CE 311K: Control flow - Branching and Iterations

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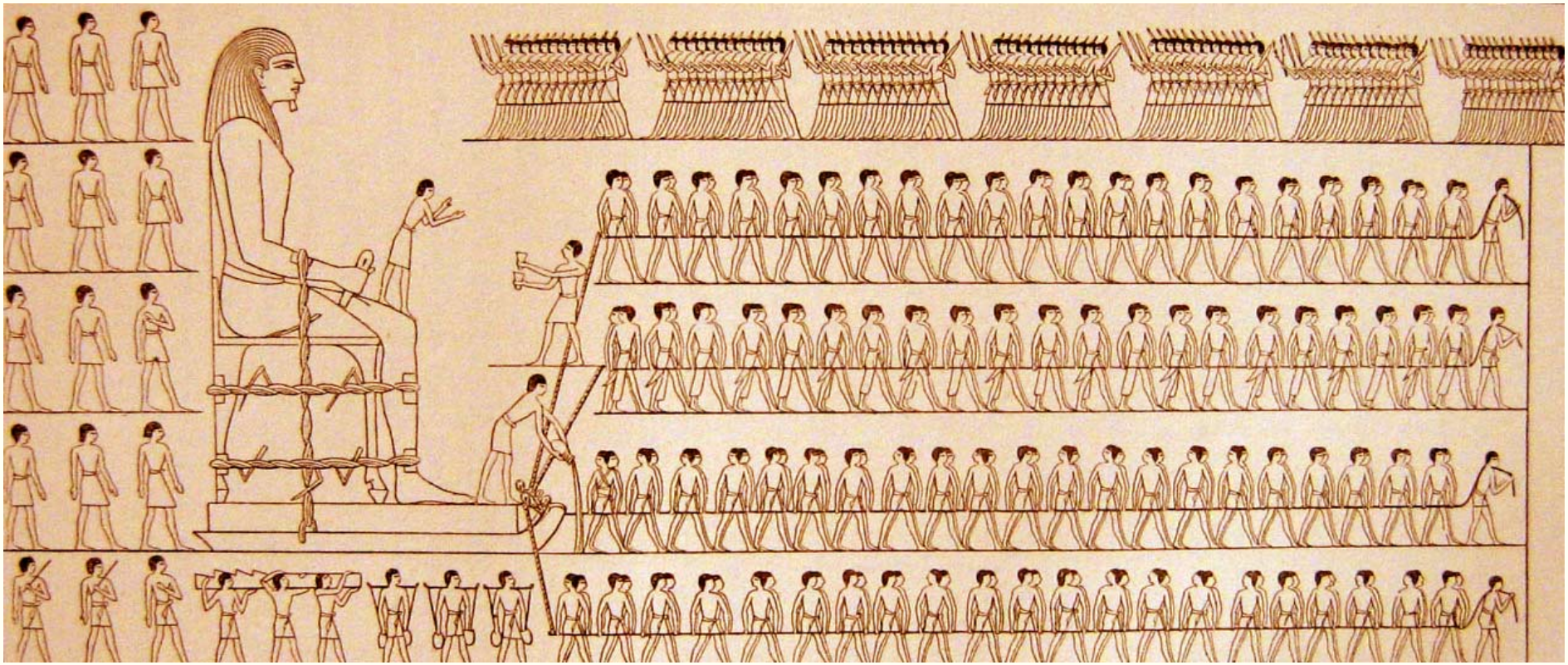
1 Numerical solution of a sliding block

