Ick, Math!
Ensuring Production Quality

IG3 West
December 10, 2019

Clustify

Panelists

- Bill Dimm, Hot Neuron
- Lilith Bat-Leah, Fronteo
- Cynthia Vasquez, CHAT Consulting
- Grady Glover, The Rodarti Group & Lawrence Bartels
- Tammi Loveland, U.S. DoJ

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Prevalence

- Percentage having some property (relevant)

Recall

- Percentage of relevant docs found
- Defensibility

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Precision

- Percentage of retrieved docs that are relevant
- Cost (review effort)

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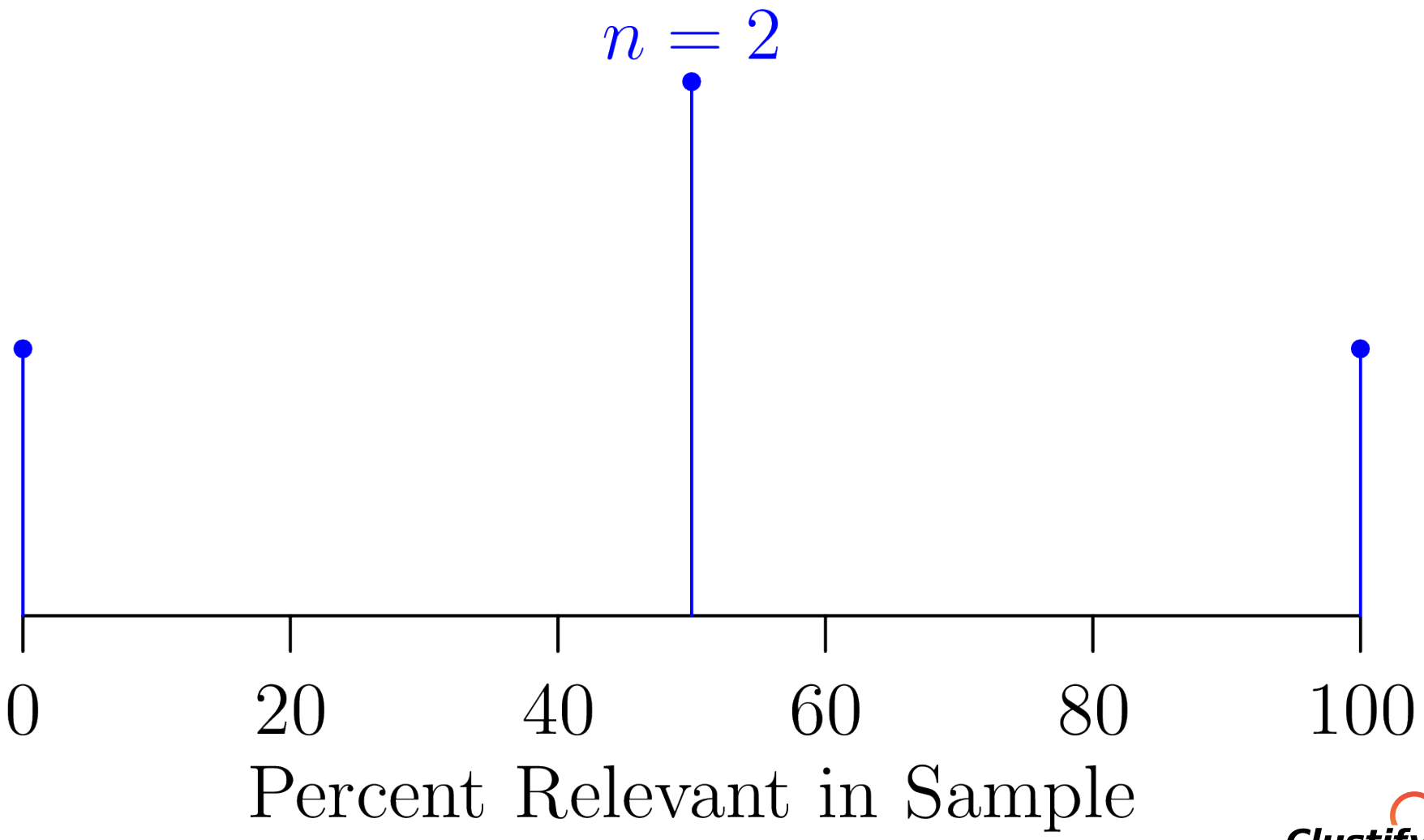
Sample 2 Docs



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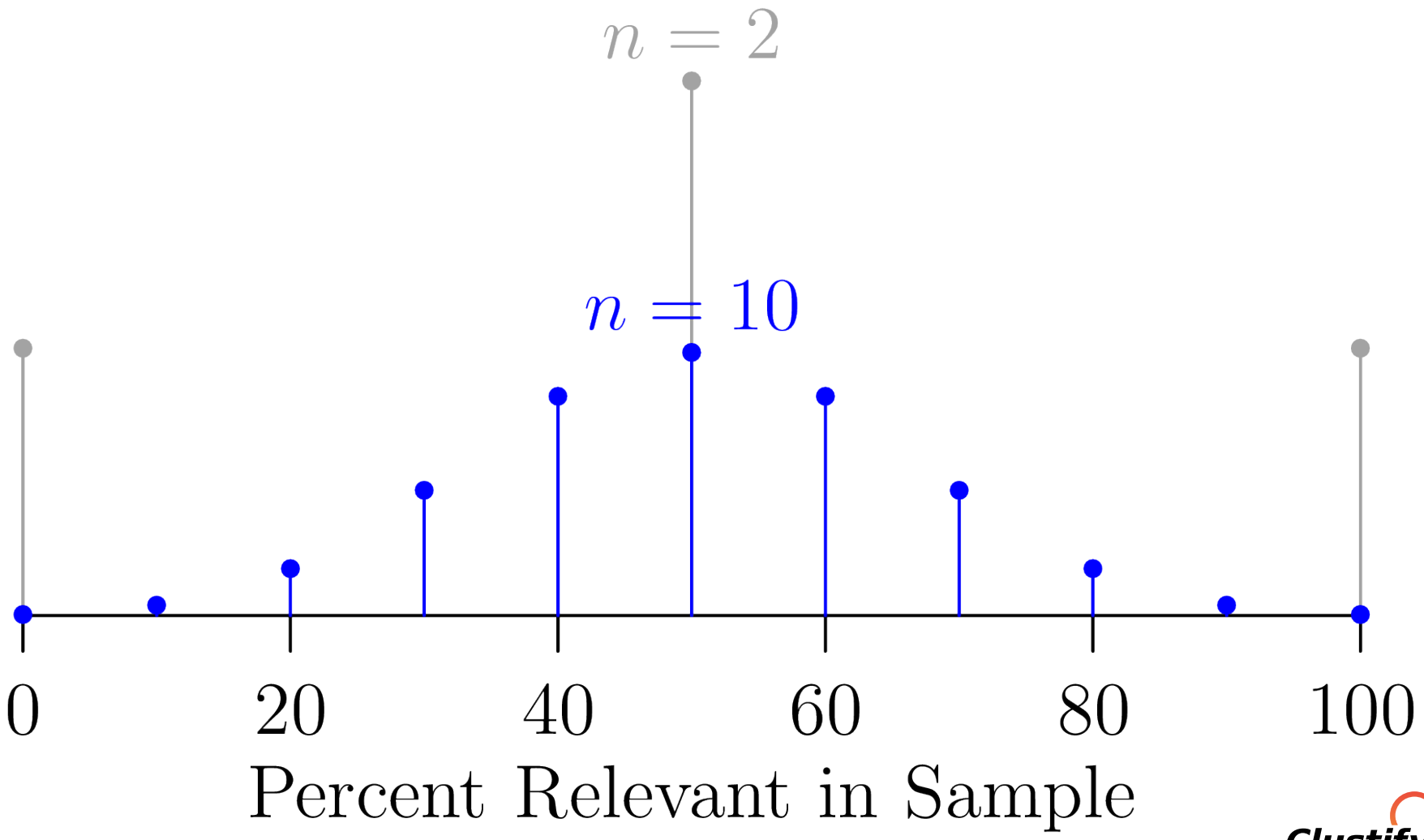
Sample 10 Docs



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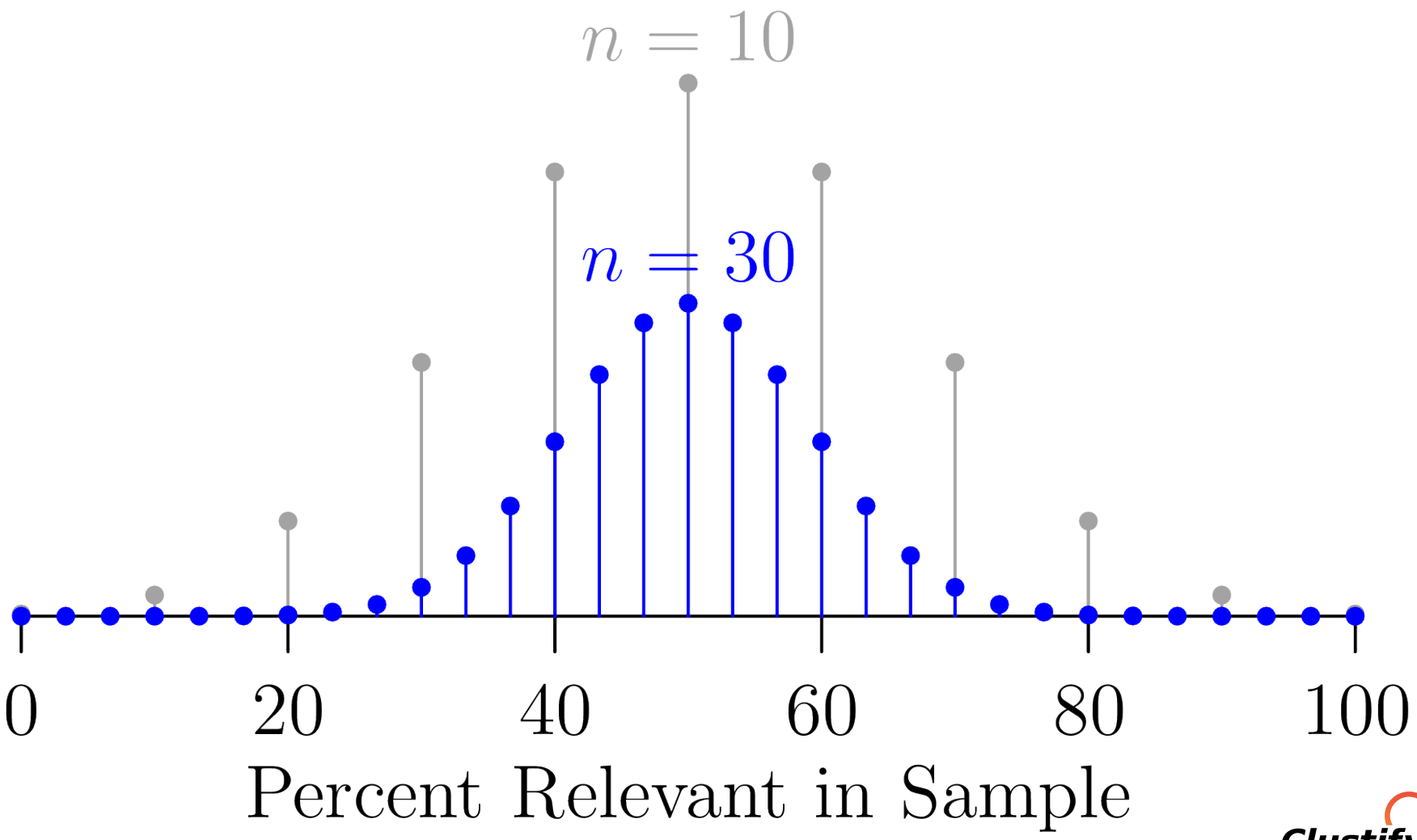
Sample 30 Docs



