How do human beings reason when the conditions for rationality postulated by the model of neoclassical economics are NOT met? Herbert A. Simon

Homo Heuristicus

Why Biased Minds Make Better Inferences

Gerd Gigerenzer

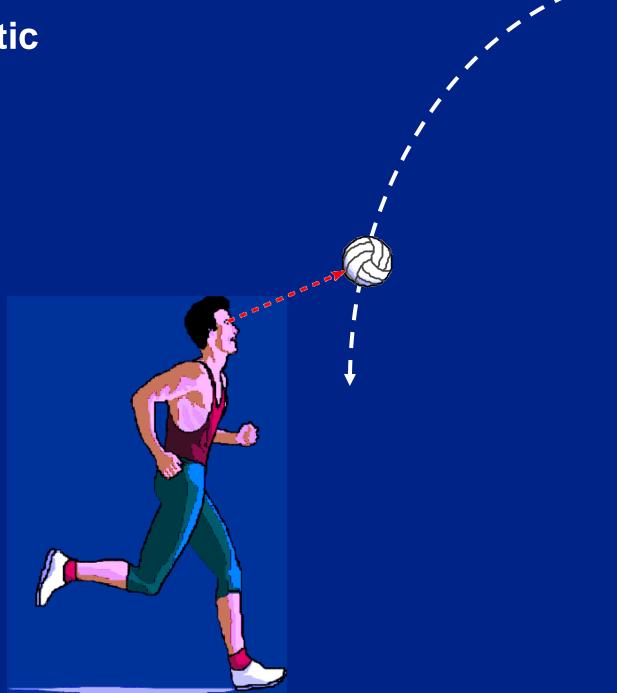
Max Planck Institute for Human Development Berlin



When a man throws a ball high in the air and catches it again, he behaves as if he had solved a set of differential equations in predicting the trajectory of the ball... At some subconscious level, something functionally equivalent to the mathematical calculation is going on.

Richard Dawkins, The Selfish Gene

-





As-if Models and Process Models Generate Different Predictions About Behavior

	As-if model	Gaze heuristic
Player's goal	Compute landing point	Intercept ball
Prediction 1	Runs to landing point and waits to catch ball	Intercepts ball while running ✓
Prediction 2	Runs in a straight line	Runs in a slight arc√
Prediction 3	Knows where the ball is landing	Does not know√

"The Miracle on the Hudson River" US Airways Flight 1549



January 15, 2009

Will the plane make it to LaGuardia Airport?

"It's not so much a mathematical calculation as visual, in that when you are flying in an airplane, a point that you can't reach will actually rise in your windshield. A point that you are going to overfly will descend in your windshield."

> Jeffrey Skiles Co-pilot, US Airways Flight 1549

Research Questions

I. The (Descriptive) Study of the Adaptive Toolbox What Heuristics Do People Use?

II. The (Normative) Study of Ecological Rationality When Are Heuristics Successful?

III. Intuitive Design

How to Design Decision Systems and Environments?

I. The Study of the Adaptive Toolbox

Research Questions

What core capacities do heuristics exploit? What are the building blocks of heuristics? How do people learn and select heuristics in an adaptive way?

Gigerenzer & Gaissmaier (2011). Heuristic decision making. Annual Review of Psychology.

Core Capacities and Heuristics in the Adaptive Toolbox

1. Recognition

Recognition heuristic: Goldstein & Gigerenzer, *Psychological Review* 2002 Fluency heuristic: Schooler & Hertwig, *Psychological Review* 2005

2. Divide Equally

1/N: DeMiguel et al. 2009, *Review of Financial Studies* Tallying: Gigerenzer & Goldstein, *Psychological Review* 1996

3. Order

Fast-and-frugal trees: Martignon, Katsikopoulos, & Woike, *J of Math Psych* 2008 Take-the-best: Gigerenzer & Goldstein, *Psychological Review* 1996 Priority heuristic: Brandstätter, Gigerenzer, & Hertwig, *Psych Review* 2006, 2008

4. Reciprocity

Tit-for-tat: Volstorf, Rieskamp, & Stevens, PLoS ONE

5. Imitation

Imitate the majority/successful: Garcia-Retamero et al, in press.

