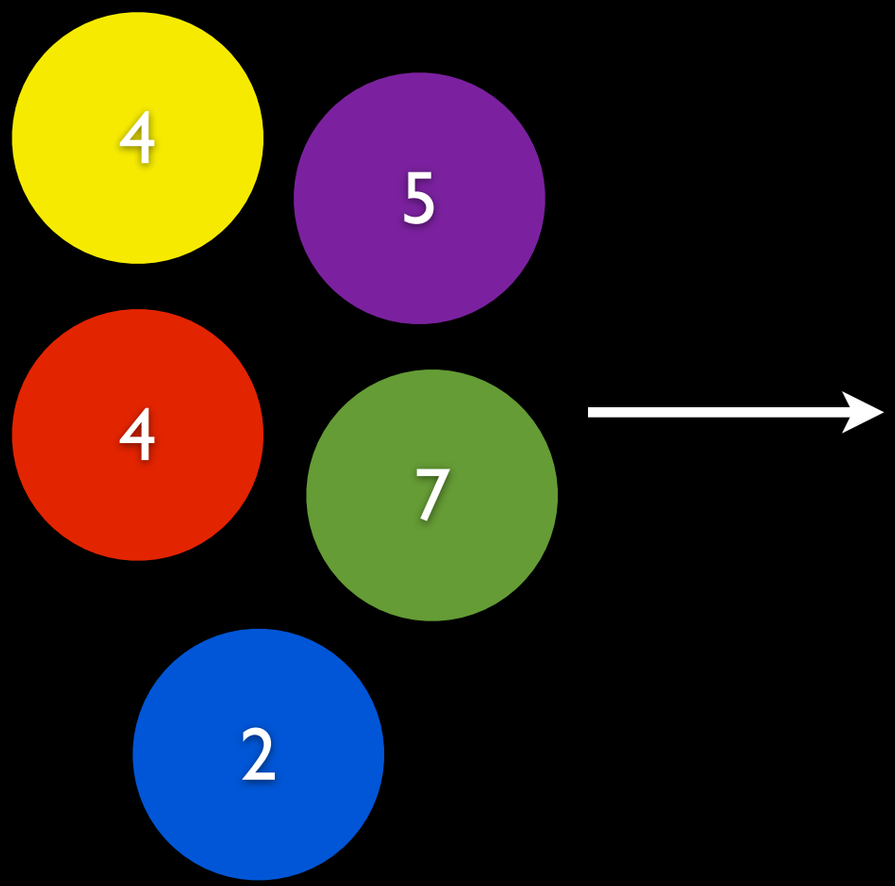

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Bootstrapped
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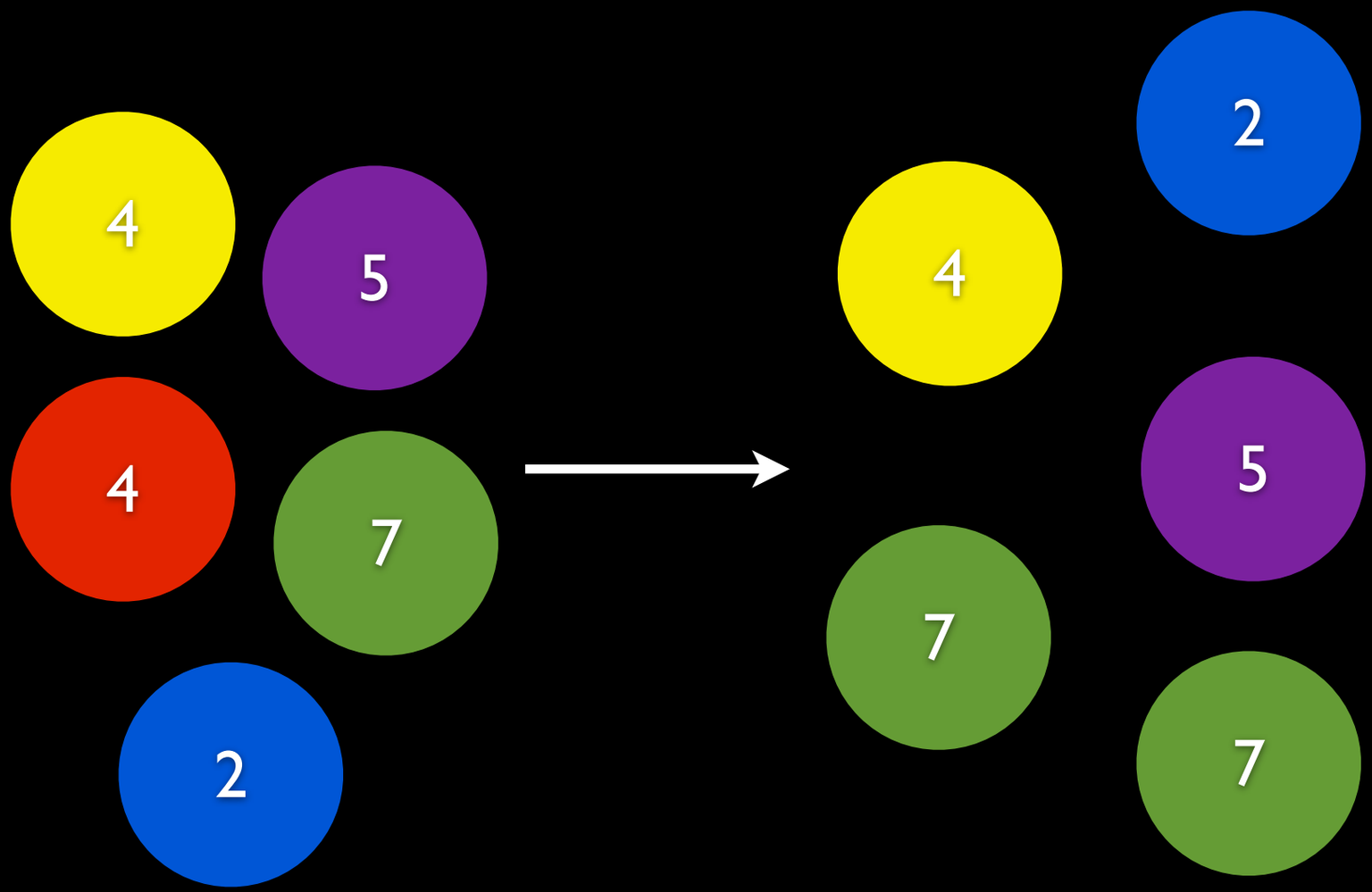