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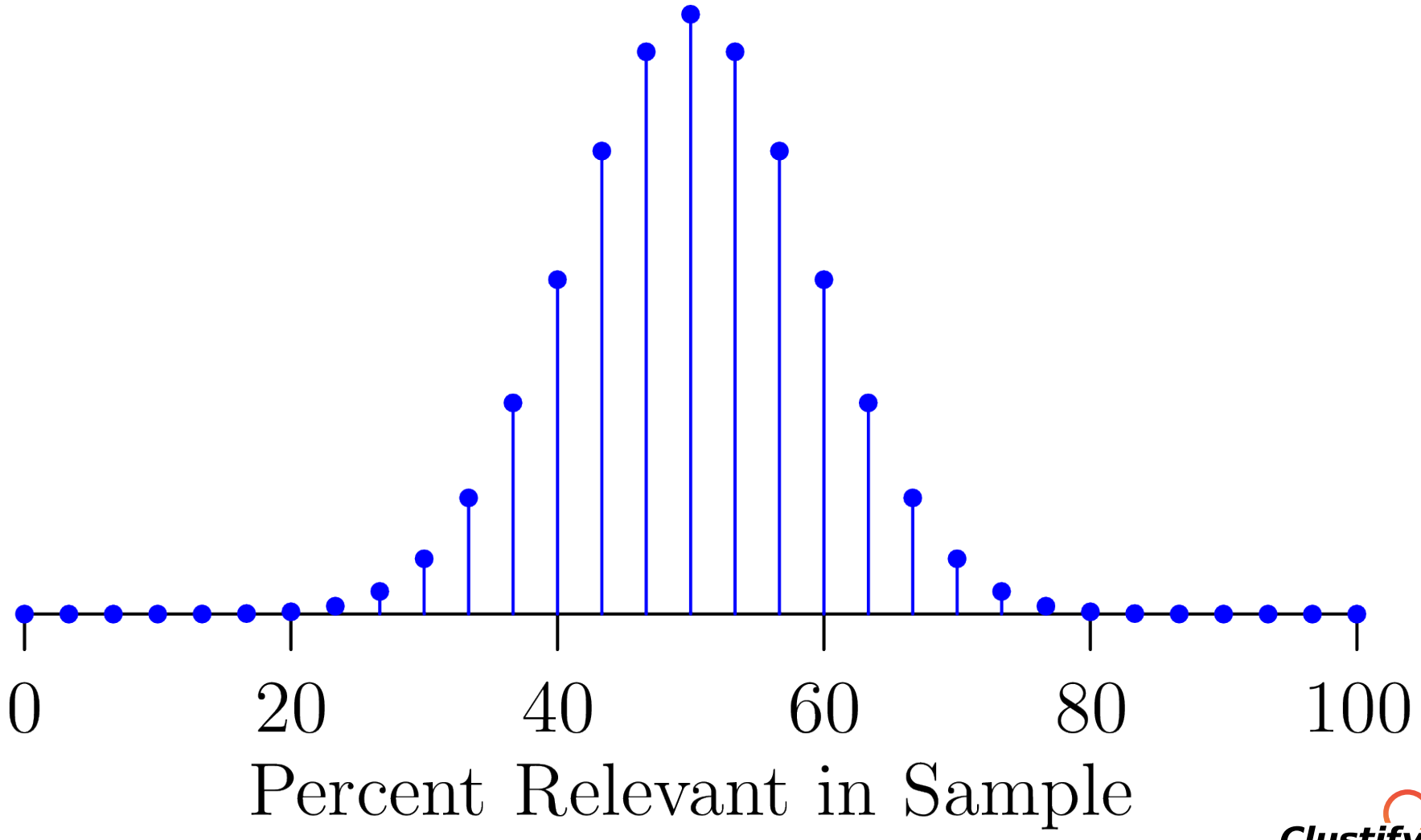
Anything Is Possible



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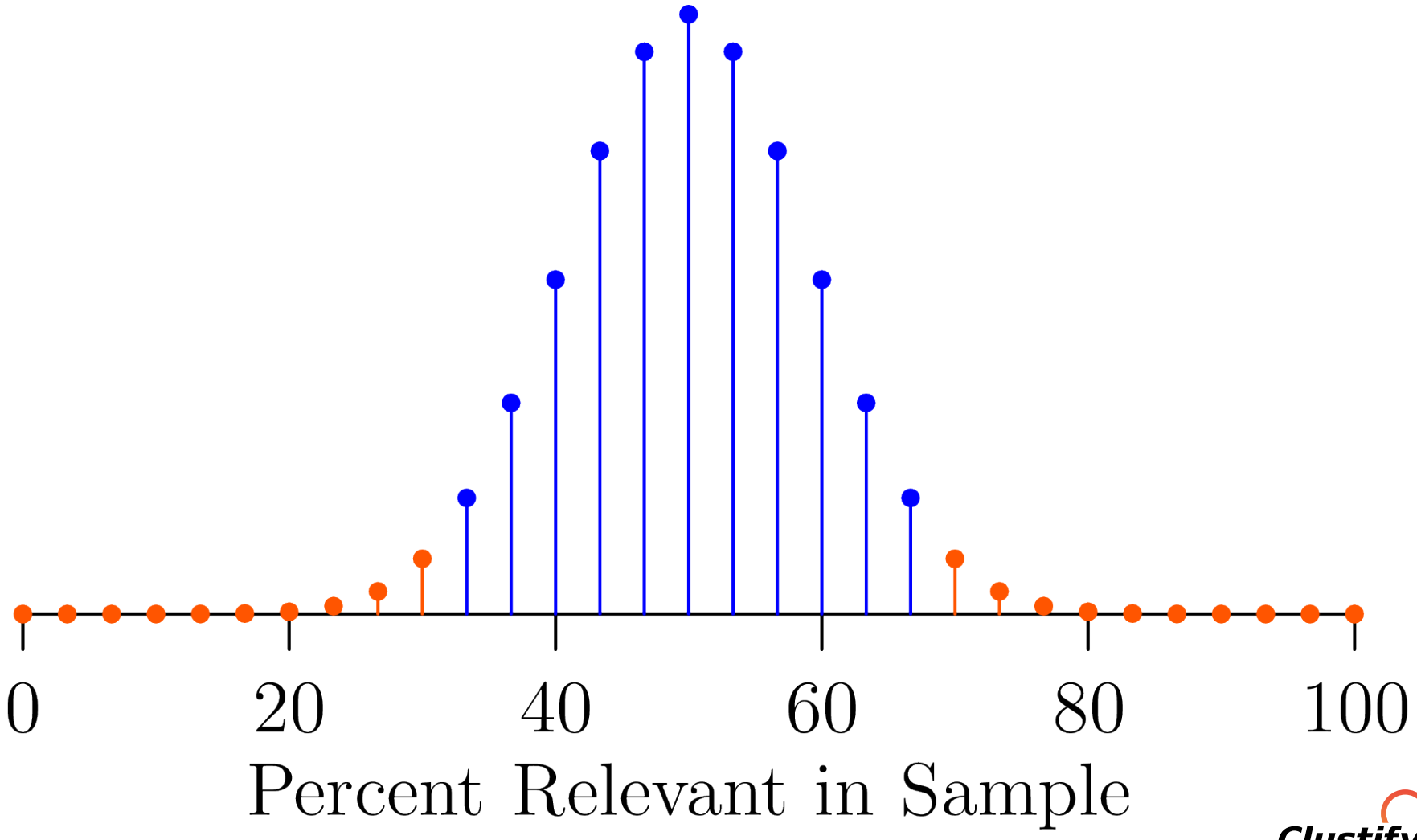
What Is Plausible?



