Optimal Stopping: The Science of When to Stop Looking

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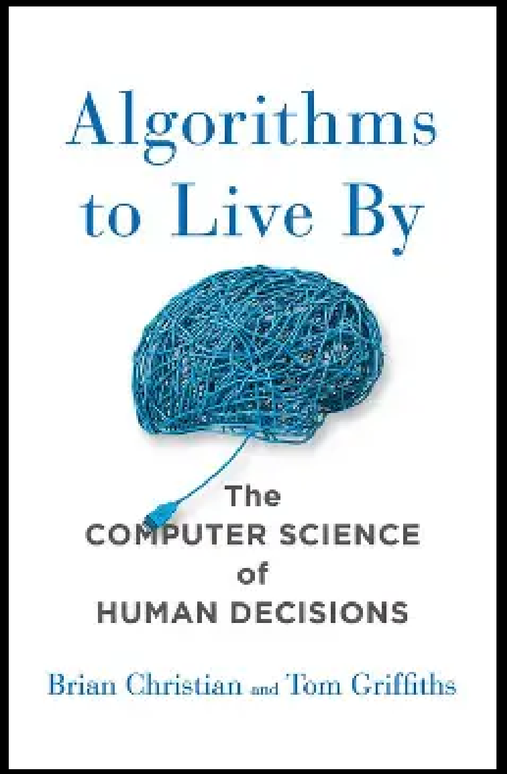
November 3rd , 2025



Tom Griffiths

Brian Christian

“ If you prefer Mr. Martin to every other person; if you think him the most agreeable man you have ever been in company with, why should you hesitate? ”

—JANE AUSTEN, EMMA

The Secretary Problem

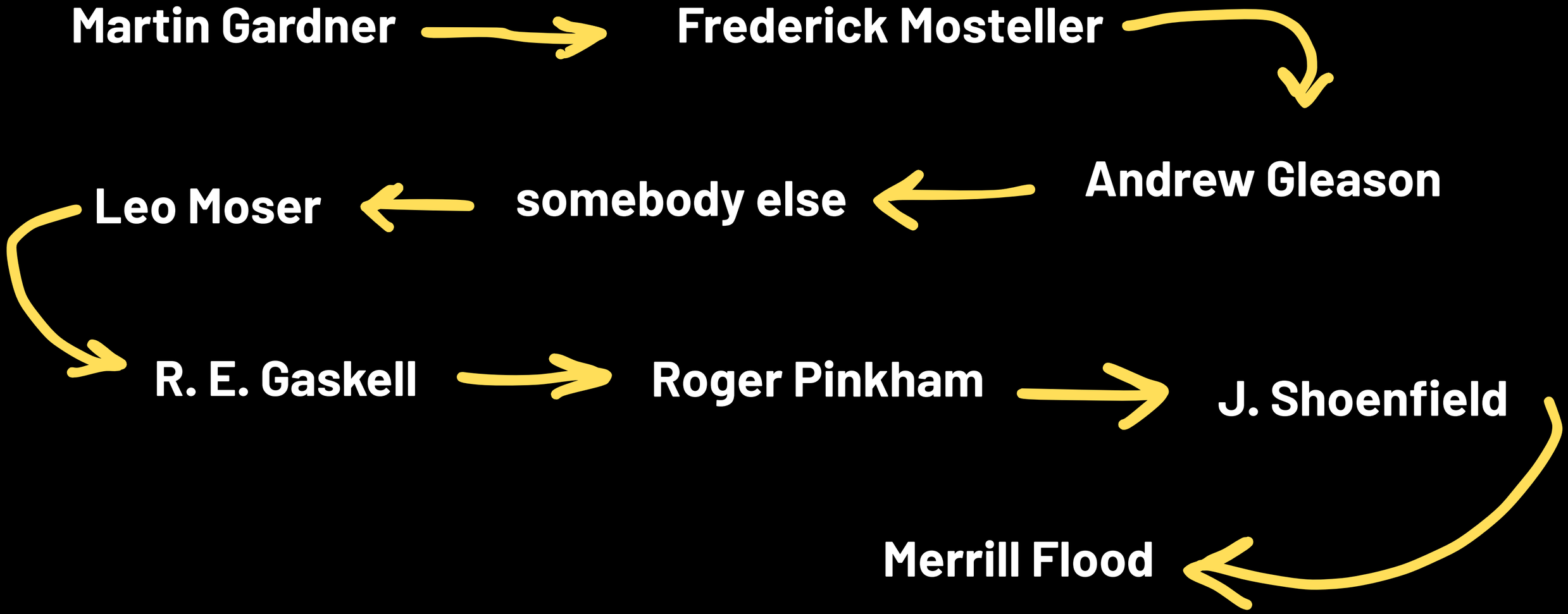
Secretary Problem

- We have a **single** secretary position
- There are **n** candidates
- We will hold interviews and hire one of them