6. Trust

Default heuristic: Pichert & Katsikopoulos, *J of Environmental Psychology* 2008 White-coat heuristic: Wegwarth & Gigerenzer, in press

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Which US city has more inhabitants, Detroit or Milwaukee?

Americans: 60% correct

Germans: 90% correct

Recognition Heuristic

If one of two objects is recognized and the other is not, then infer that the recognized object has the higher value.

Ecological Rationality

The heuristic is successful when ignorance is systematic rather than random, that is, when the recognition validity $\alpha > .5$.

Goldstein & Gigerenzer, 2002, Psychological Review



Wednesday, 12.06.1997

70 p #39987698

Manchester United vs. Shrewsbury Town

Bast Het Greek

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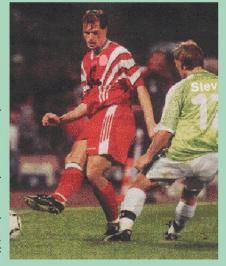
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Դերքները հունչերն նարձել իրես ապատունի, այդ հերքները եր հետ Դերքենը առաջ հատերալու առաջ հատերաների հետ նախ դեր «Դերքումը իրեսը» հետումիս առաջունը հետ հետը հետումը ու հետումիս հատ ել հատերալու հատերան հատերաներին հետումը ստ Հայ հունչերում պատումին հետ Դերքենը չու սա ու հեղեն հունչի չու ծուսալ։

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The Less-is-More Effect

The expected proportion of correct inferences c is

$$C = \frac{2n(N-n)}{N(N-1)} \alpha + \frac{(N-n)(N-n-1)}{N(N-1)} \frac{1}{2} + \frac{n(n-1)}{N(N-1)} \beta$$

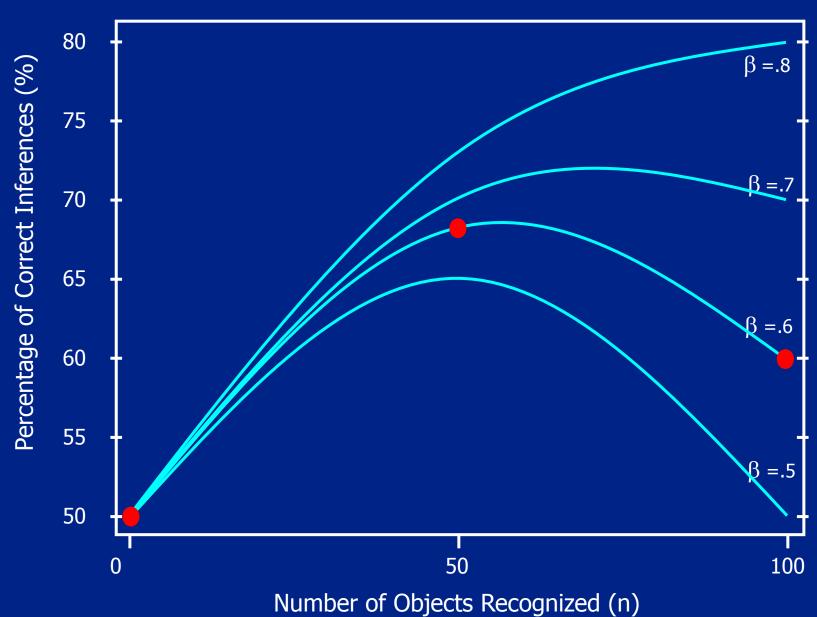
where

- *n* is the number of recognized objects
- *N* is the total number of objects
- α is the recognition validity, and
- β is the knowledge validity