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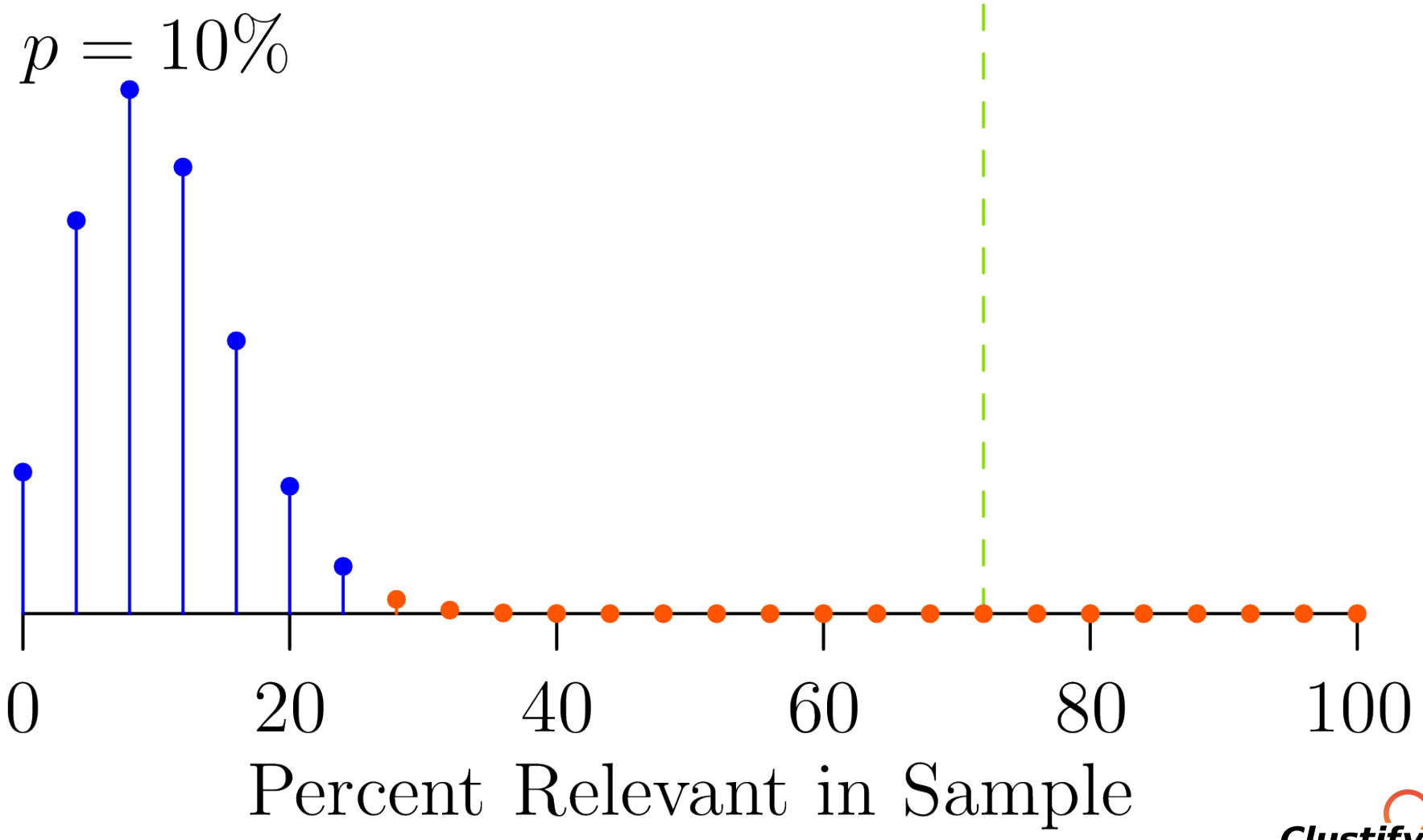
Example of Finding a Confidence Interval

- Sample 25 documents, 18 are relevant
  - 72% of sample is relevant
- What is reasonable prevalence for population?
  - Point estimate is 72%

Plausible Population Prevalence? NO



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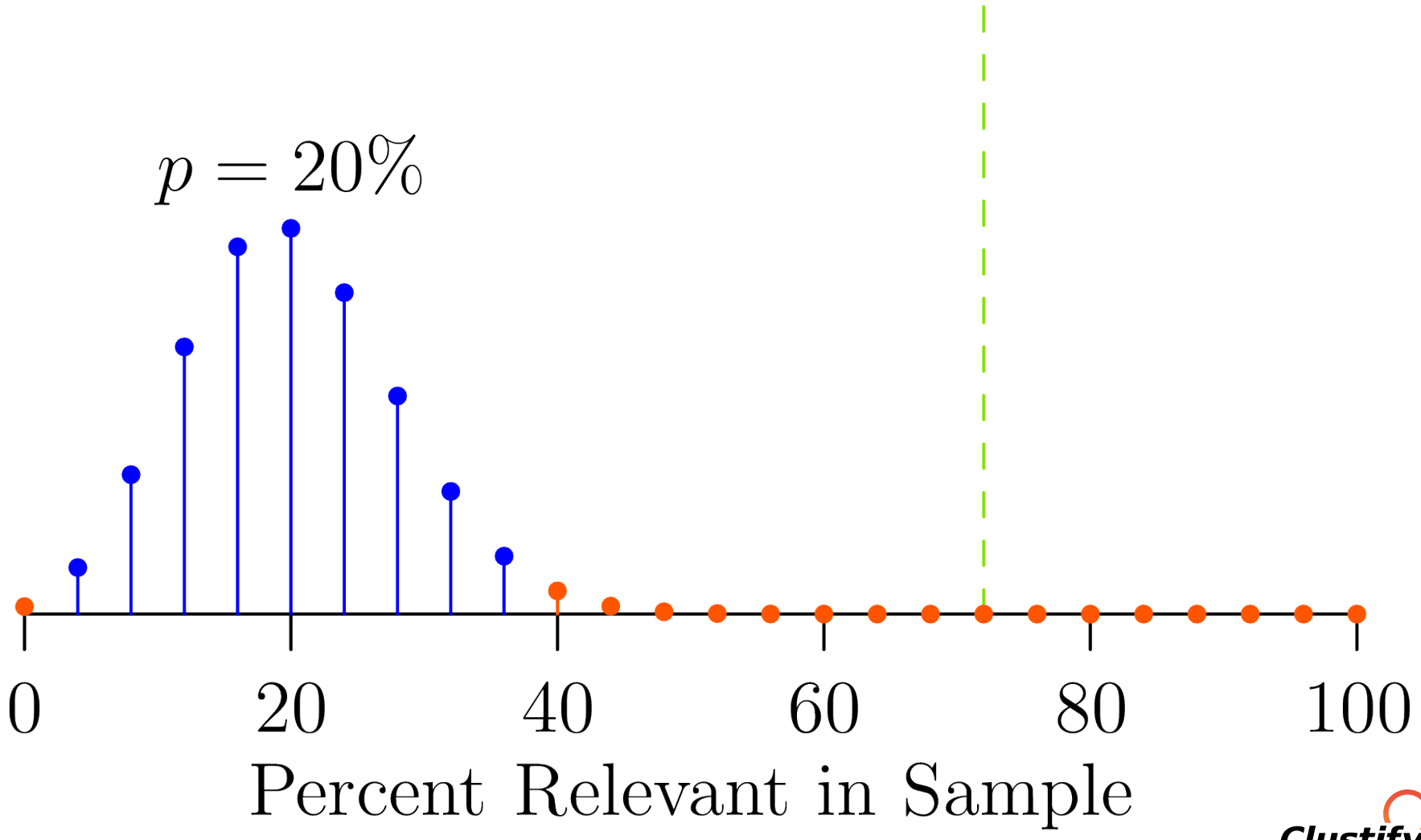
Plausible Population Prevalence? NO



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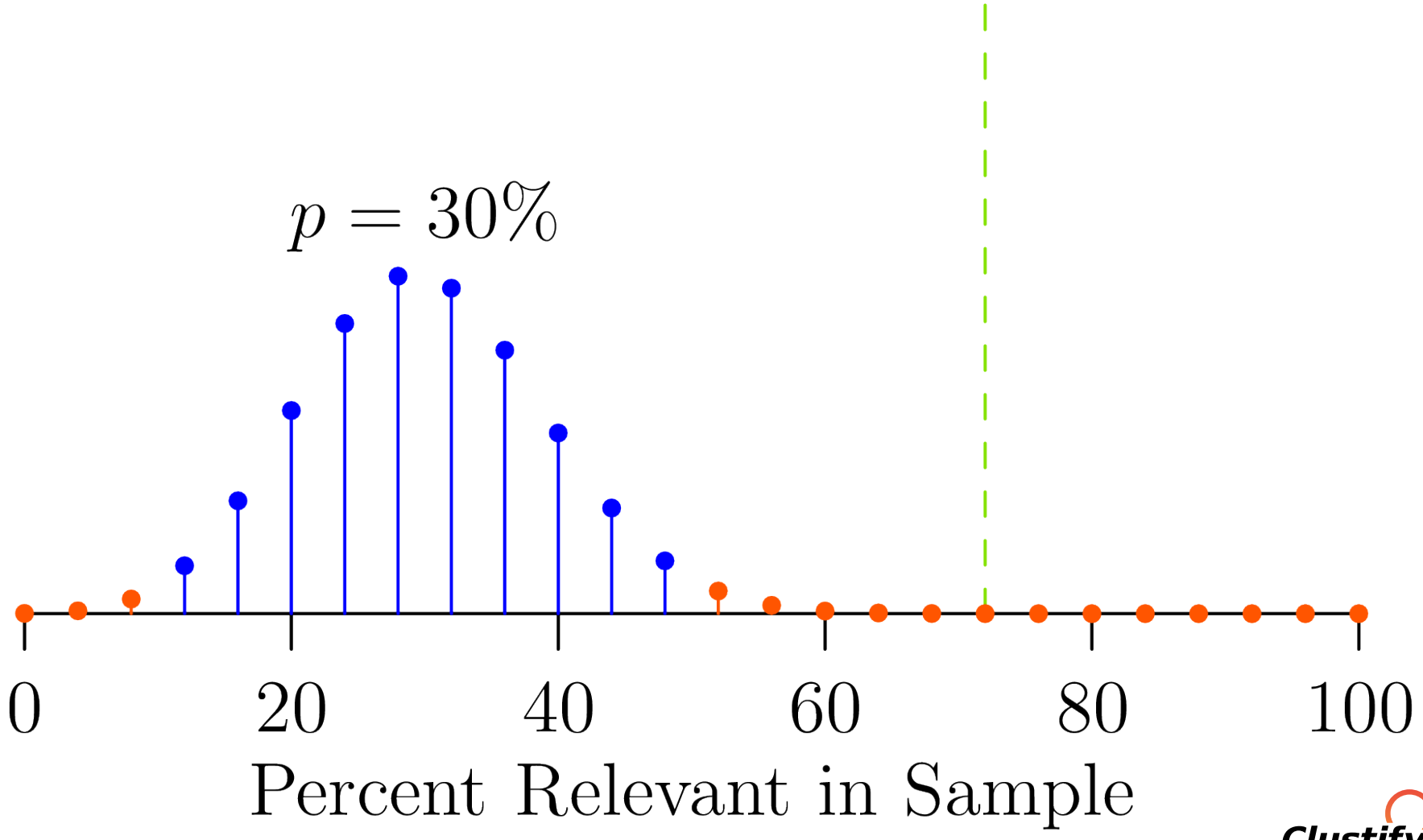

