Beyond Goodness Of Fit

An Introduction to Parameter Space Partitioning

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An Introduction to Parameter Space Partitioning

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What is a formal model?

A formal model unambiguously specifies transformations from independent variables to dependent variables.

Key reading: Wills & Pothos (2012)

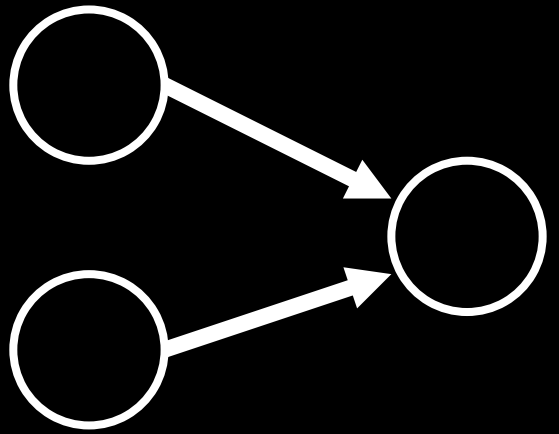
Example of a formal model

A+ AB+ B

CD+ D

B < D

Blocking (e.g. Kamin, 1969)



$\Delta w = G(\lambda - \Sigma w)$

Delta rule
(e.g. Rescorla & Wagner , 1972)

Advantages and problems of formal models

- Appreciation of problem difficulty
- Reduction of ambiguity
- Hard, and time consuming, to design, implement, and test
  - Help is at hand!

https://www.andywills.info/catlearn/

Is my model any good / better than your model?

A+ AB+ B

CD+ D

B: 0.5

D: 0.75

$\Delta w = G(\lambda - \Sigma w)$

Vary *G* to minimize difference:

	Data	Model
B	.50	.55
D	.75	.80

RMSD = 0.07

...or r^2, AIC, BIC,...

Problems with goodness of fit

- What wouldn't it have fit?
- Ordinal patterns
  - Experimental replication typically ordinal
  - 3 possible outcomes in blocking, 1 observed.
  - Does model also produce the 2 non-observed patterns?

A+ AB+ B

CD+ D

B < D ✓

B > D ?

B = D ?

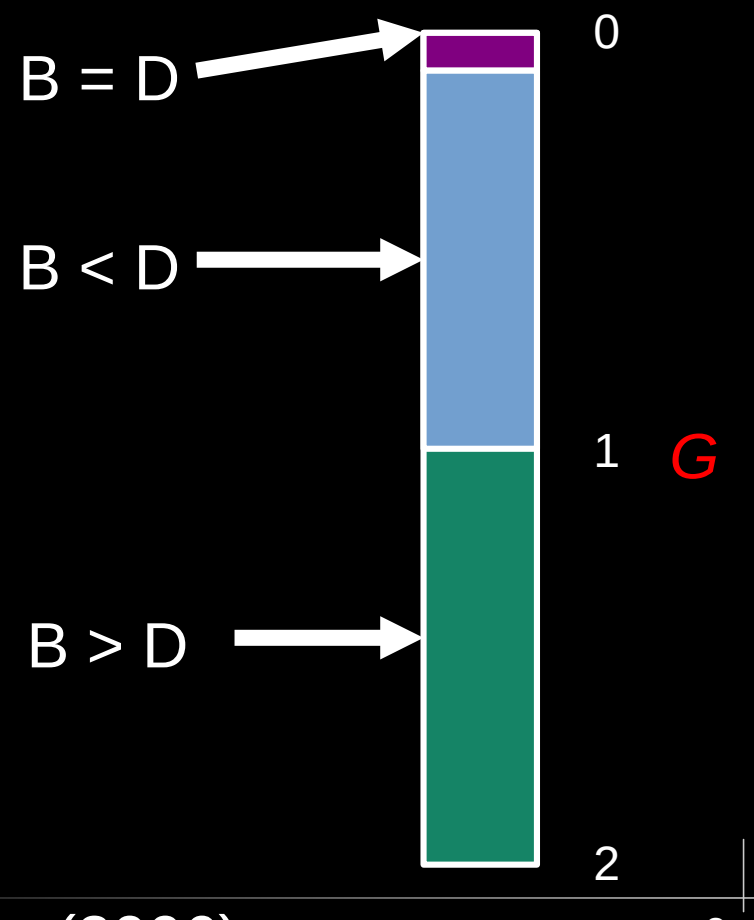
Key reading: Roberts & Pashler (2000)