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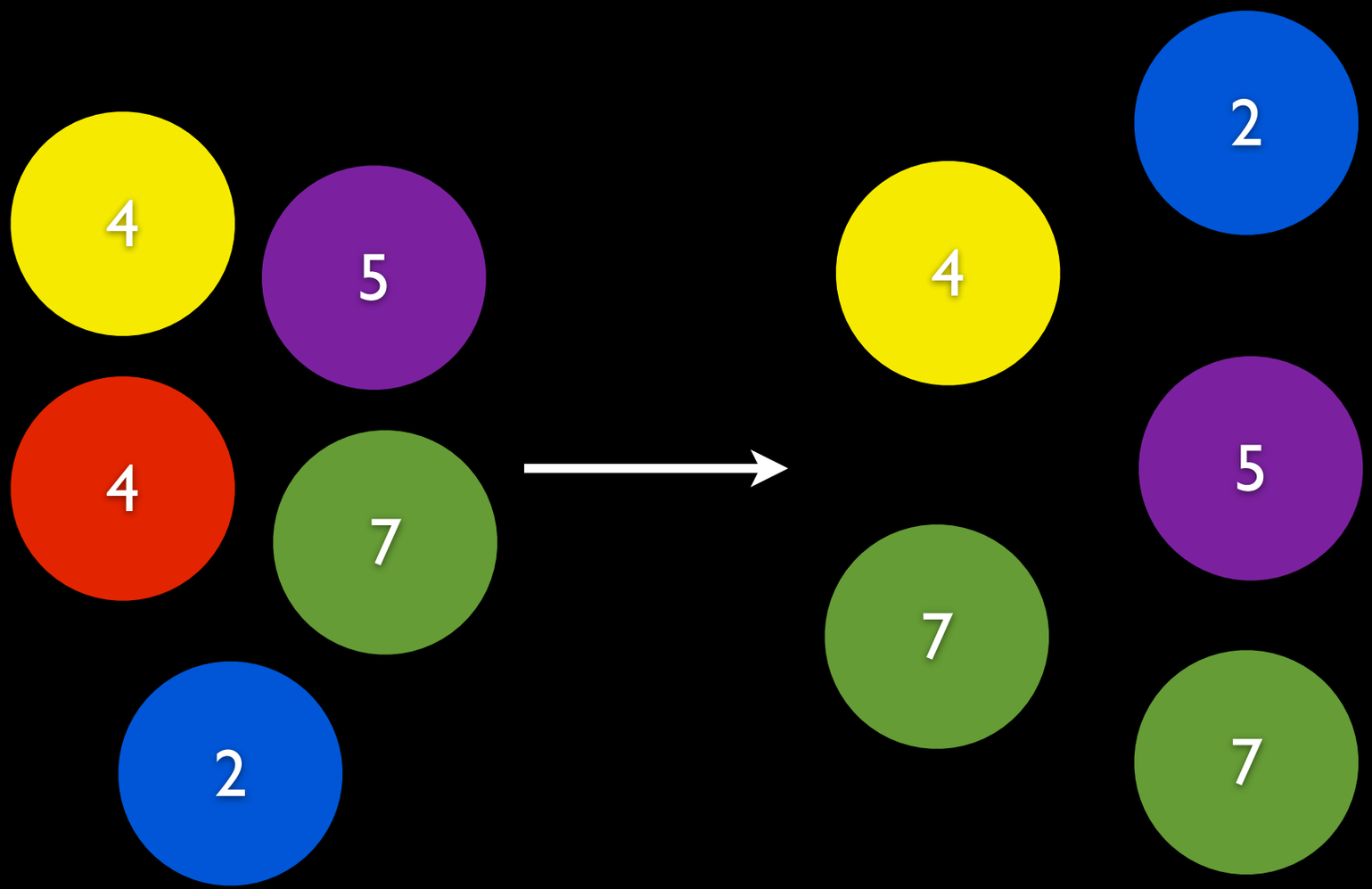

#	Mean
1	5

Sample (n=5)

Bootstrapped Sample (n=5)

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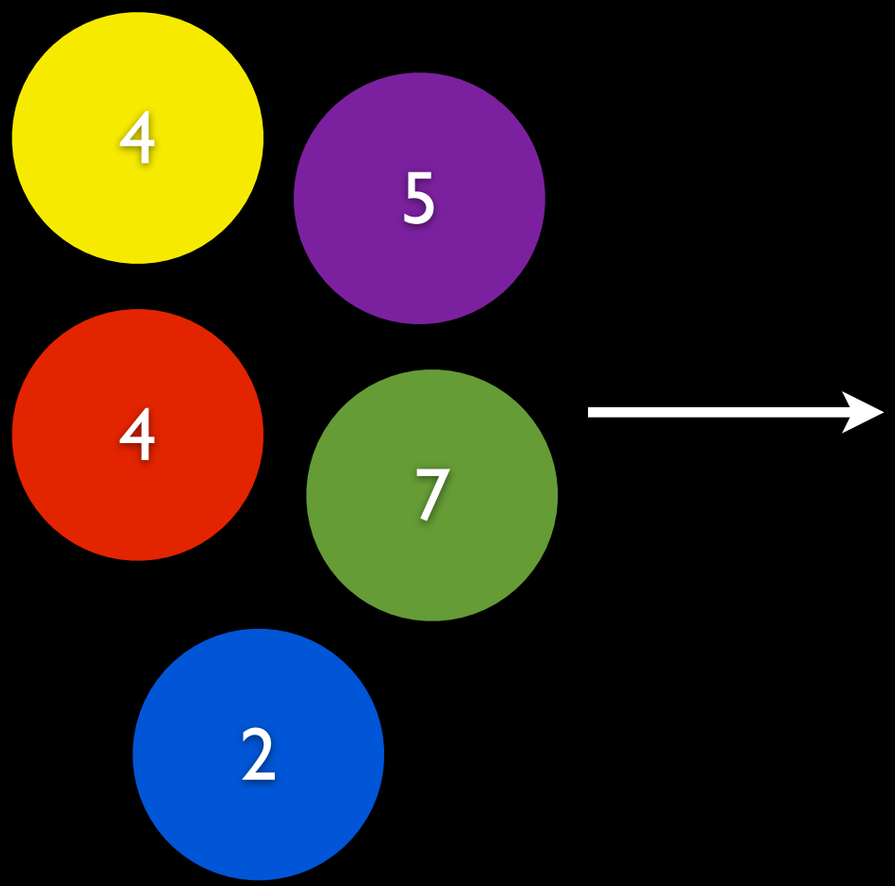