Clustify

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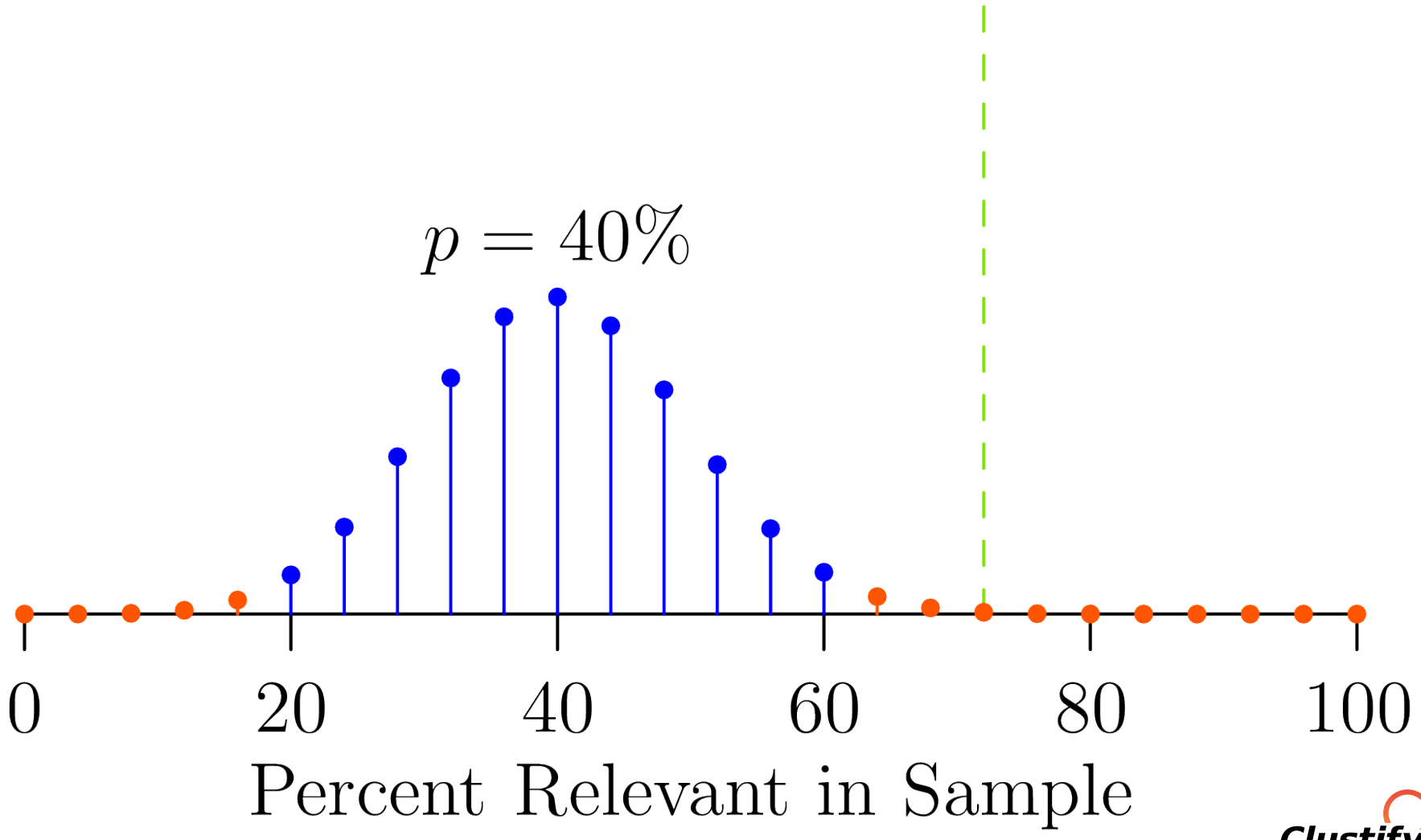
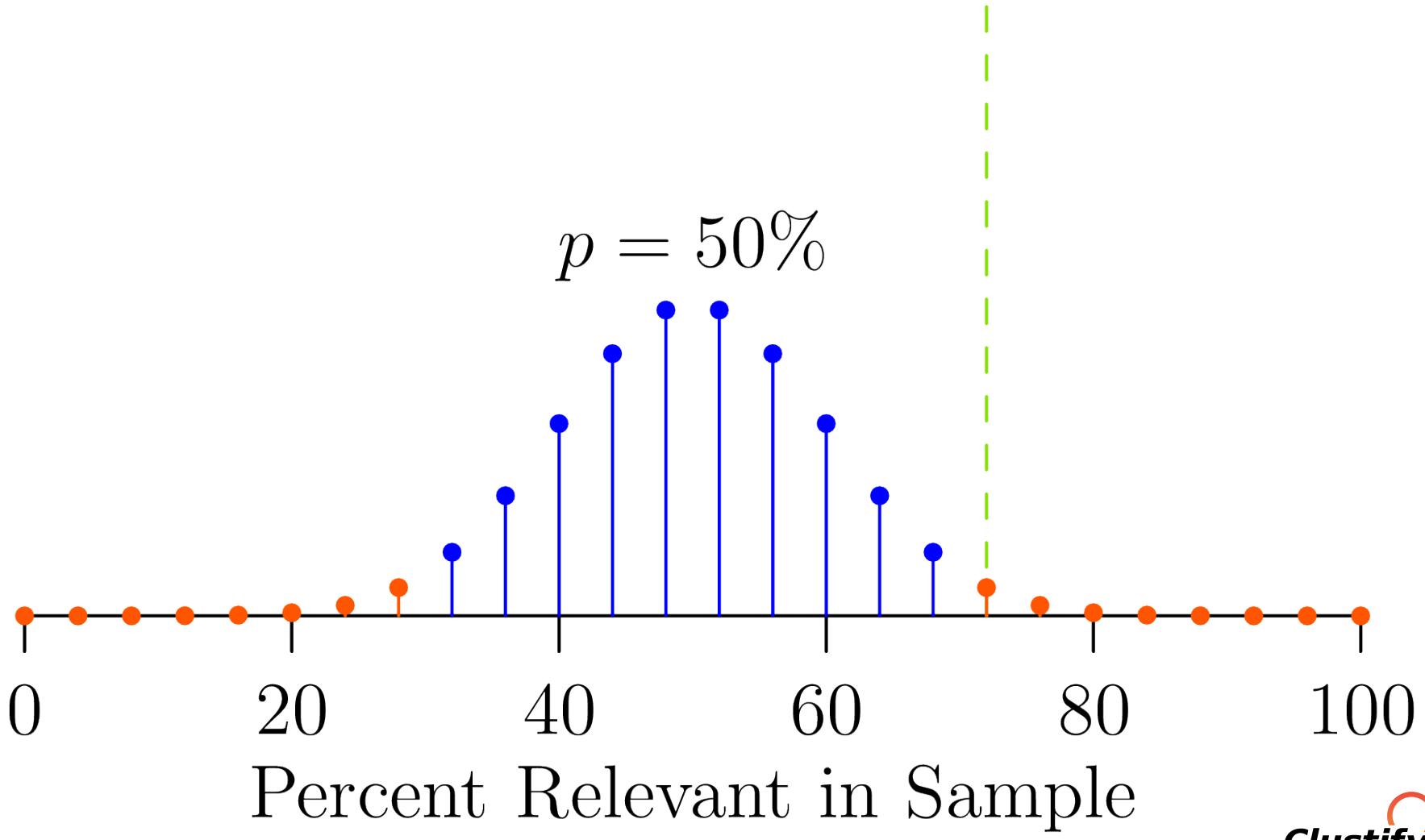