A less-is-more effect occurs when

 $\alpha > \beta$

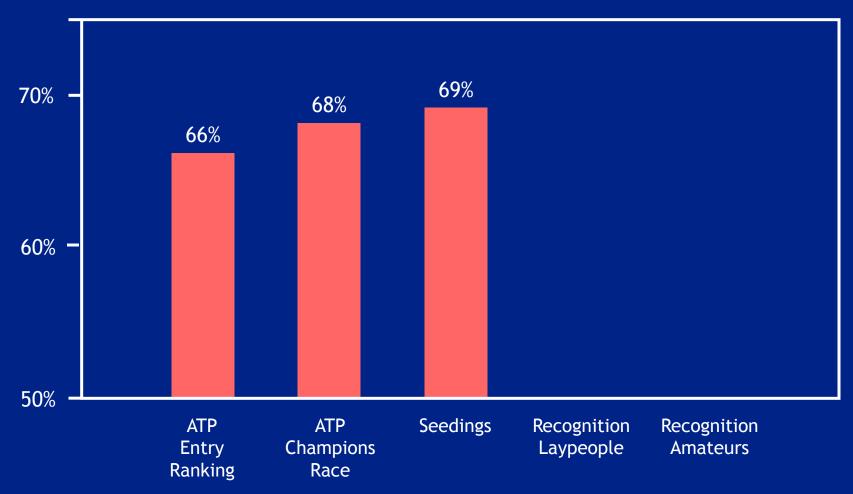
Goldstein & Gigerenzer, 2002, Psychological Review





Wimbledon 2003

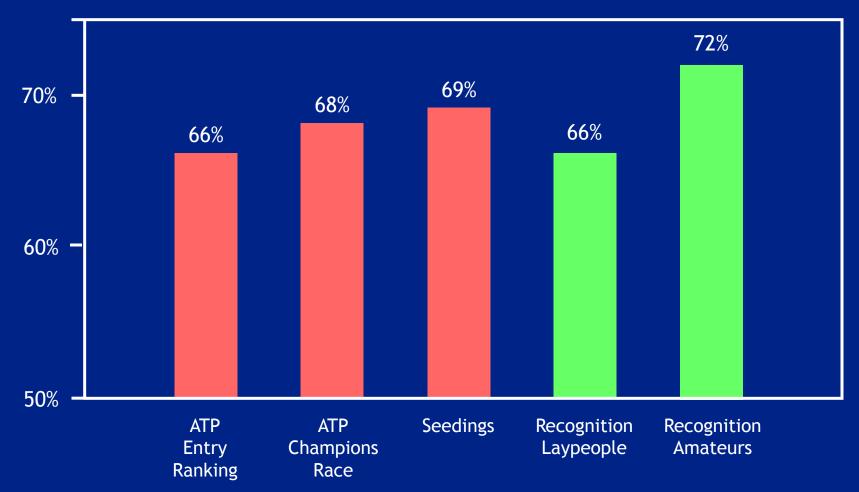




Frings & Serwe (2004)

Wimbledon 2003





Research Questions

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III. Intuitive Design How to Design Decision Systems and Environments? *II. The Study of Ecological Rationality*

Research Questions

What environmental structures – social and physical – can heuristics exploit? How do simplicity, robustness, and bias lead to better decisions? Do rational analyses of "small" worlds tell us what is rational in uncertain worlds?

Todd, Gigerenzer, & ABC Research Group, in press. *Ecological rationality; Intelligence in the world.* Oxford University Press

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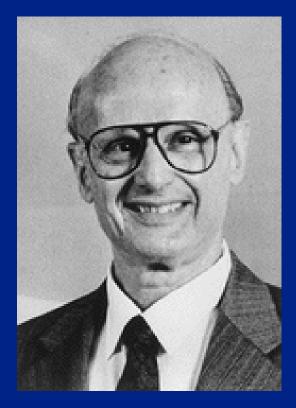
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6. Trust

Default heuristic: Pichert & Katsikopoulos, *J of Environmental Psychology* 2008 White-coat heuristic: Wegwarth & Gigerenzer, in press

How to make investment decisions?

Optimal Asset Allocation Policy "Mean-Variance-Model"

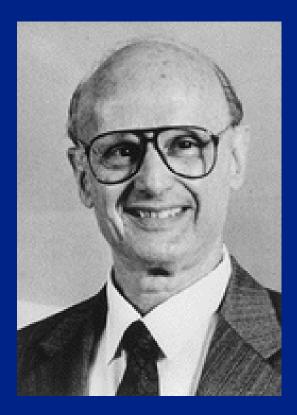


Harry Markowitz

Optimization or Heuristic?

