Types of uncertainty: Small worlds and large worlds

SIADS 542: Presenting uncertainty – Week 1, Lecture 1

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School of Information
University of Michigan

Welcome and roadmap

Week 1: Introduction to uncertainty visualization
Types of uncertainty; small vs large world

Welcome and roadmap

Week 1:	Introduction to uncertainty visualization
	Types of uncertainty; small vs large world
Week 2 & 3:	Small world uncertainty
	Continuous uncertainty encodings
	Frequency-framing uncertainty encodings

Welcome and roadmap

Week 1:	Introduction to uncertainty visualization Types of uncertainty; small vs large world
Week 2 & 3:	Small world uncertainty Continuous uncertainty encodings Frequency-framing uncertainty encodings
Week 4:	Large world uncertainty

What happens when we ignore uncertainty?

A mixed-design ANOVA with sex of face (male, female) as a within-subjects factor and self-rated attractiveness (low, average, high) and oral contraceptive use (true, false) as between-subjects factors revealed a main effect of sex of face, $F(1, 1276) = 1372$, $p < .001$, $\eta_p^2 = .52$. This was qualified by interactions between sex of face and SRA, $F(2, 1276) = 6.90$, $p = .001$, $\eta_p^2 = .011$, and between sex of face and oral contraceptive use, $F(1, 1276) = 5.02$, $p = .025$, $\eta_p^2 = .004$. The predicted interaction among sex of face, SRA and oral contraceptive use was not significant, $F(2, 1276) = 0.06$, $p = .94$, $\eta_p^2 < .001$. All other main effects and interactions were non-significant and irrelevant to our hypotheses, all $F \leq 0.94$, $p \geq .39$, $\eta_p^2 \leq .001$.

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Alternatives...

Variable	Coefficient (Standard Error)
Constant	.41 (.93)
Countries	
Argentina	1.31 (.33)**B,M
Chile	.93 (.32)**B,M
Colombia	1.46 (.32)**B,M
Mexico	.07 (.32)A,CH,CO,V
Venezuela	.96 (.37)**B,M
Threat	
Retrospective egocentric economic perceptions	.20 (.13)
Prospective egocentric economic perceptions	.22 (.12)#
Retrospective sociotropic economic perceptions	–.21 (.12)#
Prospective sociotropic economic perceptions	–.32 (.12)*
Ideological distance from president	–.27 (.07)**
Ideology	
Ideology	.23 (.07)**
Individual Differences	
Age	.00 (.01)
Female	–.03 (.21)
Education	.13 (.14)
Academic Sector	.15 (.29)
Business Sector	.31 (.25)
Government Sector	–.10 (.27)
R^2	.15
Adjusted R^2	.12
N	500

**$p < .01$, *$p < .05$, #$p < .10$ (twotailed)

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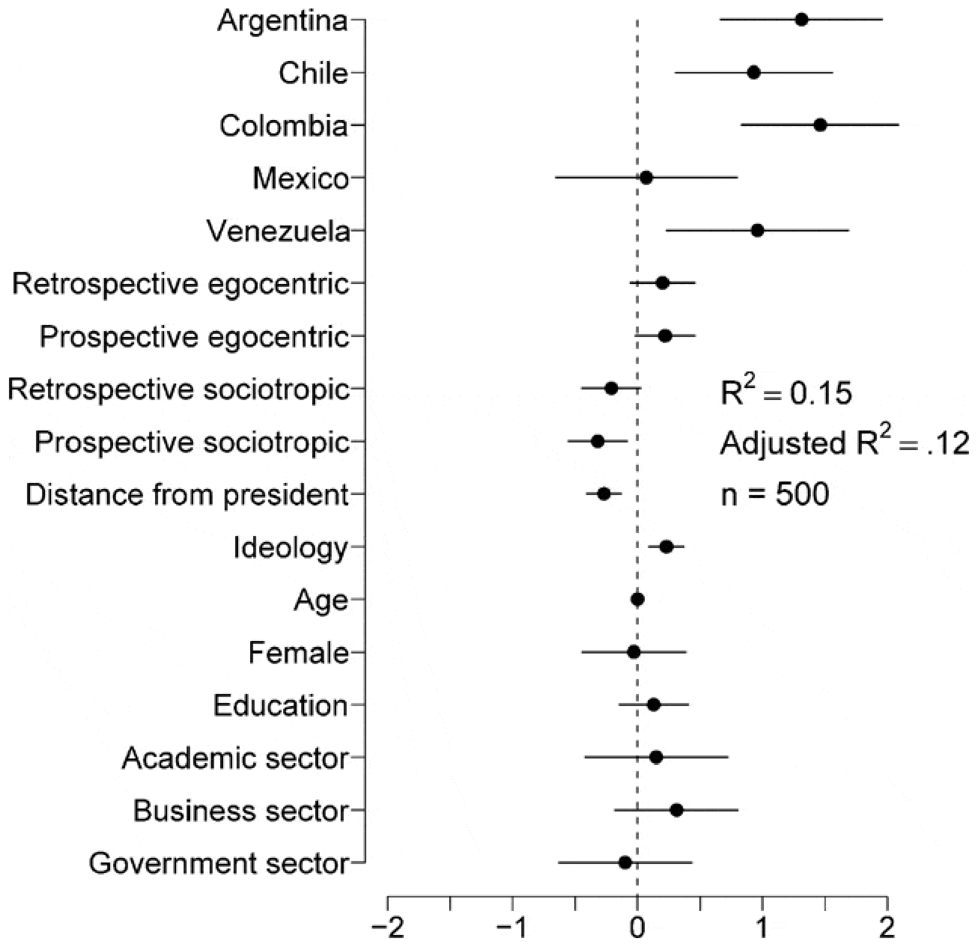

[Jonathan P Kastellec and Eduardo L Leoni. 2007. Using Graphs Instead of Tables in Political Science. Perspectives on politics 5, 4: 755–771]

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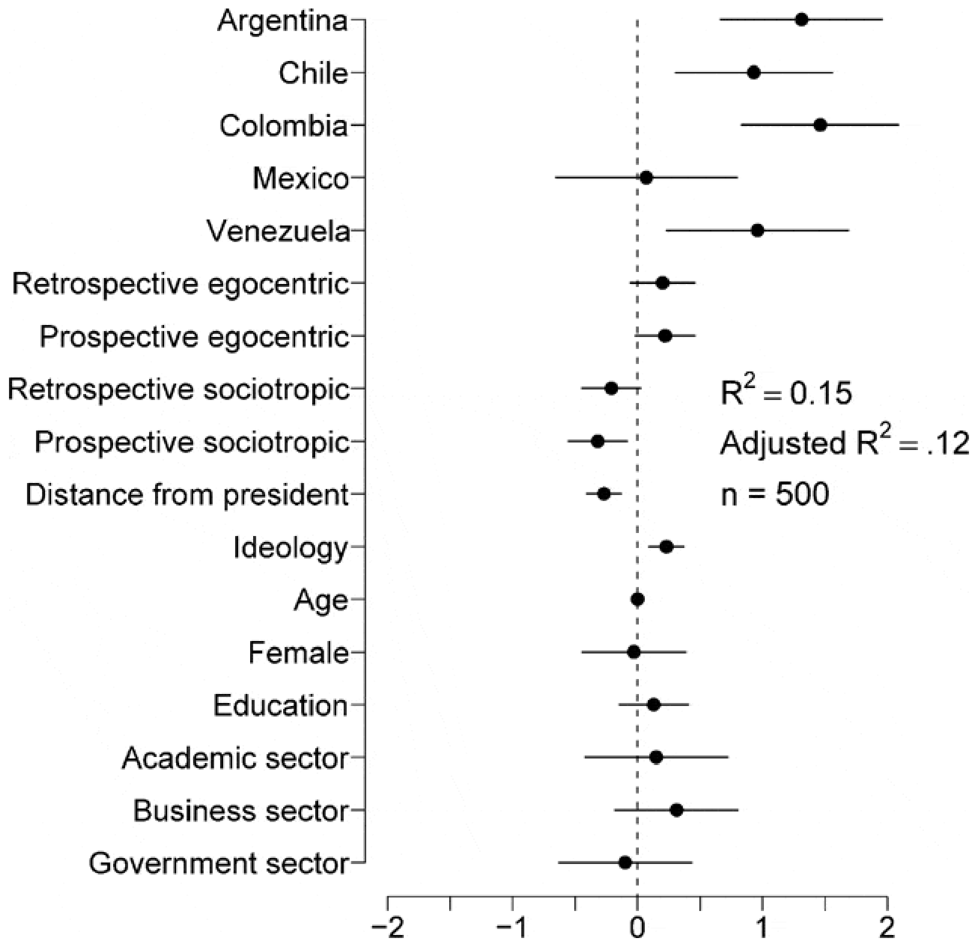

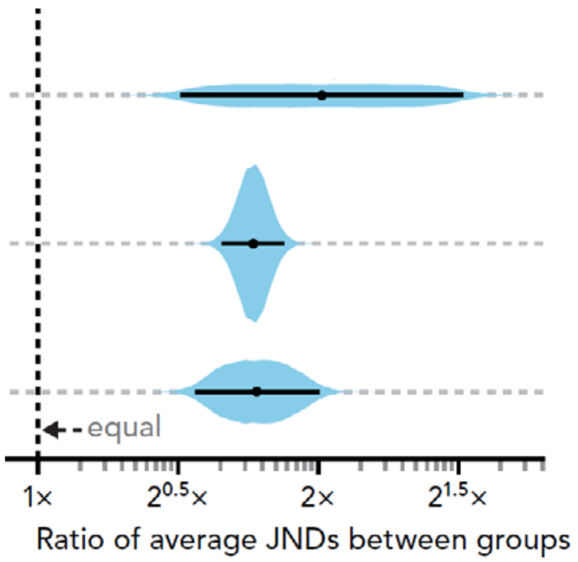

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How easy is it to ignore the uncertainty?

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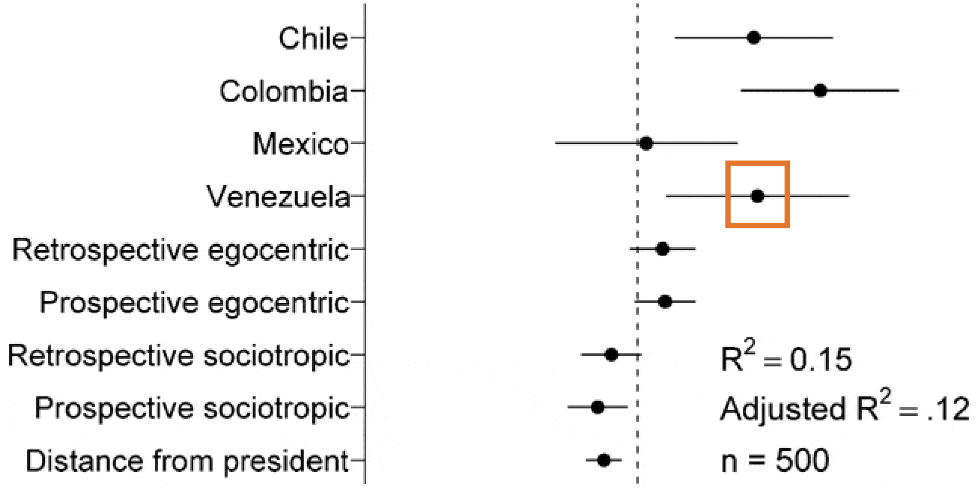
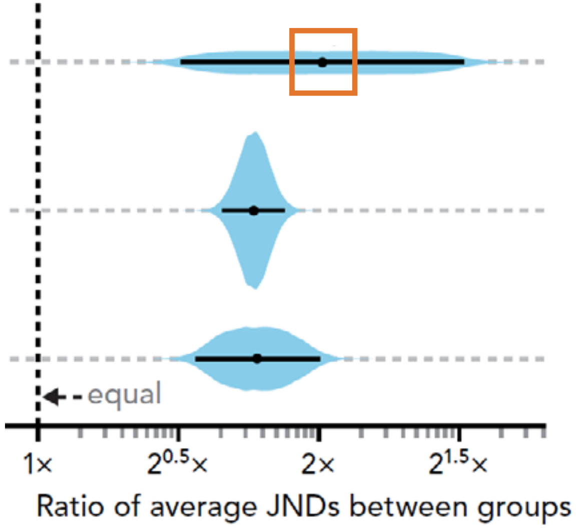




This contributes to dichotomania

The goal of this class

Uncertainty communication through visualization

Uncertainty communication to acknowledge
rather than suppress uncertainty

Today

Today

Large world versus small world uncertainty

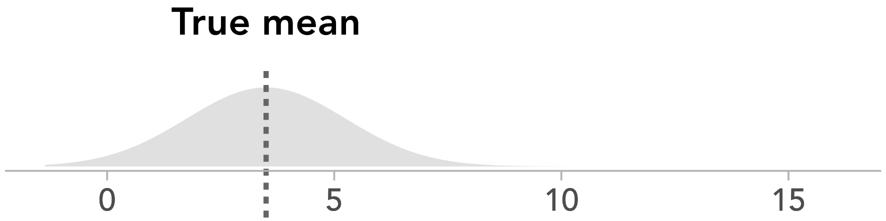
Today

Large world versus small world uncertainty

Parameter uncertainty versus predictive uncertainty

Let's start with an example...

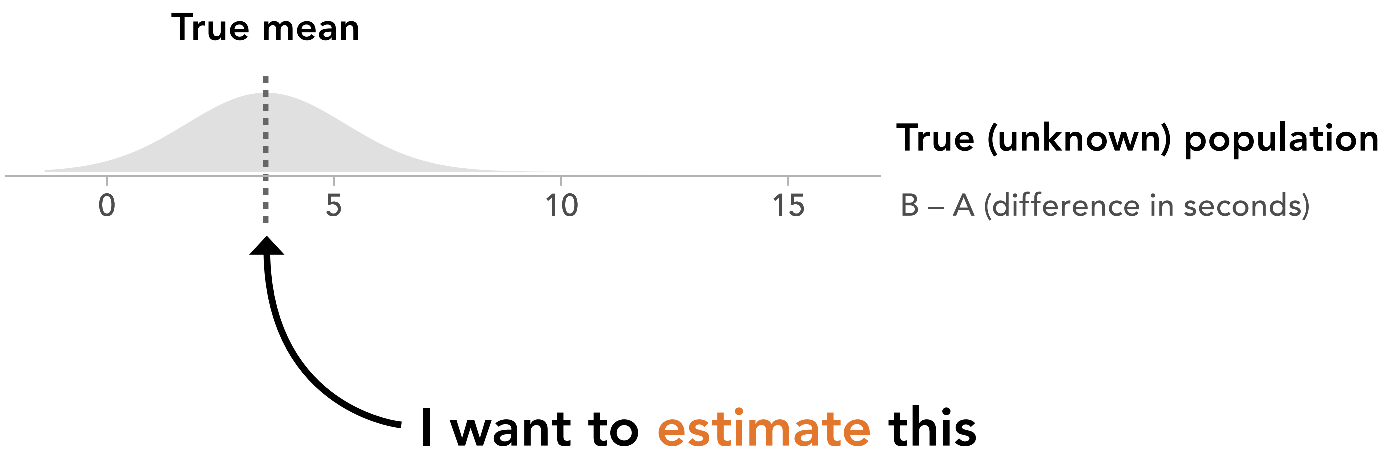
Parameter uncertainty



True (unknown) population

B – A (difference in seconds)

Parameter uncertainty



Parameter uncertainty

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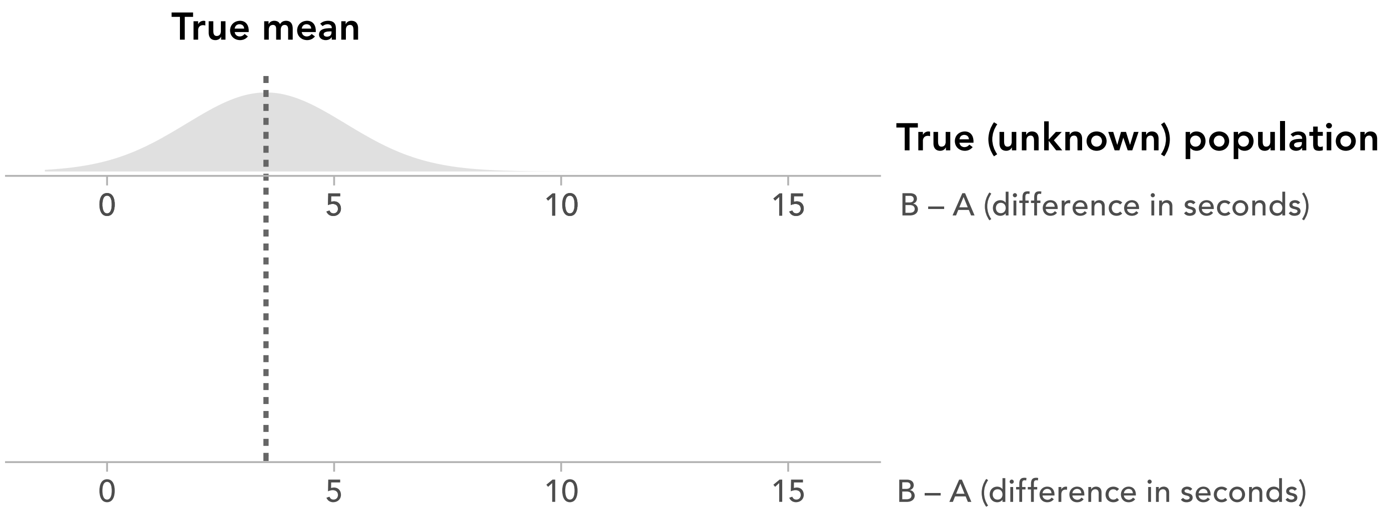