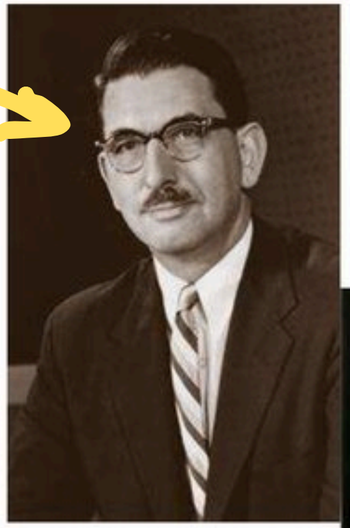
Assumptions

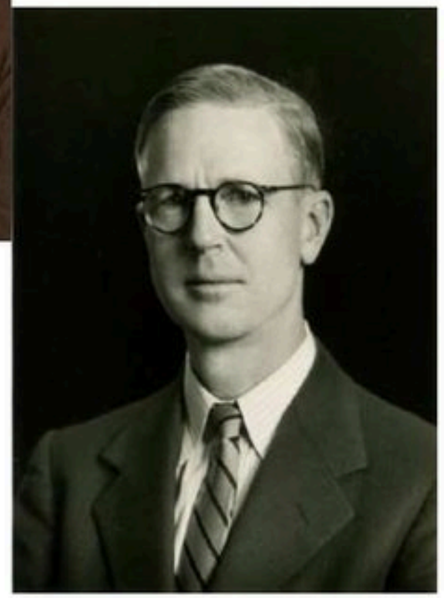
- All candidates can be **totally ordered** without tie
- The candidates arrive at a sequentially **random order**
- We can only determine the **relative ranks** of the candidates (among all interviewed candidates)
- We only aim at the **best candidate**, no one less will do
- **Irrevocable** decision is made **immediately** after the interview
- The value of **n** is known to us

history of secretary problem



Flood



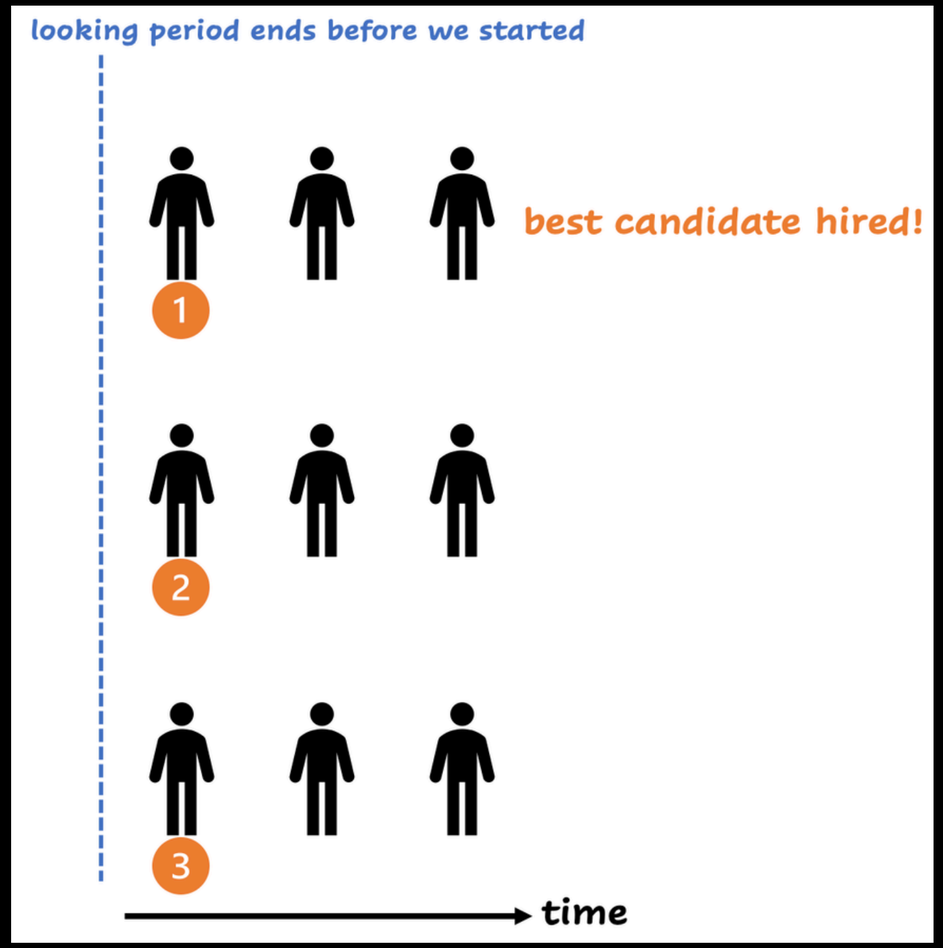


It was first considered mathematically in the 1930s by Merrill Flood who was looking to solve a school bus routing problem. Hassler Whitney at Princeton University introduced the name travelling salesman problem soon after.

