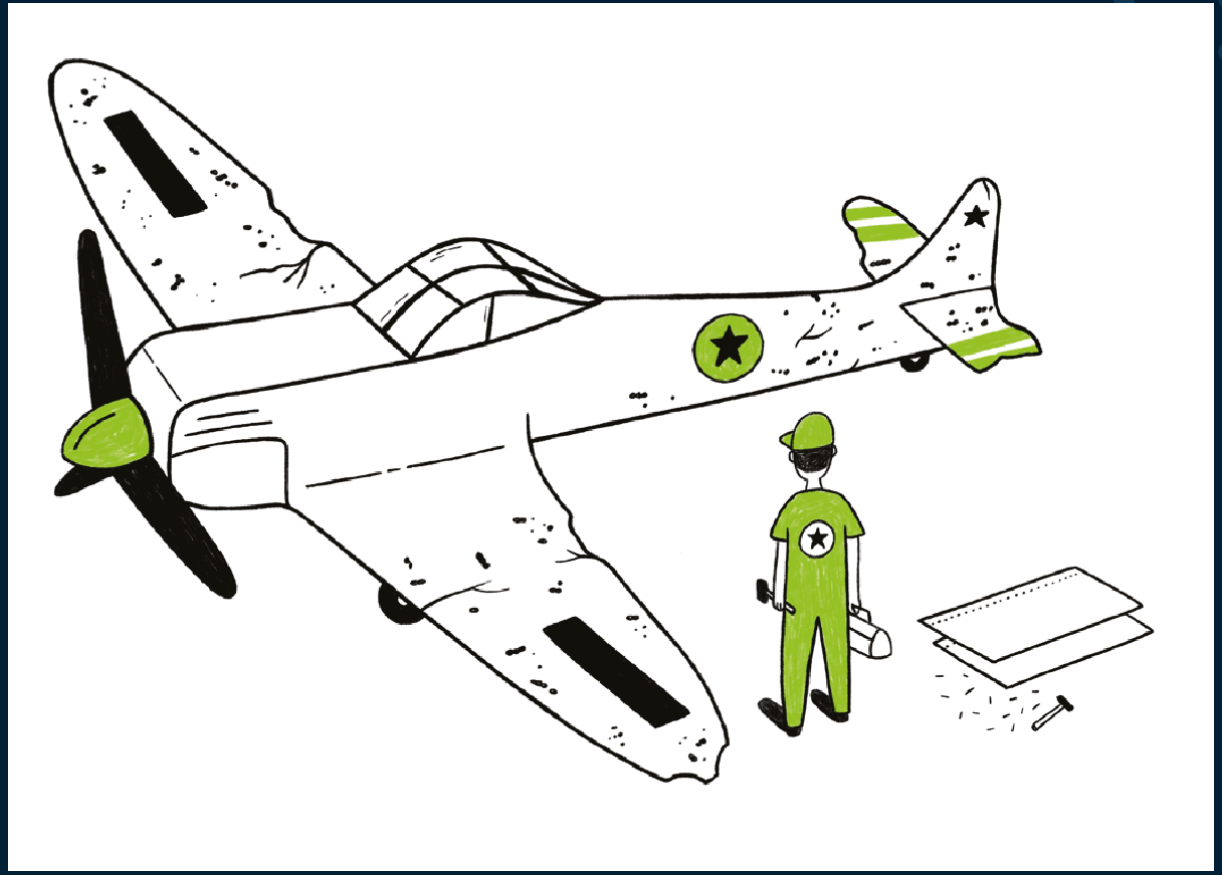


https://www.geckoboard.com/best-practice/statistical-fallacies/

Agenda

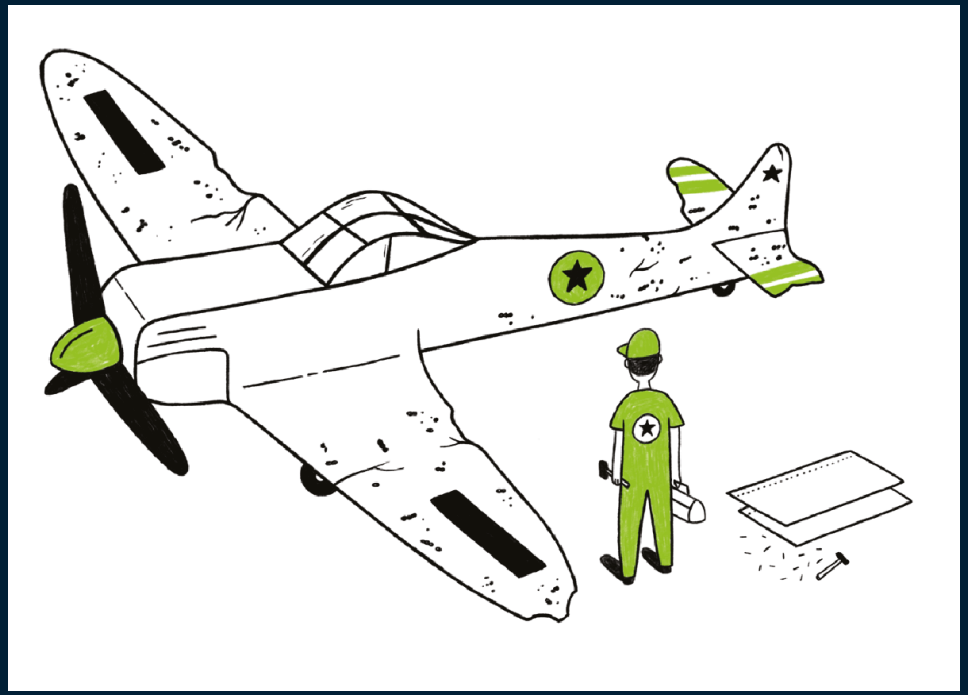
Rune Hjorth Nielsen, PhD

Data scientist & AI specialist at SAS Institute

- Prerequisites for optimization
- Different approaches to solving it
- An example