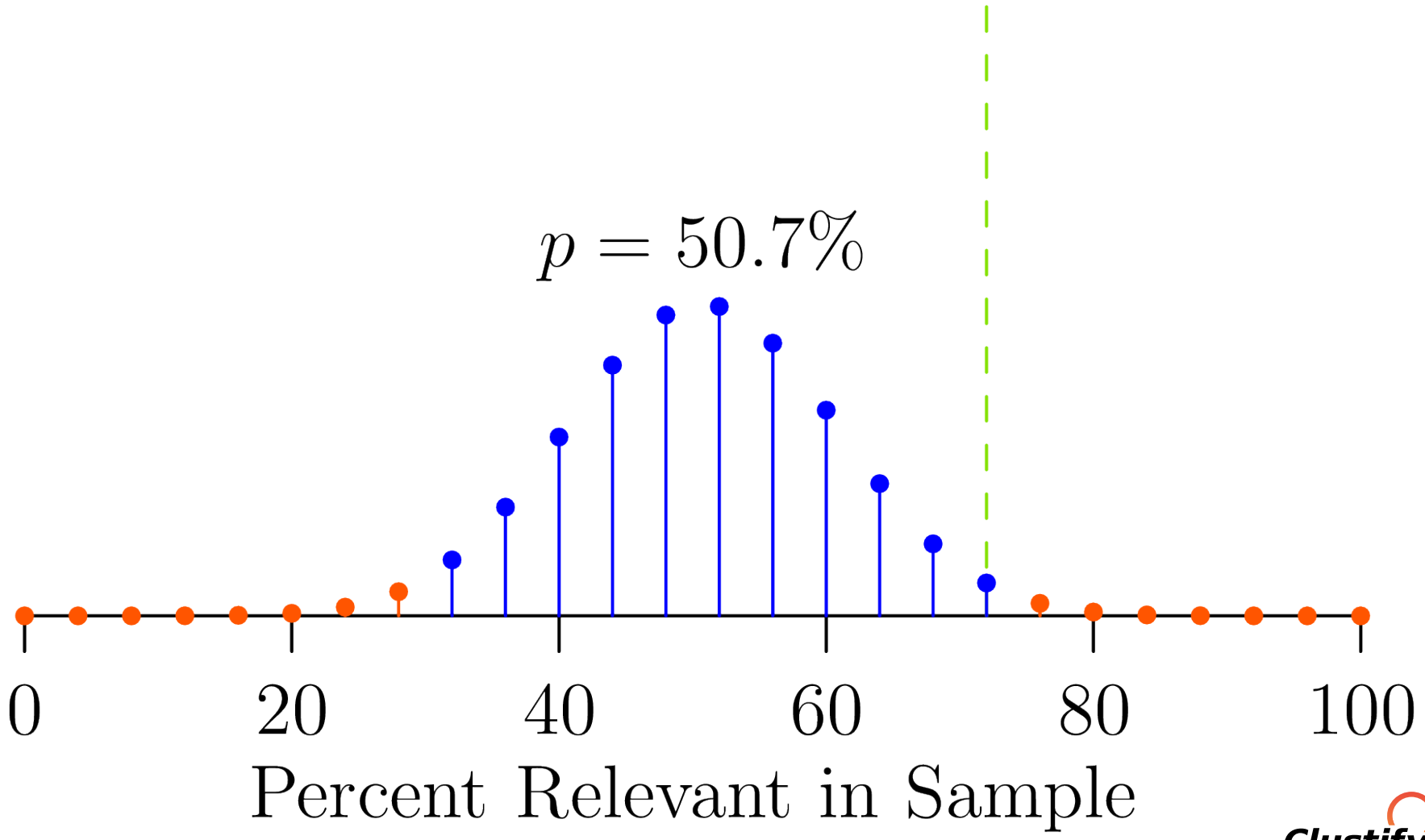
Clustify

Plausible Population Prevalence? NO



Clustify

Plausible Population Prevalence? YES



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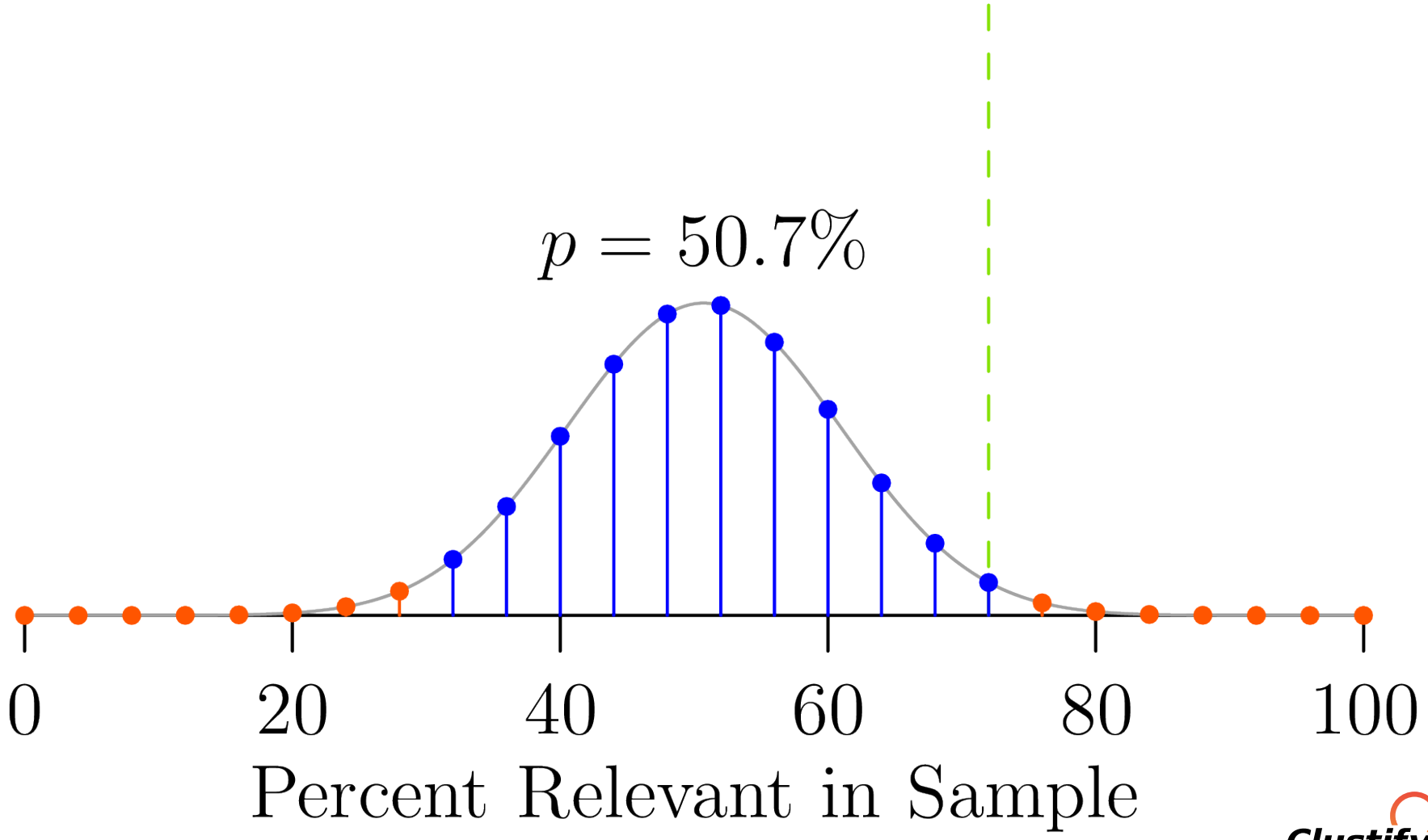
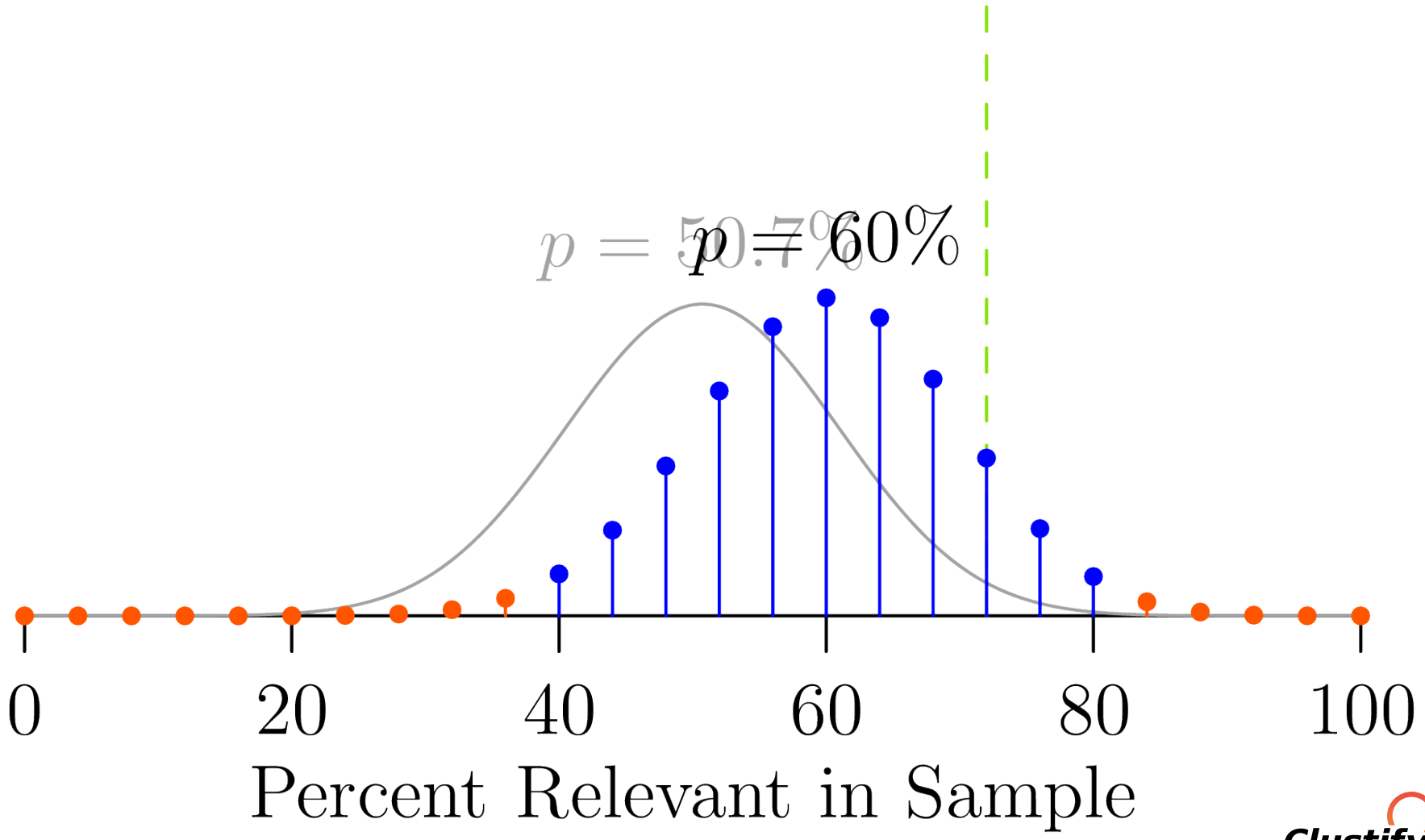
Plausible Population Prevalence? YES