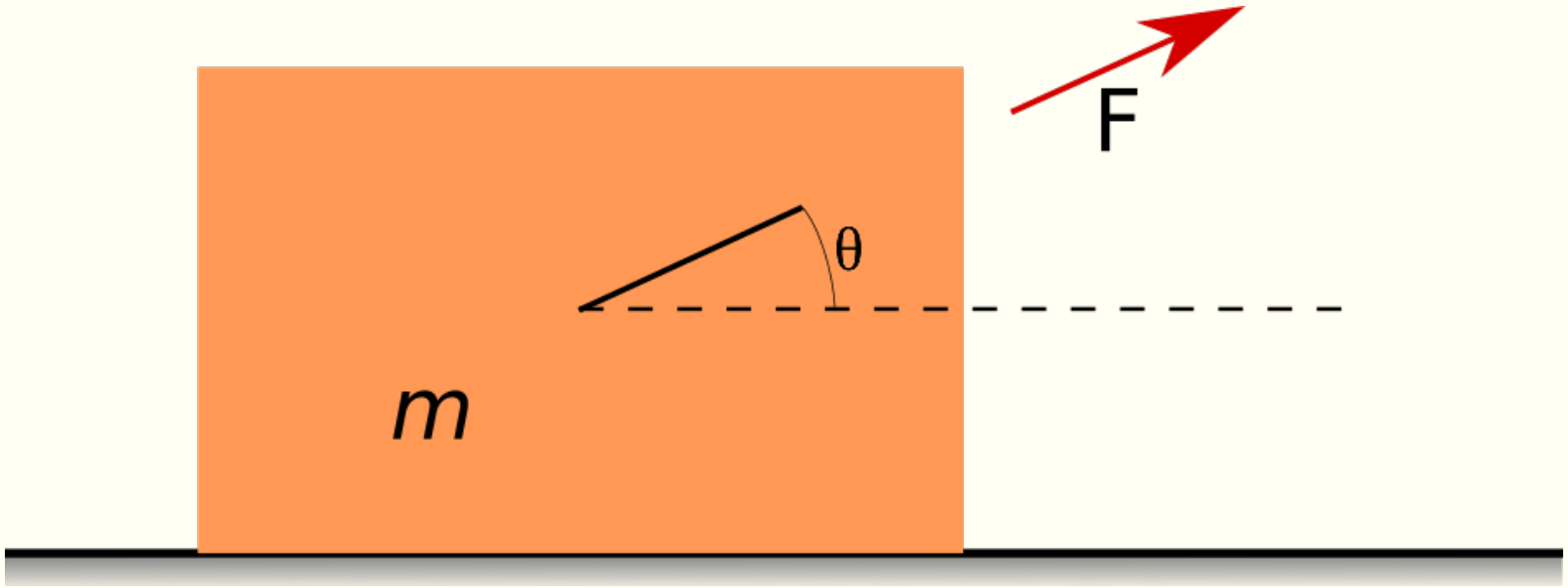
2 Bisection method

What is the optimal angle to pull the statue?