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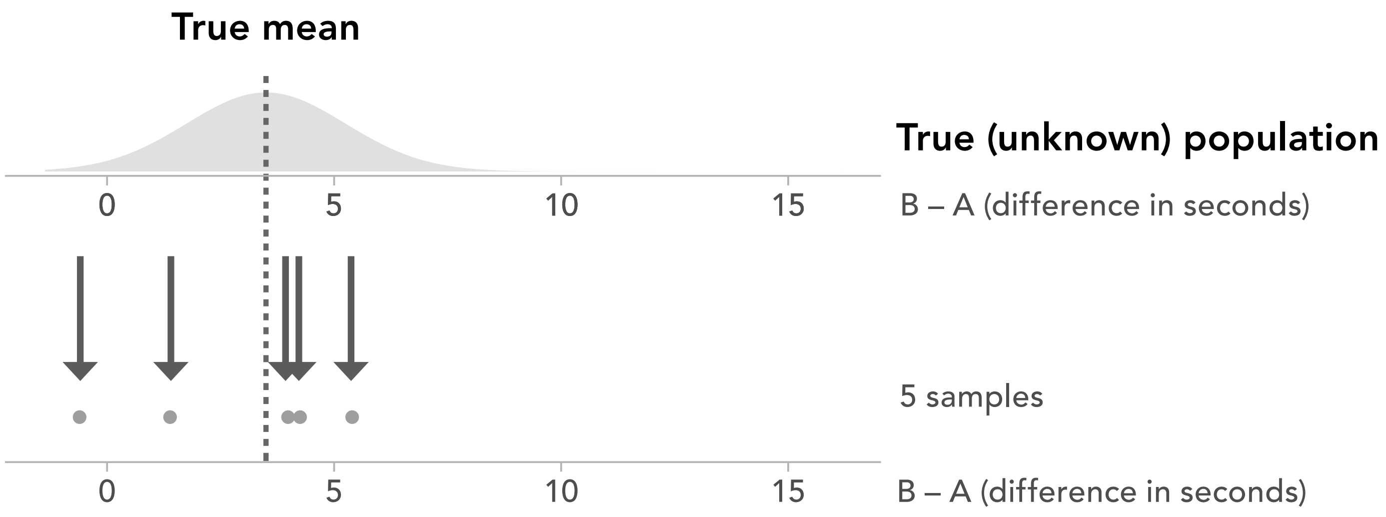
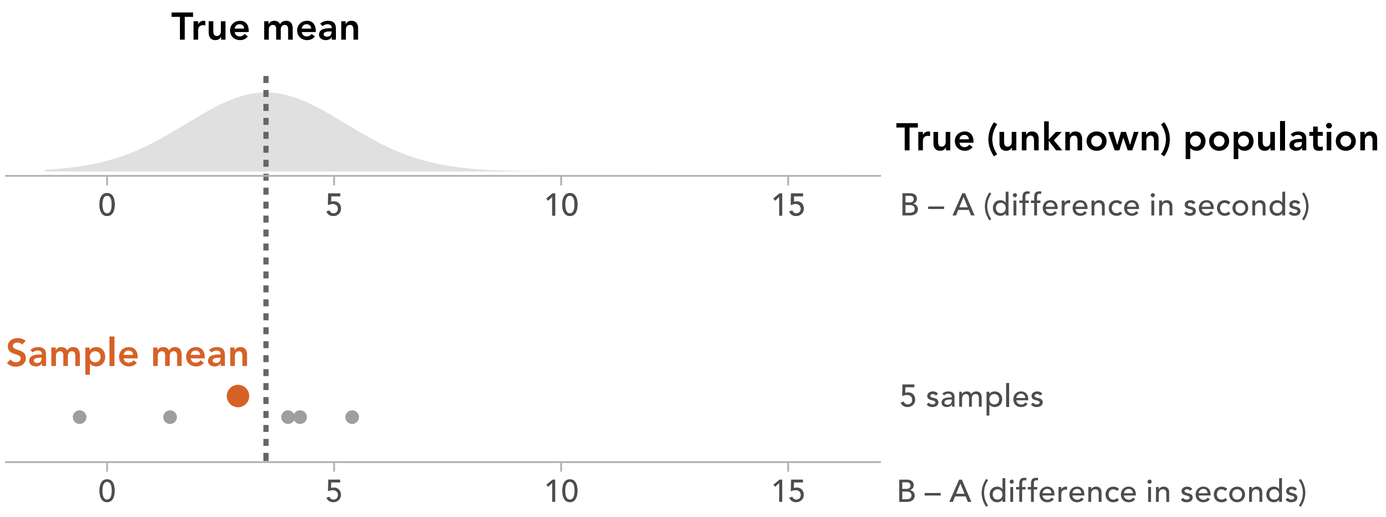
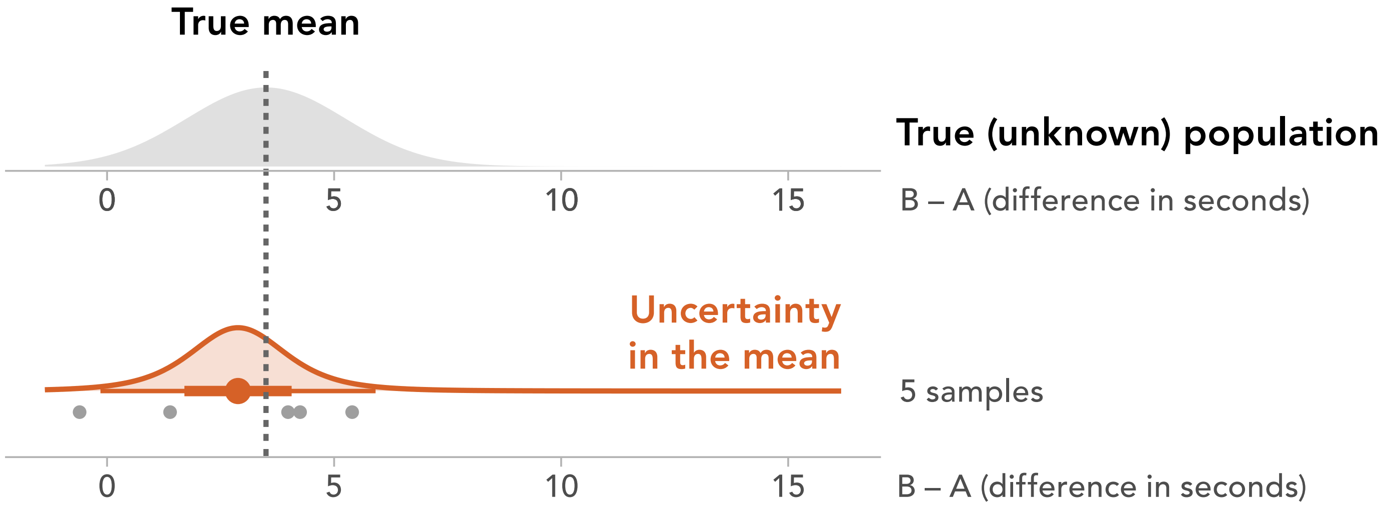


Parameter uncertainty



Parameter uncertainty



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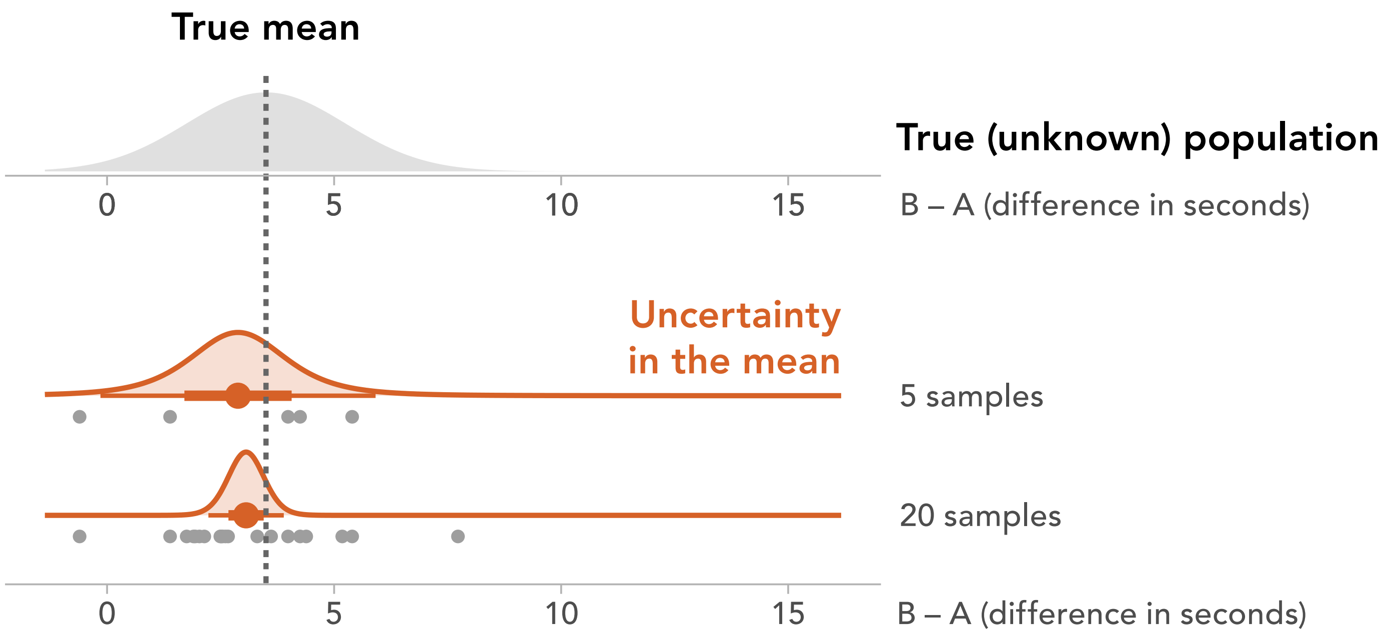

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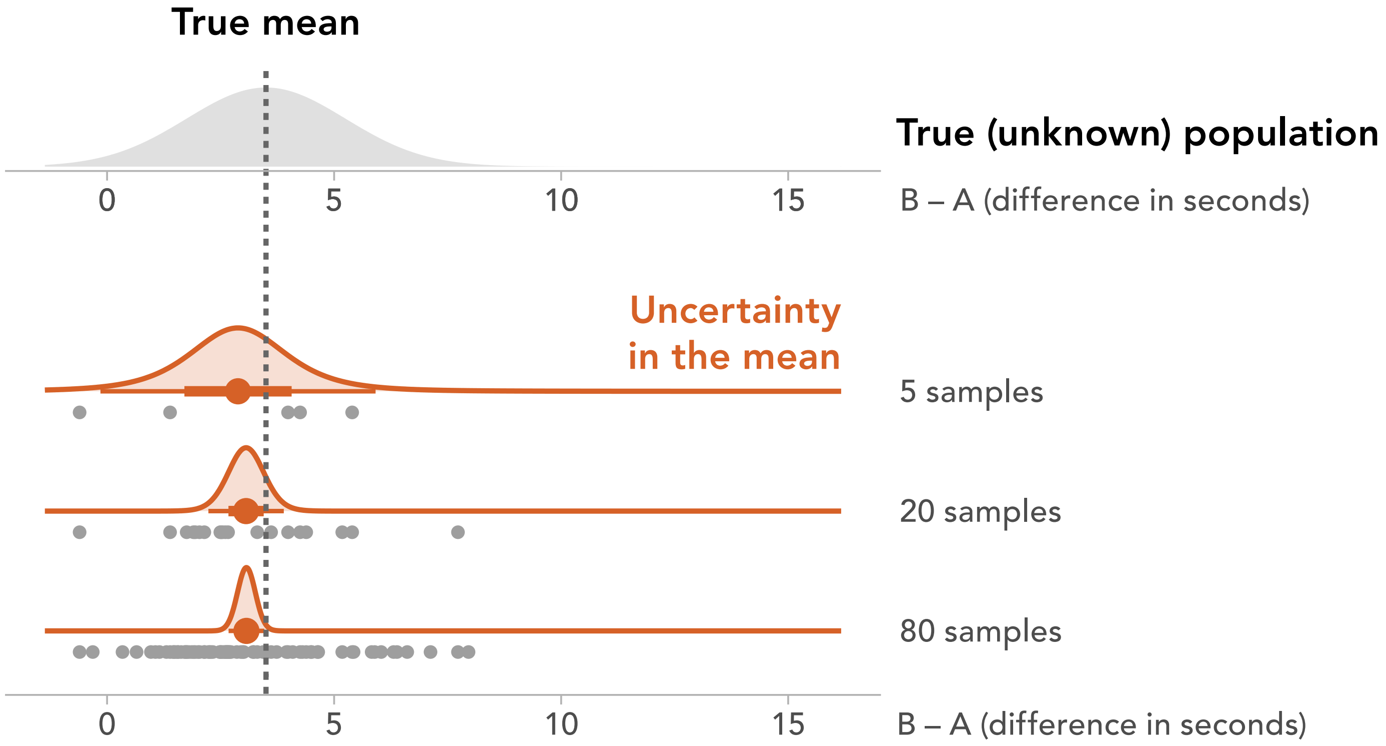

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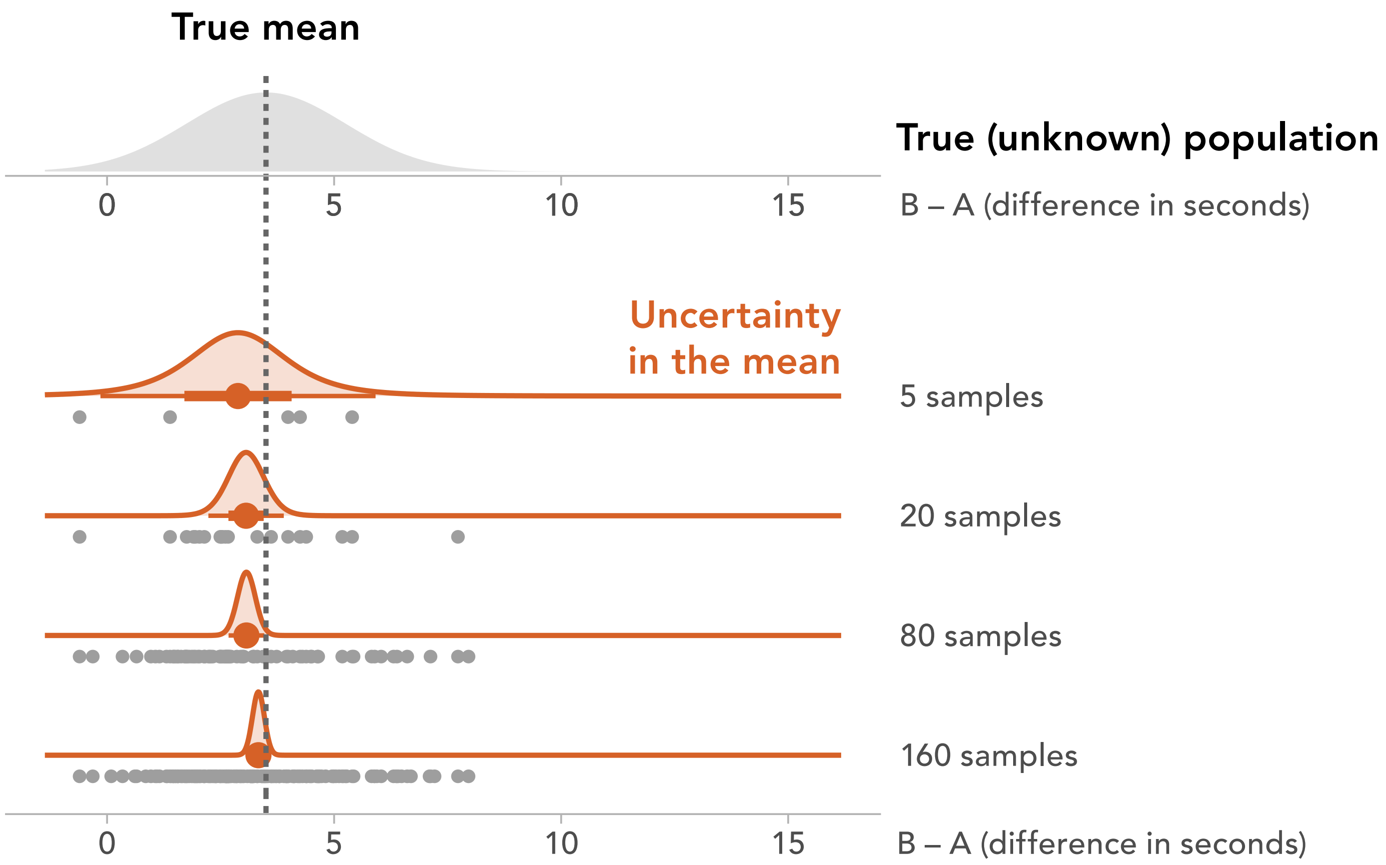