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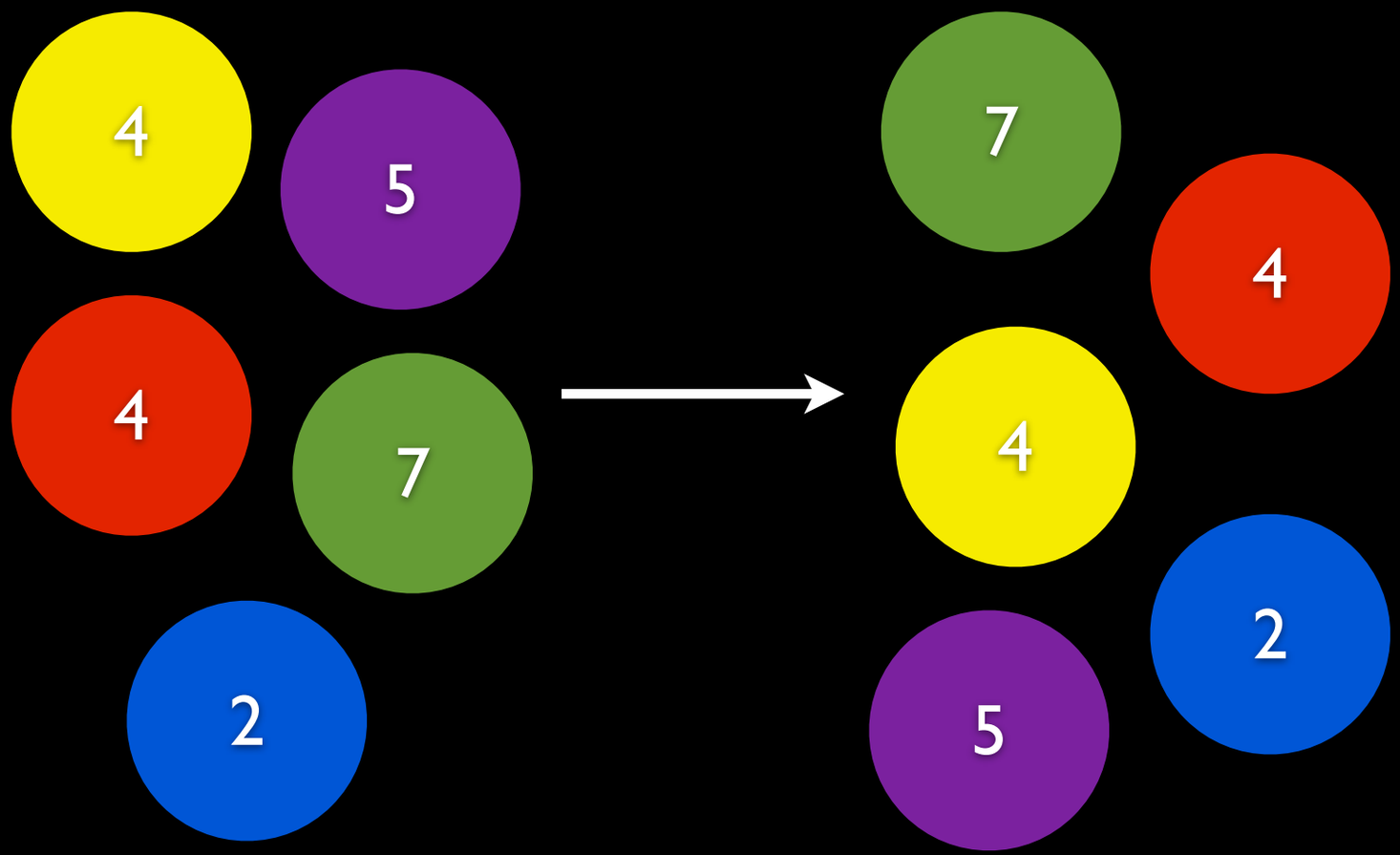

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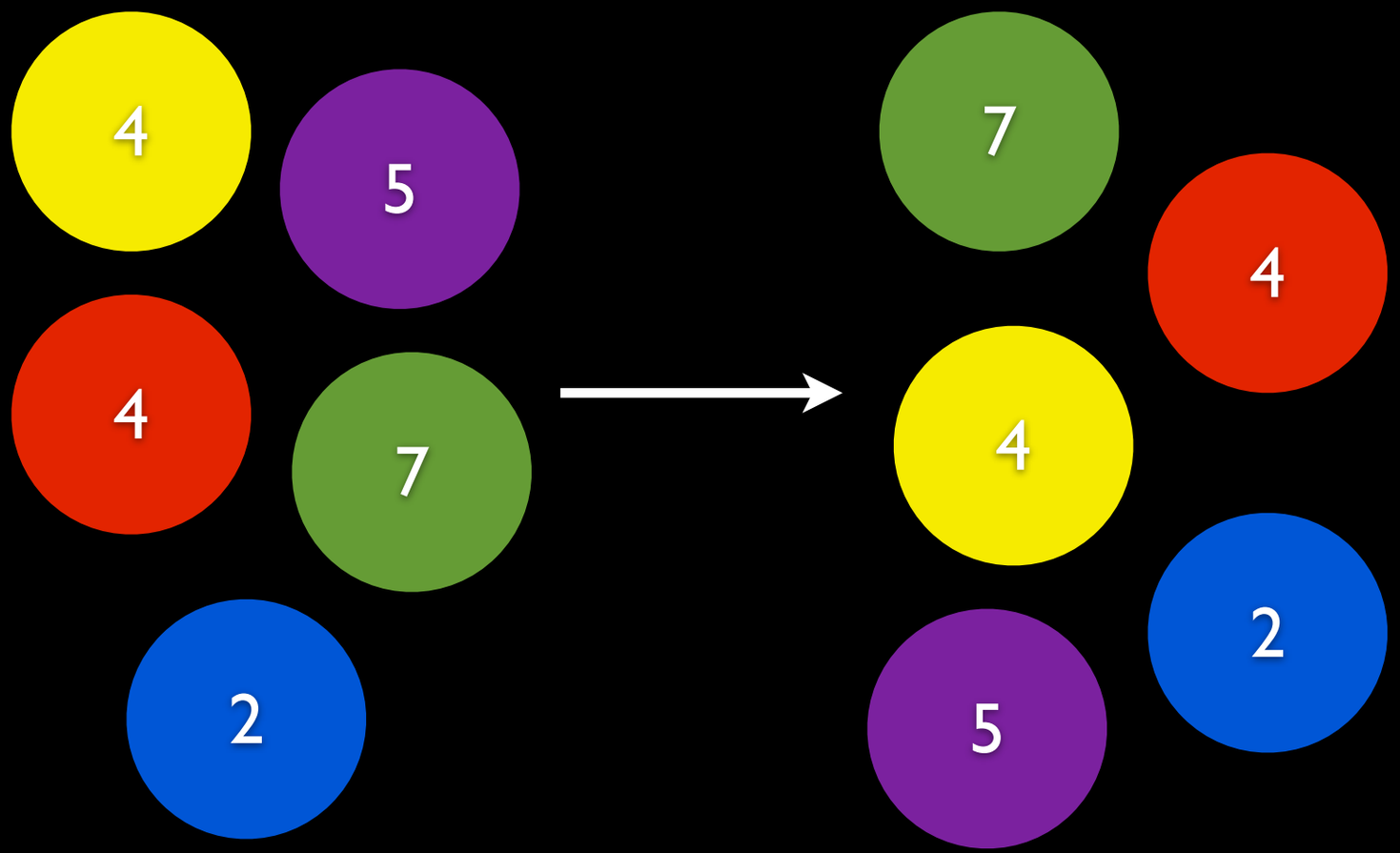