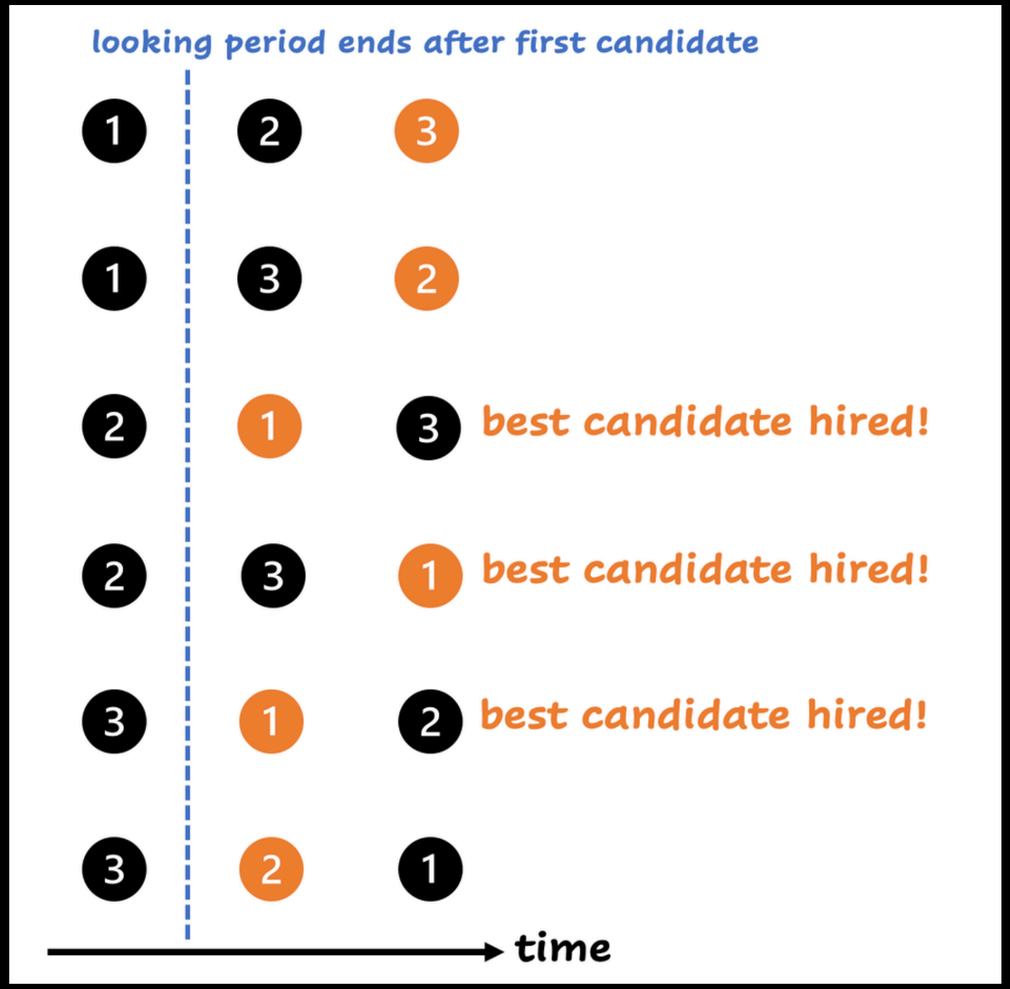
What is the best strategy for the secretary problem?

When to stop?