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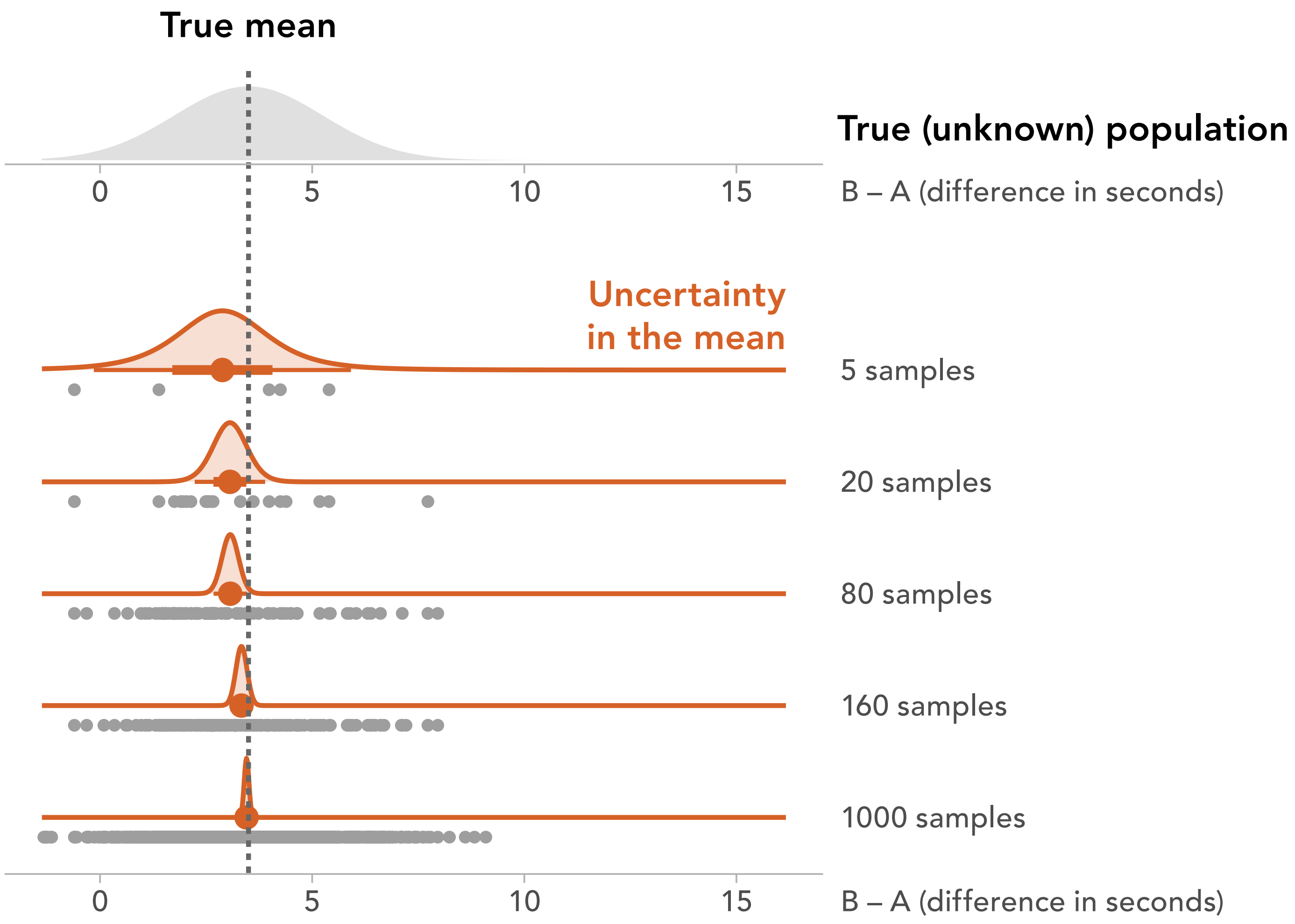

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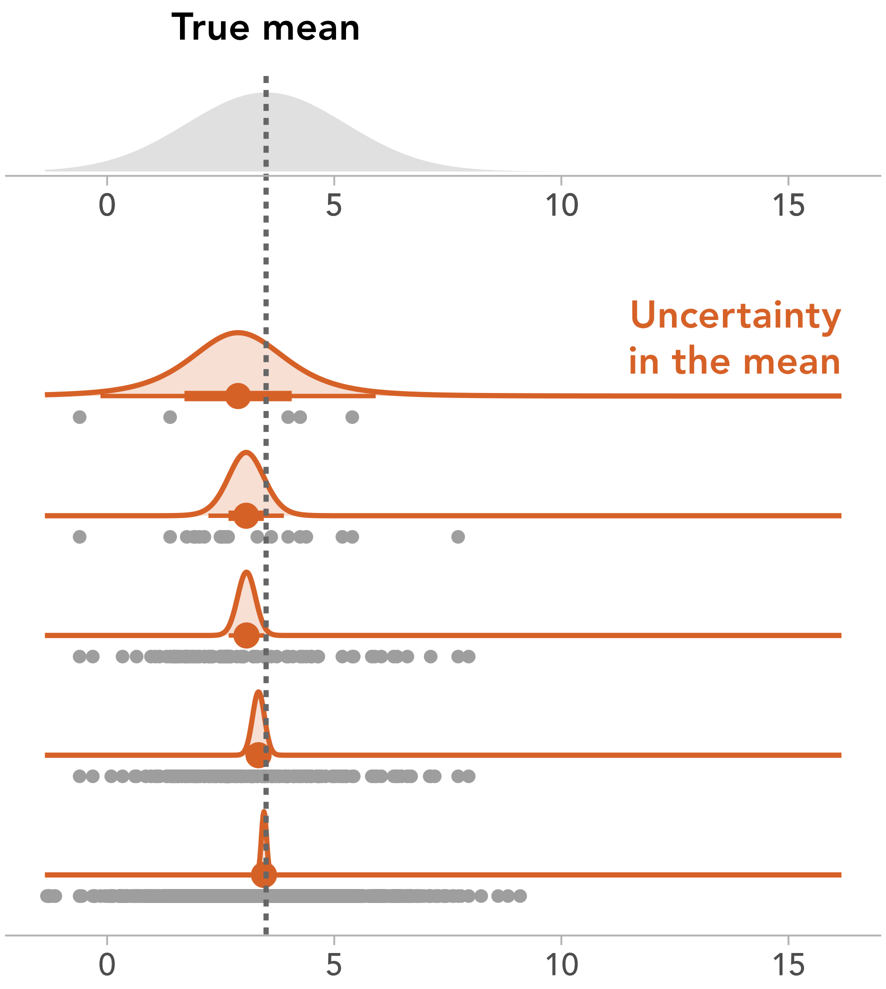
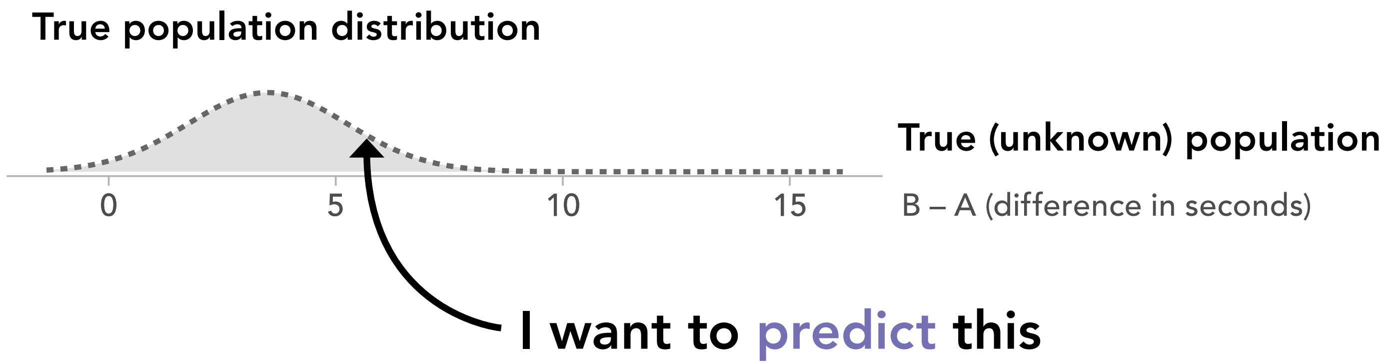


Predictive uncertainty



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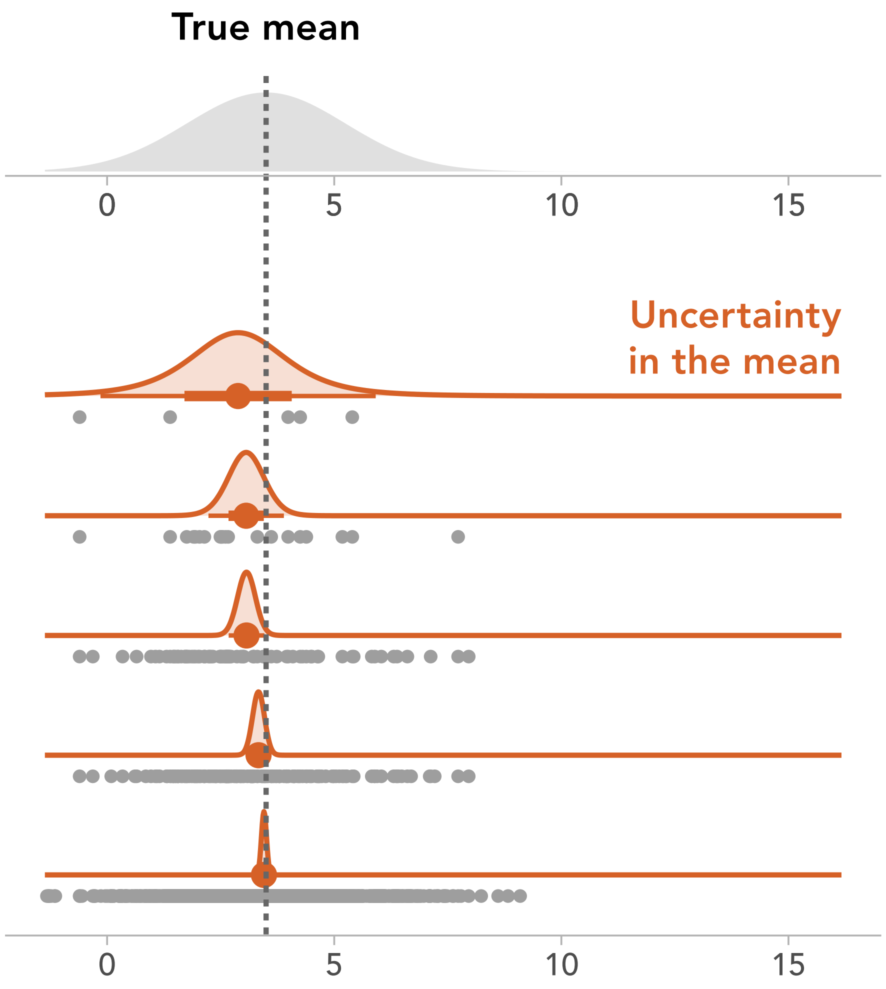

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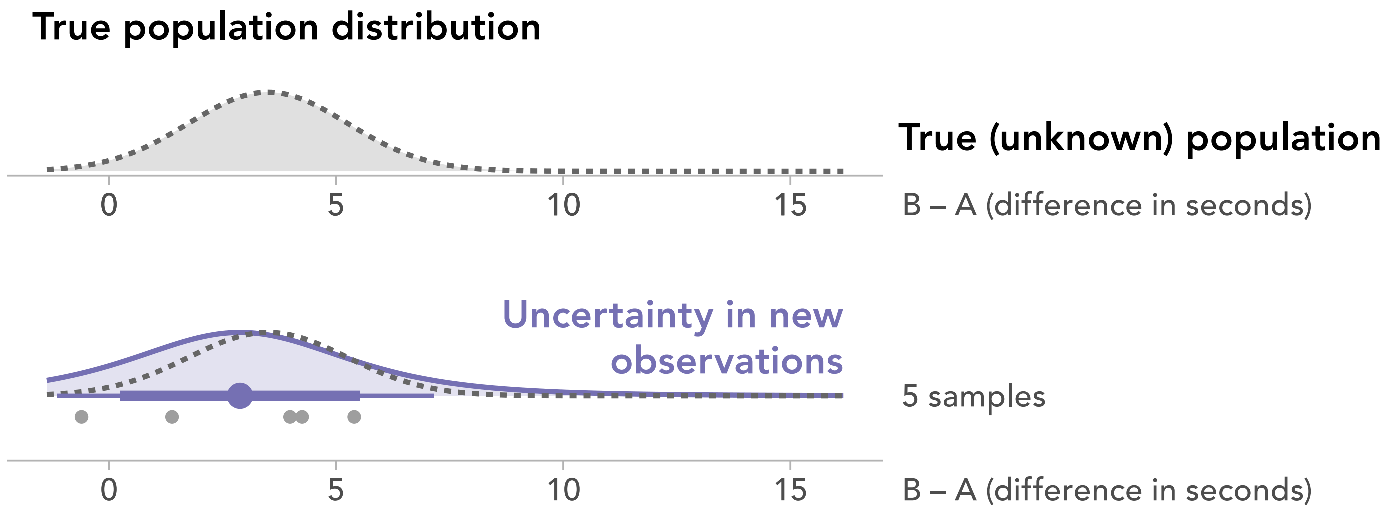
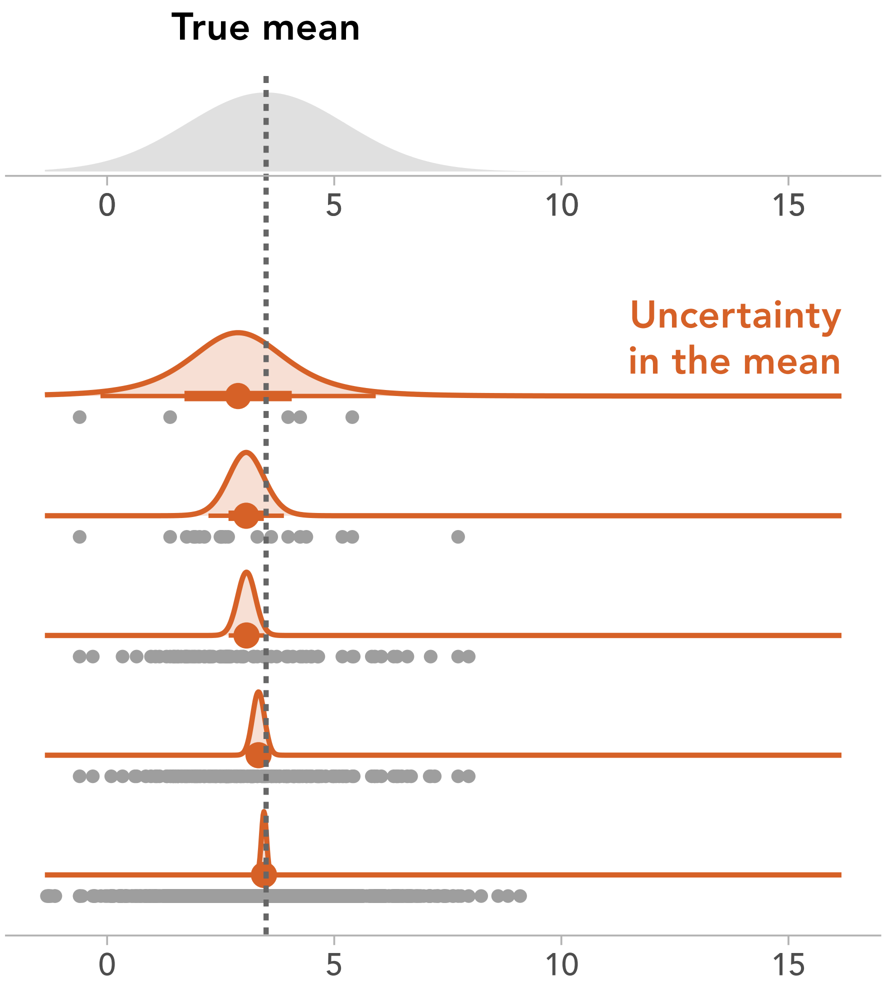
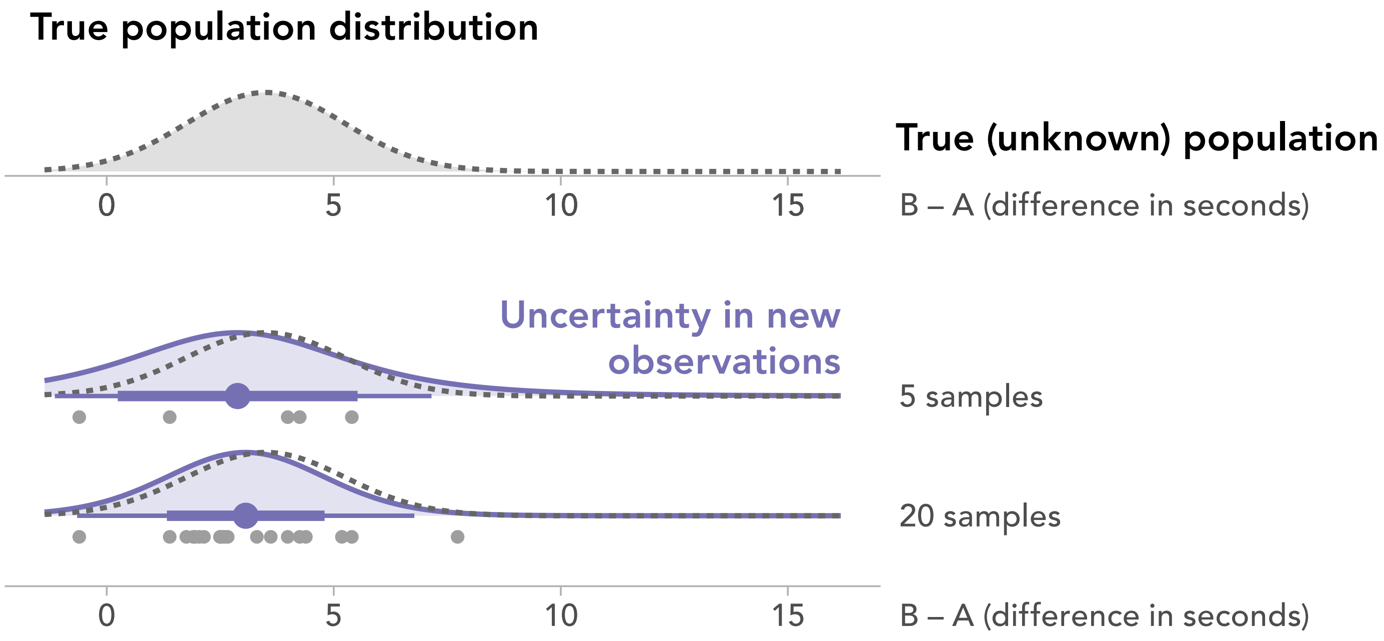