Optimal Asset Allocation Policy "Mean-Variance-Model"

1/N Allocate your money equally to each of N funds

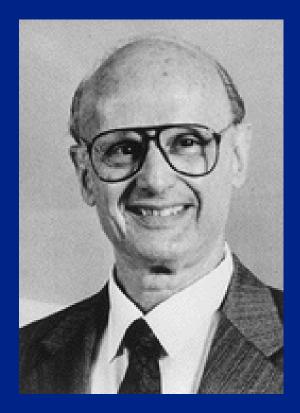


Harry Markowitz

When Is 1/N Better Than Optimization?

1/N Allocate your money equally to each of N funds

1/N is ecologically rational if:
1. Predictive uncertainty: *large* 2. N: *large* 3. Learning sample: *small*



Harry Markowitz

DeMiguel et al. 2009, Review of Financial Studies

Mit nobelpreisgekrönter Strategie zum Anlageerfolg!

Kennen Sie Harry M. Markowitz? Nein? Dann sollten Sie ihn kennenlernen: Der amerikanische Wissenschaftler erhielt im Jahr 1990 den Nobelpreis für Wirtschaftswissenschaften. Mit seiner Portfoliotheorie hatte er nachgewiesen, dass die richtige Gewichtung von Einzelwerten das Chancen-Sicherheits-Verhältnis eines Wertpapierdepots erheblich optimieren kann.

So viel zur Theorie. Die Depots der meisten Anleger sehen jedoch anders aus. Da sie oftmals eher willkürlich denn systematisch zusammengestellt worden sind besteht starker Optimierungsbedarf.



10/2007

II. The Study of Ecological Rationality

Simplicity Fosters Robustness

But How to Simplify?

Core Capacities and Heuristics in the Adaptive Toolbox

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Default heuristic: Pichert & Katsikopoulos, *J of Environmental Psychology* 2008 White-coat heuristic: Wegwarth & Gigerenzer, in press Heuristics have biases (ignore information) to improve out-of-sample prediction

Take-the-best

- Search rule: Look up the cue with the highest validity.
- Stopping rule: If cue values differ (+/-), stop search. If not, look up next cue.
- Decision rule: Predict that the alternative with the positive cue value has the higher criterion value.

Bias: ignore cues

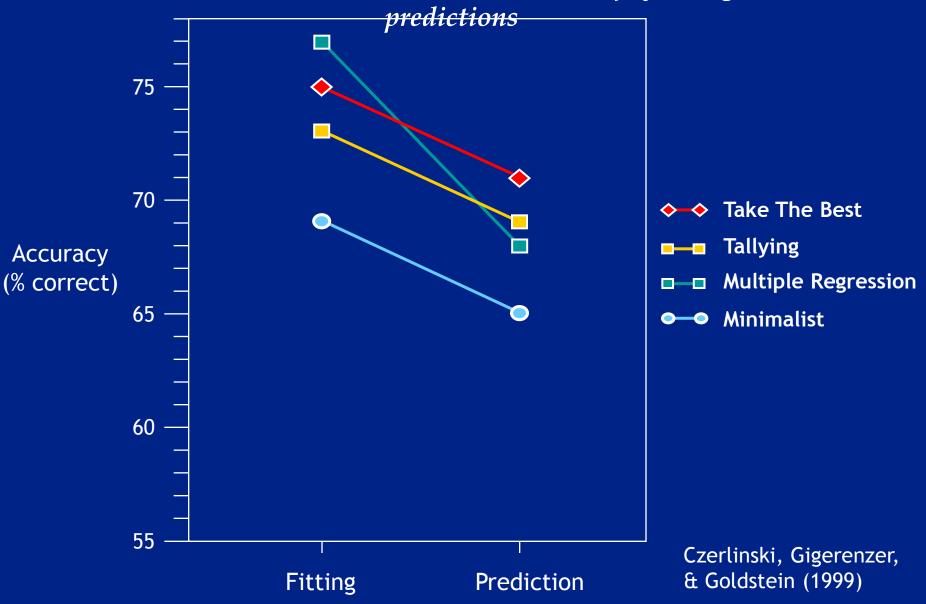
Tallying

- Search rule: Look up cues in random order.
- Stopping rule: After m $(1 < m \le M)$ cues, stop search.
- Decision rule: Predict that the alternative with the higher number of positive cue values has the higher criterion value.