Data understanding

Survivorship bias



https://www.geckoboard.com/best-practice/statistical-fallacies/

Data understanding

Understanding the parameters

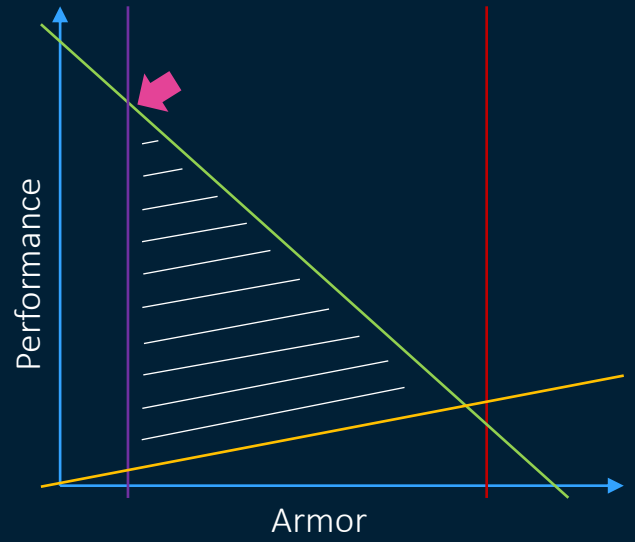
Optimizing plane armor

2-dimensional example

Objective function: airplane performance

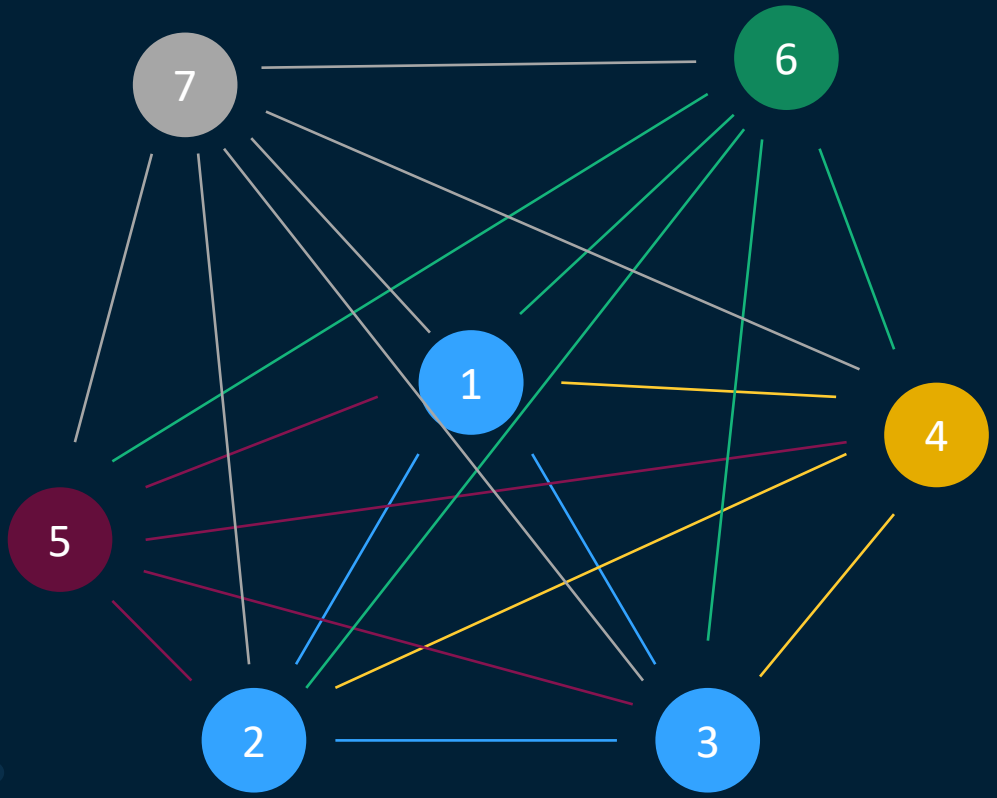
Restrictions:

- Maximum weight
- Maneuverability
- Minimum level of pilot protection
- Mission stability



Travelling salesman

Travelling salesman



Solutions:

1

3

12

60

360

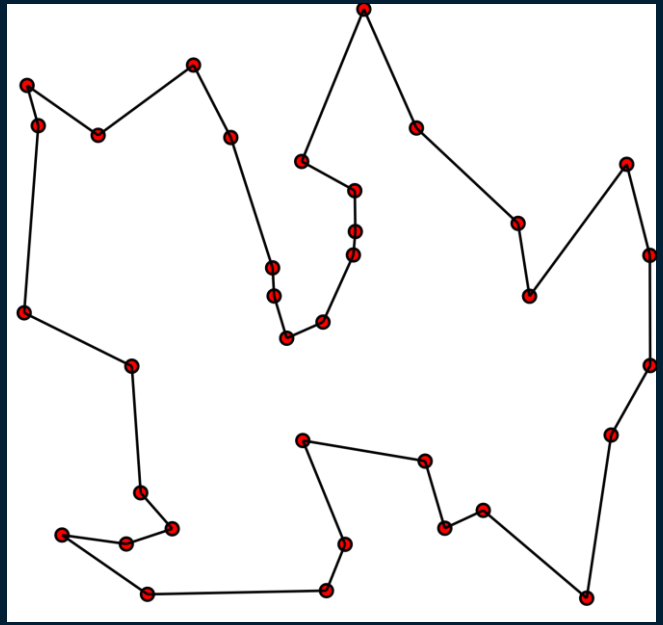
Brute force

Brute force

Combinatorial problem (n = number of locations)

Number of combinations = (n-1)! / 2

- 10 cities = $1.8 \cdot 10^5$ combinations
- 20 cities = $6.1 \cdot 10^{16}$ combinations
- 30 cities = $4.4 \cdot 10^{30}$ combinations
- 35 cities = …



Brut force

Possible routes: $1.5 \cdot 10^{38}$

1 solution solved per 1 ns (1/1,000,000 second)

Number of solutions to be checked per year: 1000*60*60*24*365 = 31536000000

Time to solution is then $4.7 \cdot 10^{38}$ years.

Conclusion: Not an option!

