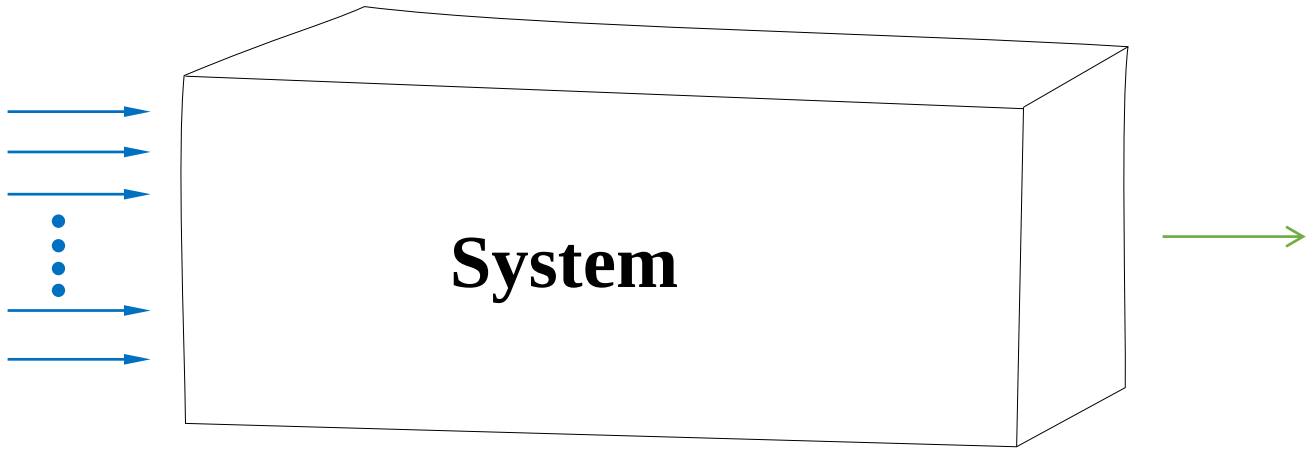
Single-objective Optimization Problems

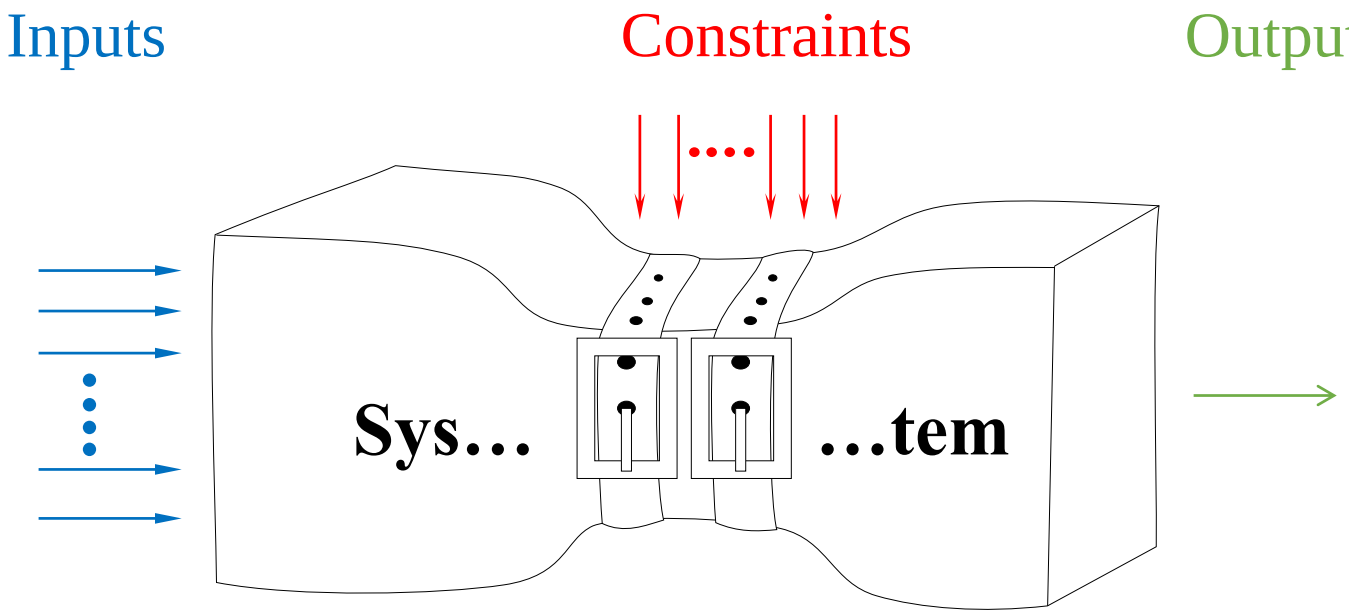
Main components of an optimization problem

Inputs (variables)