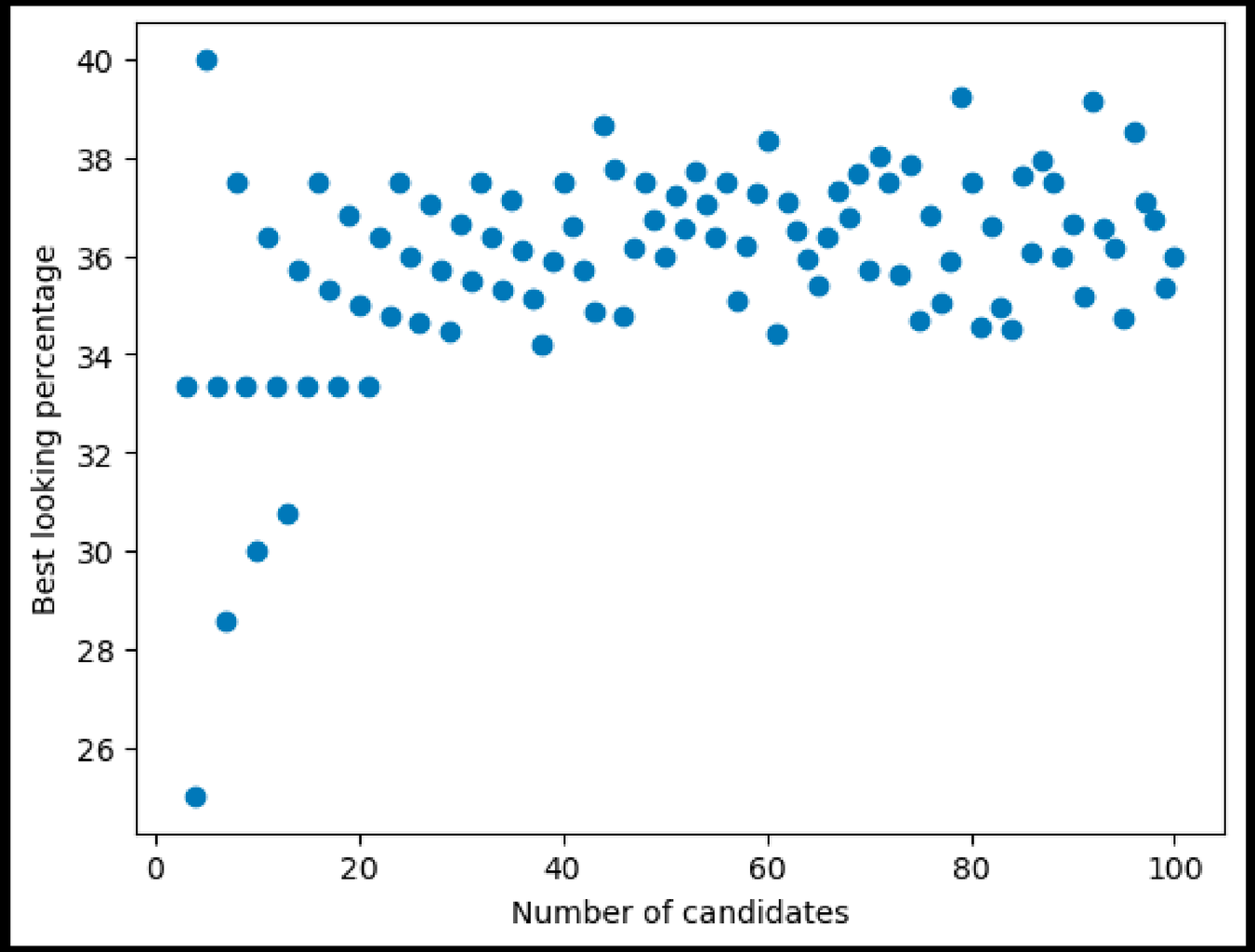
Scenario 1: don’t look, directly leap.



Scenario 2: don’t hire the first candidate, then hire the next if that one is better, else hire the last