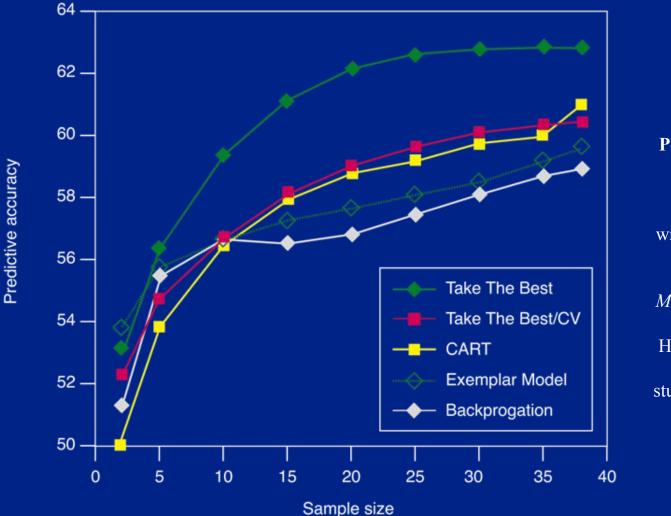
Bias: ignore weights

Less Can Be More:

20 Studies on economic, educational, and psychological



Which Chicago High. School has the higher drop-out rate? Cues: attendance rate, writing score, social science test score, % Hispanic students, % students with limited English, % African American students, etc



Policy Implications

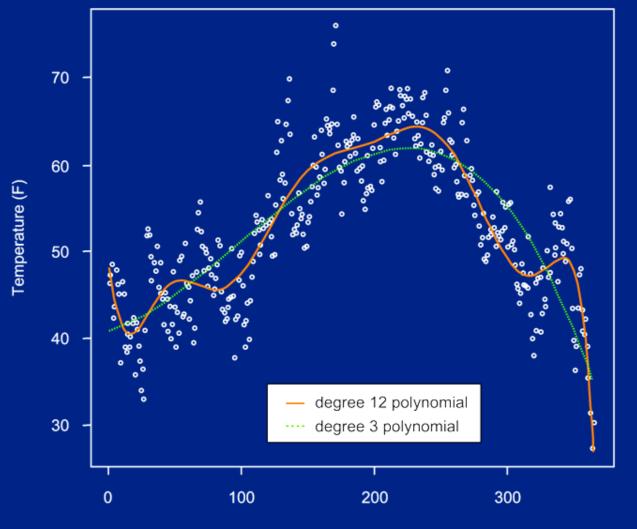
Take-the-best: attendance rate; writing score; social science score.

Multiple regression: percentage of Hispanic and Black students, students with limited English.

The Bias-Variance Dilemma in Prediction

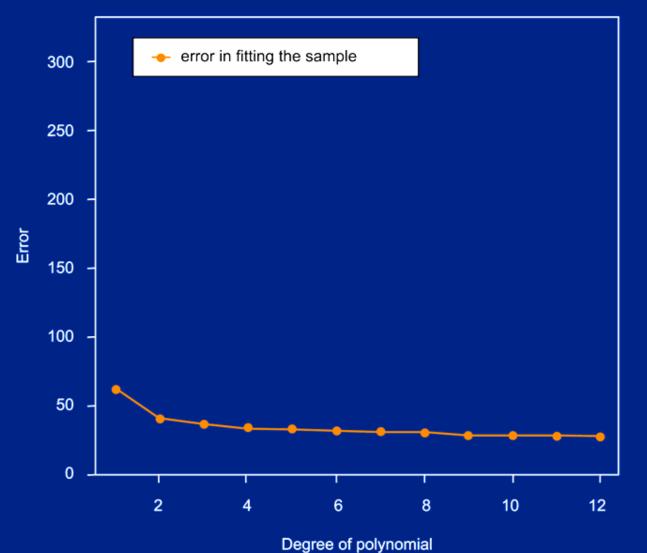
total error = $(bias)^2$ + variance + noise