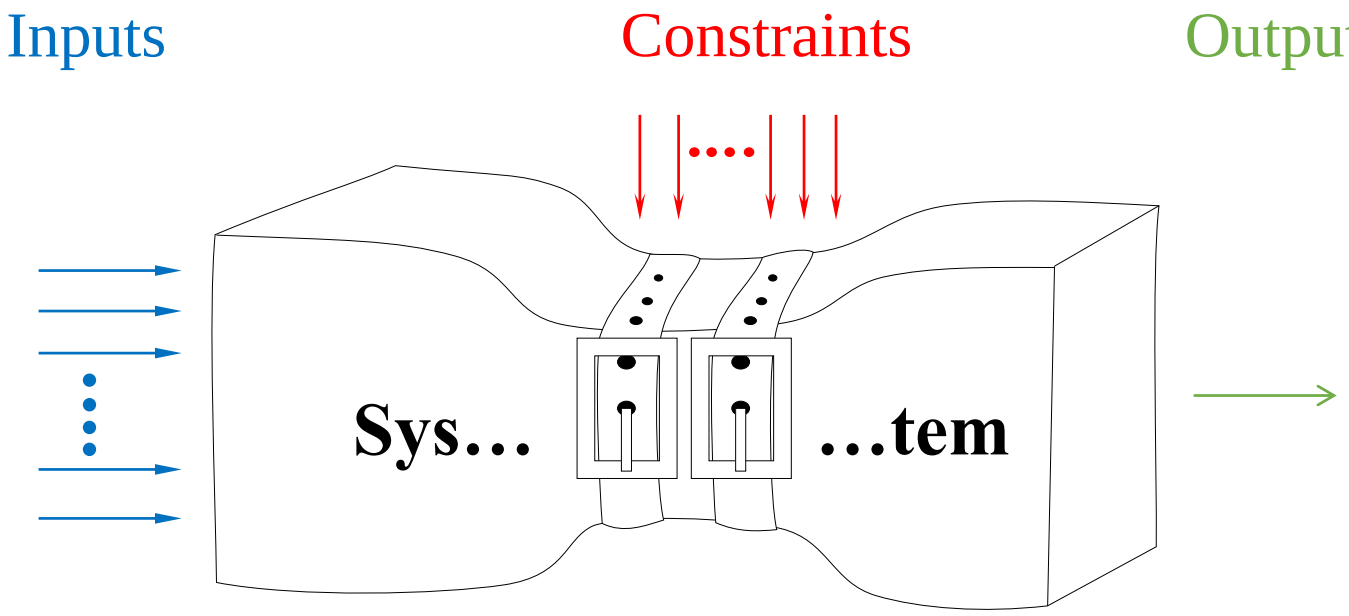
Output (objective)