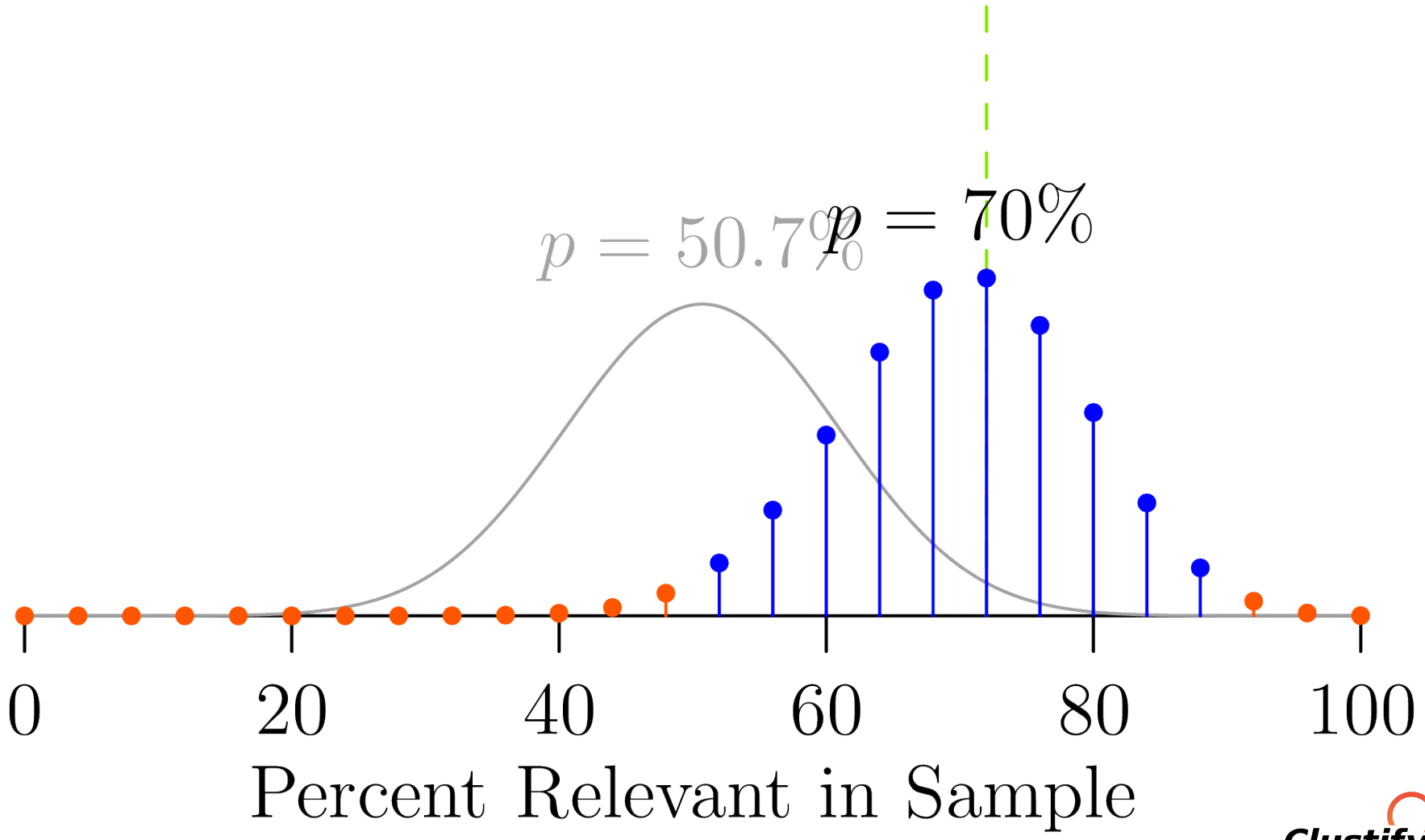
Clustify

Plausible Population Prevalence? YES



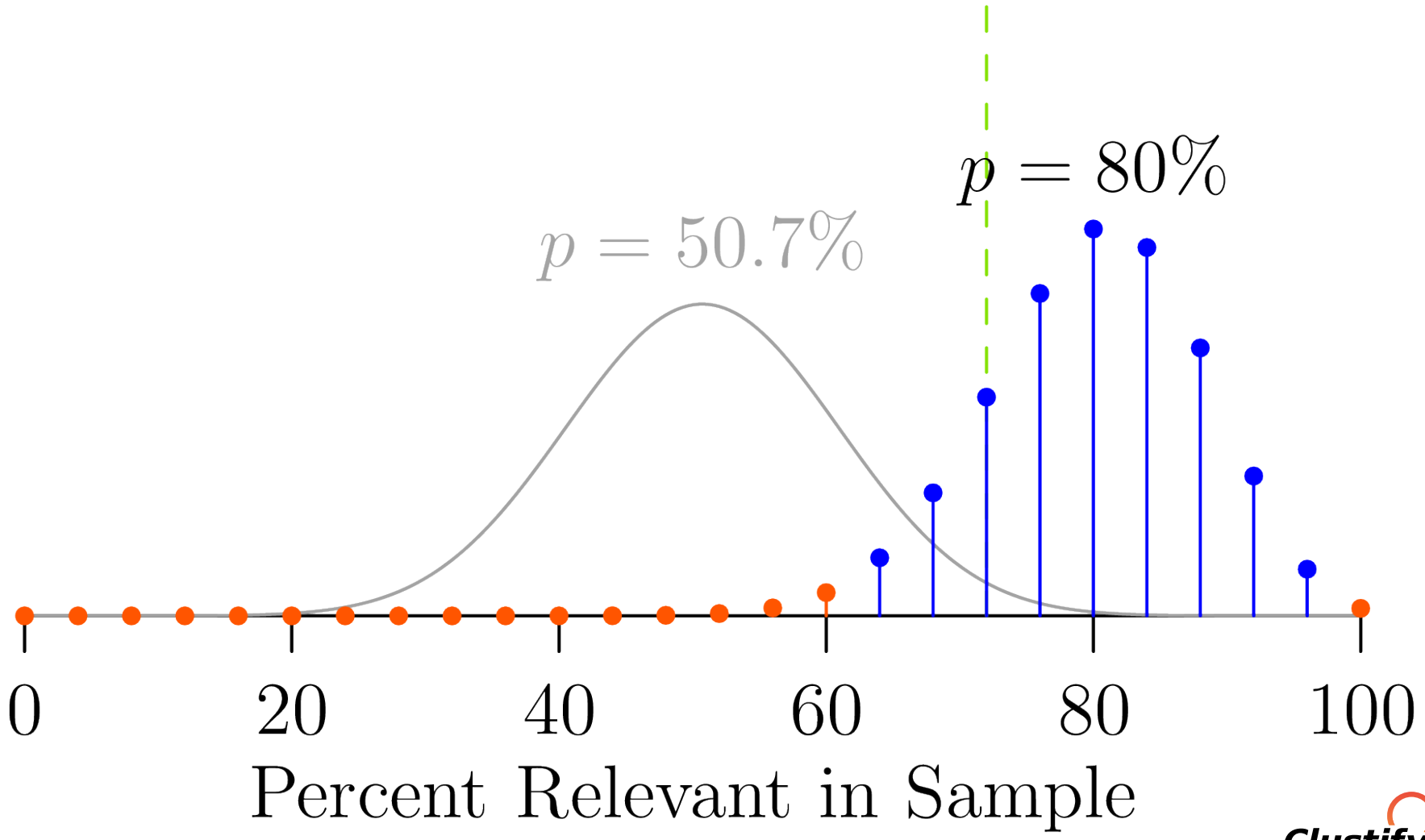
Clustify

Plausible Population Prevalence? YES



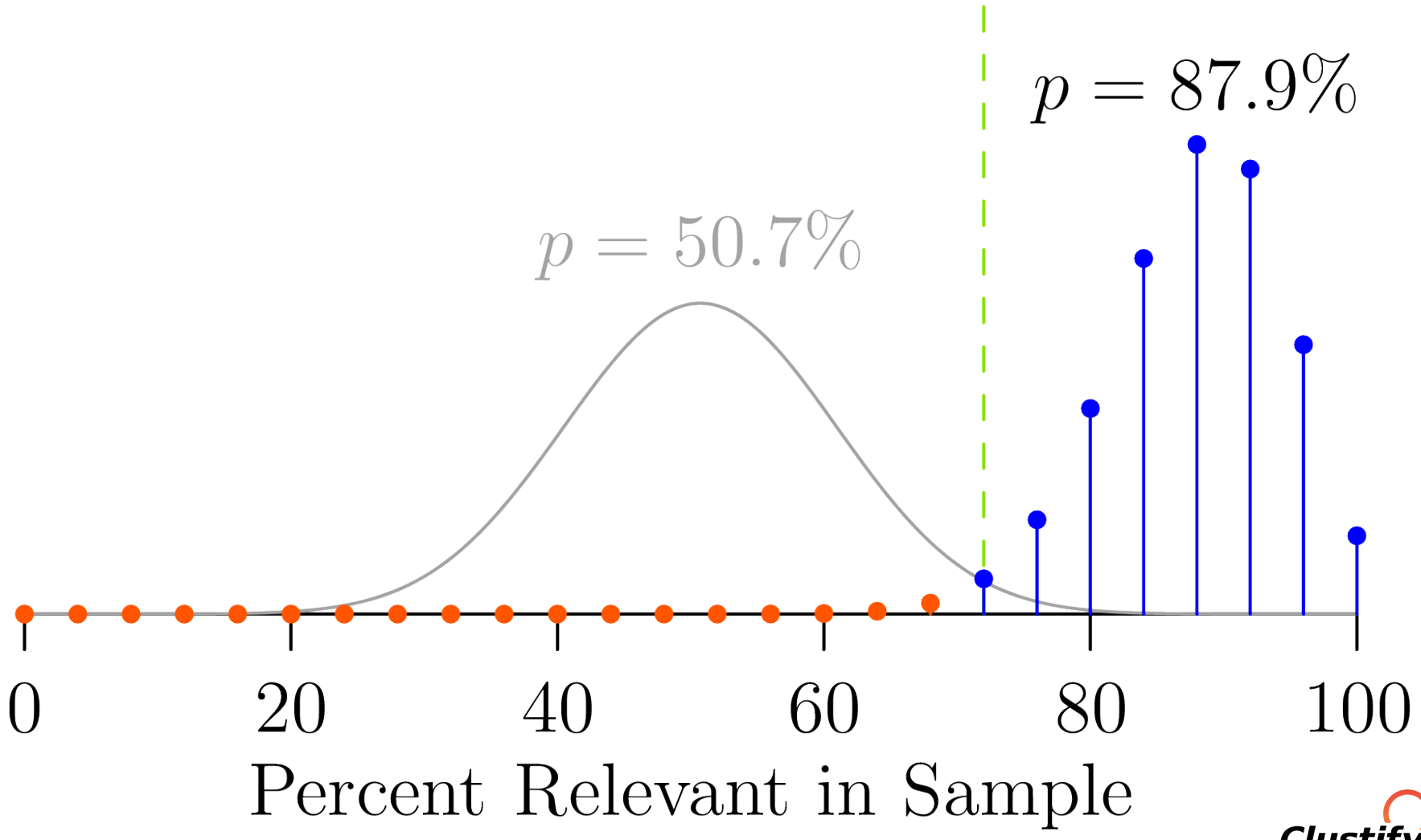
Clustify

Plausible Population Prevalence? YES



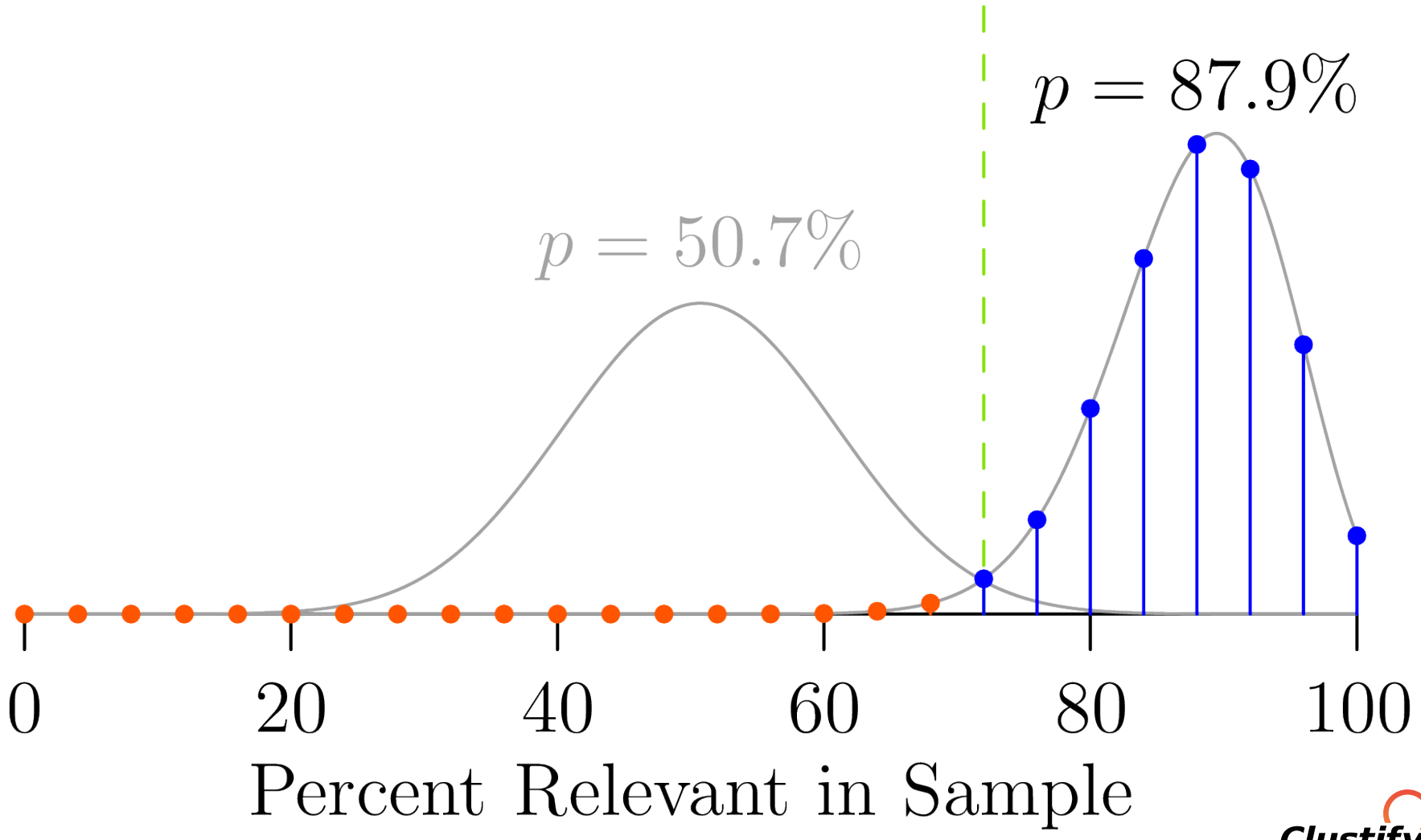