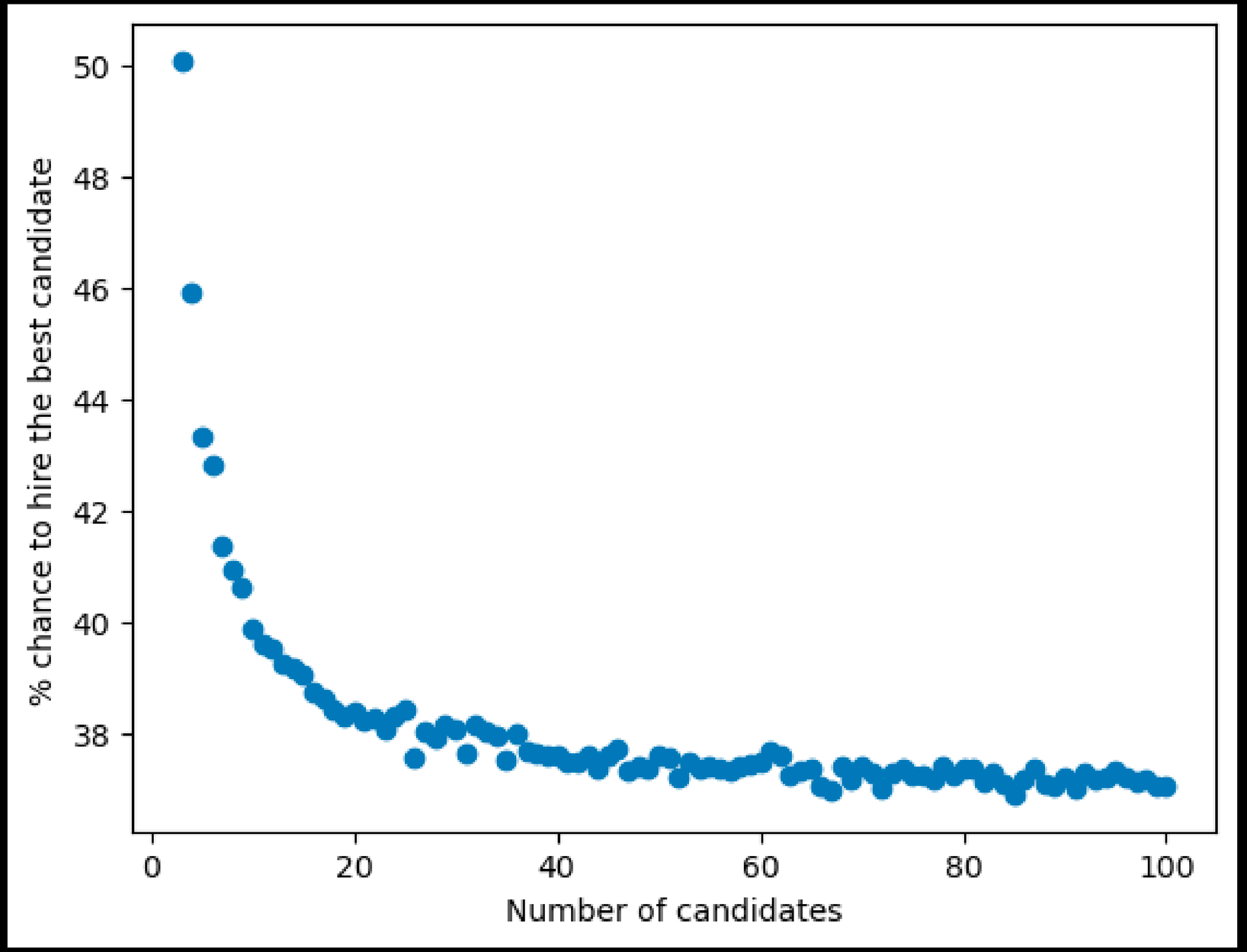


For a given number of candidates we can calculate the optimal stopping percentage with simulation.



37% Rule

The optimal time to stop "looking" and start "leaping" is after you have seen 37% of the options (or spent 37% of your total search time). This specific number (mathematically 1/e) gives you the highest possible chance of success.



Percentage of cases in which you hire the best candidate if you stick to the best looking percentage.

Number of Applicants	Take the Best Applicant After	Chance of Getting the Best
3	1 (33.33%)	50%
4	1 (25%)	45.83%
5	2 (40%)	43.33%
6	2 (33.33%)	42.78%
7	2 (28.57%)	41.43%
8	3 (37.5%)	40.98%
9	3 (33.33%)	40.59%
10	3 (30%)	39.87%
20	7 (35%)	38.42%
30	11 (36.67%)	37.86%
40	15 (37.5%)	37.57%
50	18 (36%)	37.43%
100	37 (37%)	37.10%
1000	369 (36.9%)	36.81%