#	Mean
1	5
2	4.4

Sample (n=5)

Bootstrapped Sample (n=5)

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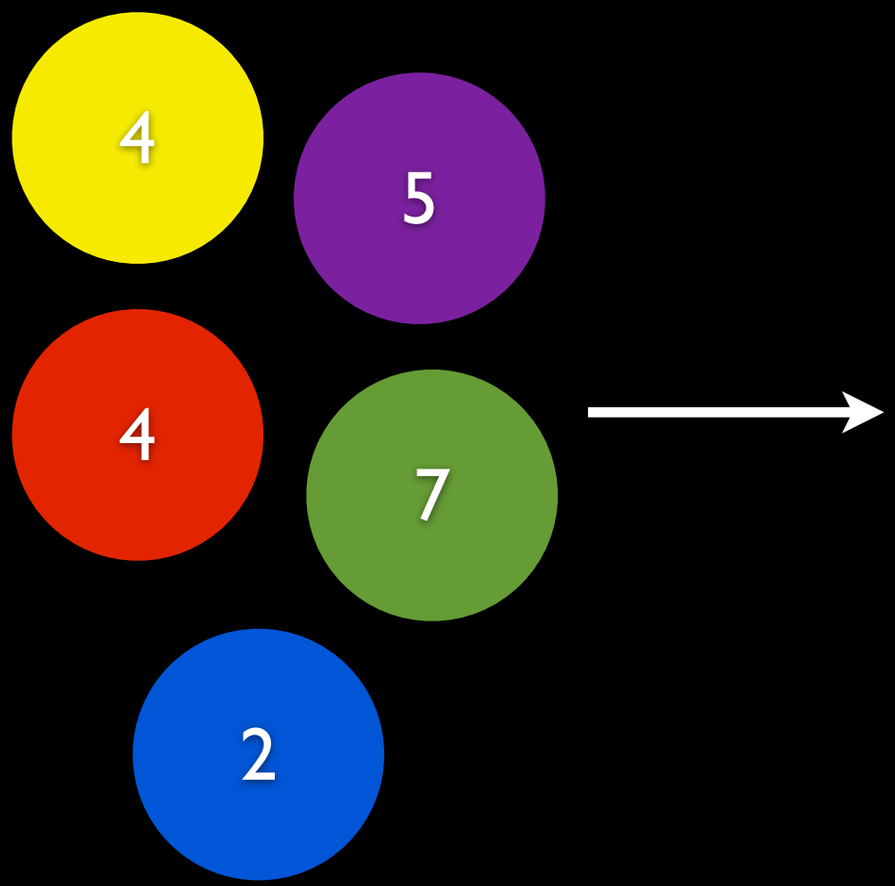

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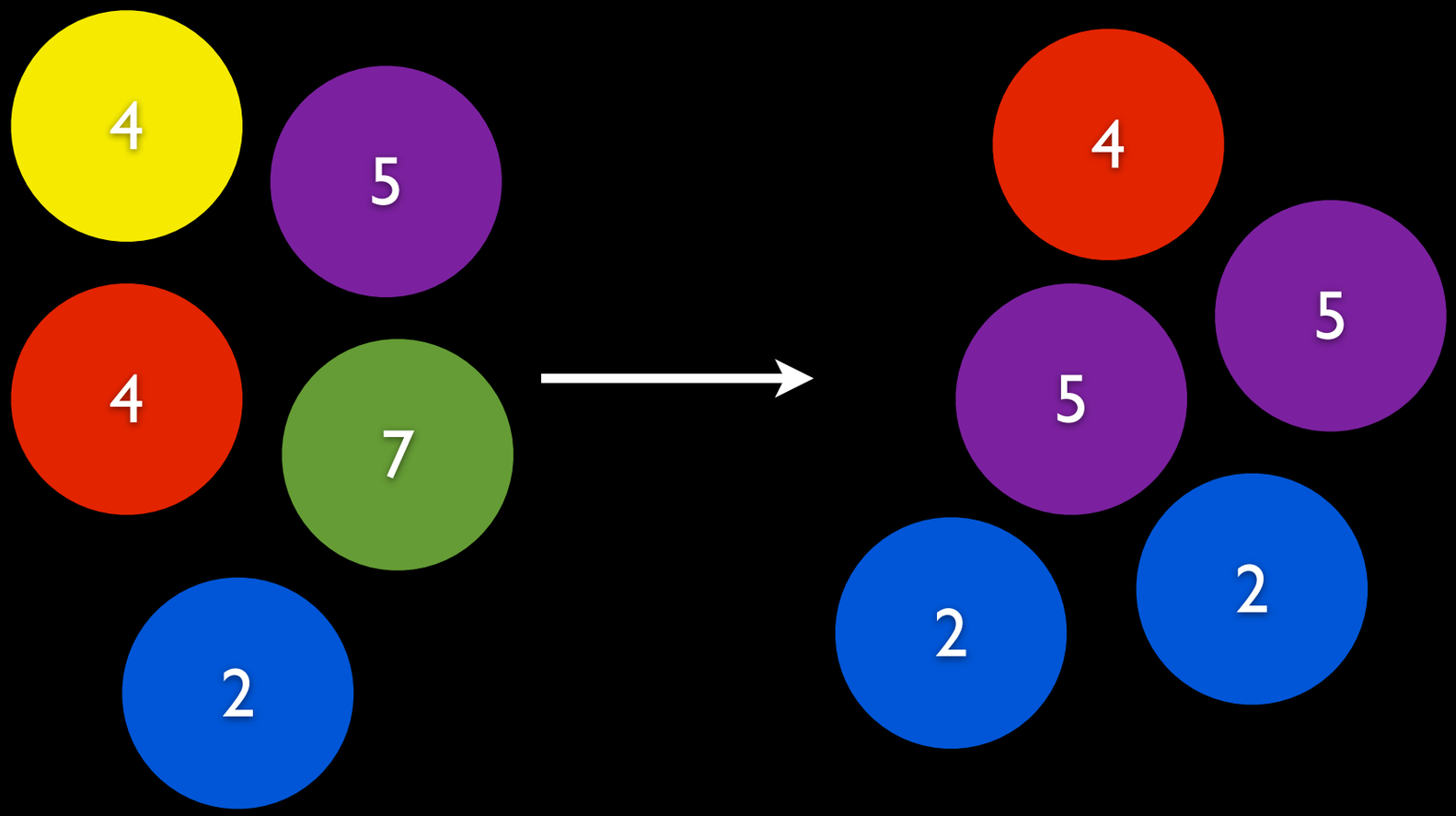