Analytical approach

Objective function subject to restrictions

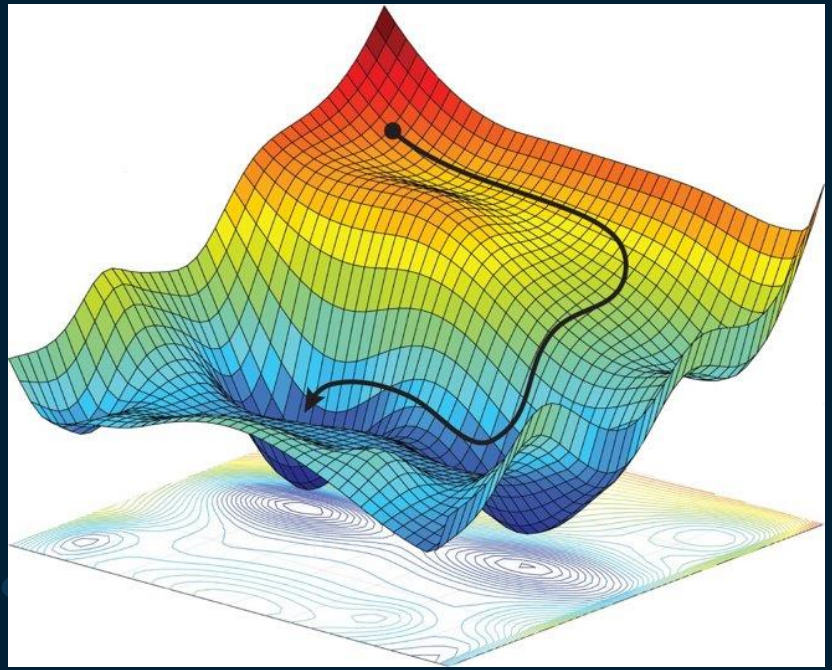
Formulate problem as a mathematical model

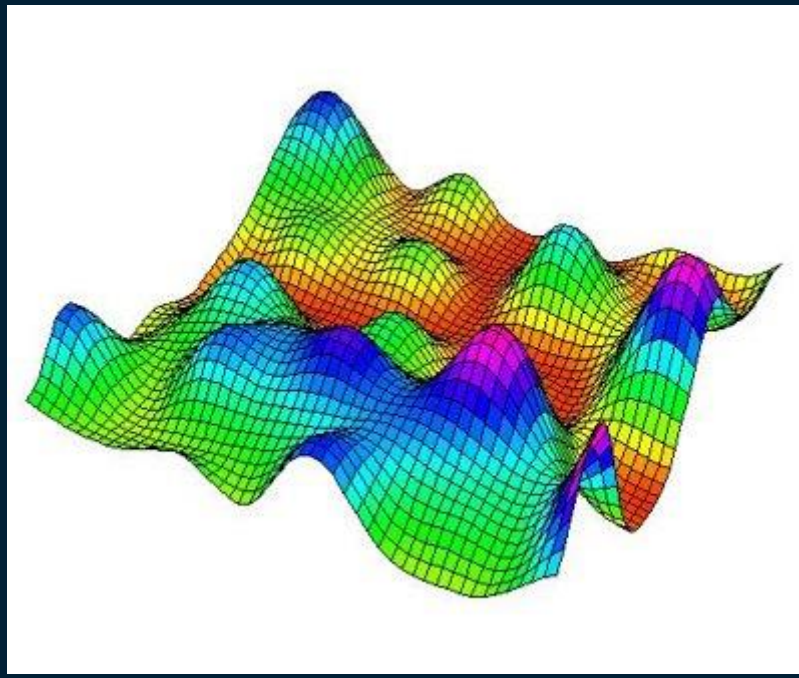
Solve with a solver that can find a solution without trying all combinations.

Hard to manage when solutions becomes very large.