Parameter uncertainty

Predictive uncertainty





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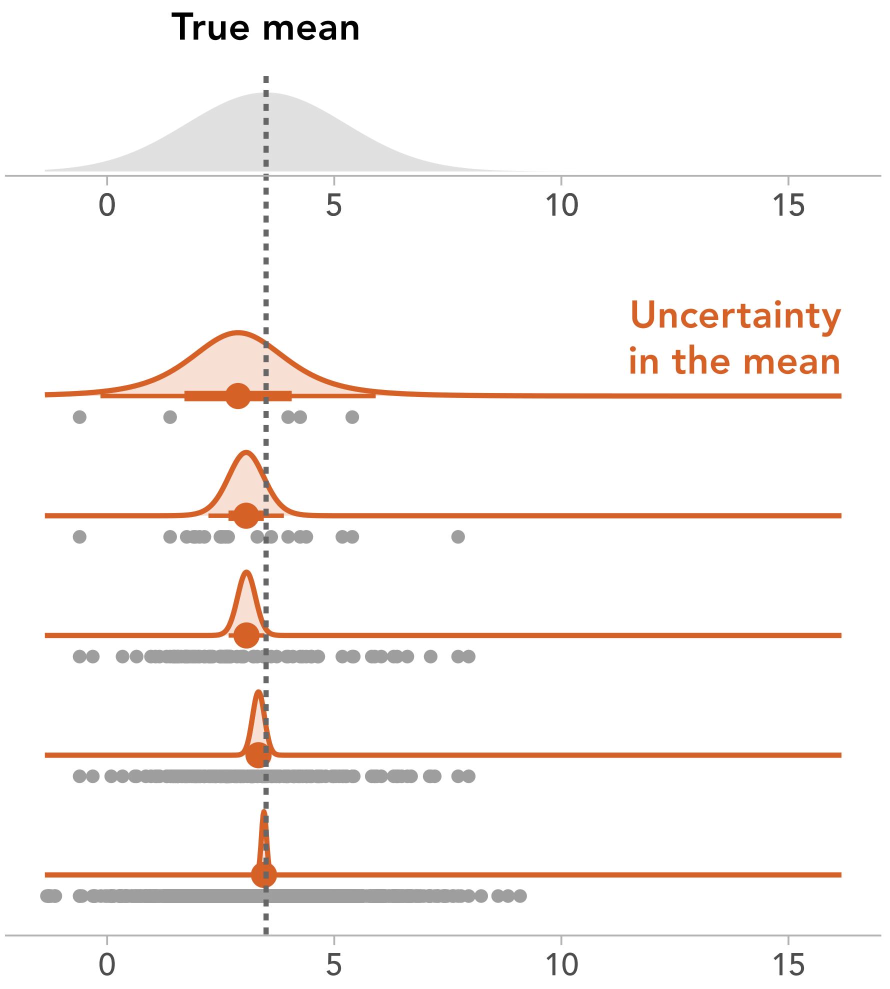

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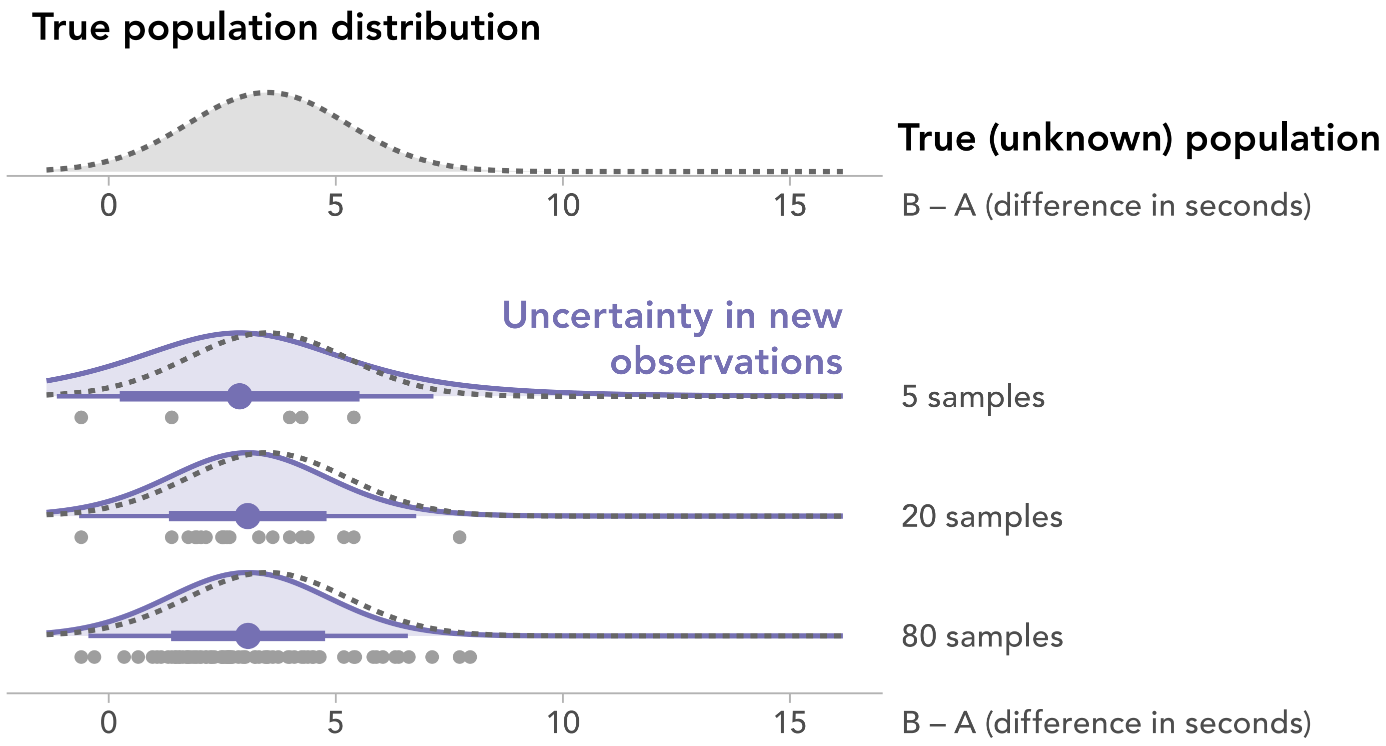

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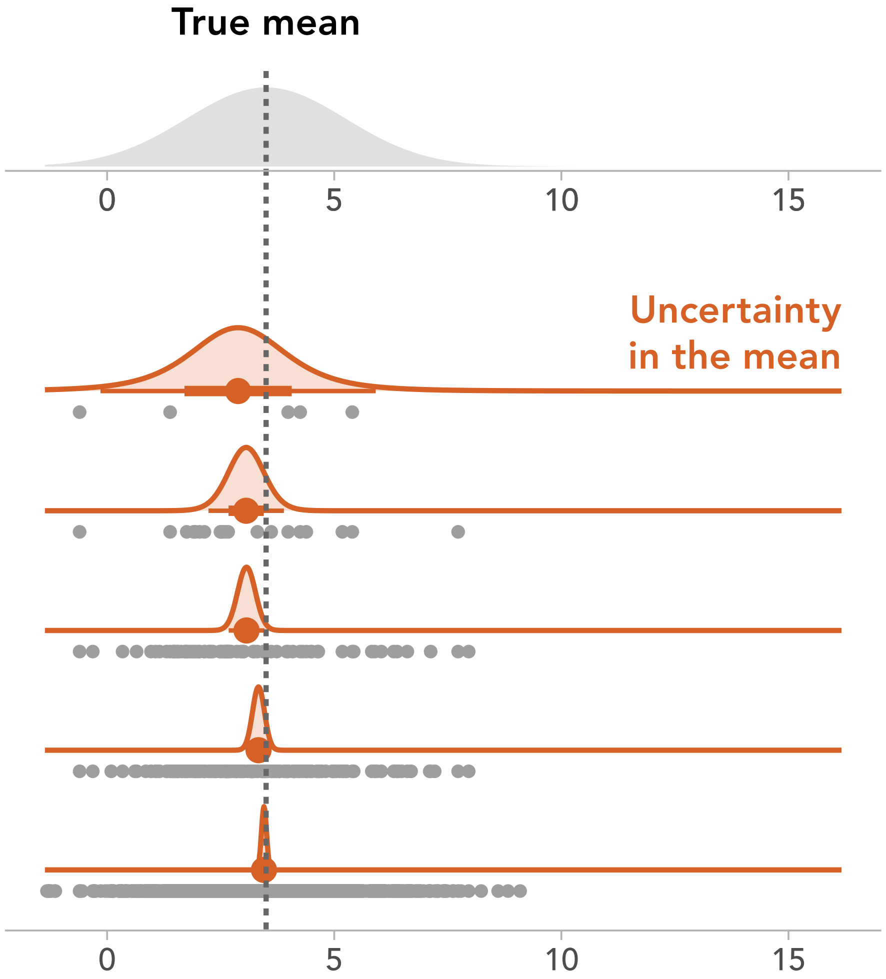

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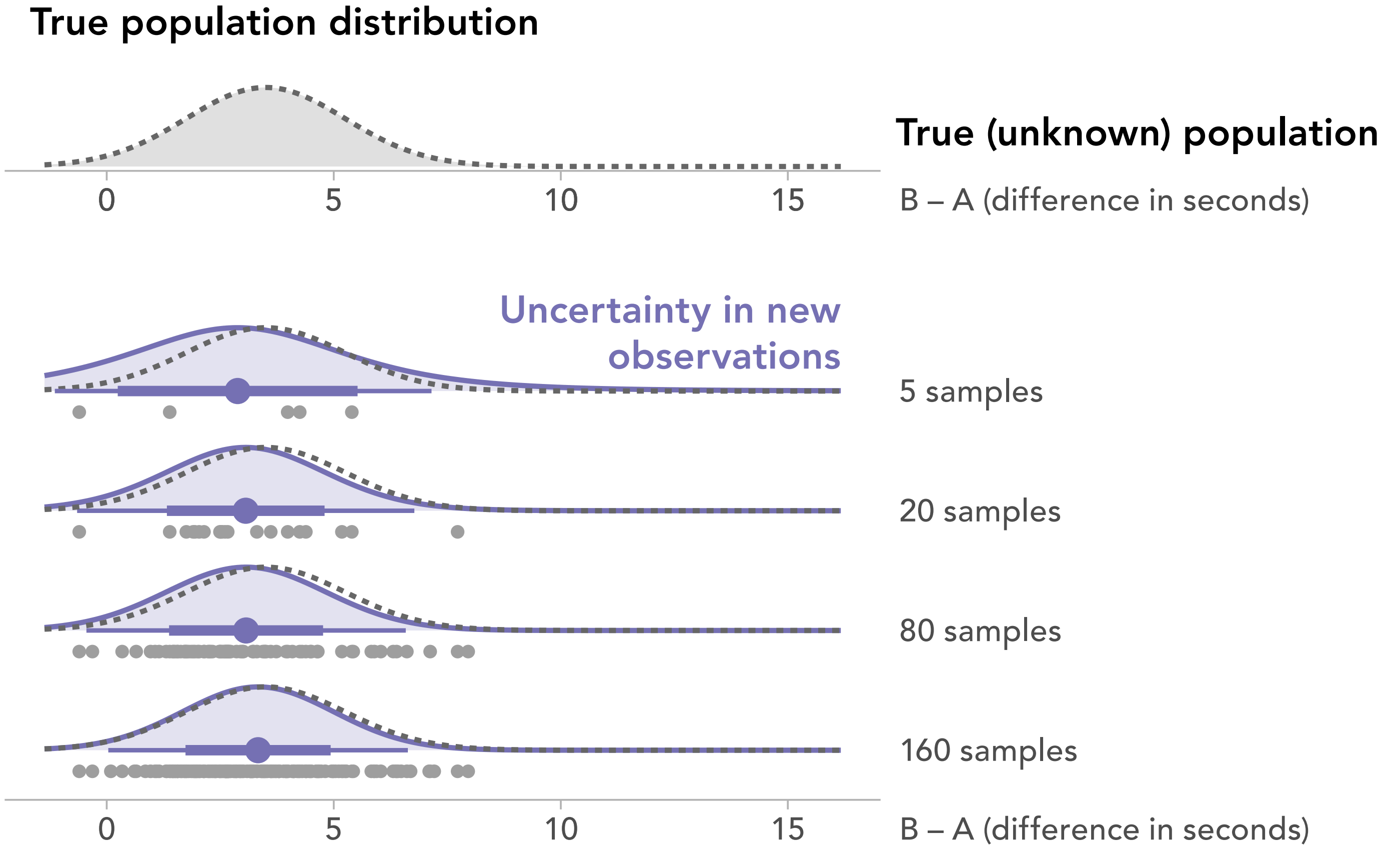
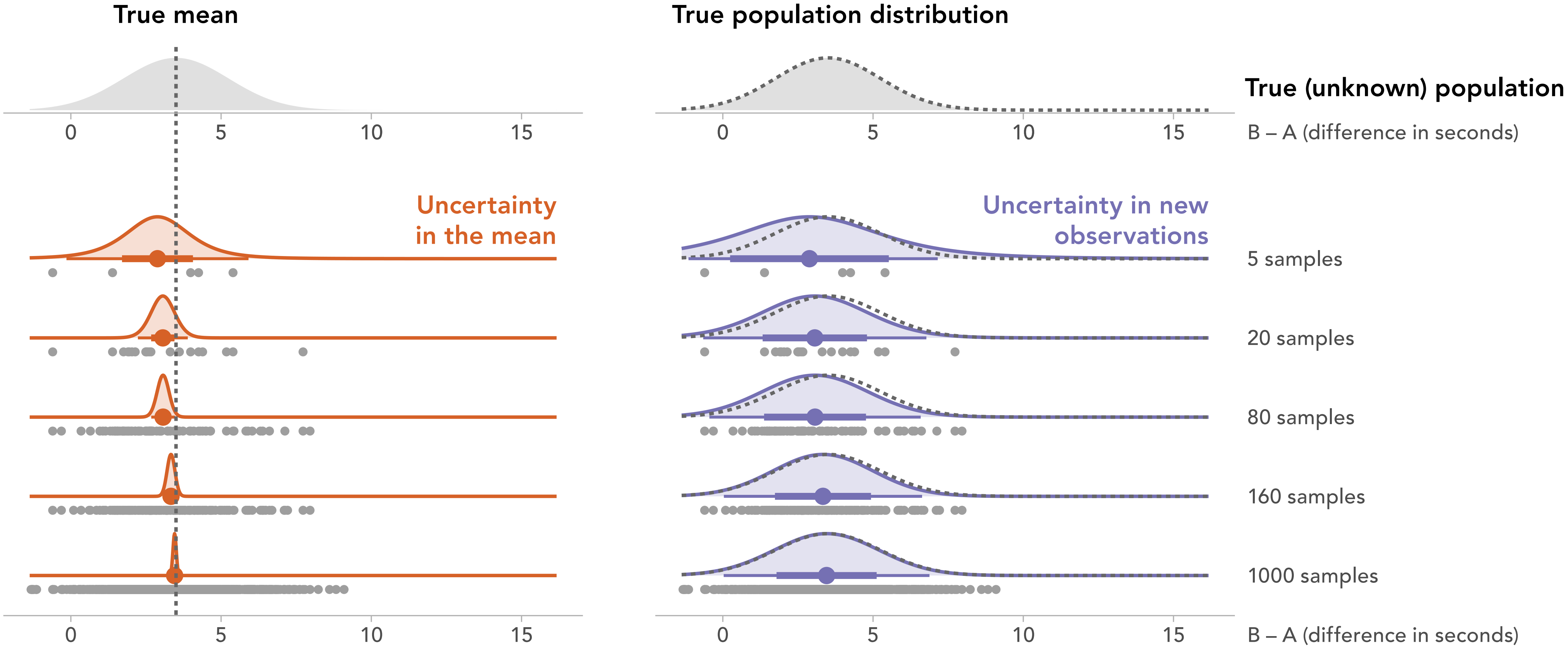


Parameter uncertainty

Predictive uncertainty

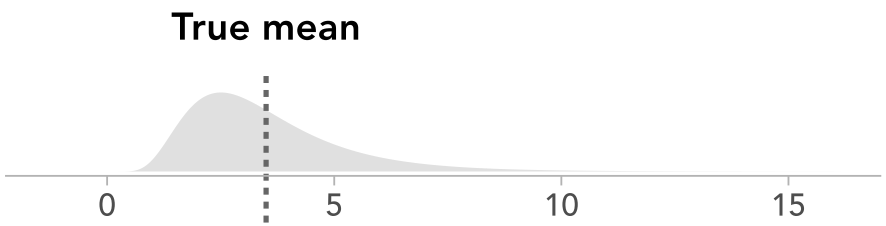


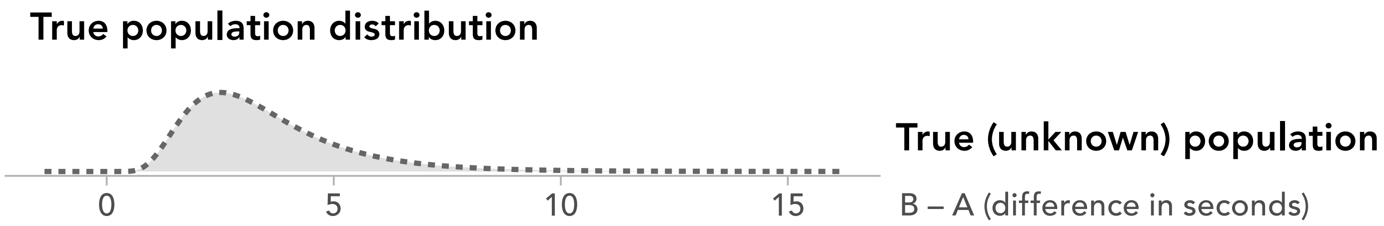
This is small world uncertainty

What if my model is wrong?