Lover’s Leap

Michael Trick

Johannes Kepler

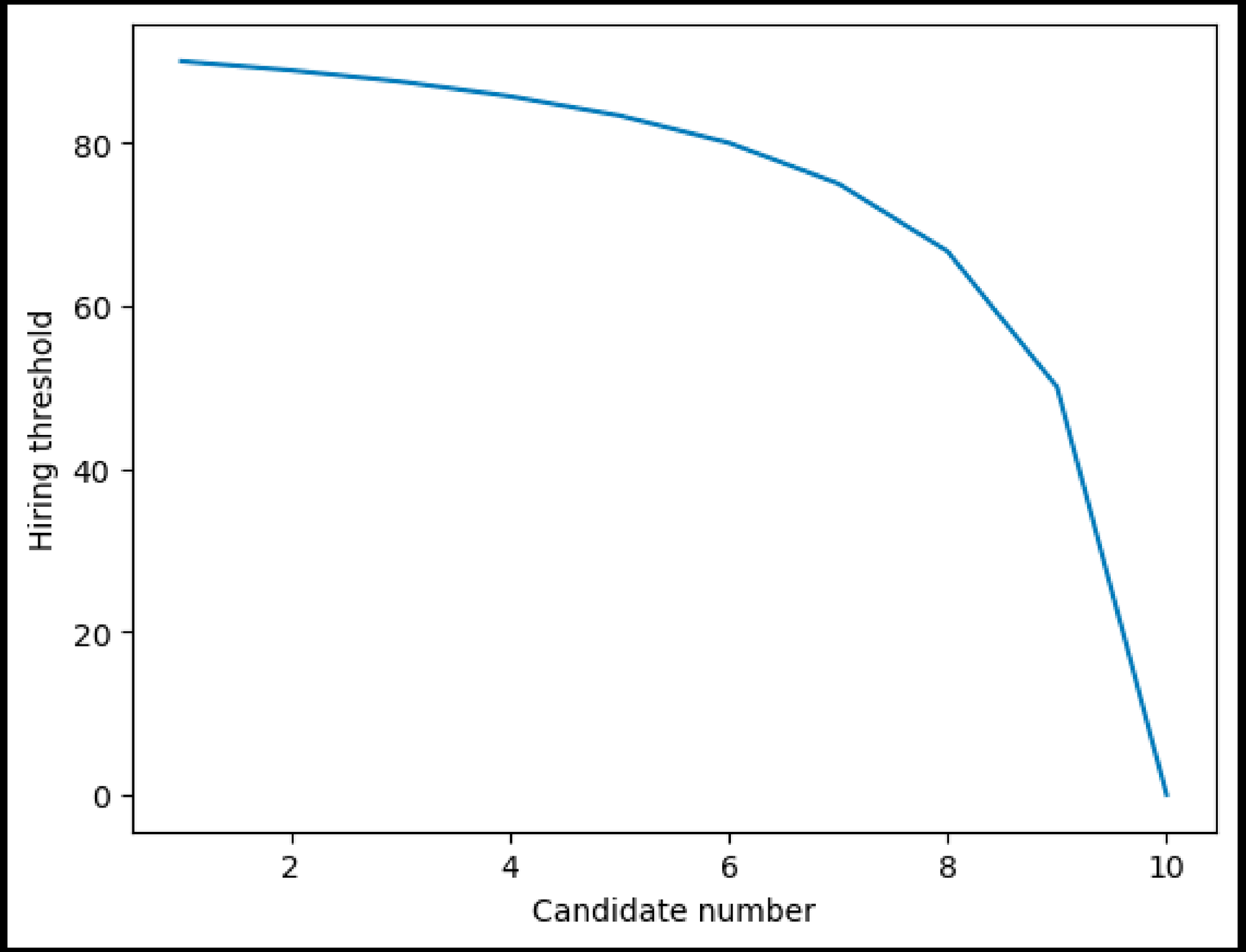
No information vs. full information

When you have an objective score (like a percentile or a price), you're in a "full information" game. The strategy changes to the "Threshold Rule": set a high threshold when you have many options, and lower it as your options dwindle.