Main components of an optimization problem



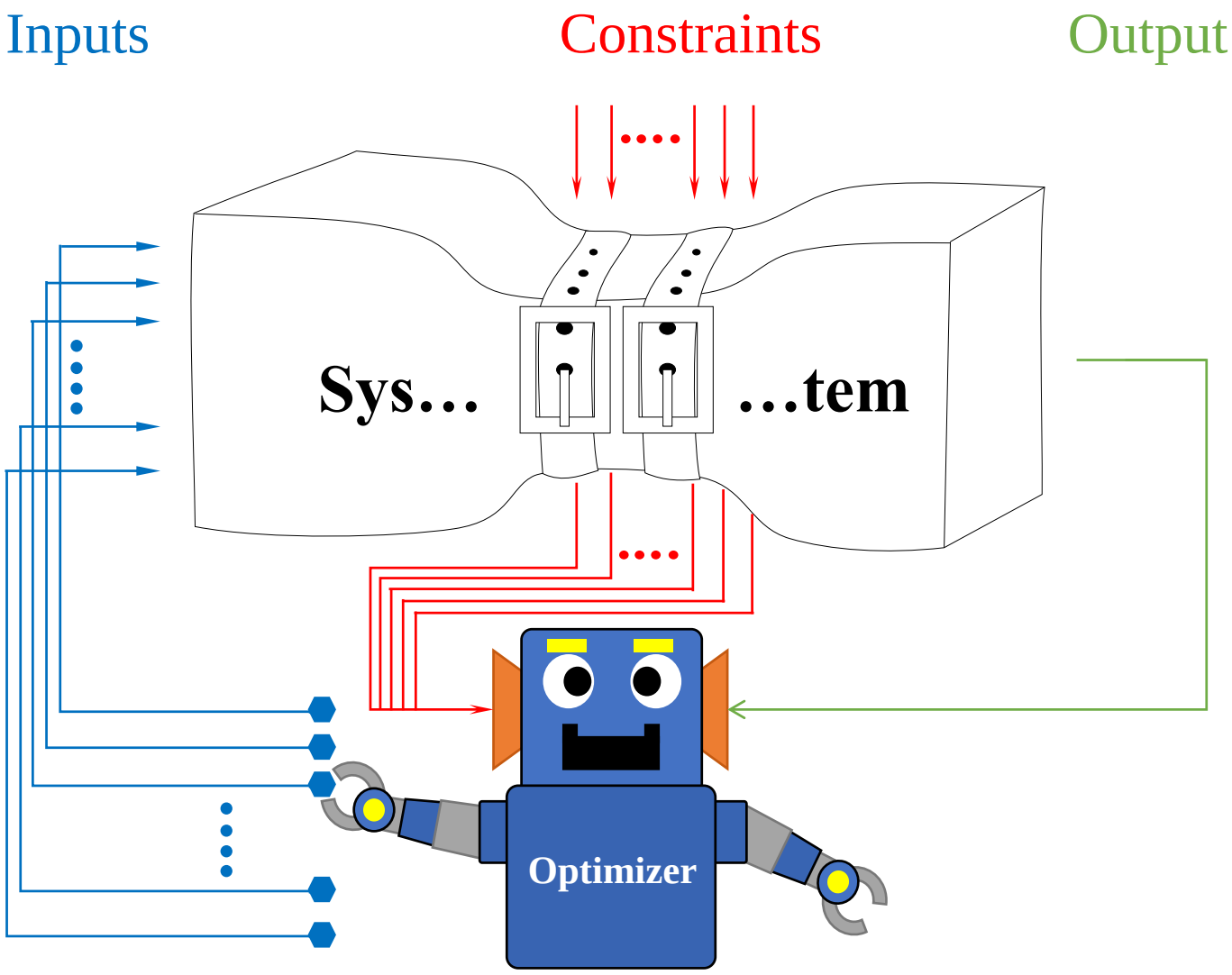
Formulating an optimization problem



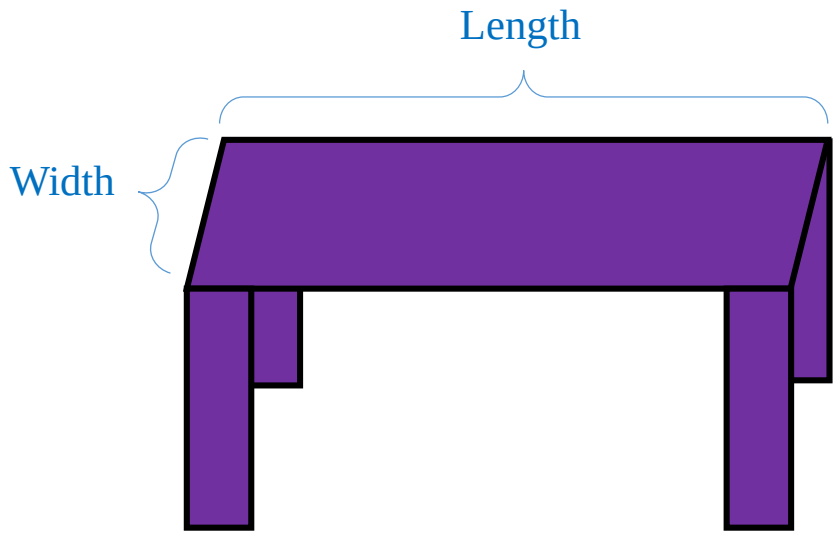
$$Minimise: \quad f(x_1, x_2, \ldots, x_n)$$