Analytical approach

Objective function subject to restrictions





Heuristics

Specific solutions to specific problems

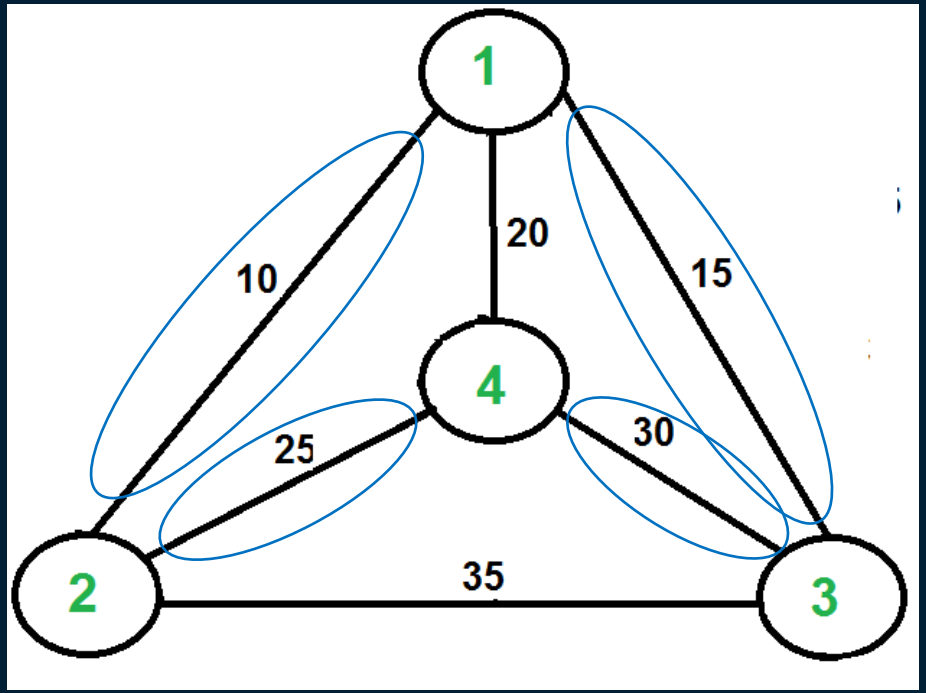
Tailor made approaches to specific problems.

Often output a good solutions that is directly implementable.

Heuristics does not necissarily provide the optimal solutions.

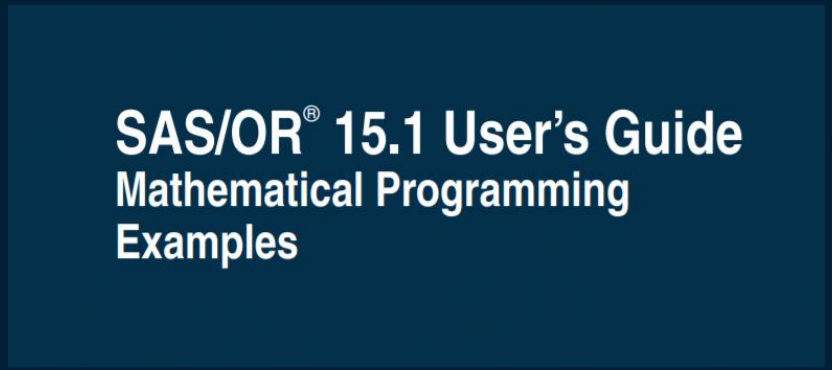
Heuristics

Specific solutions to specific problems



Example

Proc OptModel



https://support.sas.com/documentation/onlinedoc/or/151/ormpex.pdf

Example

Refining and mixing oil

Cost of oil

Veg1	Veg2	Oil1	Oil2	Oil3
110	120	130	110	115

Hardness of oil

Veg1	Veg2	Oil1	Oil2	Oil3
8.8	6.1	2.0	4.2	5.0

Revenue per unit = 150

Upper bound veg = 200

Upper bound nonveg = 250

Lower bound hardness = 3

Upper bound hardness = 6

Example

Proc OptModel

```
proc optmodel;
        /* Declare variables */
        veg1, veg2, oil1, oil2, oil3

        /* Declare constraints */
        Maximum use of veg an non-veg oils
        Hardness requirement

        /* Declare objective */
        max Profit = Revenue - costs

        solve;

        /* Print results*/
        veg1 veg2 oil1 oil2 oil3;
quit;
```

Example extended

Refining and mixing oil

Cost of oil

	Veg1	Veg2	Oil1	Oil2	Oil3
Jan	110	120	130	110	115
Feb	130	130	110	90	115
Mar	110	140	130	100	95
Apr	120	110	120	120	125
May	100	120	150	110	105
Jun	90	100	140	80	135

Hardness of oil

Veg1	Veg2	Oil1	Oil2	Oil3
8.8	6.1	2.0	4.2	5.0

Revenue per unit = 150

Upper bound veg = 200

Upper bound nonveg = 250

Lower bound hardness = 3

Upper bound hardness = 6

Upper bound store = 1000

Storage cost per unit = 5

Initial storage = 500

SAS Optimization

Visualization of a travelling salesman type problem

Rune Hjorth Nielsen
Providing insights within data science and AI
for SAS customer advisory