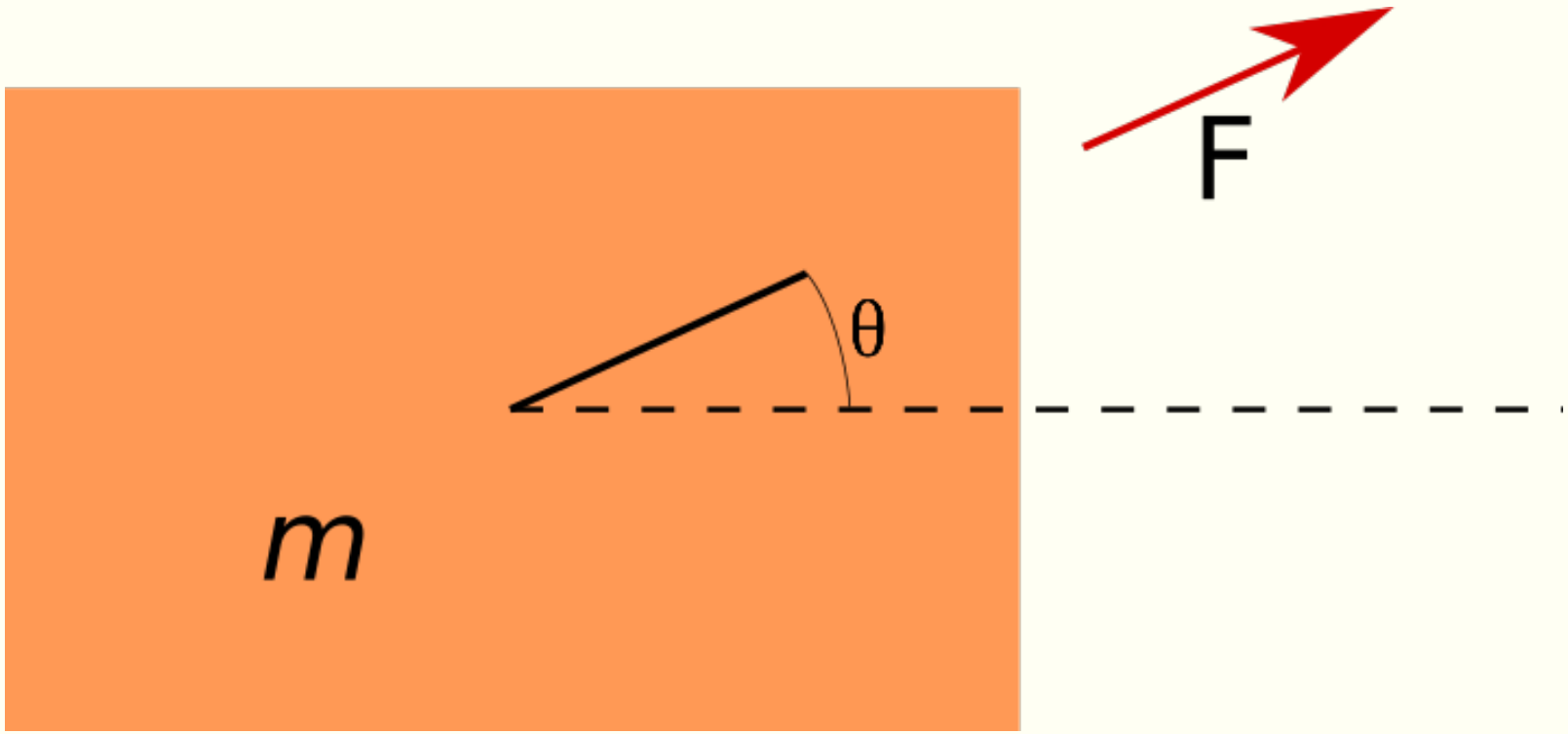
A wall painting from the tomb of Djehutihotep (credit: martinhumanities.com)