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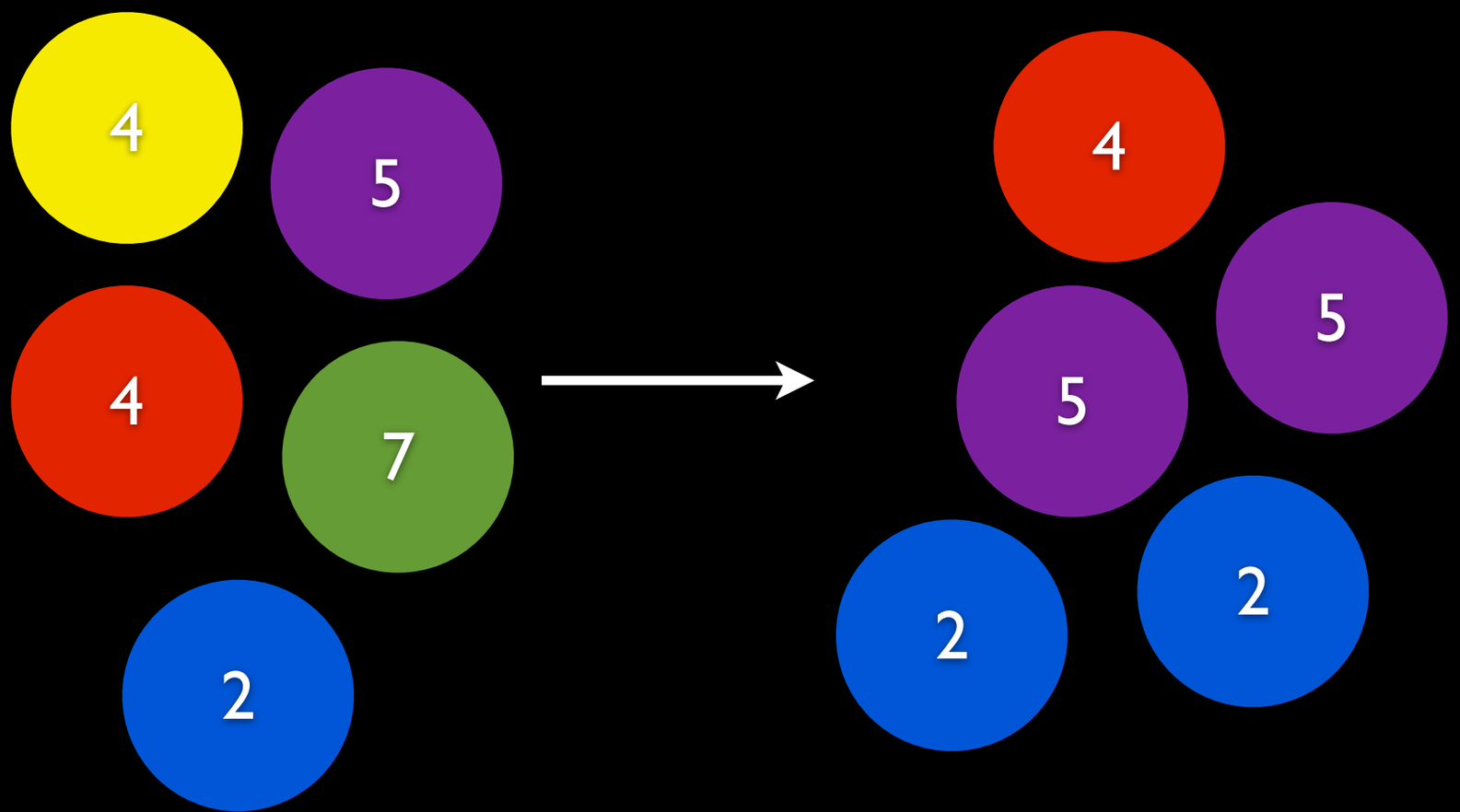

#	Mean
1	5
2	4.4
3	3.6

Sample (n=5)

Bootstrapped Sample (n=5)

Bootstrapping

Sample (n=5)

…

#	Mean
1	5
2	4.4
3	3.6
4	5.4
…	…

Bootstrapped Sample (n=5)

Bootstrapping

Sample (n=5)

Rank	1	2	3	4	5	6	...
Mean	2.6	3	3	3.2	3.3	3.3	...

Rank	...	48	49	50	51	52	...
Mean	...	4.4	4.4	4.4	4.6	4.8	...

Rank	...	95	96	97	98	99	100
Mean	...	5.7	5.6	5.8	5.8	5.9	6

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Sample (n=5)

Rank	1	2	3	4	5	6	...
Mean	2.6	3	3	3.2	3.3	3.3	...

Rank	...	48	49	50	51	52	...
Mean	...	4.4	4.4	4.4	4.6	4.8	...

Rank	...	95	96	97	98	99	100
Mean	...	5.7	5.8	6	6	6	6.2

Bootstrapping

Sample (n=5)