$$Suject\ to: \quad \boldsymbol{Constraints}$$

Optimization algorithm



Example: designing a table

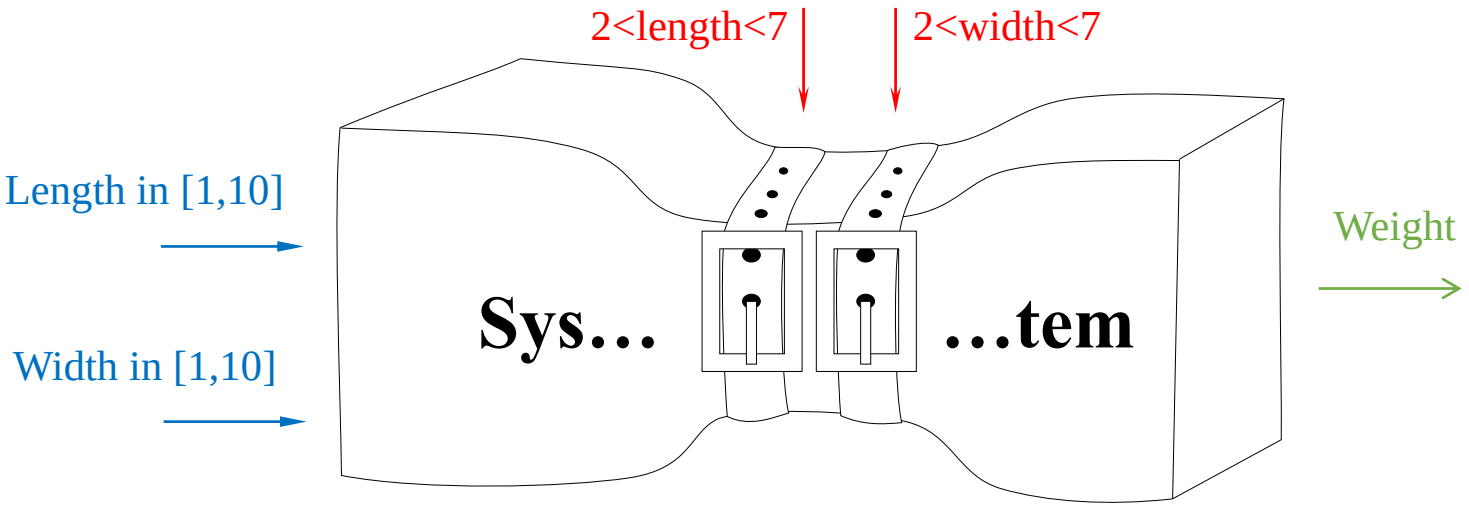


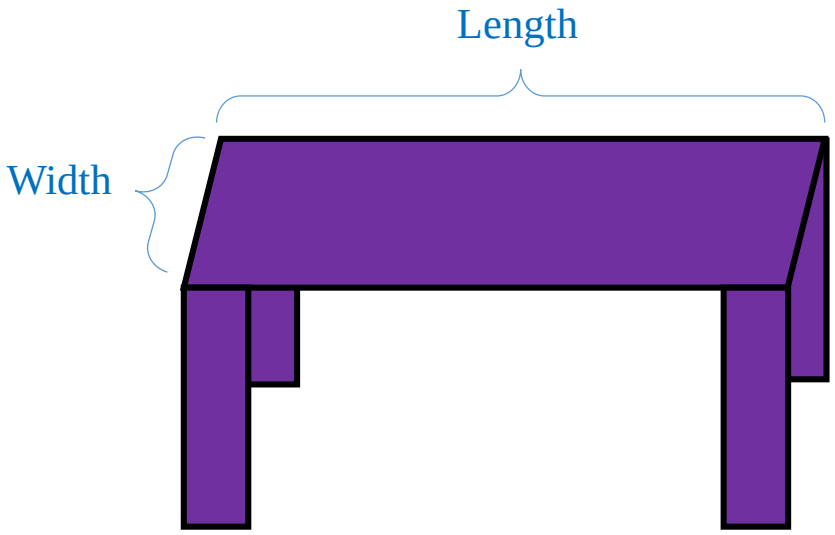
Example: designing a table

Inputs

Constraints

Output

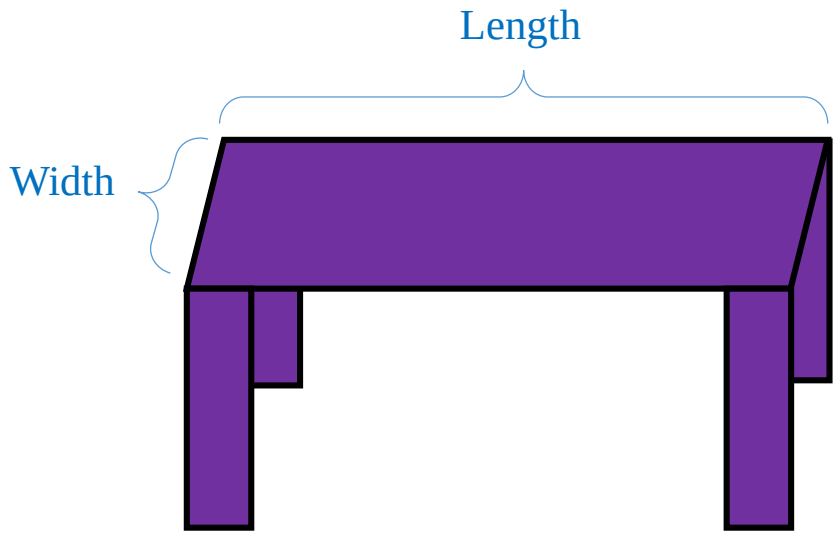




Weight = 1*(Length + Width)

The objective is to minimize the weight

Example: designing a table



$Minimise$: $f(length, width)$=1*(Length + Width)

$Suject\ to$: $2 < length < 7$

$2 < width < 7$

Search landscape of the table problem

Inputs:

width , length

Output:

weight

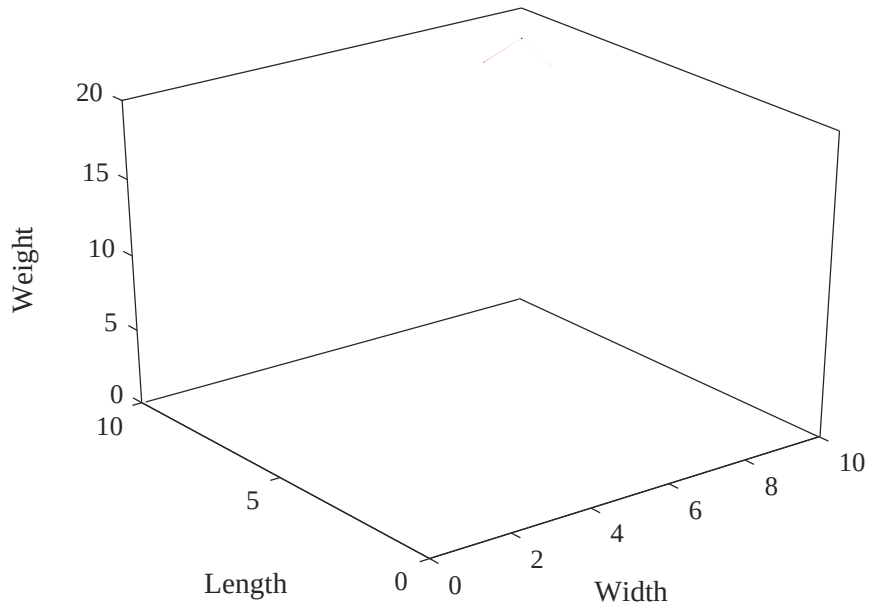


Table #1: W=10, L=10

Table #2: W=9 , L=10

Table #3: W=10, L=9

Table #4: W=9 , L=9

Search landscape of the table problem

Inputs:

width , length

Output:

weight

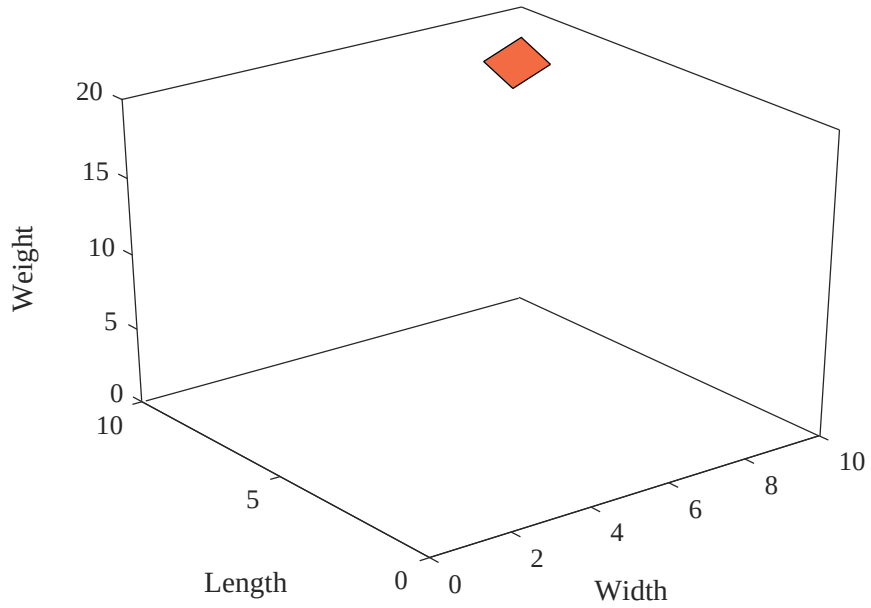


Table #1: W=10, L=10

Table #2: W=9 , L=10

Table #3: W=10, L=9

Table #4: W=9 , L=9

Example

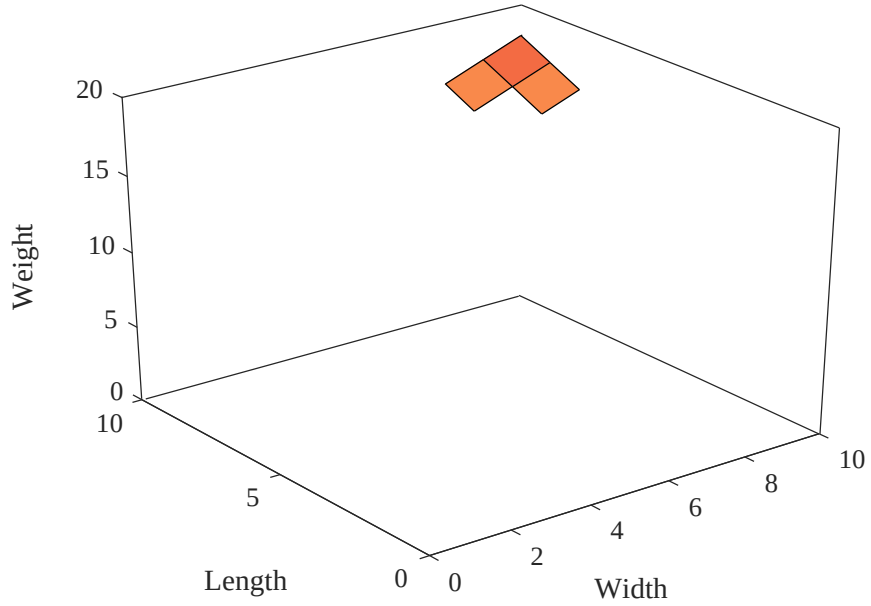
8 tables

Inputs:

width , length

Output:

weight



Example

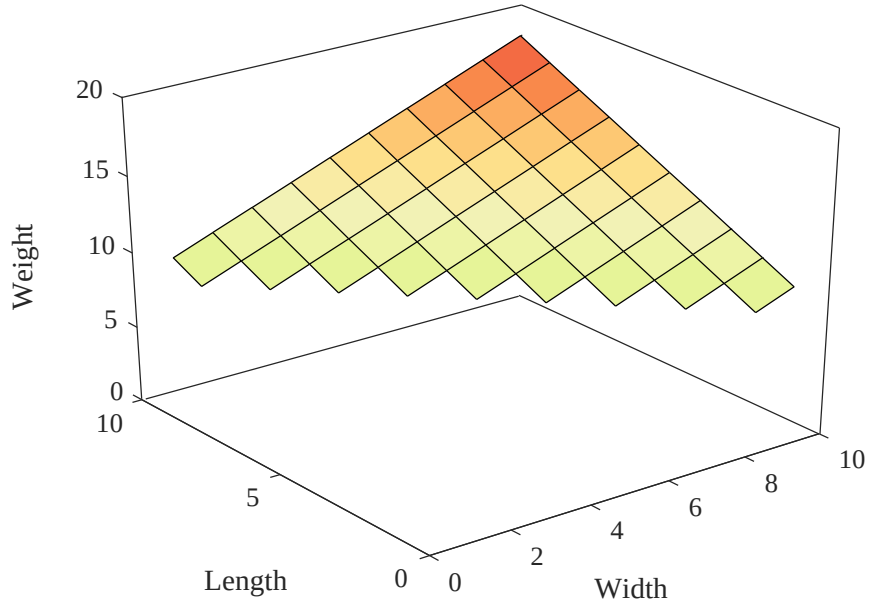
50 tables

Inputs:

width , length

Output:

weight



Example

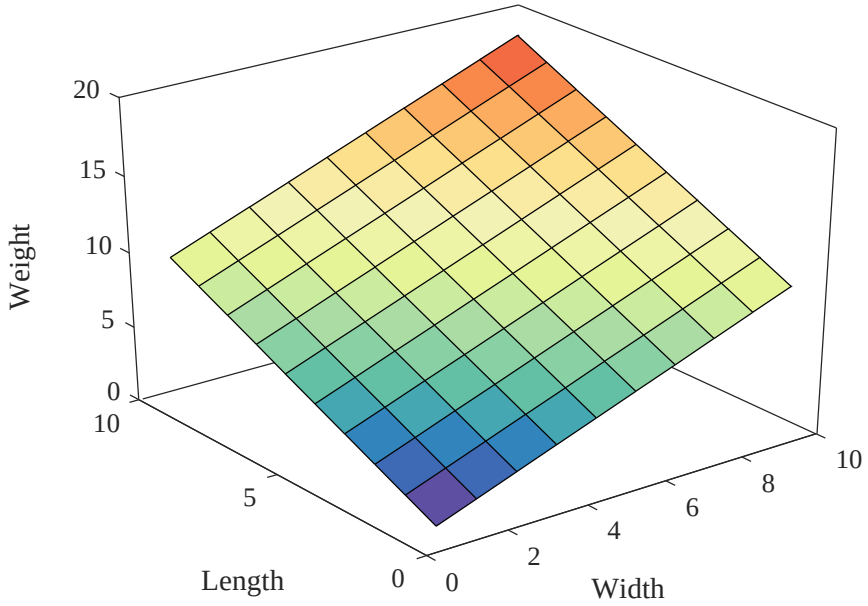
100 tables

Inputs:

width , length

Output:

weight



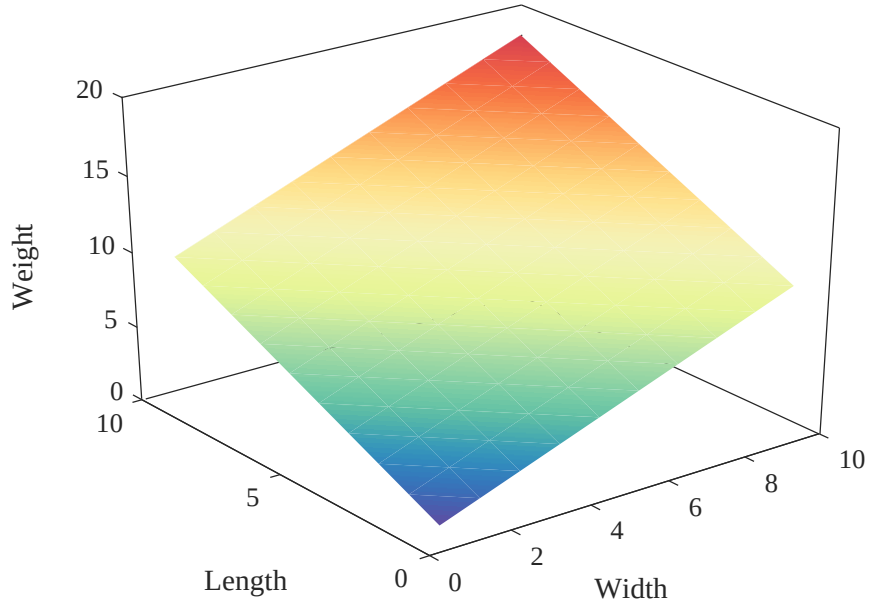
Example

Inputs:

width , length

Output:

weight



Example

Inputs:

width , length

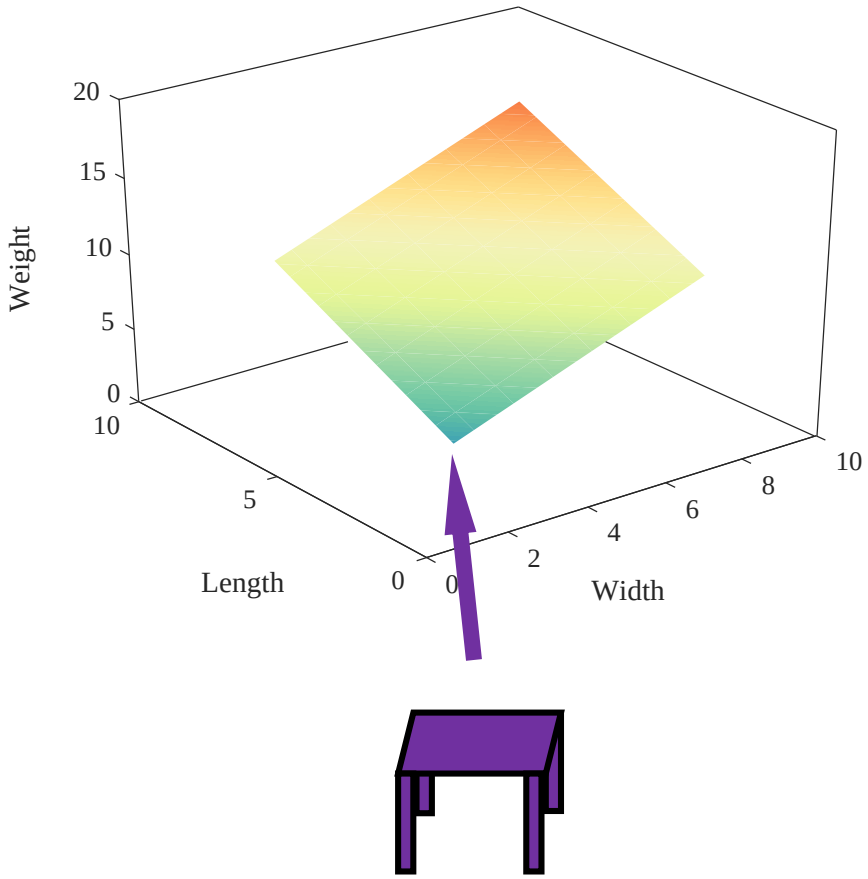
Output:

weight

Constraints:

2< width <7

2< length <7



Search landscape

Inputs:

x , y

Output:

f(x,y)

Constraints:

$(y \leq 3.2) \vee (y \geq 3.4)$

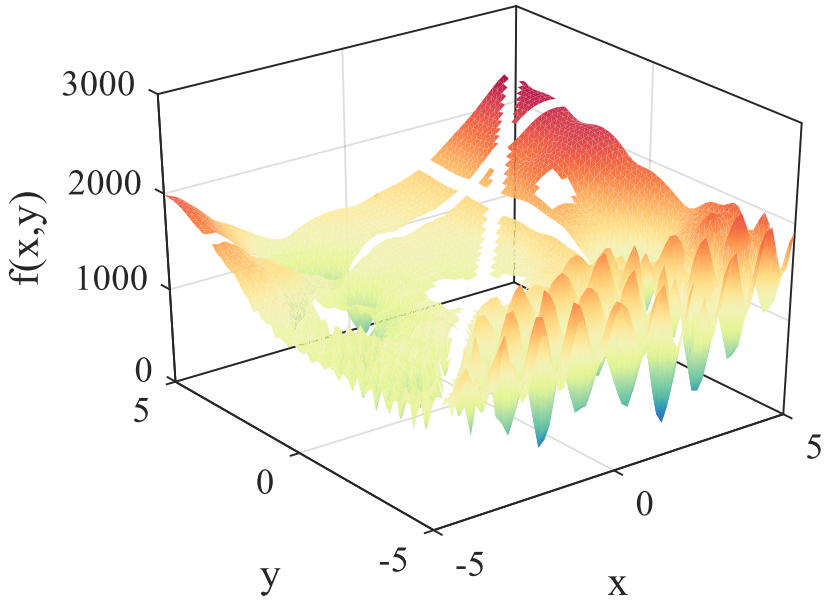
$(x \leq 2.2) \vee (x \geq 2.3)$

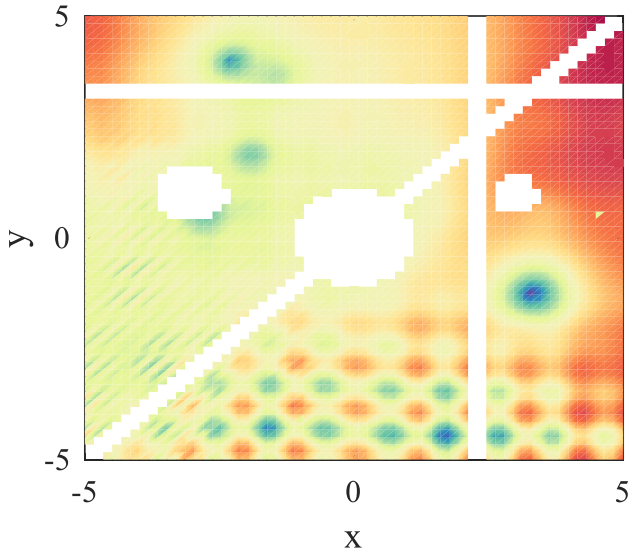
$(x-3)^2 + (y-1)^2 \geq 0.1$

$(x+3)^2 + (y-1)^2 \geq 0.3$

$x^2 + y^2 \geq 1$

$x \neq y$





Search landscape

Inputs:

x , y

Output:

f(x,y)

Constraints:

$(y \leq 3.2) \vee (y \geq 3.4)$

$(x \leq 2.2) \vee (x \geq 2.3)$

$(x-3)^2 + (y-1)^2 \geq 0.1$

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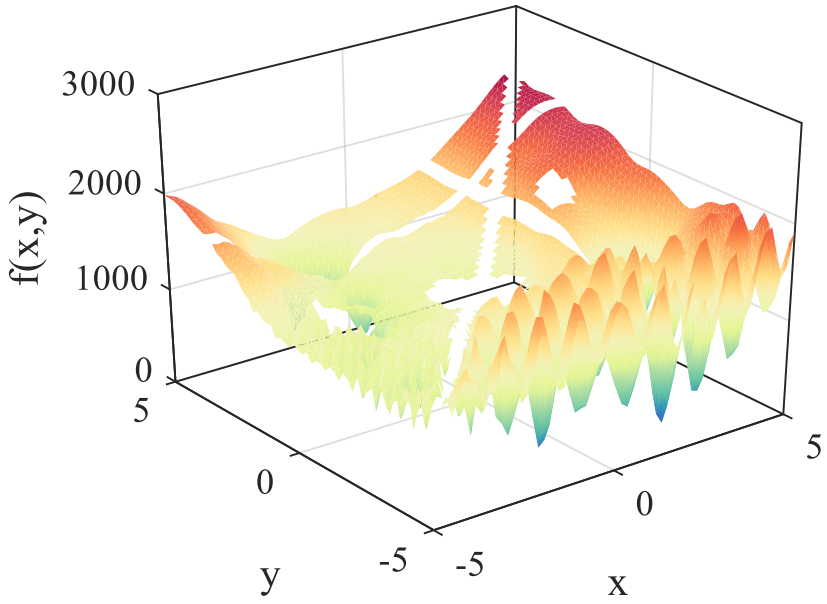

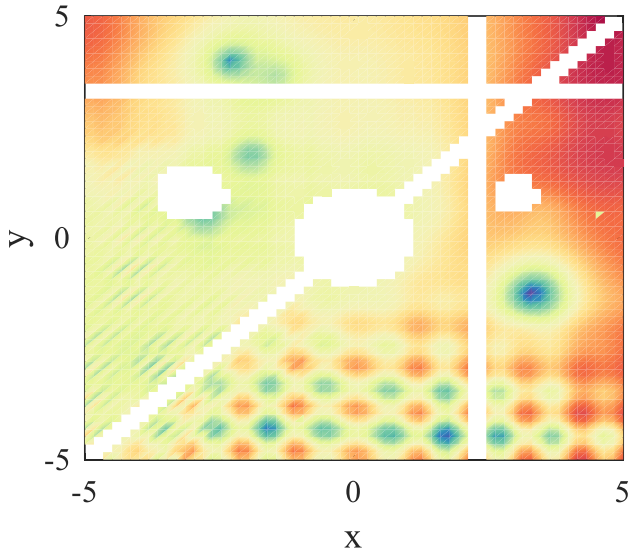

Difficulties of a real-world problem

- A large number of local solutions
- A large number of constraints
- Discrete variables
- Deceptive search space
- Multiple objectives
- Dynamically changing
- Uncertainties in inputs, outputs, or constraints
- Etc.