Parameter Space Partitioning

A+	AB+	B
	CD+	D

$\Delta w = G(\lambda - \Sigma w)$

	Model	Data
B < D	✓	✓
B > D	✓	X
B = D	✓	X

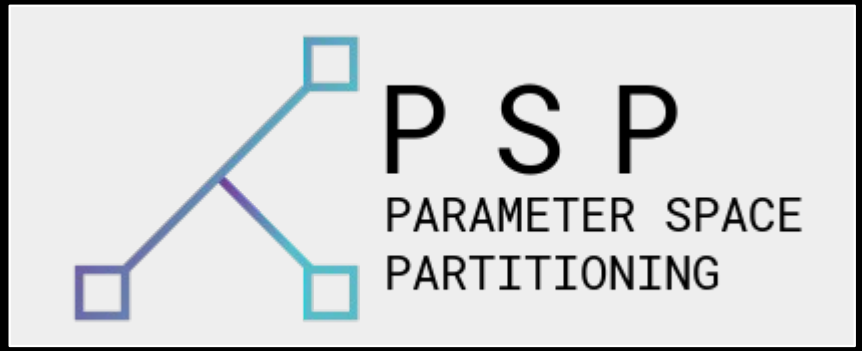


Key reading: Pitt, Kim, Navarro & Myung (2006)

PSP: Implementation

- Generalizes to *N* parameters.
- Grid search is slow and likely to miss things, particularly as N rises.
- Computationally intensive:
  - Efficient model code
  - Efficient PSP code
  - Multi-core compatible

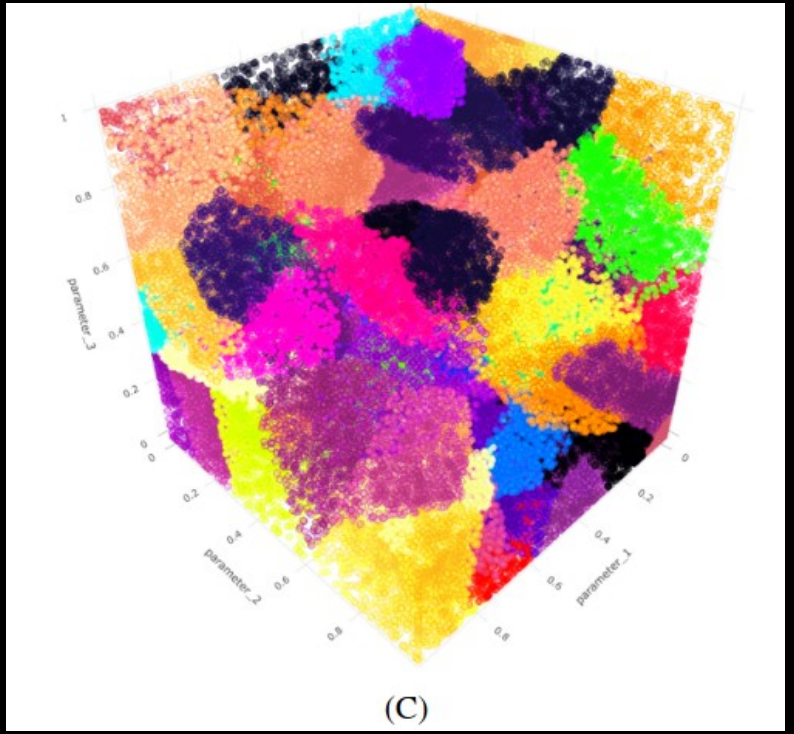
Help is at hand!



lenarddome.github.io/software/psp/

PSP: Implementation

- Pick a point
  - Run model
  - Discretize pattern
  - Look at close-by points
  - Repeat
- New pattern?
  - New, parallel, search from that point.