Parameter uncertainty

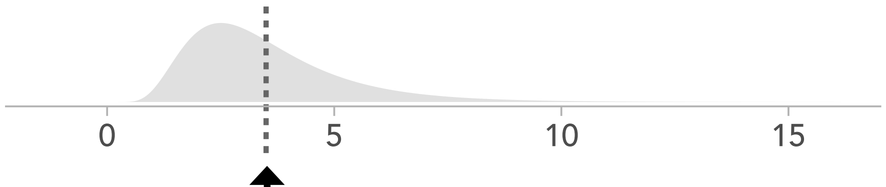
Predictive uncertainty





Parameter uncertainty

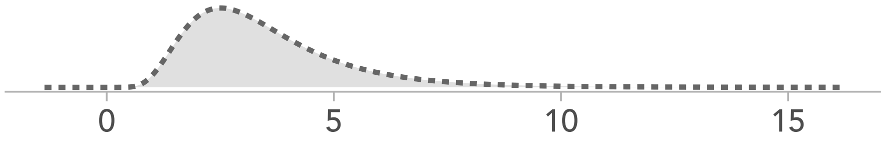
True mean



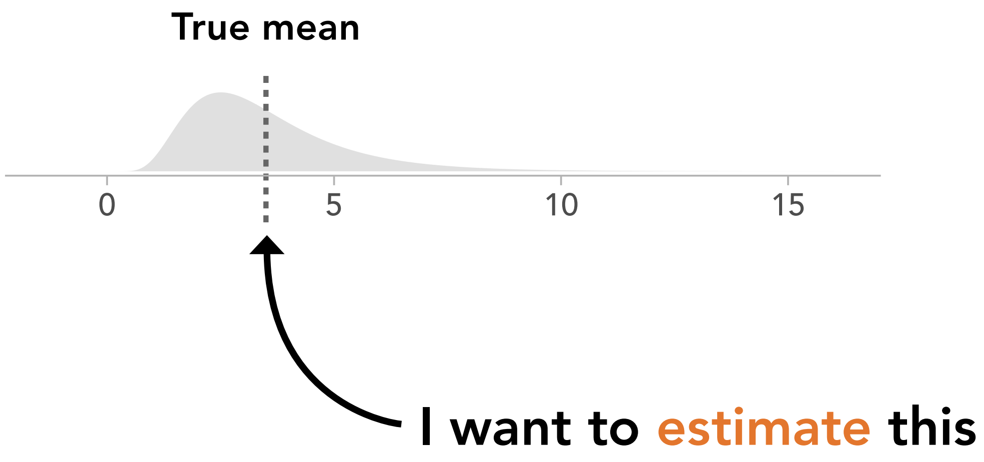
I want to estimate this

Predictive uncertainty

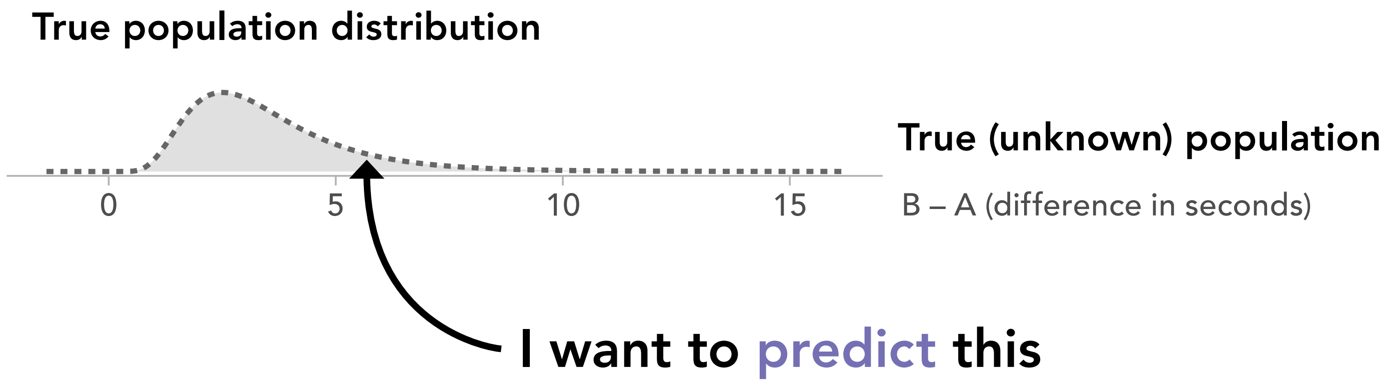
True population distribution



Parameter uncertainty



Predictive uncertainty



Parameter uncertainty

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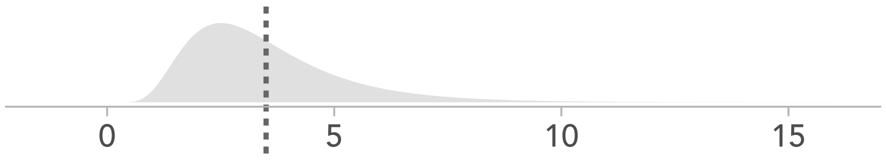

I want to estimate this

Predictive uncertainty

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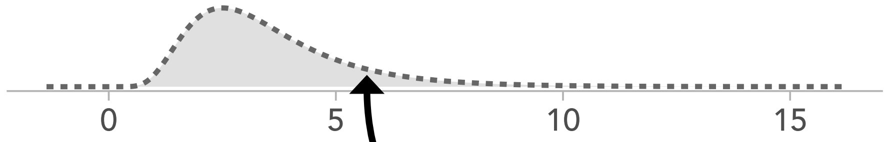
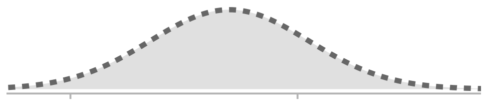


True (unknown) population

B – A (difference in seconds)

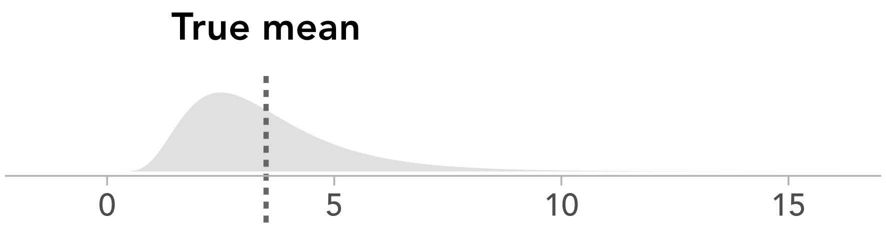
I want to predict this
but my model assumes this:

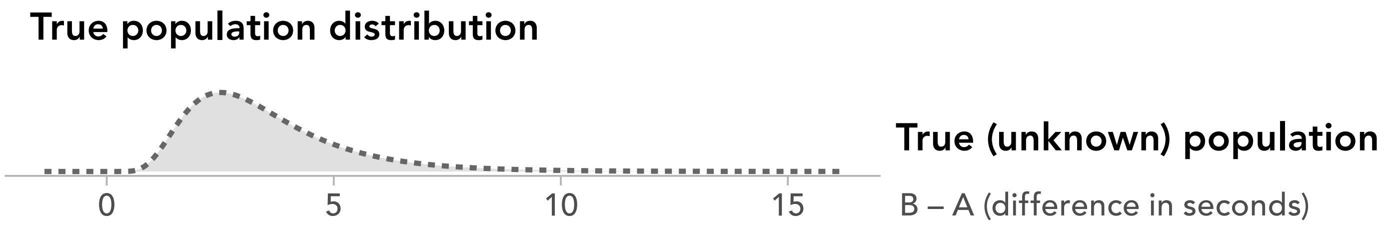


$x \sim \text{Normal}(\mu, \sigma)$

Parameter uncertainty

Predictive uncertainty





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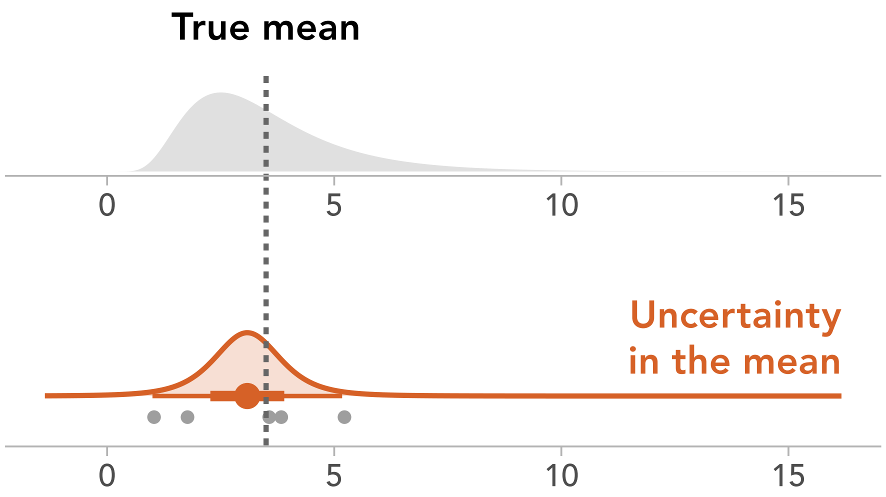
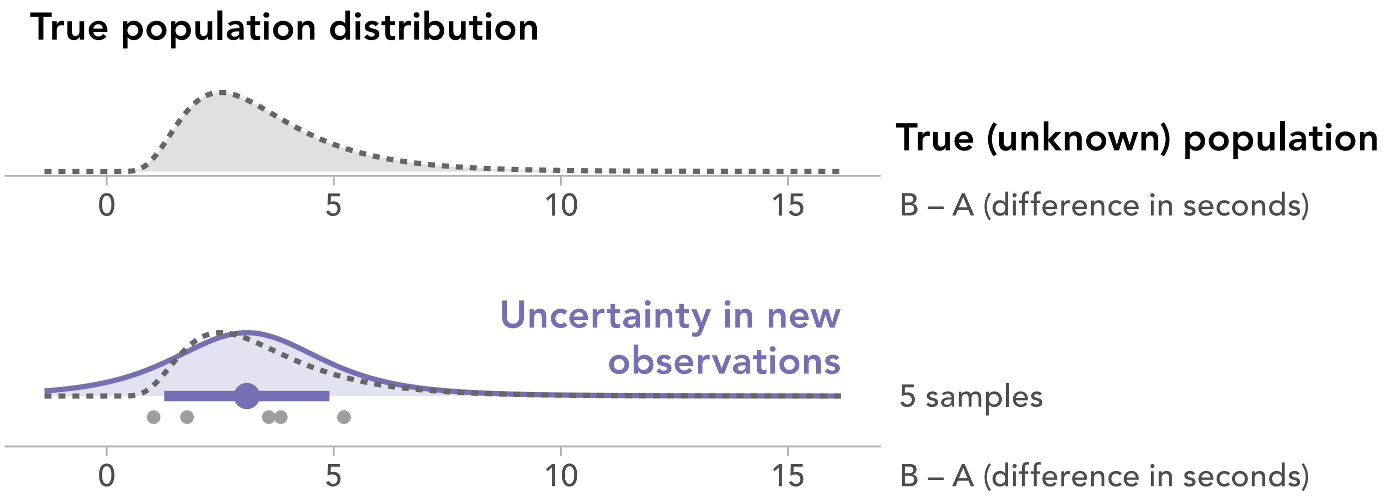


Predictive uncertainty



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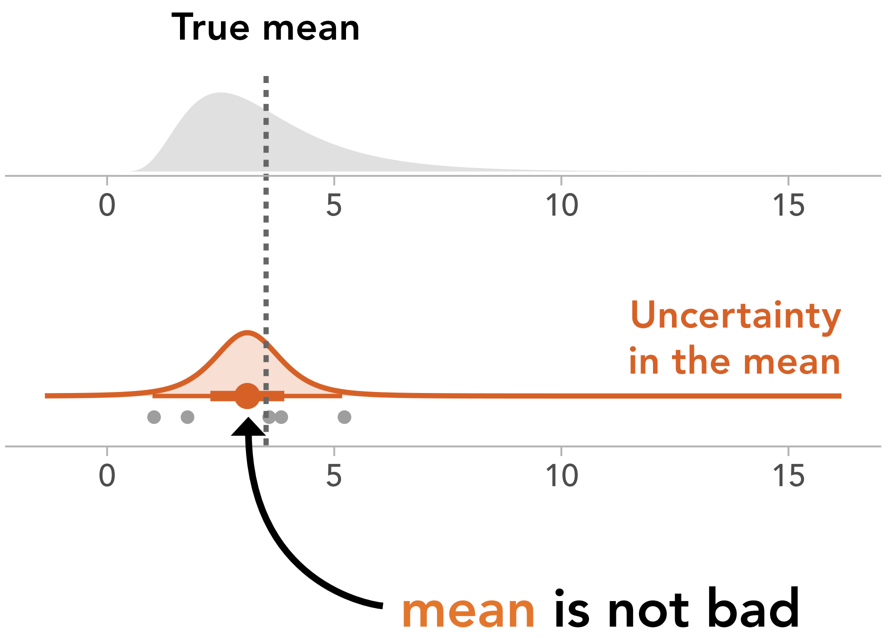

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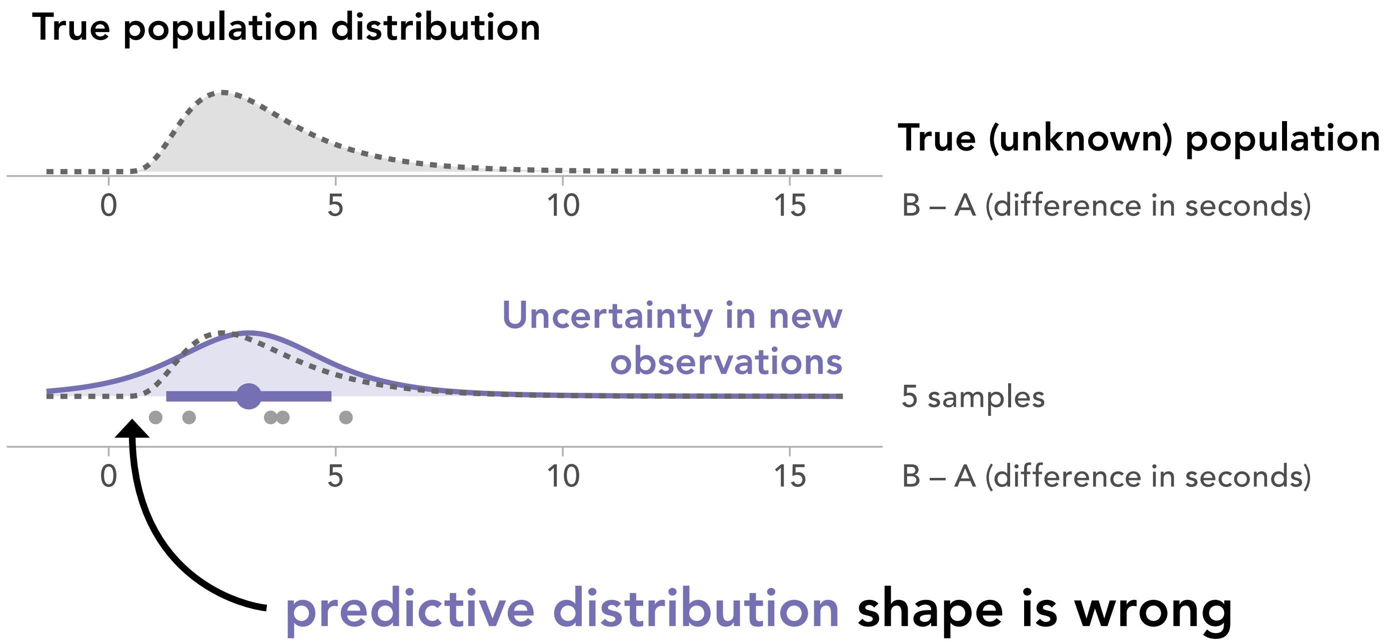