Numerical solution of a sliding block: Approximation

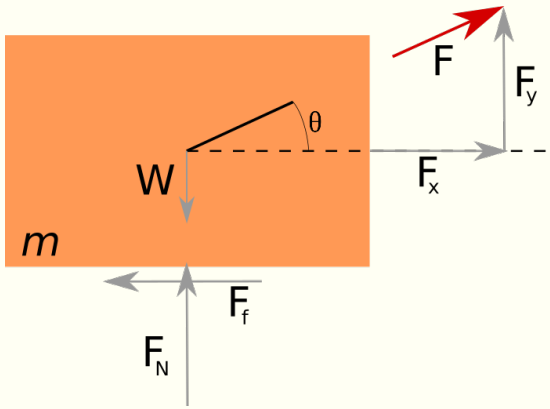


What is the optimal angle to pull the block applying the least amount of force?

Numerical solution of a sliding block: Forces



Numerical solution of a sliding block: Forces



$$F = \frac{\mu \cdot mg}{(\cos\theta + \mu \sin\theta)}$$

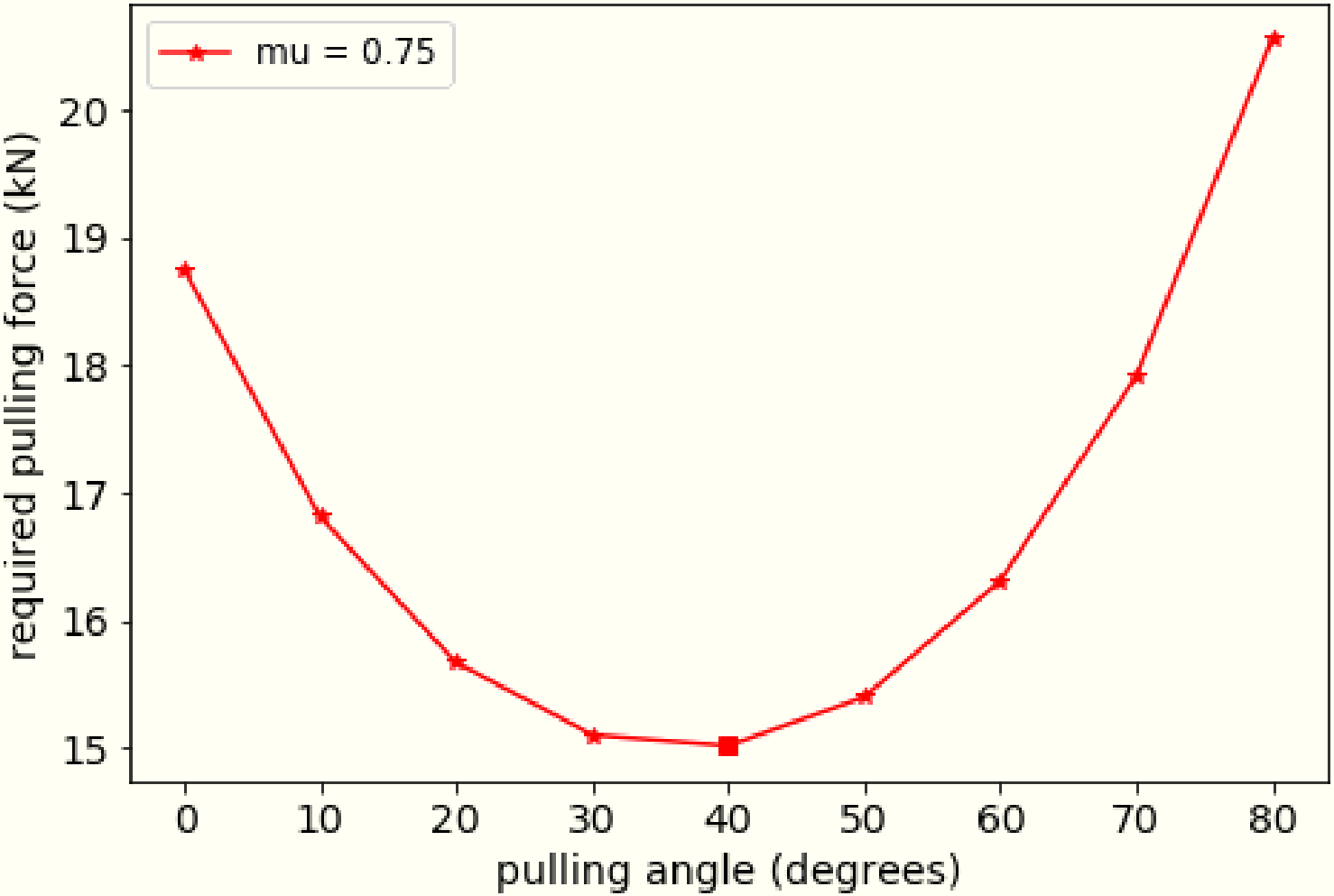
Numerical solution of a sliding block: Compute force

- Given $W = 25kN(2500\,\text{kg})$, $\theta = 45^o$ and $\mu = 0.75$ (35^o):

- Given $W = 25kN(2500\,\text{kg})$ and $\mu = 0.75$, what's the optimum θ?

Numerical solution of a sliding block: Optimal theta?

Given $W = 25\,\text{kN}(2500\,\text{kg})$ and $\mu = 0.75$, what's the optimum θ?



Lists

- A list is a sequence of data. (mutable)
- An 'array' in most other languages is a similar concept, but Python lists are more general than most arrays as they can hold a mixture of types.
- A list is constructed using square brackets:

```
>>> a = [0, 10, 20, 30, 40, 50, 60, 70, 80]
>>> print(a)
[0, 10, 20, 30, 40, 50, 60, 70, 80]
>>> type(a)
<class 'list'>
>>> len(a)
10
>>> a.append(90)
>>> print(a)
[0, 10, 20, 30, 40, 50, 60, 70, 80, 90]
```

Iterating through a list: for loops

Looping over each item in a list (or more generally a sequence) is called 'iterating'. We iterate over the members of the lab group using the syntax:

```
for each item in list do
        print(item)

for item in list:
        print(item)
```

⚠ Indentation matters in python!

np.arange()

We need a new library called 'numpy', we are going to import the new library. `import numpy as np` The `np.arange()` returns a sequence of numbers:

`range(stop)`

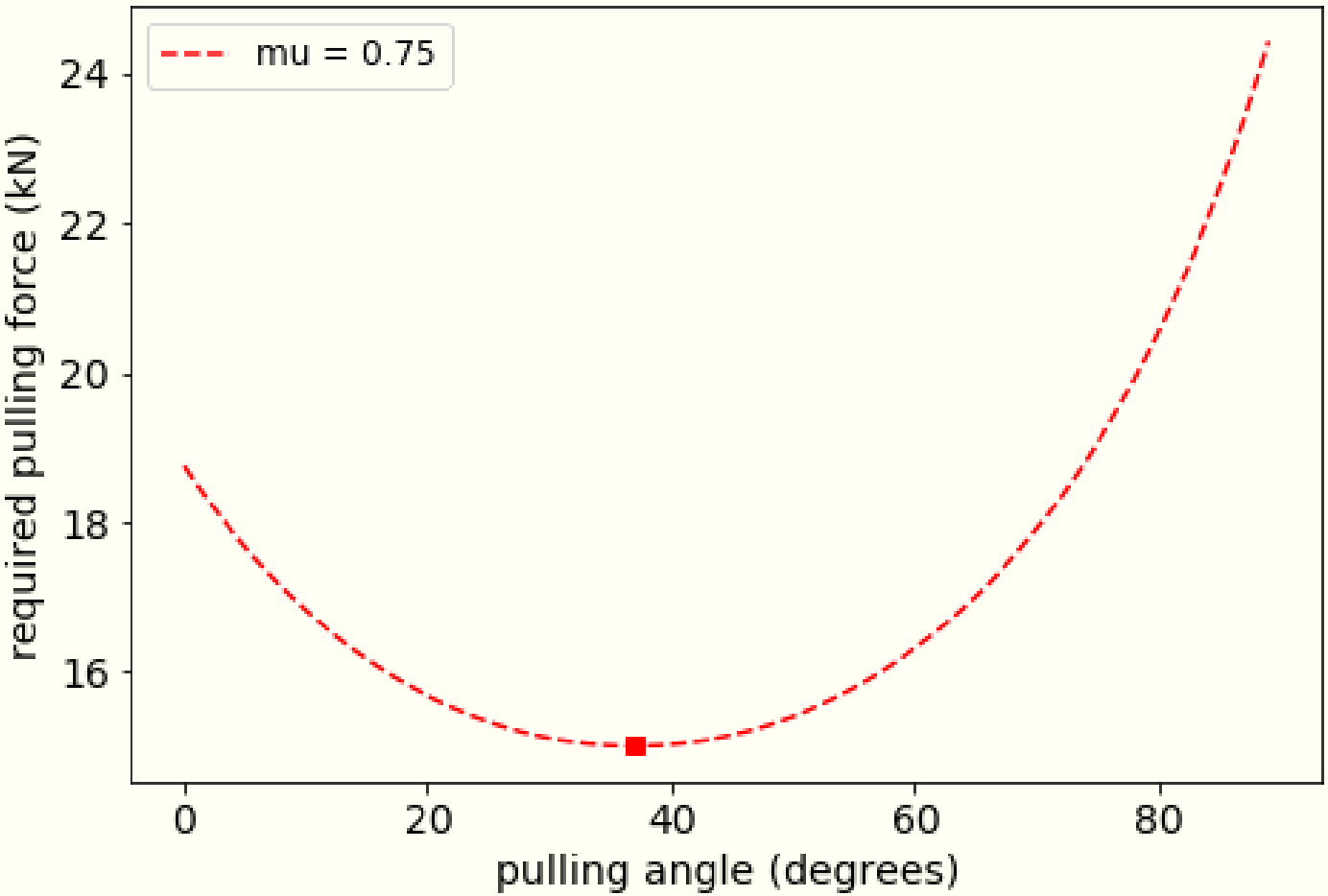
stop: Number of integers (whole numbers) to generate, starting from zero. eg. np.arange(3) yields a sequence of [0, 1, 2].

`np.arange([start], stop[, step])`

- *start*: Starting number of the sequence.
- *stop*: Generate numbers up to, but not including this number.
- *step*: Difference between each number in the sequence.

Numerical solution of a sliding block: Optimal theta?

Given $W = 25\,\text{kN}(2500\,\text{kg})$ and $\mu = 0.75$, what's the optimum θ?



