Stirling's formula

Stirling's formula to approximate the value of a large factorial

$$n! = \sqrt{2\pi n}\left(\frac{n}{e}\right)^{-n}$$

Note: The approximation by Stirling's formula tend to underestimate slightly the value of the factorial, as we will see on the graph (slide4).

Time complexity:

Stirling's approximation: $\mathcal{O}(1)$

$n!$: $\mathcal{O}(n)$

Stirling's formula in R

```r
stirling = function(n) {

  sqrt(2 * pi * n) * (n^n) * exp(-n)

}

# comparison
approximation = stirling(15)
exact = factorial(15)
approximation # 1.300431e+12
exact # 1.307674e+12
```

Stirling's formula in Python

```
1 import math
2
3 def stirling(n):
4     return math.sqrt(2 * math.pi * n) * (n**n) * math.exp(-n)
5
6 # Comparison
7 approximation = stirling(15)
8 exact = math.factorial(15)
9
10 print("Approximation:", approximation)
11 Approximation: 1300430722199.4658
12 print("Exact value:", exact)
13 Exact value: 1307674368000
```

Visualization