Non-Parametric

Sample
Bootstrapped, 5000 iterations

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Parametric

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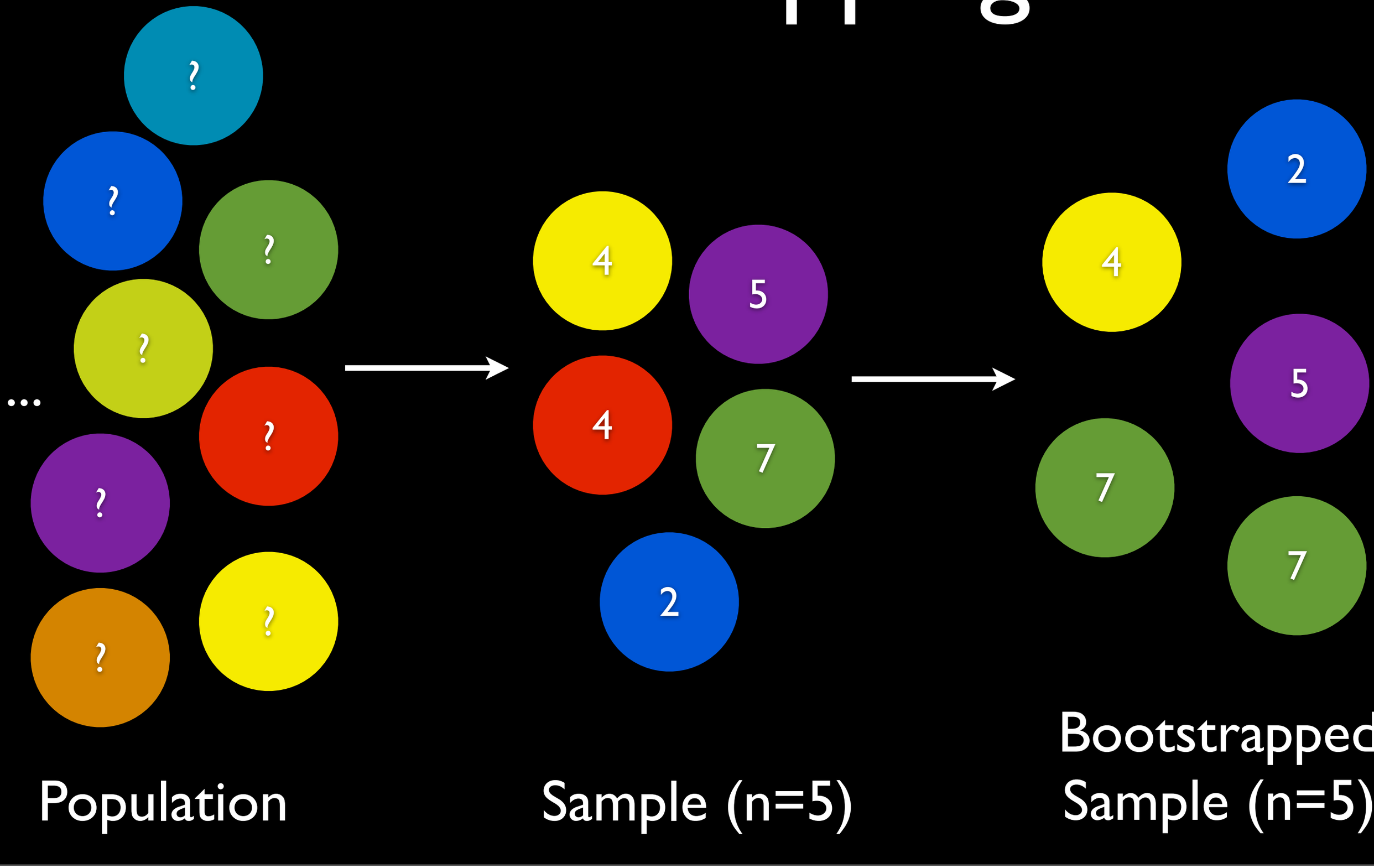
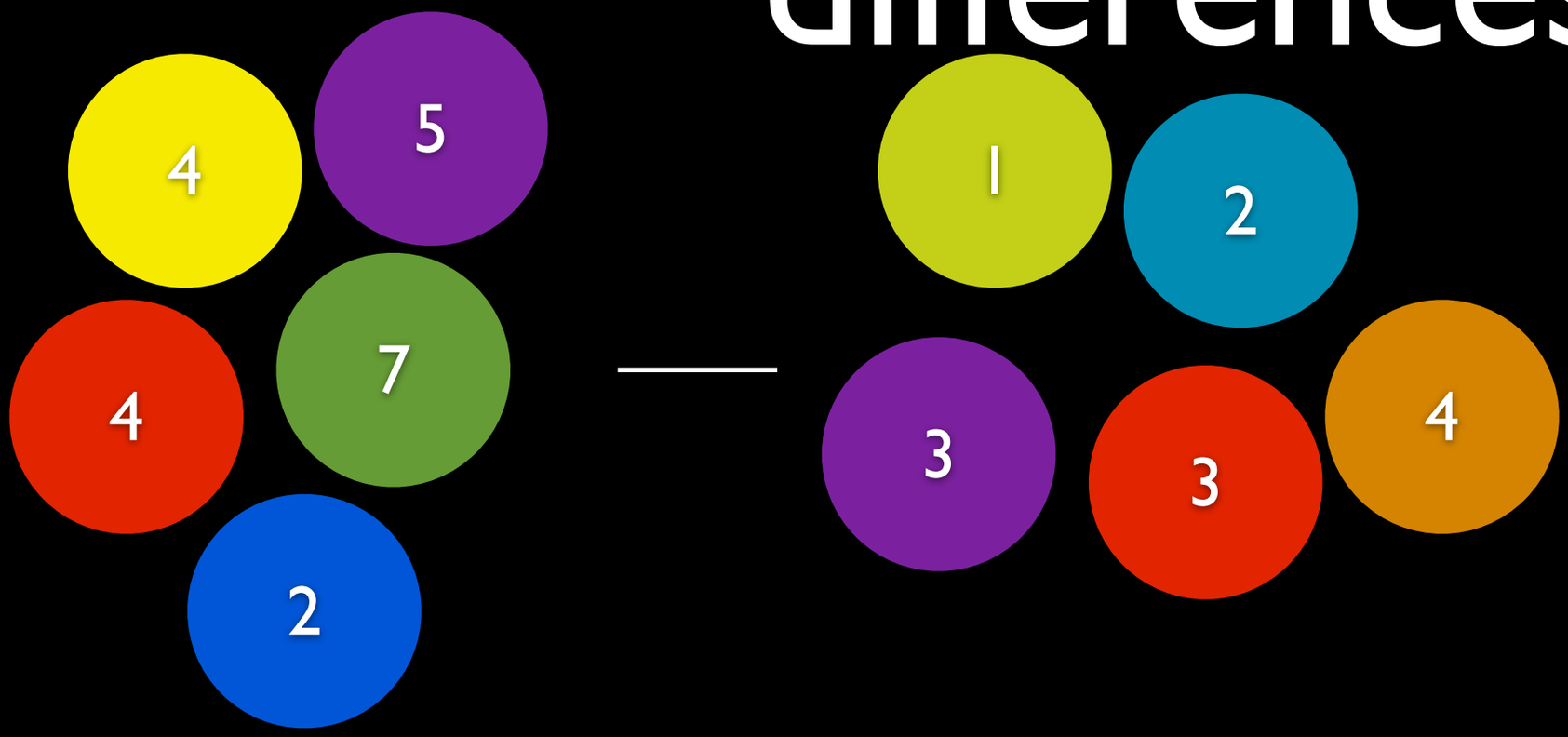


Bootstrapping

- "The population is to the sample what the sample is to the bootstrapped sample"
- You can bootstrap (almost?) anything!