? Identifying optimum requires conditional statements

Comparison on int, float and strings

`i` and `j` are variable names and comparisons below evaluate to a Boolean

Logic operators on bools

`a` and `b` are variable names with Boolean values

A	B	A and B	A or B
True	True	True	True
True	False	False	True
False	True	False	True
False	False	False	False

Designing a smart window: if condition

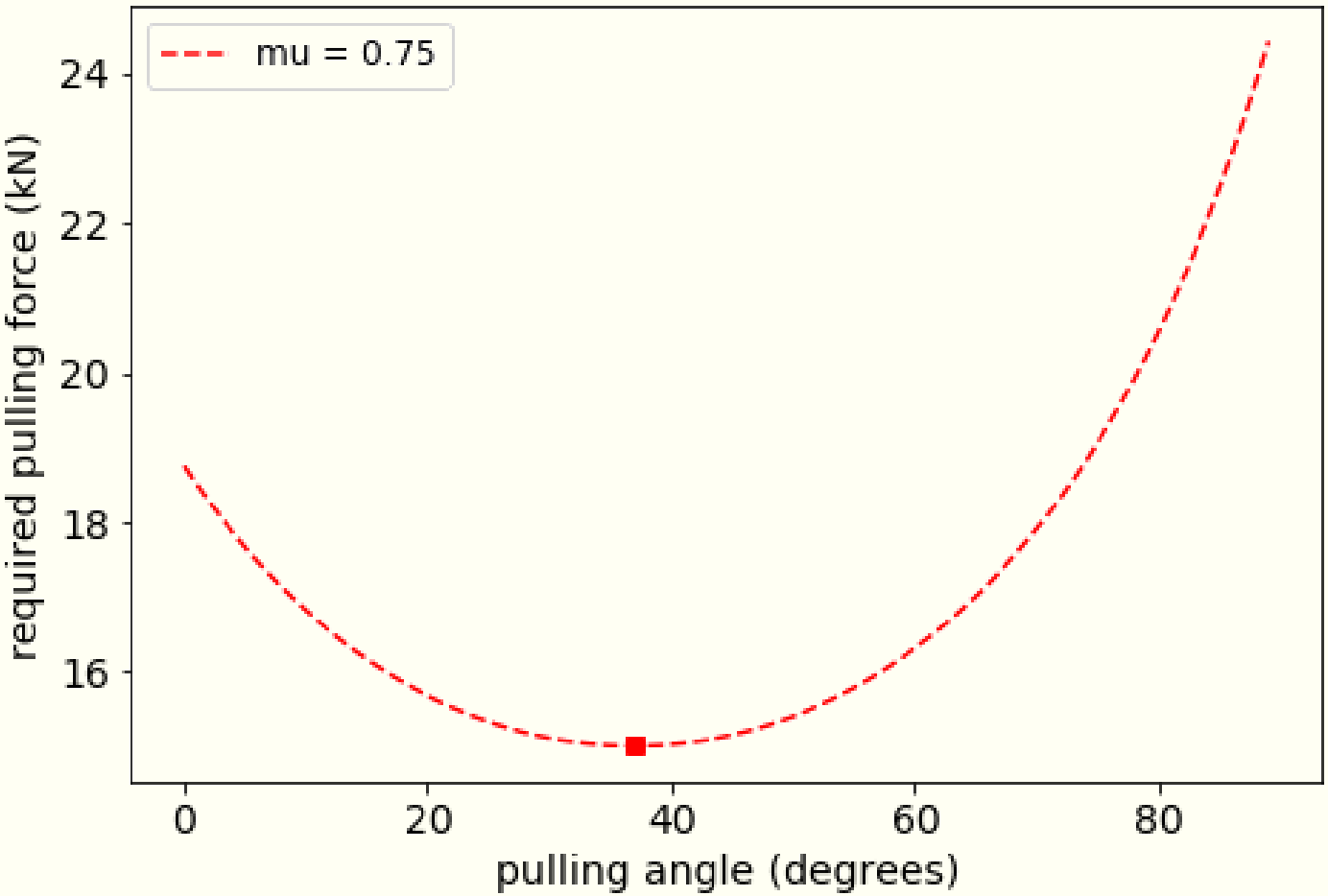
- An electric window opener, attached to a rain sensor and a temperature gauge, might be controlled by the following program:

Designing a smart window: if condition

```
# If raining, close the window
if raining:
        close_window()

# If the temperature is over 80 F, open window
elif temperature > 80: # else if
        open_window()

# If the temperature is below 66 F, close window
elif temperature < 66:
        close_window()

# Otherwise, do nothing and leave window as it is
else:
        continue
```

Numerical solution of a sliding block: Optimal theta?

Given $W = 25\,\text{kN}(2500\,\text{kg})$ and $\mu = 0.75$, what's the optimum θ?