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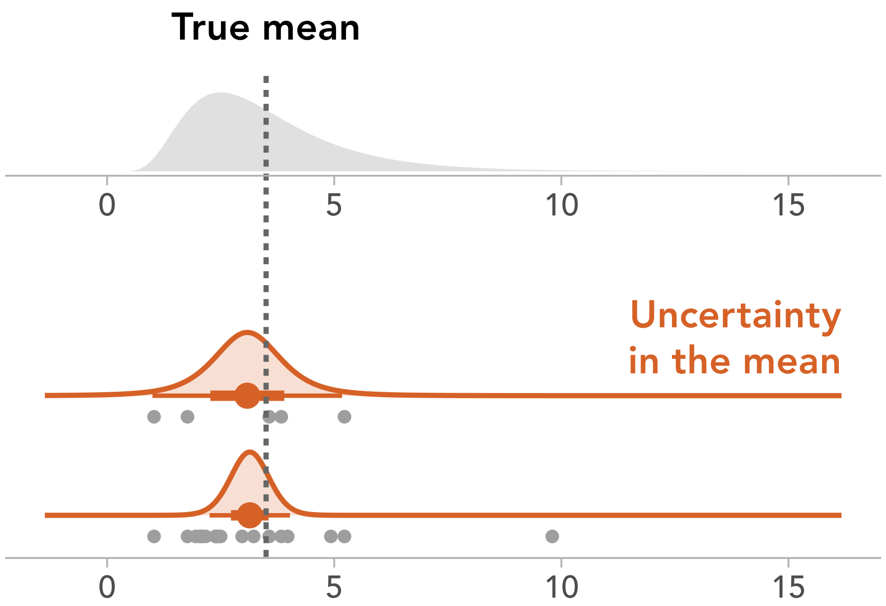

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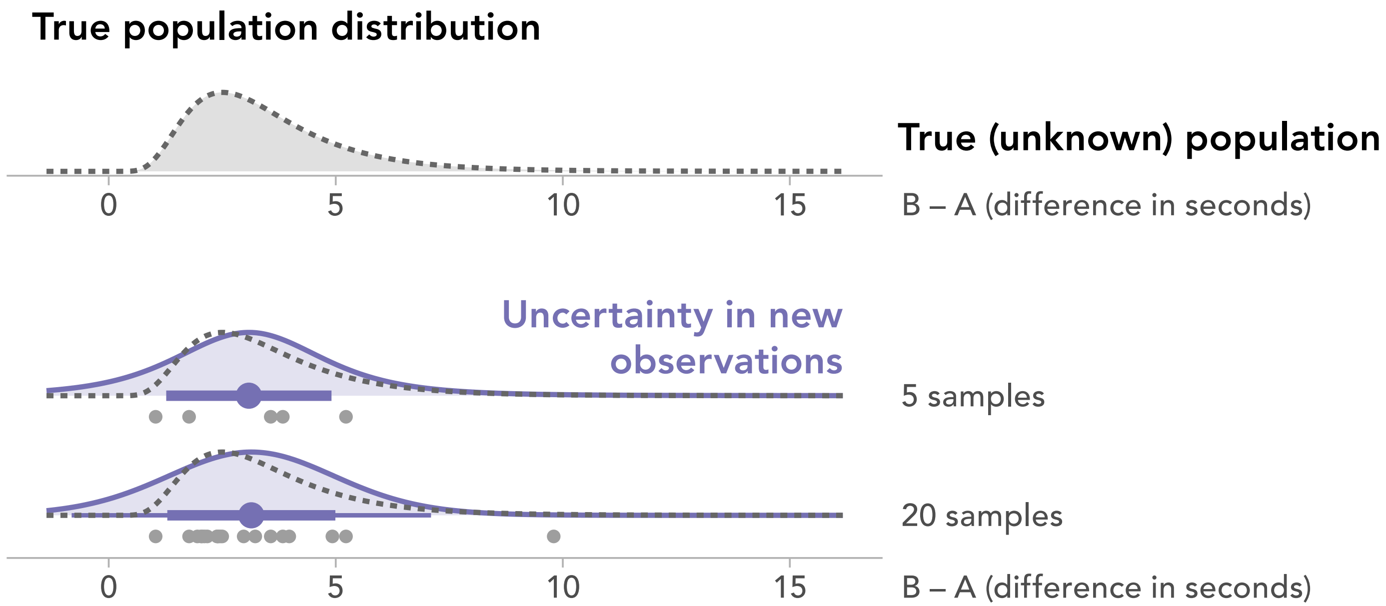
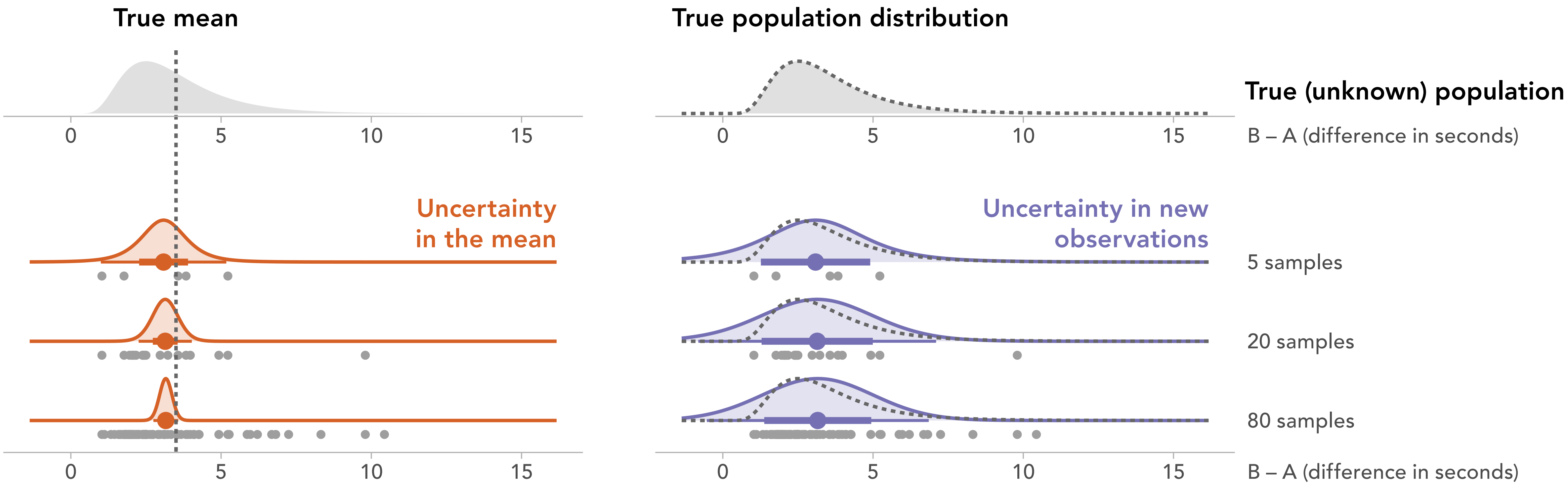


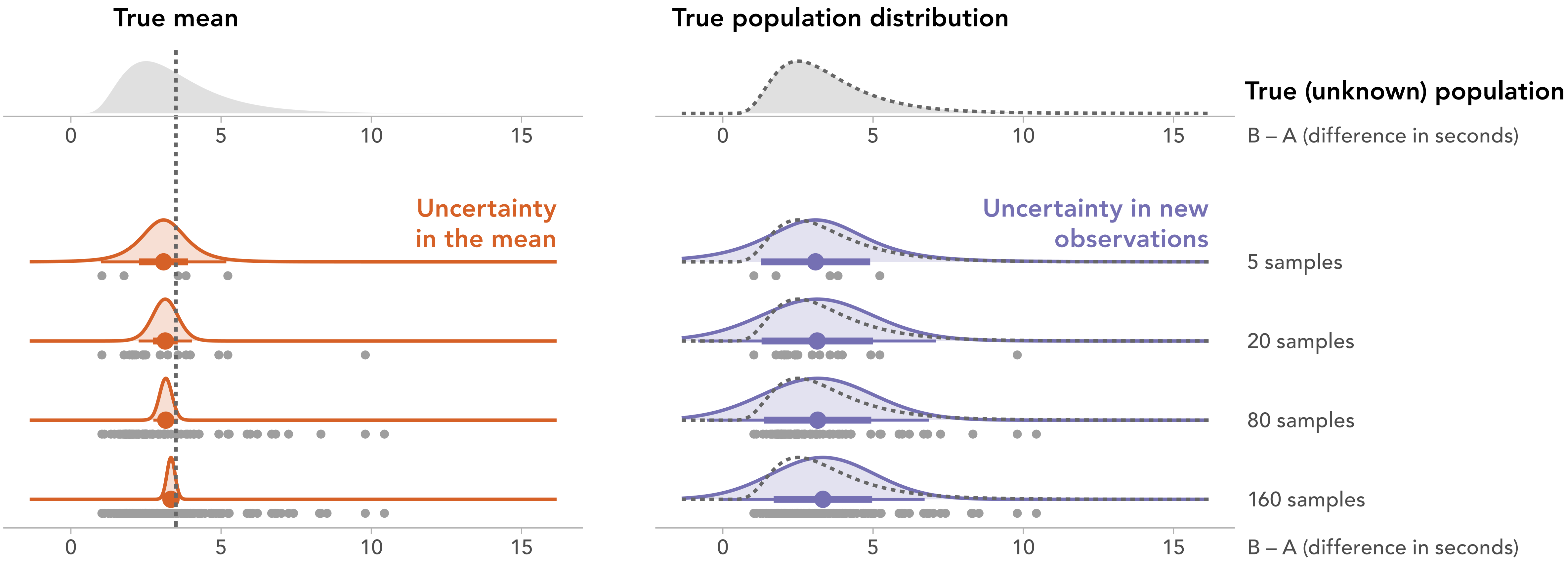
Parameter uncertainty

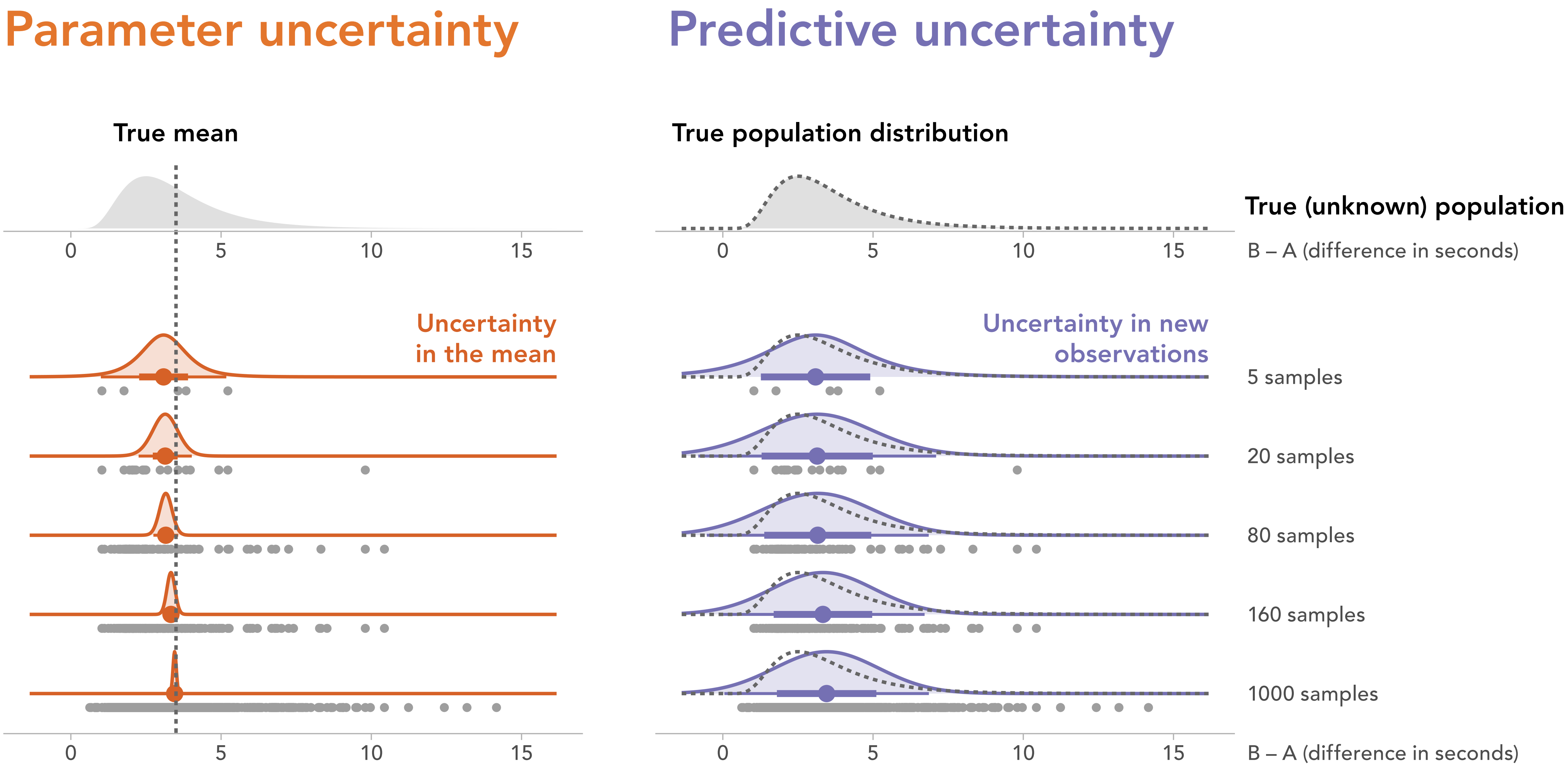
Predictive uncertainty



Parameter uncertainty

Predictive uncertainty

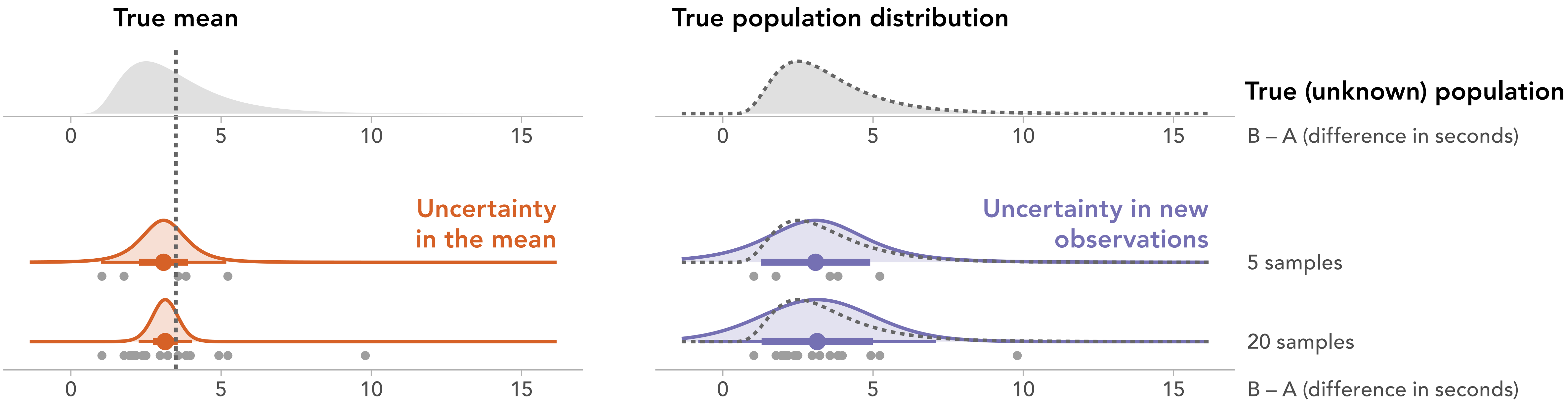




Parameter uncertainty
Predictive uncertainty
True mean
True population distribution
True (unknown) population
B – A (difference in seconds)
Uncertainty in the mean
Uncertainty in new observations
5 samples
20 samples
80 samples
160 samples
1000 samples
0
5
10
15