Clustify

Plausible Population Prevalence? YES



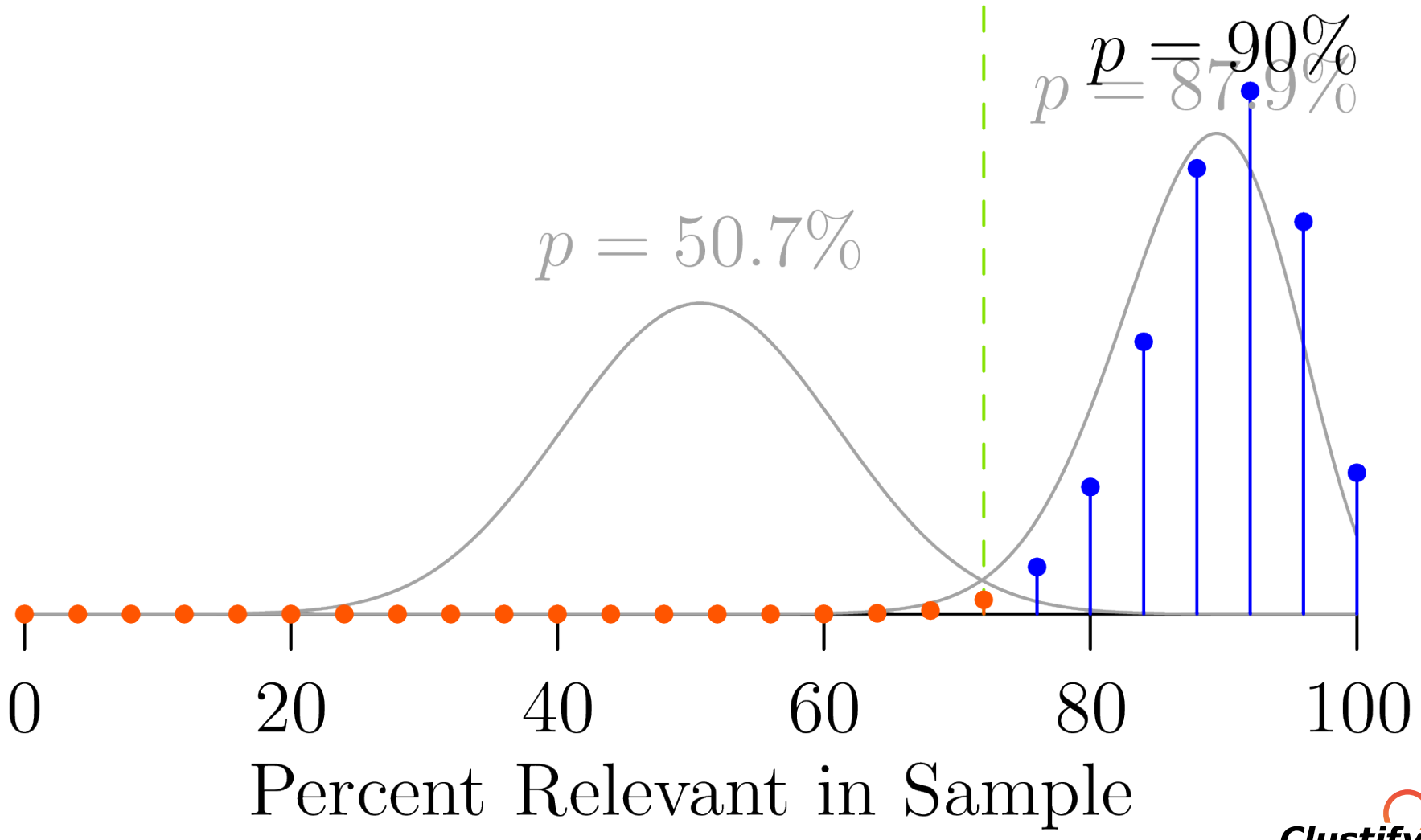
Clustify

Plausible Population Prevalence? YES



Clustify

Plausible Population Prevalence? NO



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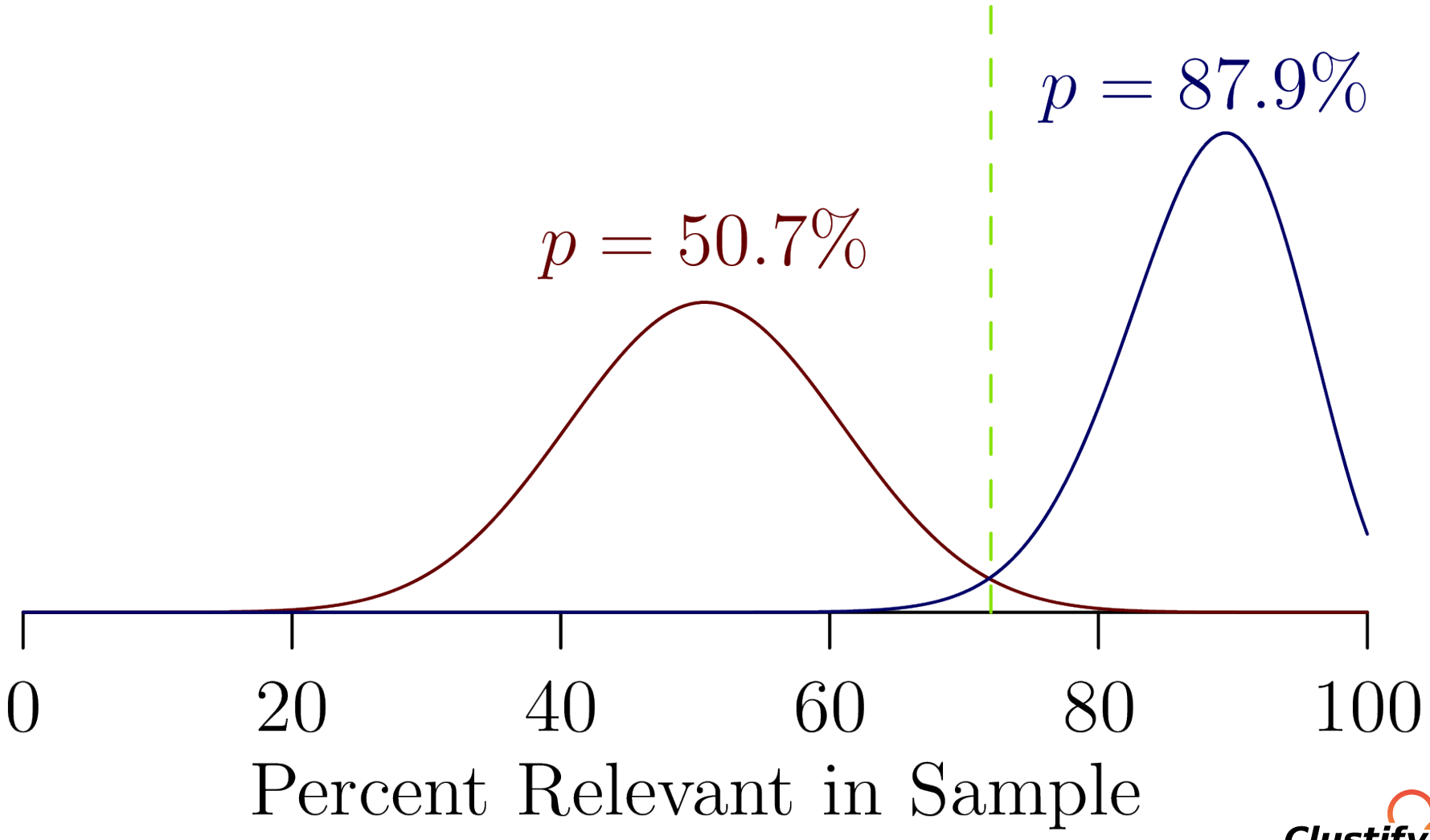
Confidence Interval