Identify optimum with an if conditional statement

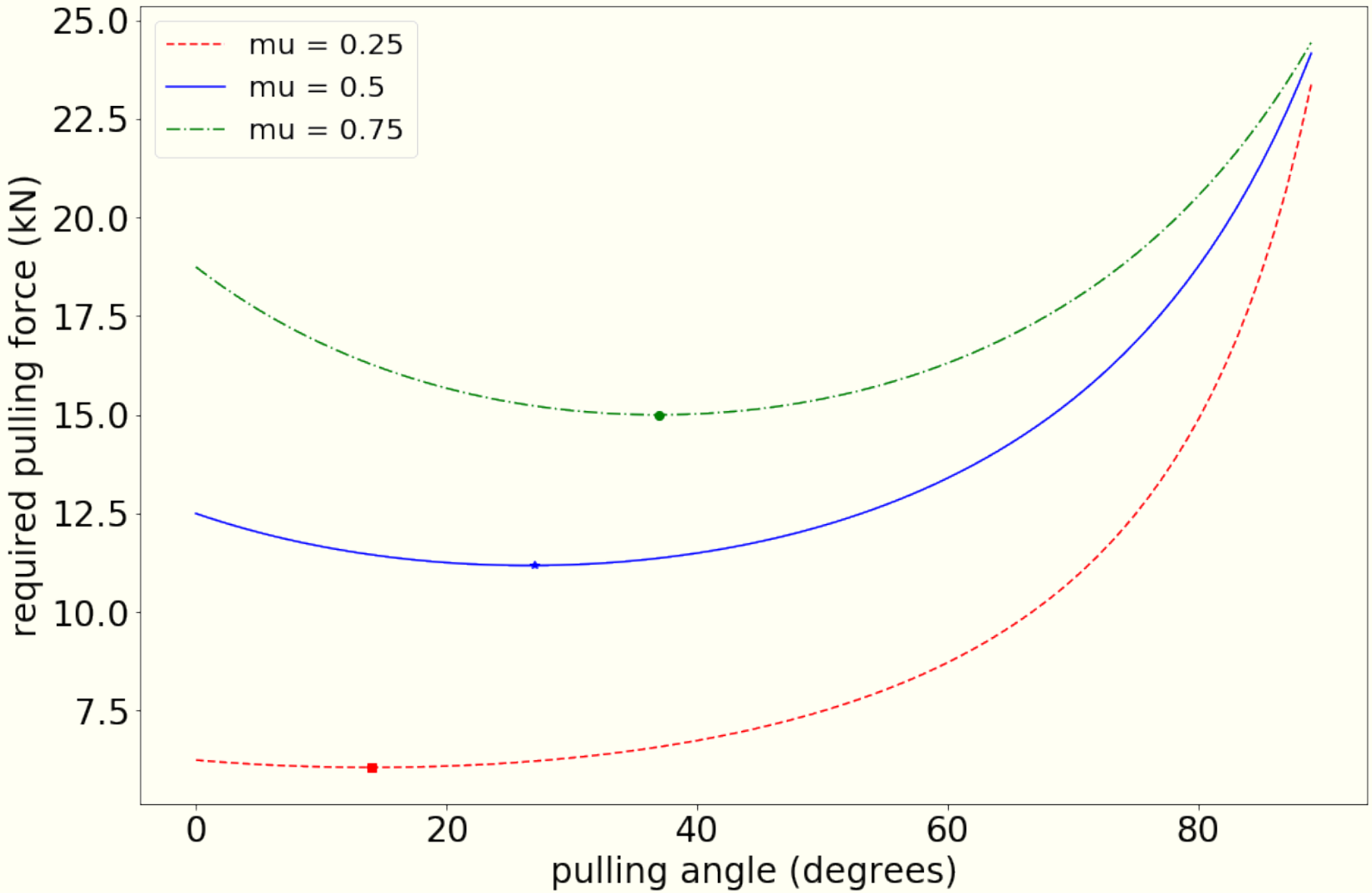
1. Numerical solution of a sliding block
2. Bisection method

Calculate the optimum angle to pull for a given force

- Given $F = 17.5\,\text{kN}(1750\,\text{kg})$, $W = 25\,\text{kN}$ and $\mu = 0.75$, what's θ?

Calculate the optimum angle to pull for a given force

- Given $F = 17.5\,\text{kN}(1750\,\text{kg})$, $W = 25\,\text{kN}$ and $\mu = 0.75$, what's θ?

What are the characteristics of a numerical solution?

Numerical solution of a sliding block: Friction angles