Temperature in London 2000

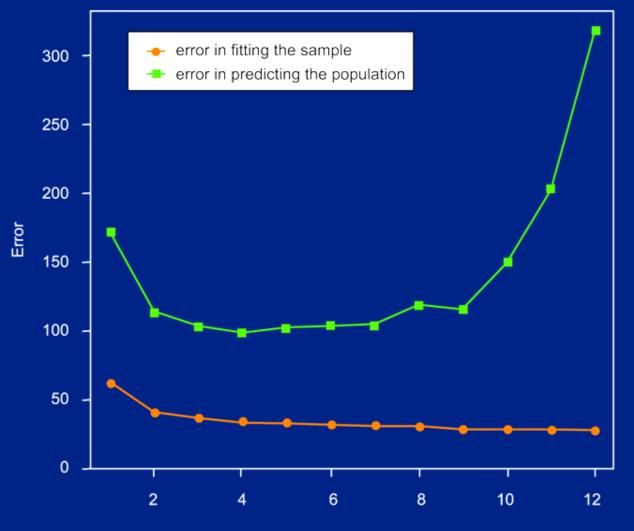


Days since 1st January, 2000

More Is/Bettes-Bettiendsightti(Figtting)

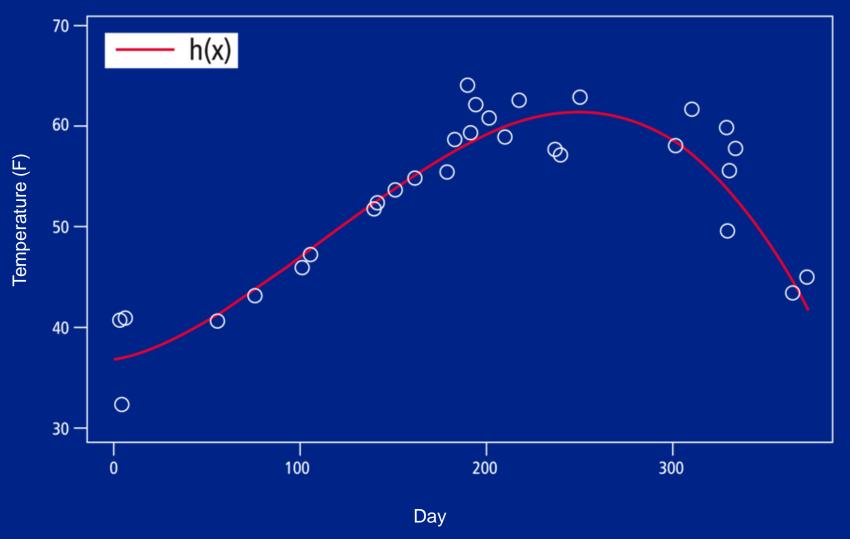


Less-Is-More in Prediction

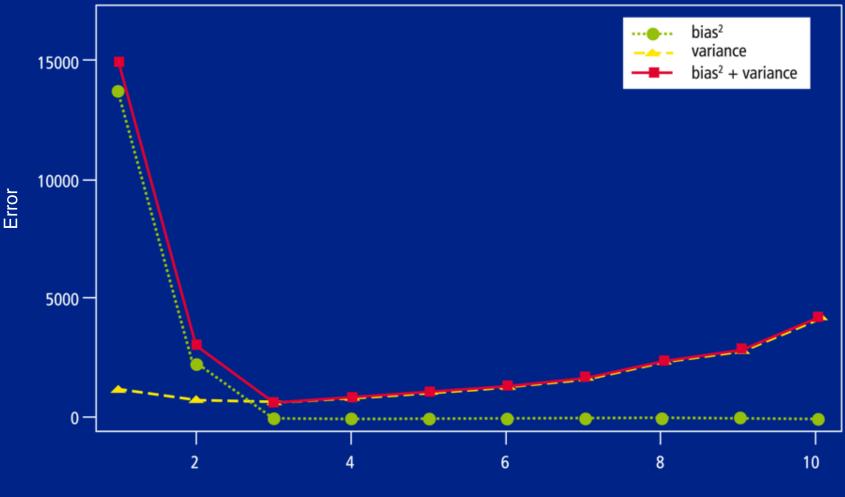


Degree of polynomial

A Fictional Temperature Function h(x) to Demonstrate Bias and Variance



Bias and Variance in Prediction



Degree of Polynomial

Research Questions

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III. Intuitive Design How to Design Decision Systems and Environments? III. How to Design Decision Systems and Environments? Intuitive Design

Research Questions

How to design expert systems that embody intuitive principles?