Parameter uncertainty

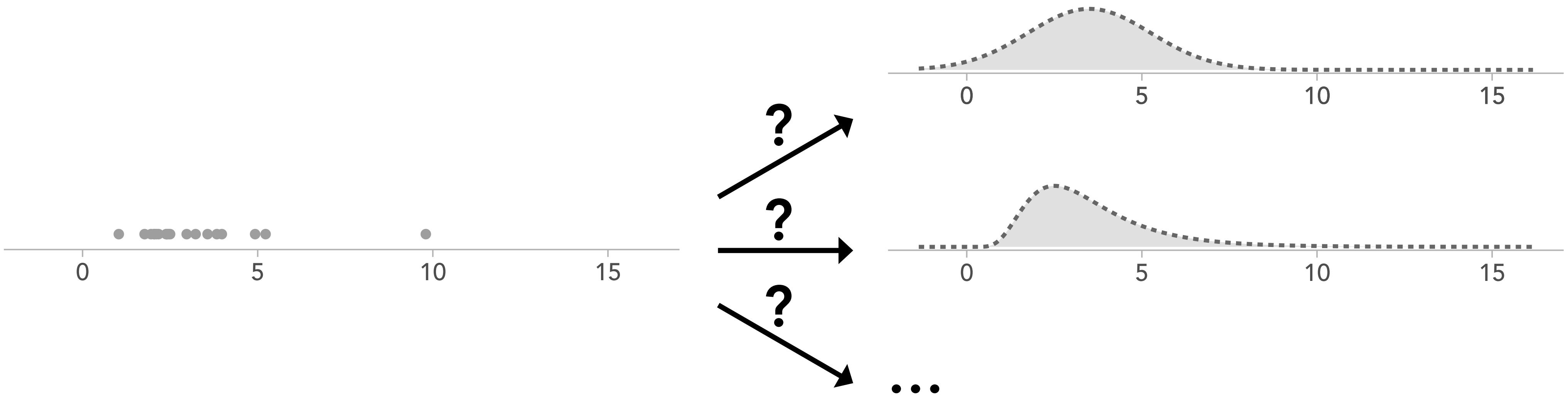
Predictive uncertainty



Small world uncertainty

contigent upon model, assumptions

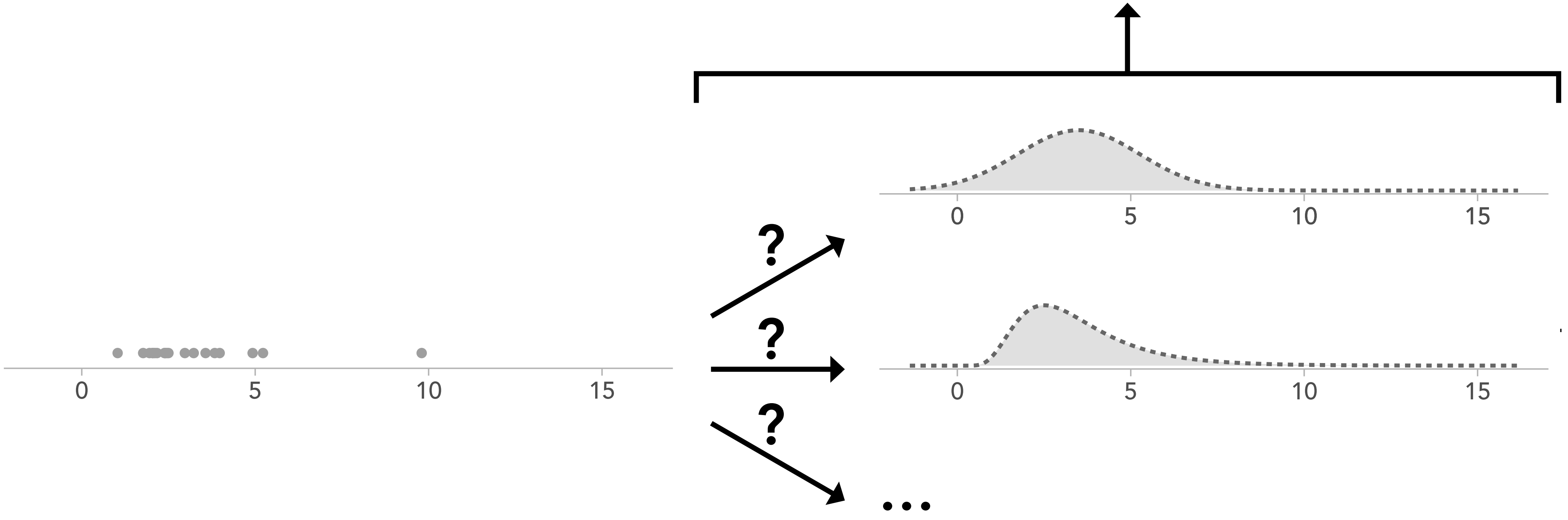

0
5
10
15



0
5
10
15
?
?
?
...

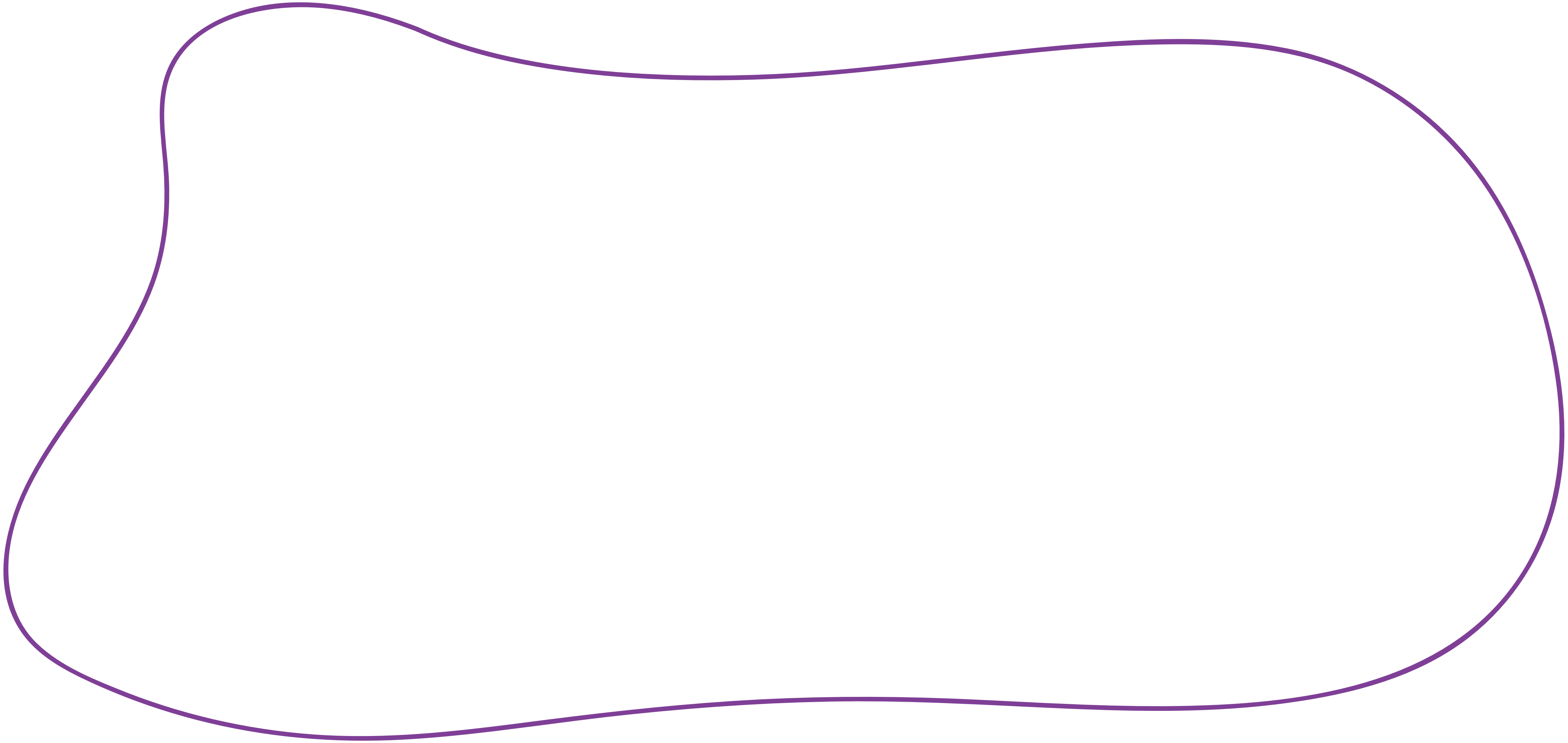
Large world uncertainty

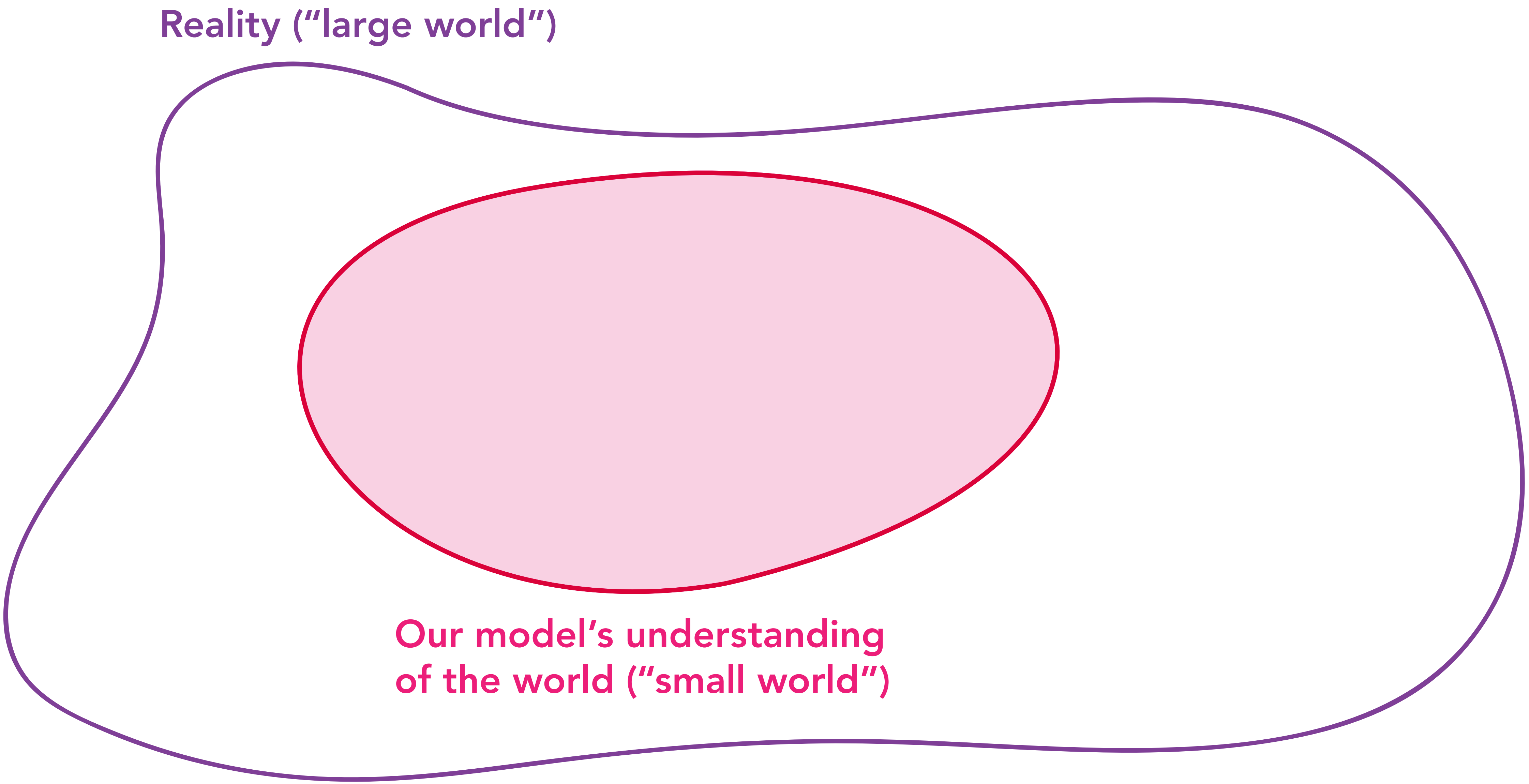
questions model, assumptions

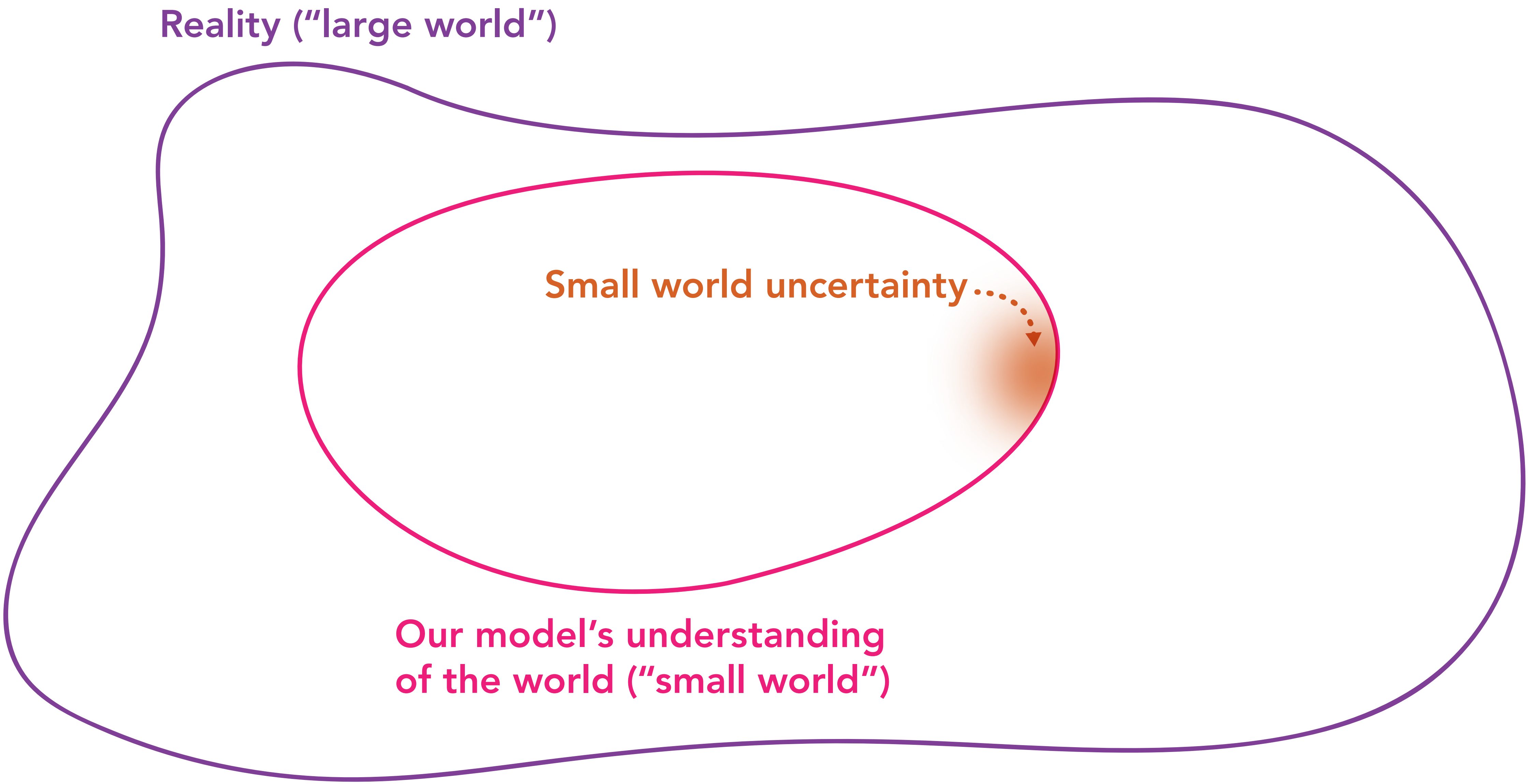


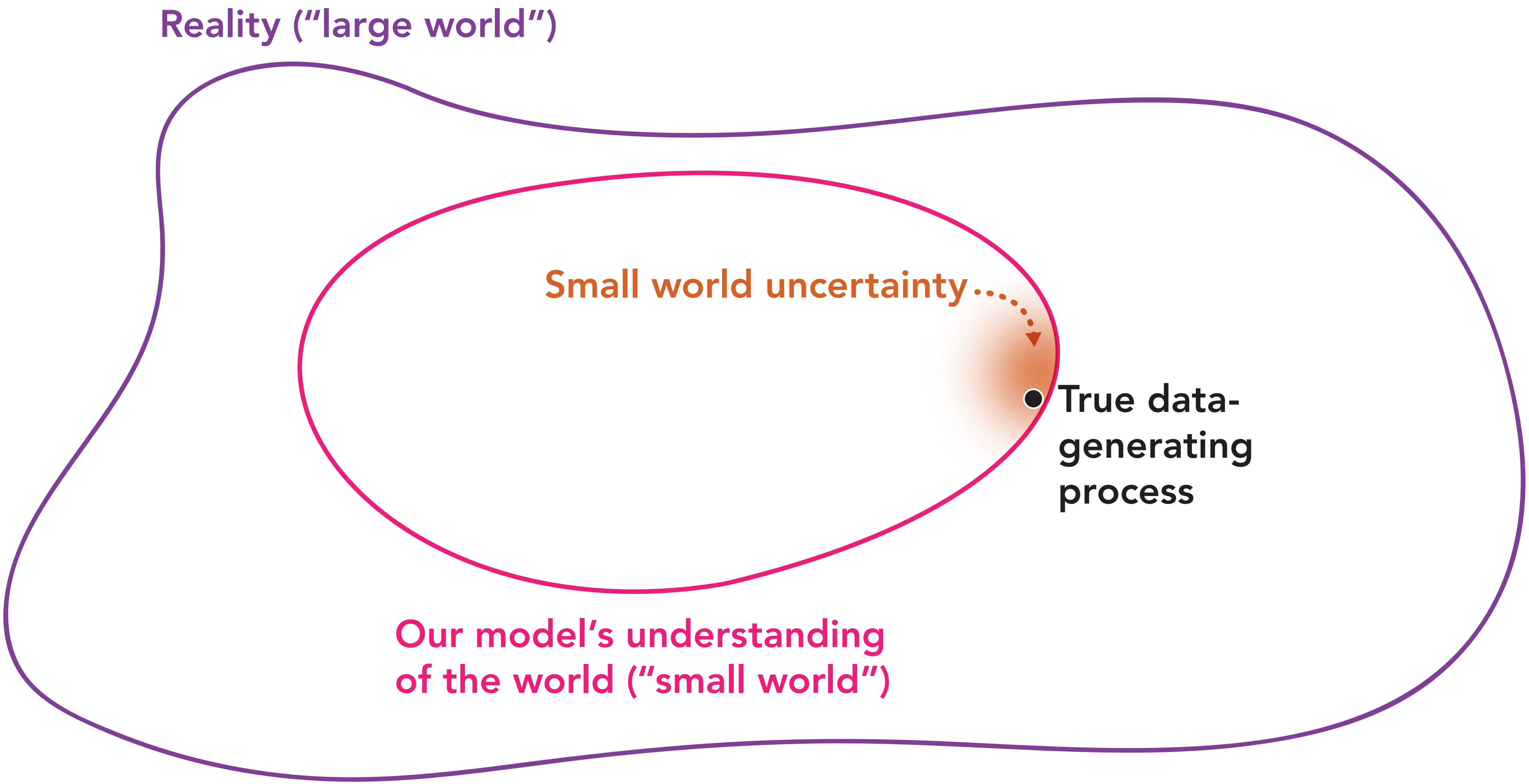
Let's take a conceptual look at large world versus small world uncertainty