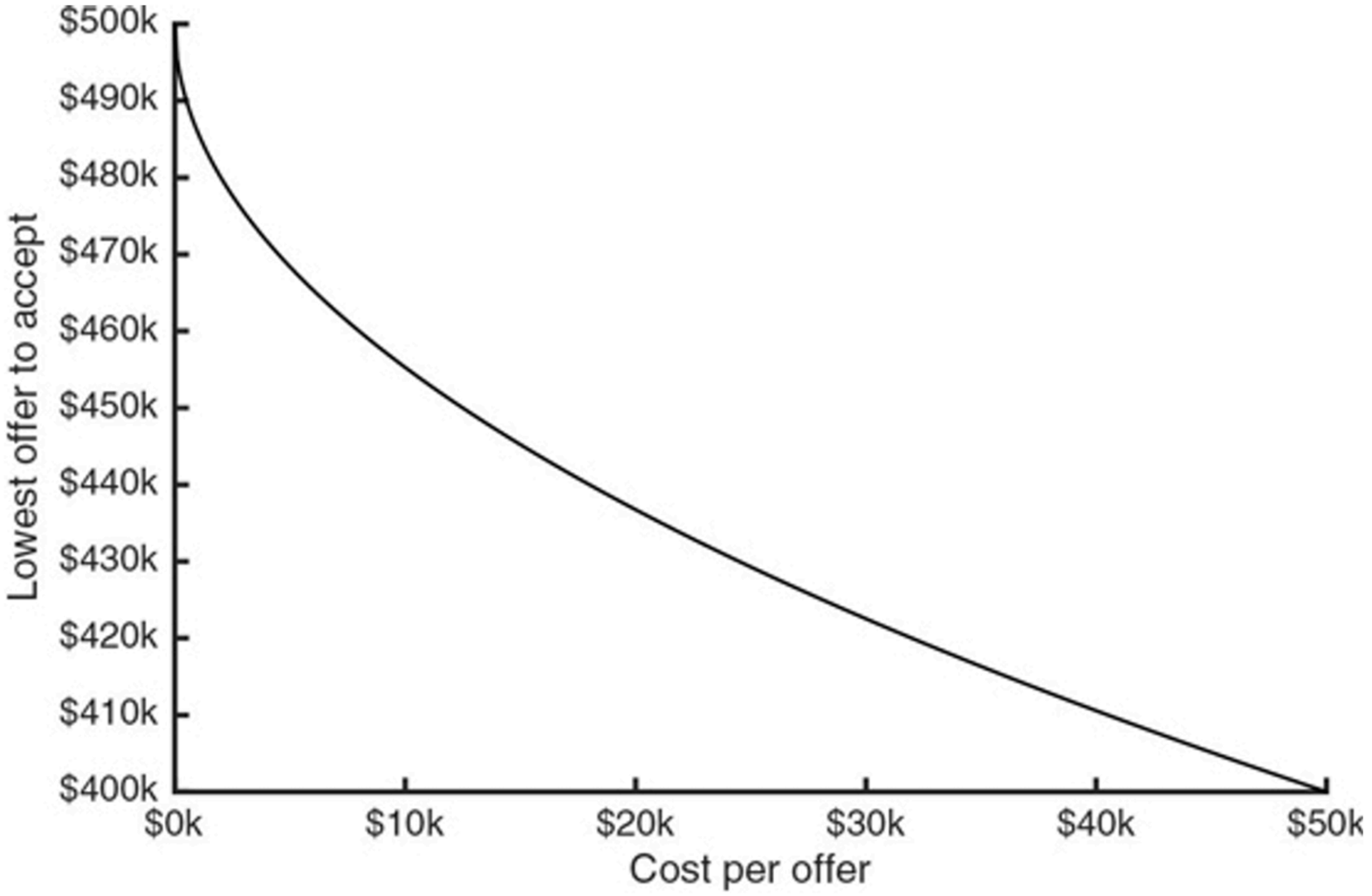
Threshold Rule In Machine Learning

A model might output a probability (e.g., spam email = 0.8).

If that probability > 0.5, it’s classified as “spam”; otherwise, “not spam.”