How to design environments – social and physical – that match intuitive principles?

The heart disease predictive instrument (HDPI)

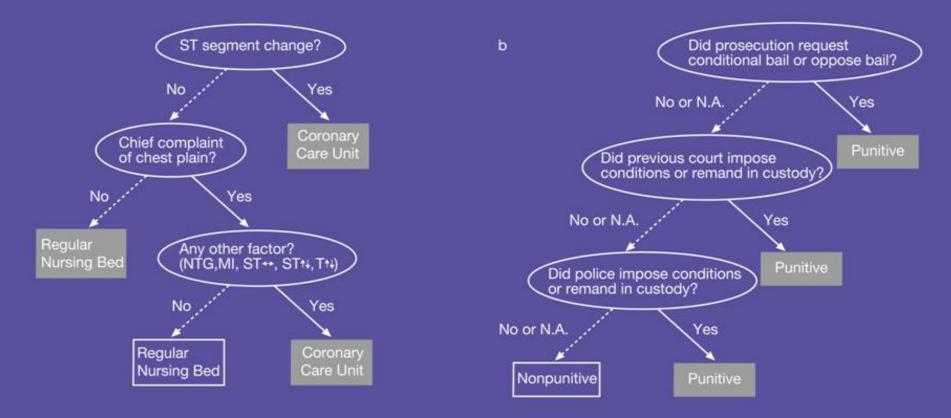
History	ST&T Ø	ST⇔	т∬Џ	ST⇔	ѕт⇔ѧт̂ПЏ	ѕтՈ҄↓ѧтՈ
NO MI& NO NTG	19%	35%	42%	54%	62%	78%
MI or NTG	27%	46%	53%	64%	73%	85%
MI and NTG	37%	58%	65%	75%	80%	90%
	Chest P	ain, NOT	Chief C	omplain	t	
		KG (ST, T				
History	ST&T Ø	ST⇔	т∬∜	ST⇔	ѕт⇔&тîіЏ	ѕтՈ҄∜&тՈ
NO MI& NO NTG	10%	21%	26%	36%	45%	64%
MI or NTG	16%	29%	36%	48%	56%	74%
MI and NTG	22%	40%	47%	59%	67%	82%
		No Ches	st Pain			
	EI	(G (ST, T	wave ∆'	s)		

See reverse for definitions and instructions

Fast-and-Frugal Trees: Deliberate and Intuitive Judgments

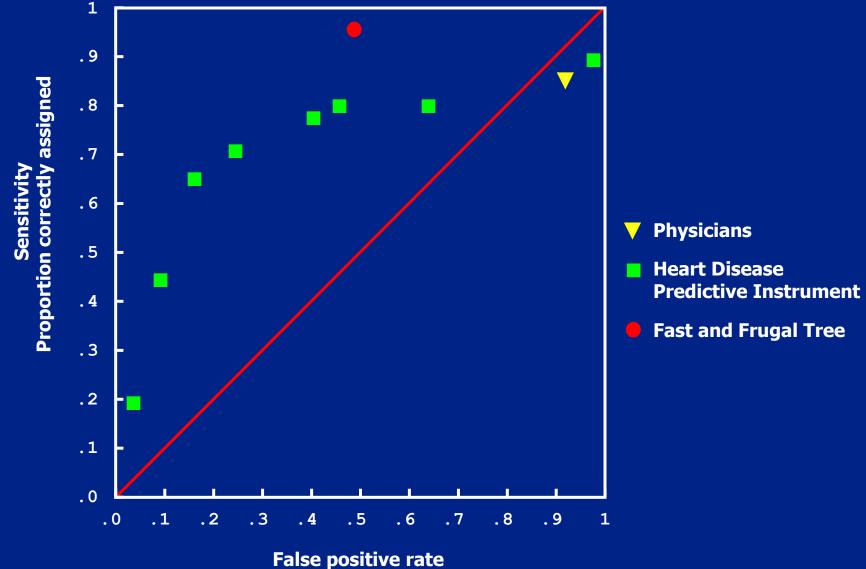
Coronary Care Unit Allocation

Bail Decisions in London Courts



Gigerenzer, Hertwig & Pachur (Eds). *Heuristics: The foundations of adaptive behavior*. Oxford University Press 2011

Emergency Room Decisions: Admit to the Coronary Care Unit?