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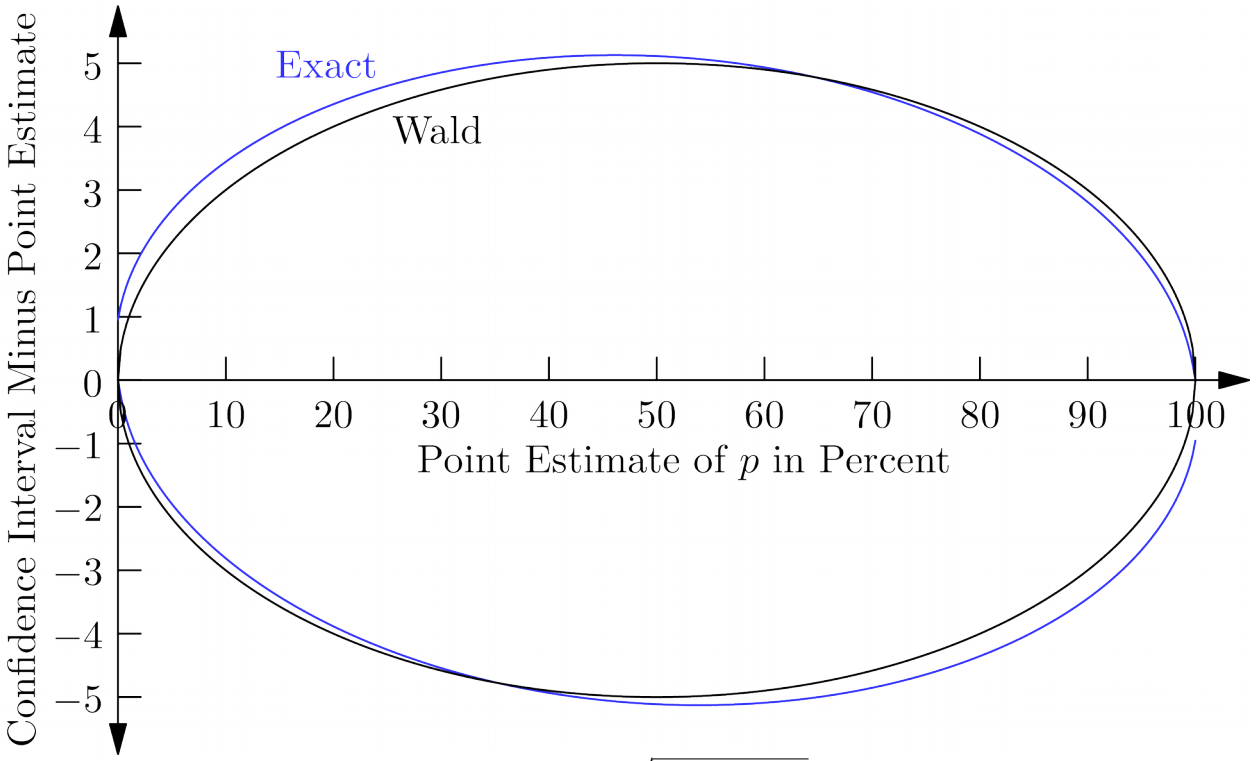
Wald Approximation



$$\delta p = 1.96\sqrt{\frac{p(1-p)}{S}}$$

$$\delta p_{\max} = \frac{0.98}{\sqrt{S}}$$

$$S = \frac{0.96}{\delta p_{\max}^2}$$

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Standard Sample Sizes, 95% Confidence

$\delta\rho_{\max}$	S
1%	9,600
2%	2,400
3%	1,067
4%	600
5%	384
7%	196
10%	96
15%	43

Example

- Sample 10,000 Docs From Full Population
  - 100 are relevant
  - 200 match search query
  - 80 are relevant and match search query

Quantity	Point Est	Sample Size	Worst Case CI	Wald CI
Prevalence	1%	10,000	±1%	±0.2%
Precision	40%	200	±7%	±6.8%
Recall	80%	100	±10%	±7.8%

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Elusion Sampling

- Synonyms:
  - Null Set
  - Elusion Set
  - Discard Set
  - Negatives
- Problems
  - Bias (no fix)
  - Sample Size

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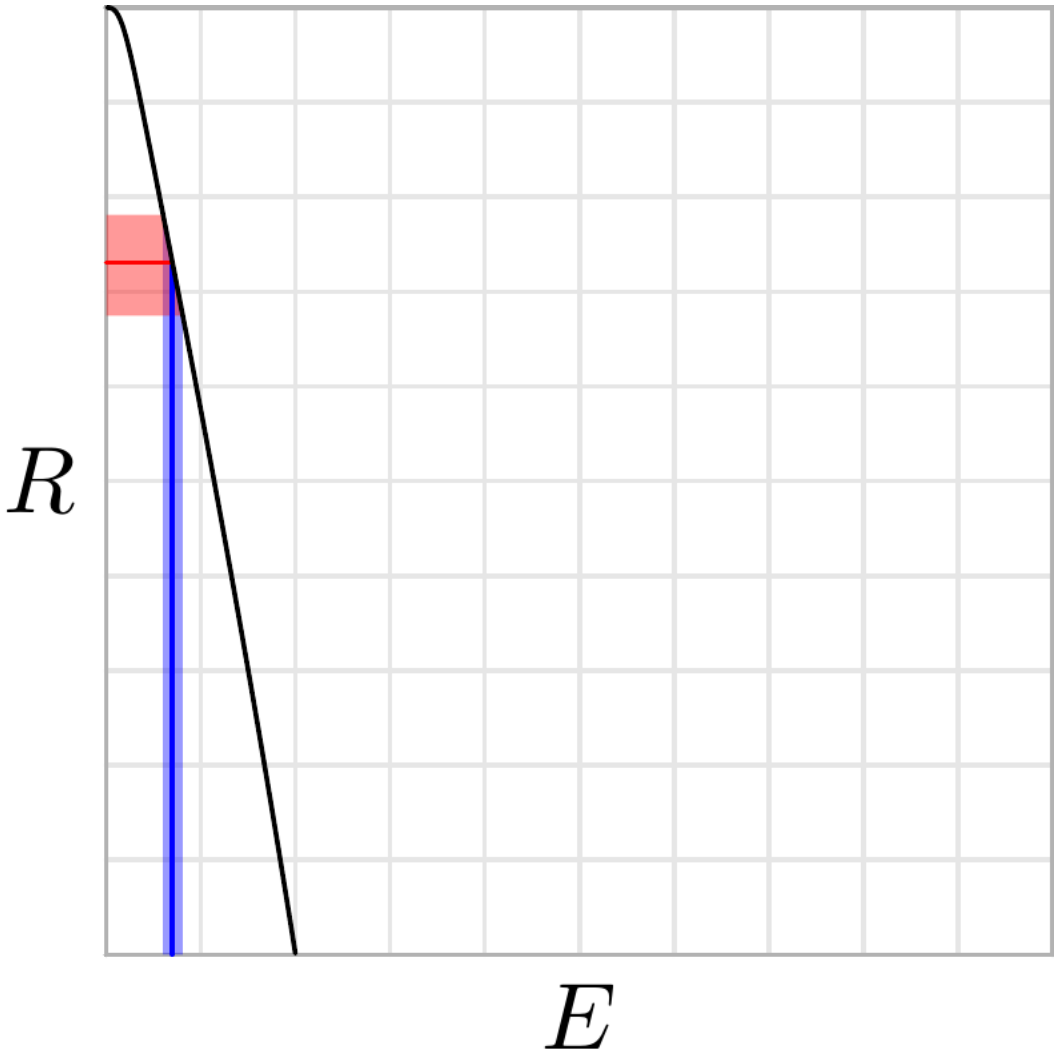
Recall From Elusion



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Elusion Sampling

$$R = \frac{\mathrm{TP}}{\mathrm{TP} + (N-n)E}$$

$$\delta R = 1.96\sqrt{\frac{E(1-E)}{S}}\frac{(N-n)\mathrm{TP}}{[\mathrm{TP} + (N-n)E]^2}$$

$$\delta R_{\max} = \frac{0.98}{\sqrt{S}}\frac{9}{8\sqrt{3}}\sqrt{\frac{N-n}{\mathrm{TP}}}$$

$$S = \frac{0.96}{\delta R_{\max}^2}\frac{27}{64}\frac{N-n}{\mathrm{TP}}$$

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Elusion vs. Direct Method

R	$S_{\text{Elusion}}/S_{\text{Direct}}$
0.90	0.47
0.80	0.53
0.70	0.60
0.60	0.70
0.50	0.84
0.40	1.05
0.30	1.41
0.20	2.11
0.10	4.22

Lies, Damn Lies, and Statistics

- Inclusive Emails
- Search Terms

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