Bootstrapping differences



t-test
cohen's D

$$d = \frac{\bar{x} - \bar{y}}{s}$$

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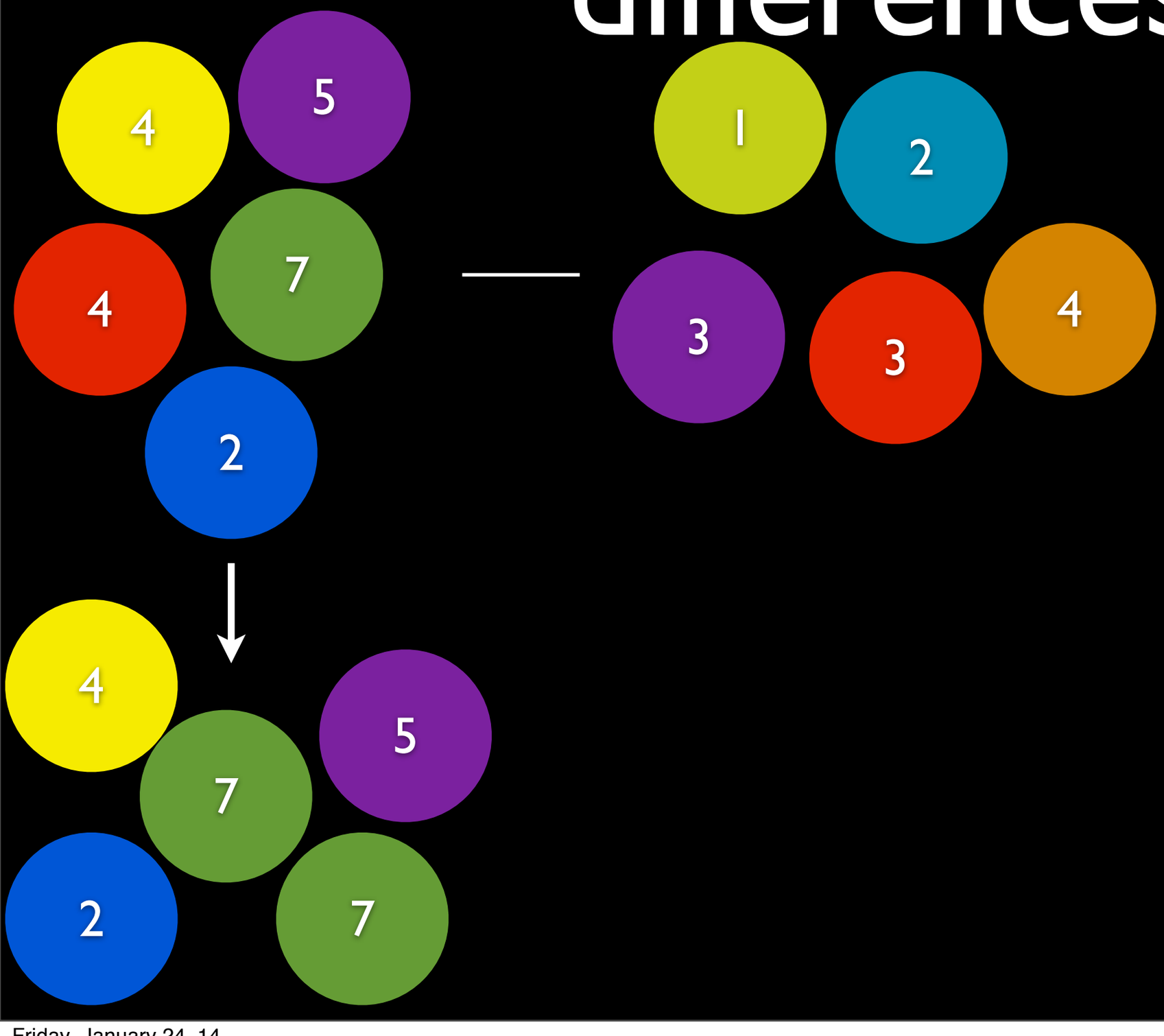

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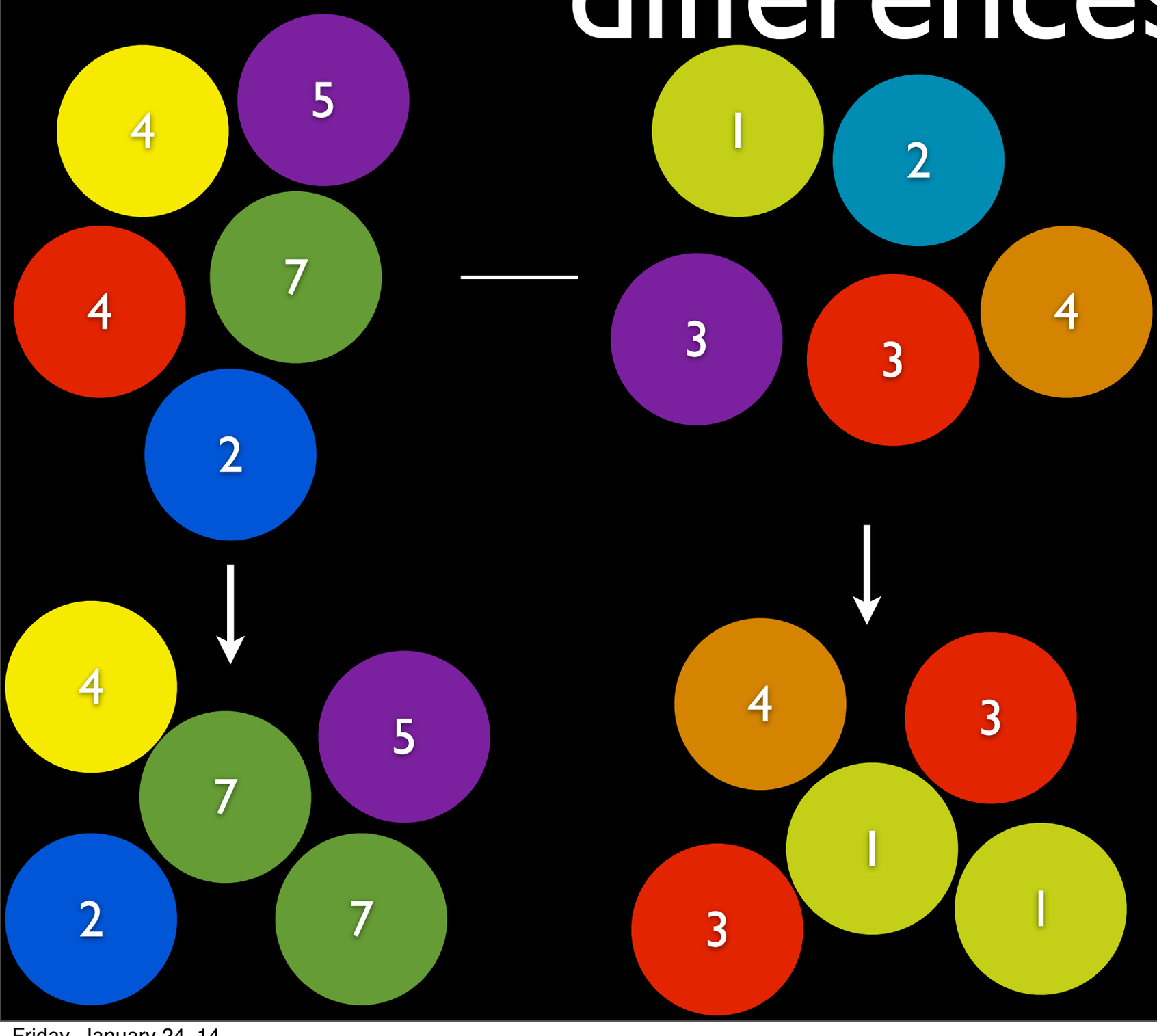