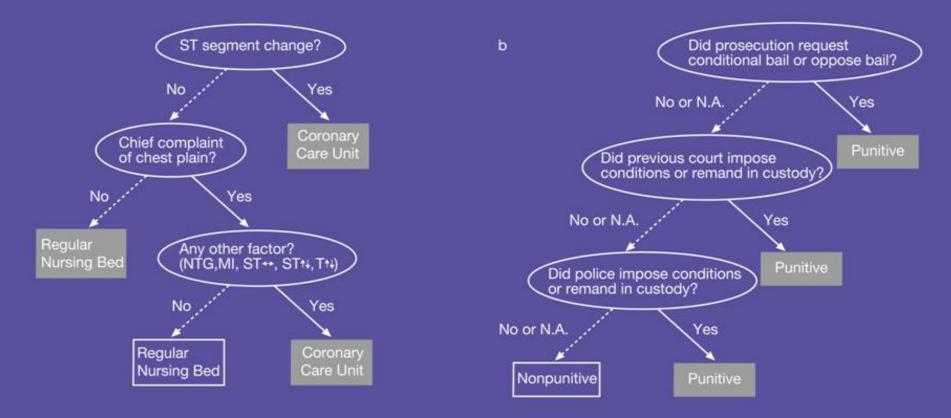


Proportion of patients incorrectly assigned

Fast-and-Frugal Trees: Deliberate and Intuitive Judgments

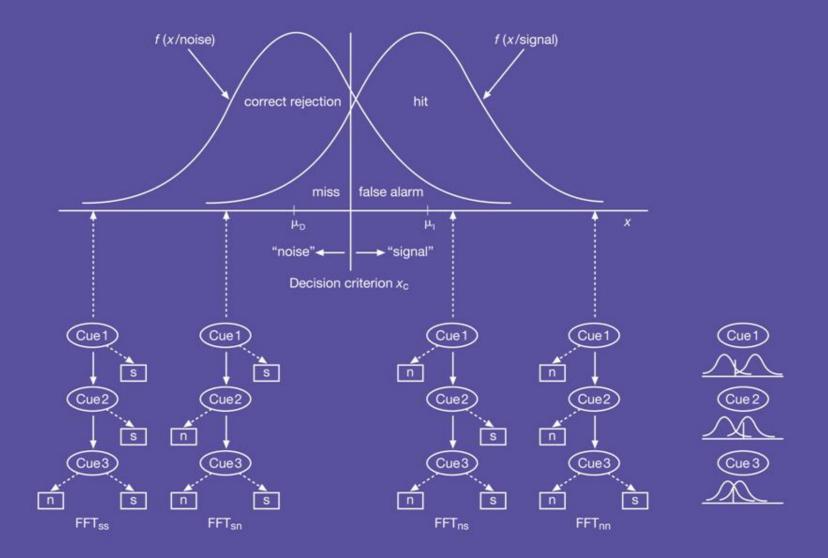
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A Signal-Detection-Analysis of Fast-and-Frugal Trees



Luan, Schooler & Gigerenzer 2011 Psychological Review

Three Misconceptions

- 1. Heuristics produce second-best results; optimization models are always better.
- 2. People rely on heuristics because of the accuracy-effort trade-off.
- 3. More information, time, and computation is always better.

Rationality in uncertain worlds

Heuristics ignore information (Bias)

Bias protects against Variance

Less-is-more: Heuristics can make better inferences than complex models

Ecological rationality

HEURISTICS

THE FOUNDATIONS OF ADAPTIVE BEHAVIOR

EDITED BY GERD GIGERENZER, RALPH HERTWIG, AND THORSTEN PACHUR

OXFORE

Oxford UP 2011