Hiring threshold
80
60
40
20
0
2
4
6
8
10
Candidate number

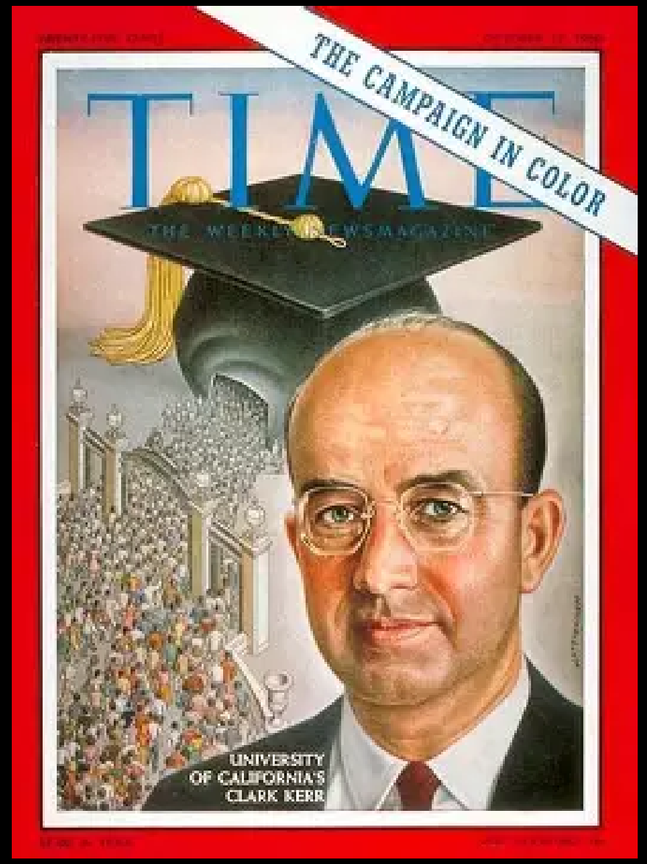
When to sell



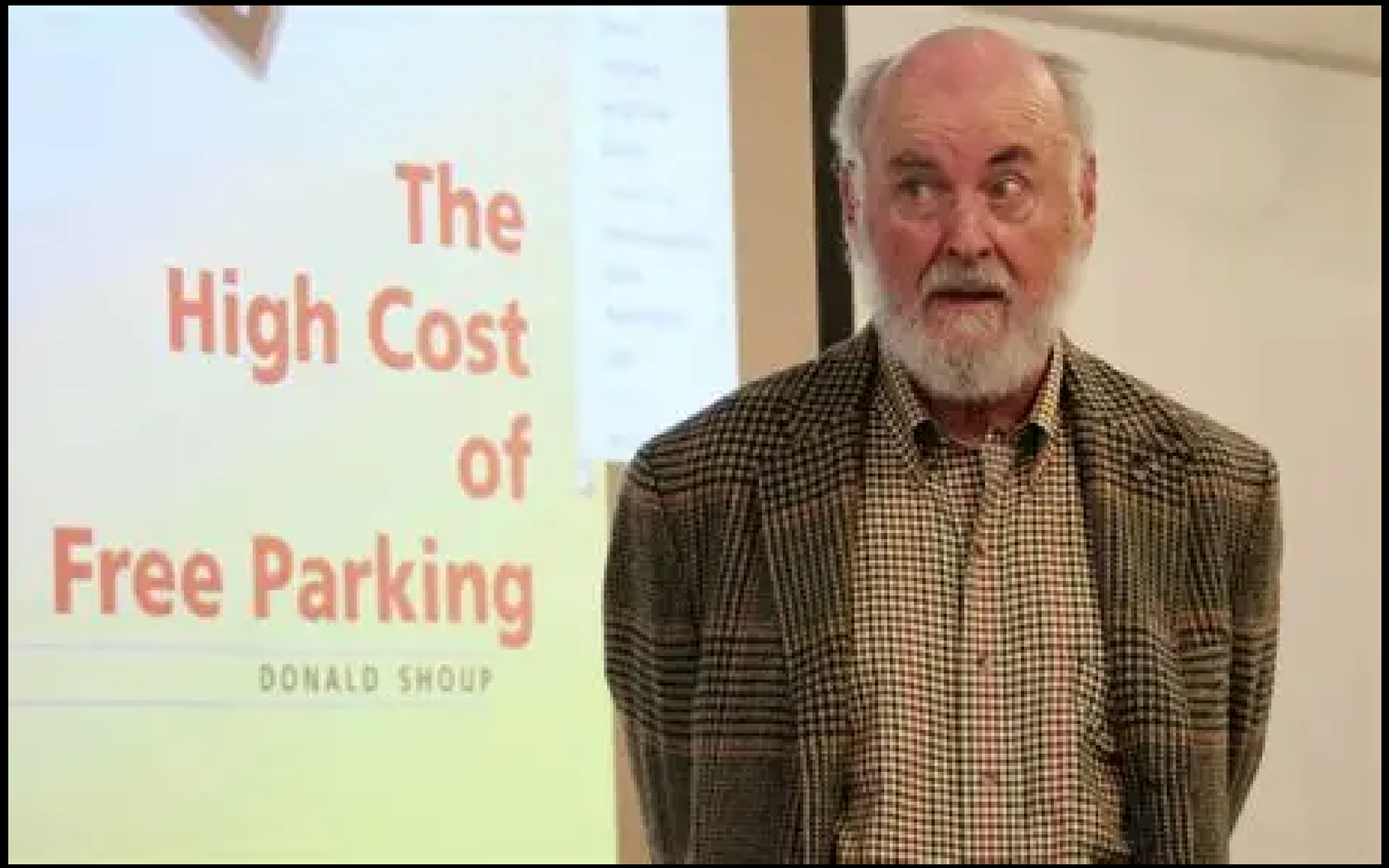
Optimal stopping thresholds in the house-selling problem.

When to Park

“I find that the three major administrative problems on a campus are sex for the students, athletics for the alumni, and parking for the faculty.”



CLARK KERR, PRESIDENT OF UC BERKELEY, 1958–1967



Donald Shoup

occupancy rate

The proportion of all parking spots that are currently occupied.

The higher the occupancy rate (how full the spots are), the earlier you must start your "leap" phase. If 99% full, start looking 70 spots away. If 85% full, you can wait until you're 5 spots away.

With this occupancy rate (%)	Wait until this many spaces away, then take the next free spot
0	0
50	1
75	3
80	4
85	5
90	7
95	14
96	17
97	23
98	35
99	69
99.9	693

“I ride my bike.”

When to Quit : Boris Berezovsky Story

people tend to stop early, leaving better applicants unseen.

“After searching for a while, we humans just tend to get bored. It’s not irrational to get bored, but it’s hard to model that rigorously.”

Exploitation VS Exploration

	Exploration	Exploitation
Type 1		
Type 2		
Type 3		
Type 4		

Read more:

Strategic dating: The 37% rule

The 37% rule: How many people should you date before settling down?

When Should You Stop Searching? | Towards Data Science

Glossary

Secretary problem
37% Rule
No-information game
full-information game
Threshold Rule
occupancy rate
Exploration vs Exploitation

Thank You!