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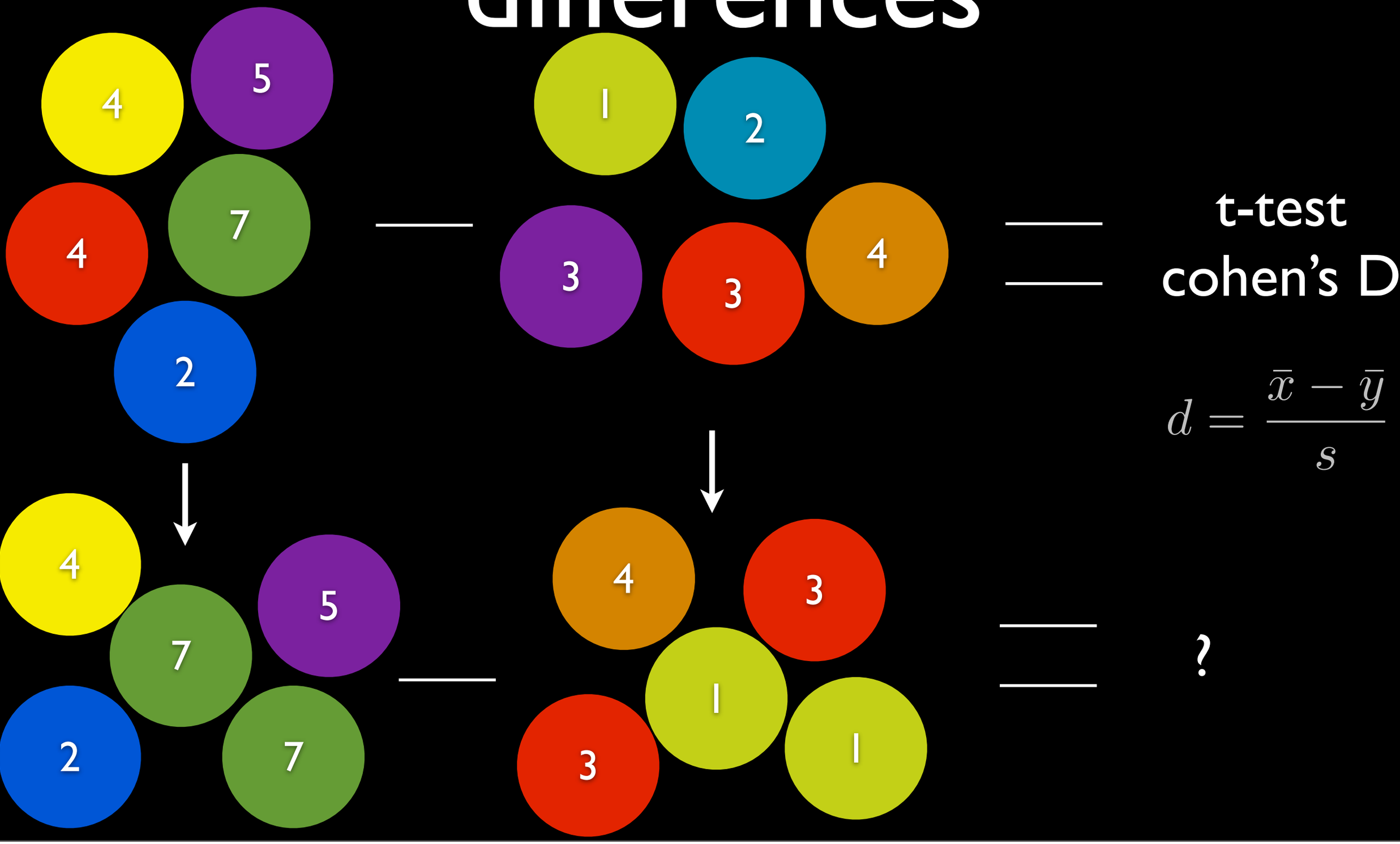

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Bootstrapping

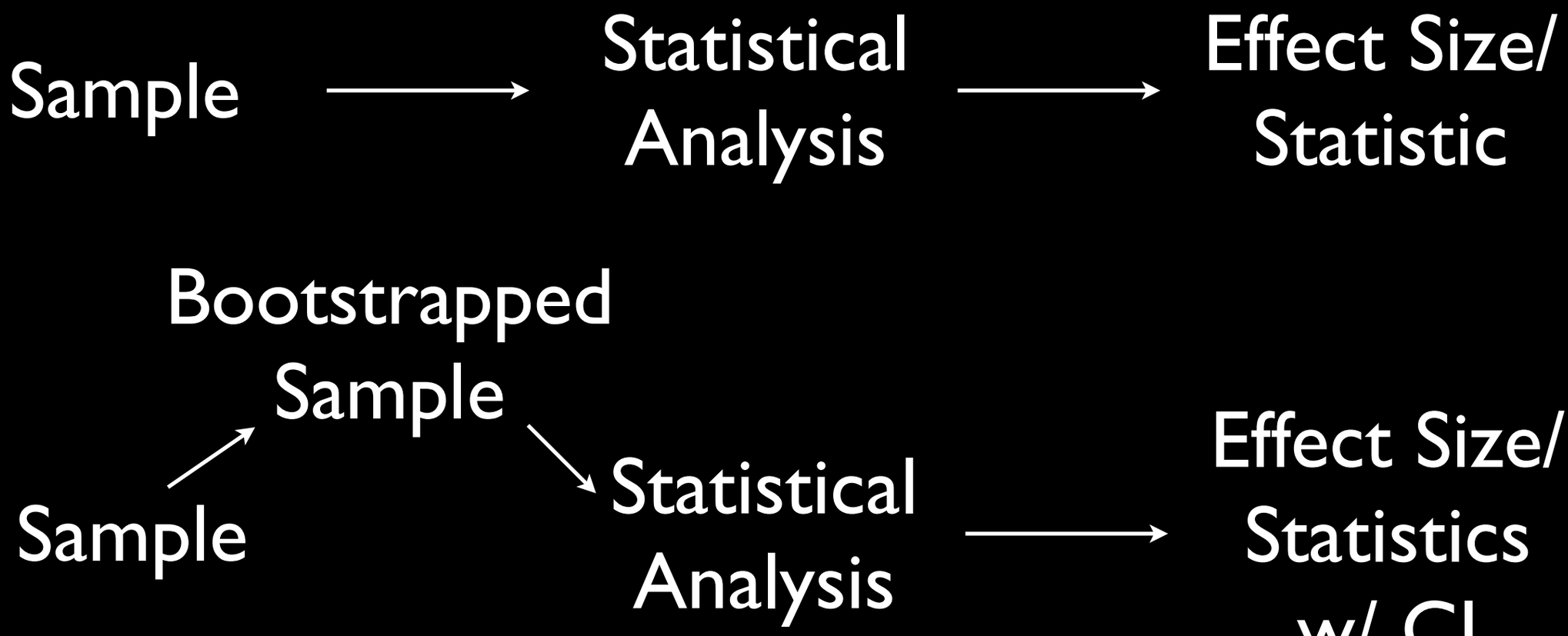
$$\eta^2 = \frac{SS_{\text{Treatment}}}{SS_{\text{Total}}}$$

Sample ⟶ Regression ⟶ Regression Coefficients

Bootstrapped Sample

Sample ↗ ↘ Regression ⟶ Regression Coefficients w/ CI

Bootstrapping



- Demo
- https://github.com/desmond-ong/doBootstrap/