Reality ("large world")

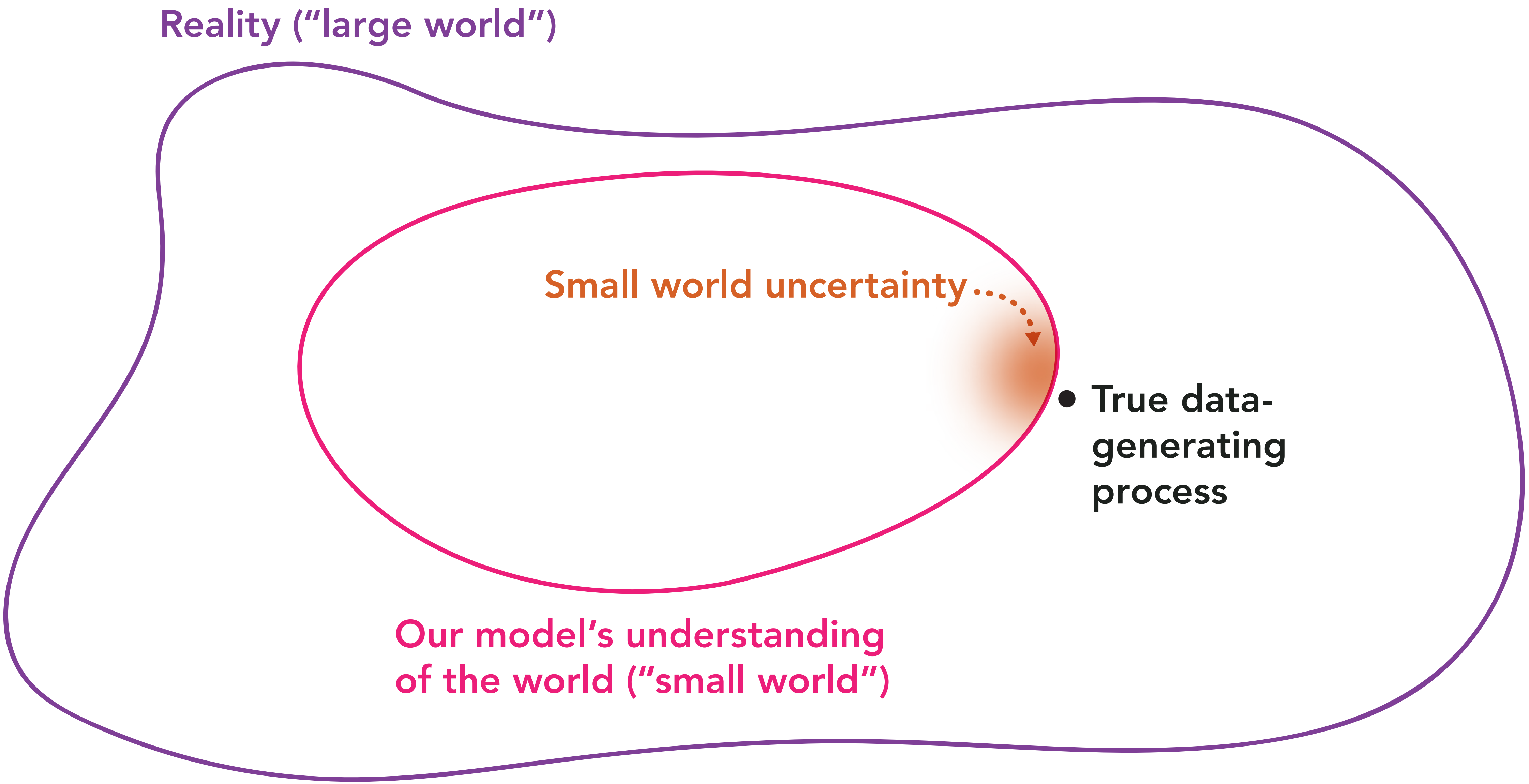



Reality ("large world")
Our model's understanding of the world ("small world")


Reality ("large world")
Small world uncertainty
Our model's understanding
of the world ("small world")



Reality ("large world")
Small world uncertainty
True data-generating process
Our model's understanding of the world ("small world")


Reality ("large world")
Small world uncertainty
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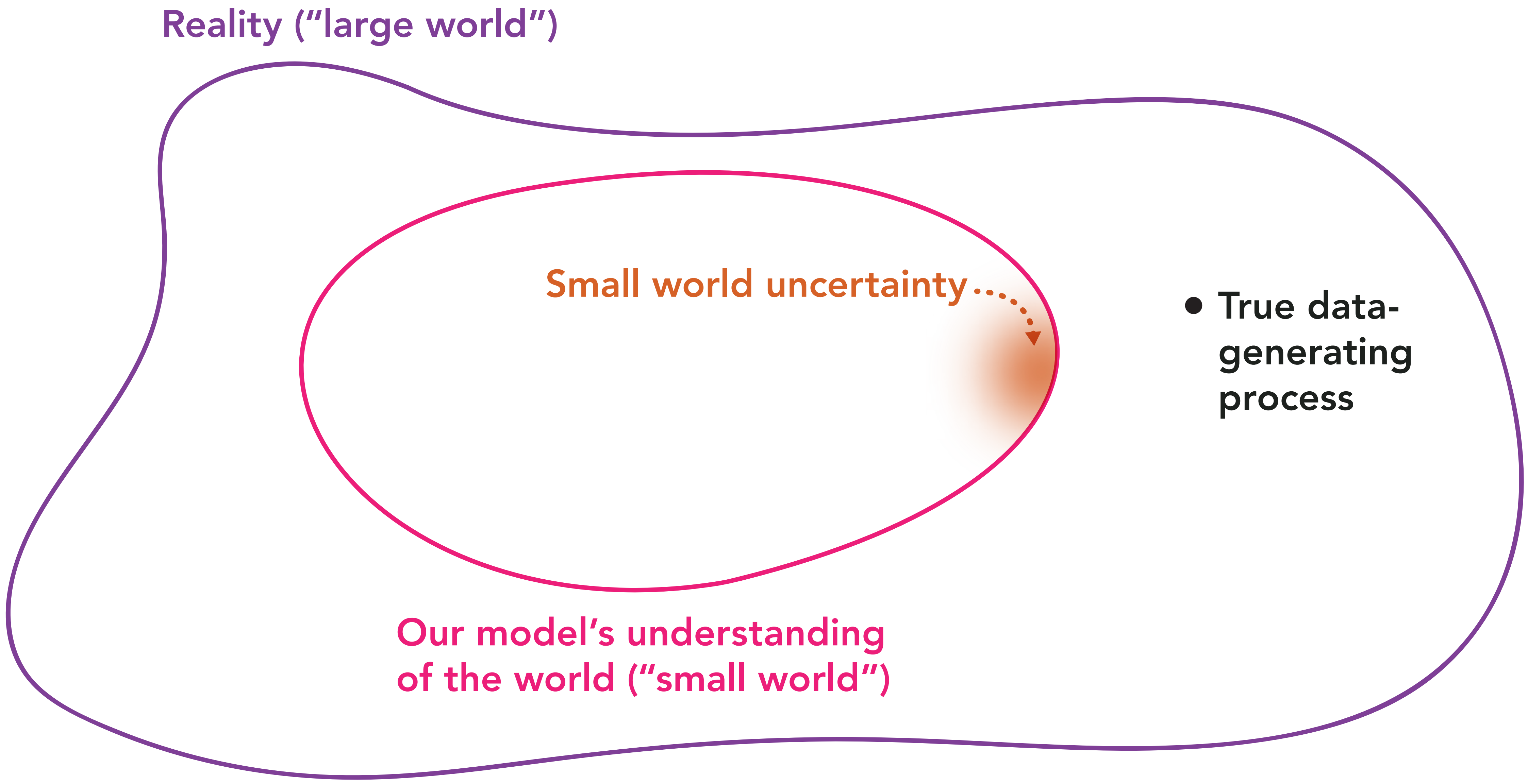
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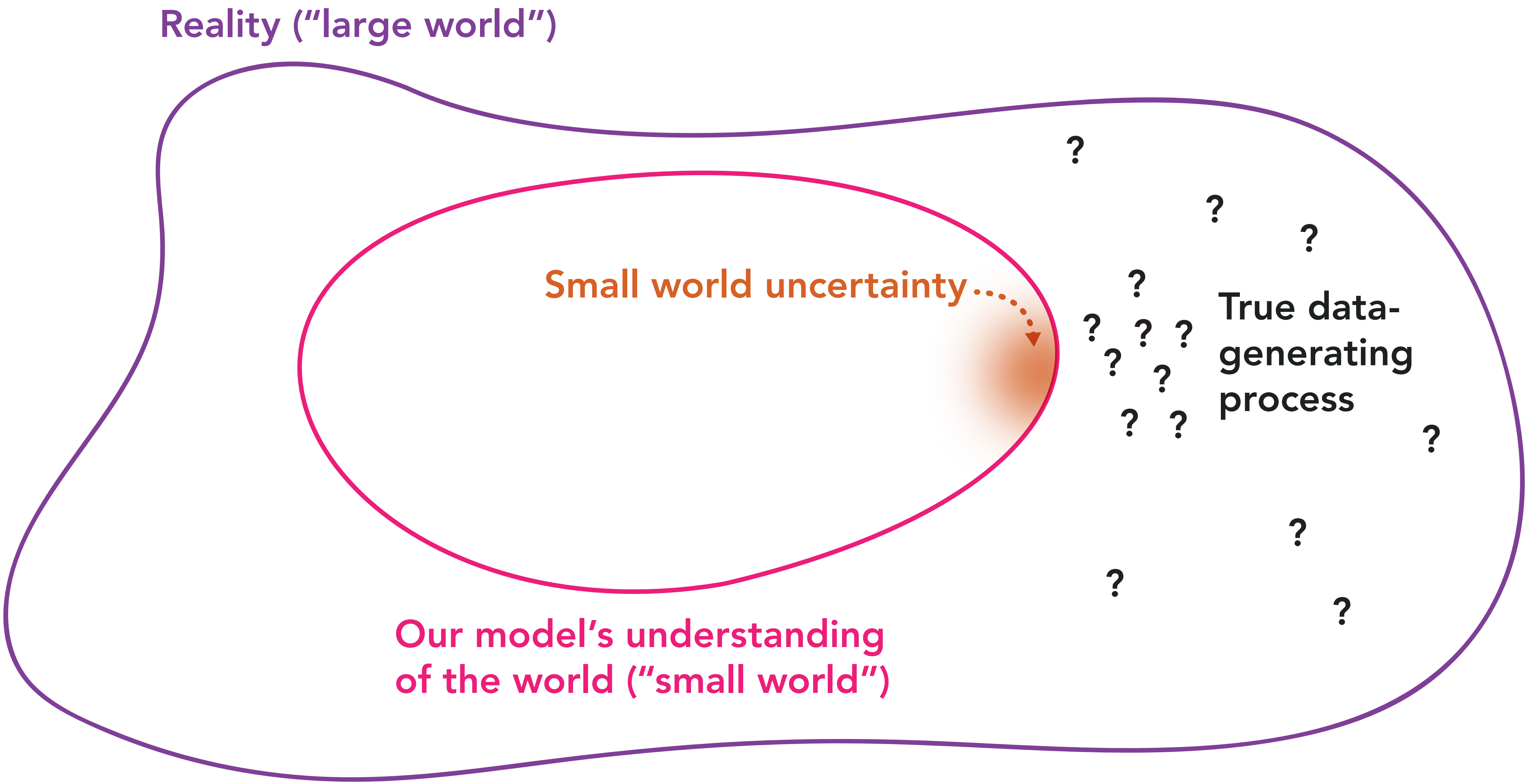
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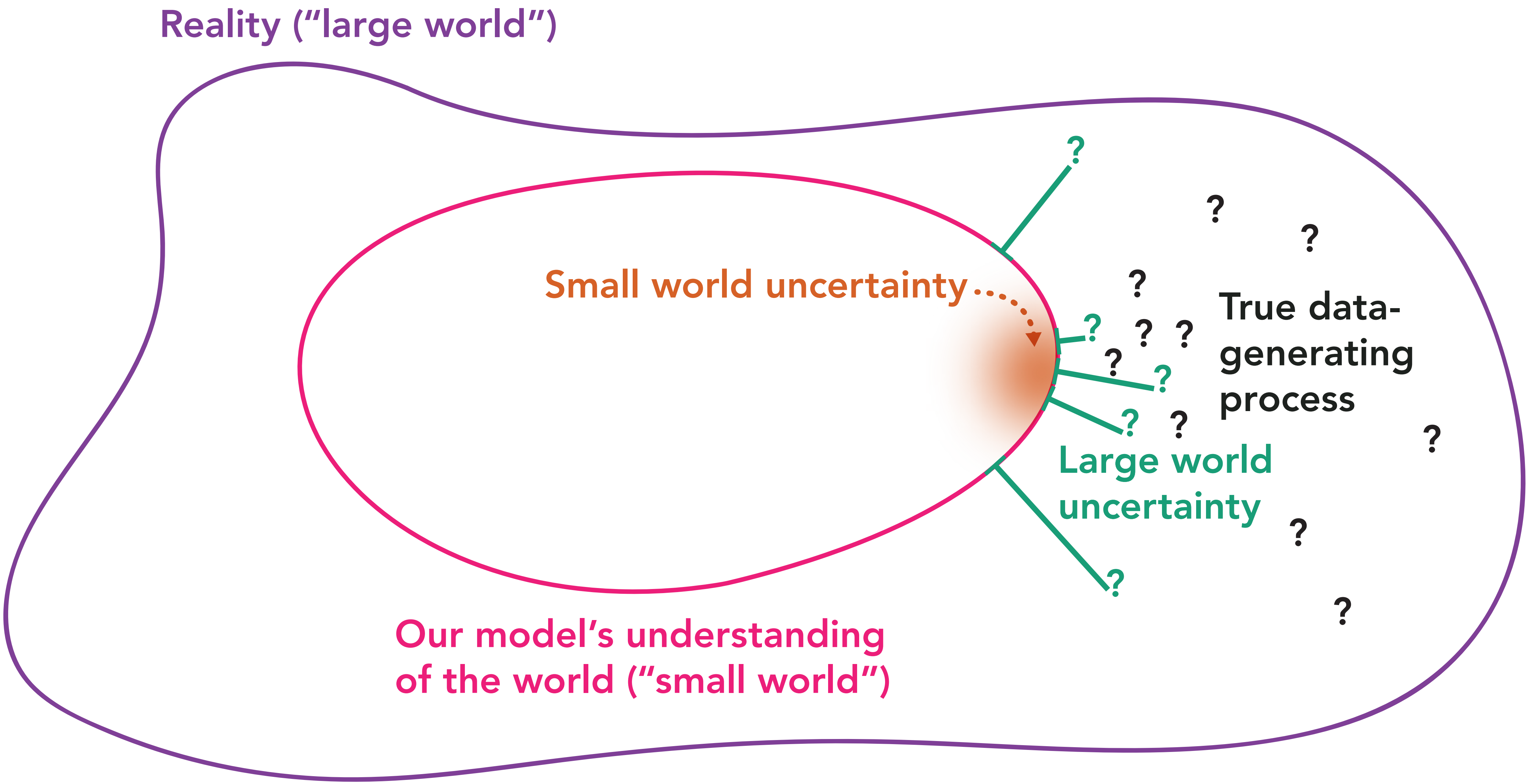
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Summing up

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Small world uncertainty: **quantified** uncertainty in estimates, predictions contingent upon modeling assumptions

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Small world uncertainty: **quantified** uncertainty in estimates, predictions contingent upon modeling assumptions

Large world uncertainty: largely **unquantified** uncertainty in modeling assumptions, data collection process, etc …

Small world uncertainty contains:

Parameter uncertainty: uncertainty in some parameter of interest (e.g. a mean, scale parameter, etc)

Predictive uncertainty: uncertainty in new outcomes

Rough mapping to Spiegelhalter [2017]

Parameter uncertainty -> epistemic

Predictive uncertainty -> aleatory

Large world uncertainty -> ontological

Types of uncertainty: Small worlds and large worlds

SIADS 542: Presenting uncertainty – Week 1, Lecture 1

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