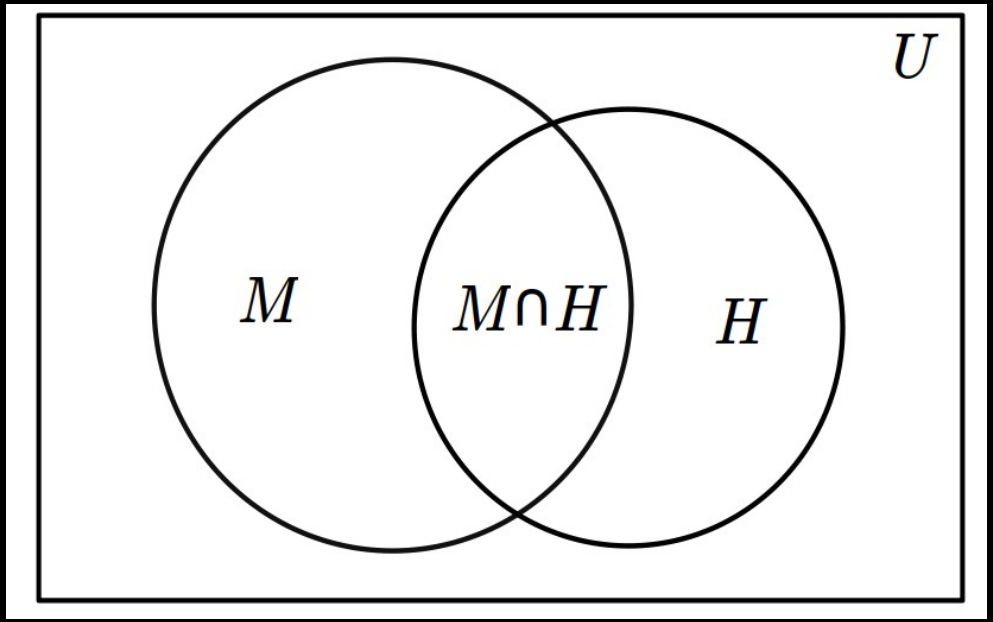


https://vimeo.com/652405415

Computationally intensive

Accommodation and prediction

- **Accommodation:** Pattern observed in both human and model.
- **Prediction:** Pattern observed in model but not (yet) in human.



Dome & Wills (in prep.)

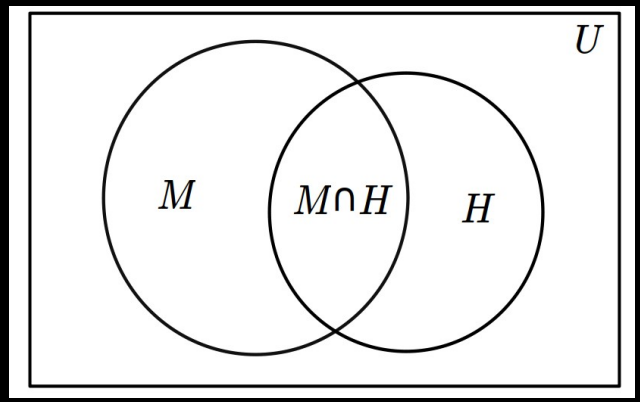
Accommodation and prediction

- **Accommodation:** Pattern observed in both human and model.

$$\alpha = \frac{|M \cap H|}{|H|}$$

- **Prediction:** Pattern observed in model but not (yet) in human.

$$\beta = \frac{|M \cap H'|}{|H'|}$$



Dome & Wills (in prep.)

Formal models of the IBRE

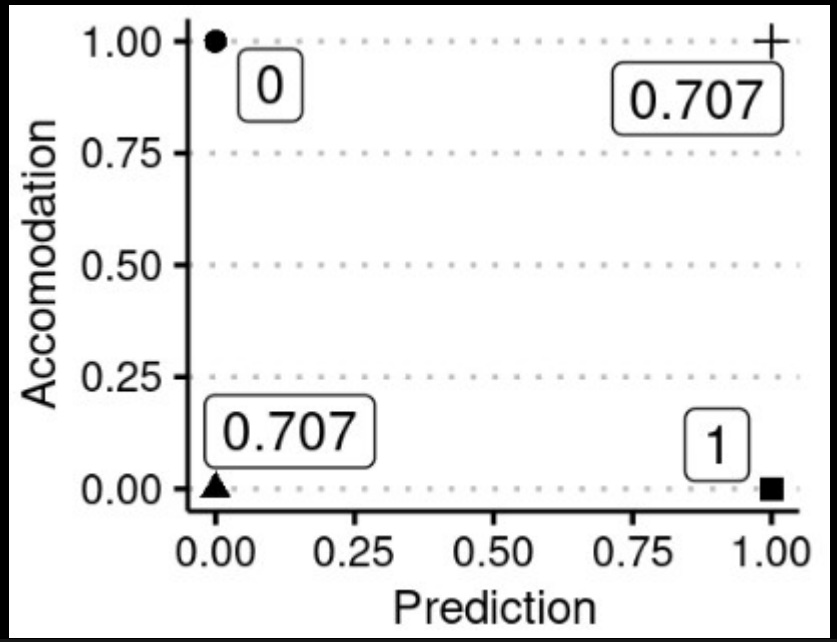
	α	β
Ideal model*	1	0
EXIT		
Full	.09	.17
CAG	.03	.03
RAS	.05	.08
DGCM		
(2007)	.38	.92
(2018)	.12	.12
Known weak model **	.01	0

* Under conditions of complete information

** Gluck & Bower (1988), does not capture group-level IBRE effect.

Dome & Wills (in prep.)

g-distance



$$g = \sqrt{w_\alpha (1-\alpha)^2 + (1-w_\alpha)(0-\beta)^2},$$

Summary

- Formal models are great!
- A good fit is not persuasive
- Parameter space partitioning provides an alternative
- Assess models by:
  - Accommodation
  - Prediction
  - g-distance

Thanks for listening!