On the Energy Efficiency of Sorting Algorithms

Experimentação em Engenharia de Software - Mestrado Engenharia Informática

Agenda

- Methodology and Testing Environment

- Benchmarking

- Towards a Ranking of Sorting Algorithms

- Conclusions

Methodology and Testing Environment

Methodology

- Implementation of Sorting Algorithms
- Energy Consumption Monitoring
- Powercap
- Memory Monitoring

Testing Environment

| Model Name	Intel(R) Core(TM) i7-8550U
Base Frequency	1.80GHz
Max Turbo Frequency	4.00GHz
Architecture	x86_64
CPU op-mode(s)	32-bit, 64-bit
Address sizes	39 bits physical 48 bits virtual
Byte Order	Little Endian
CPU(s)	8
CPU Family	6
Model	142
Thread(s) per core	2
TDP	15W
Configurable TDP-up	25W
Configurable TDP-down	10W

Benchmarking

Temp Before
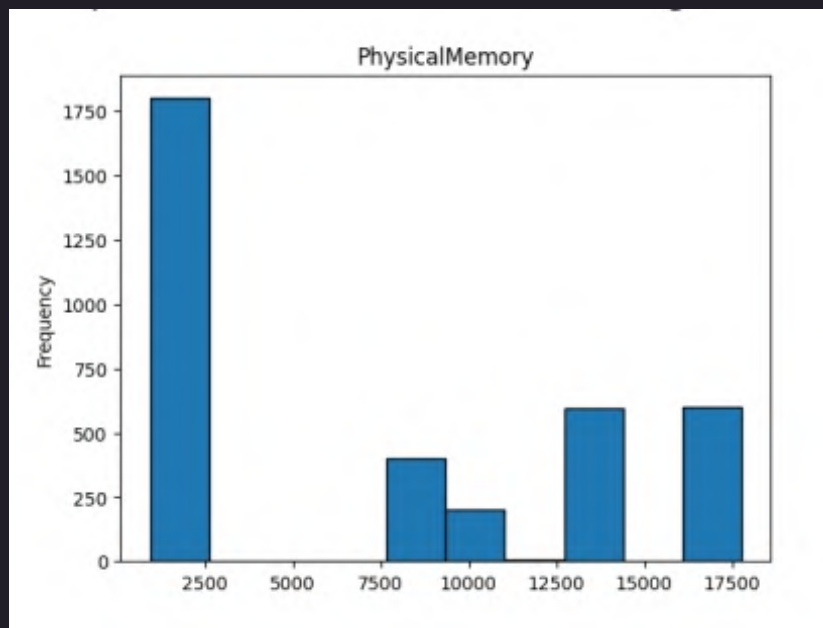
Physical Memory

largest amount of physical
memory the process has ever
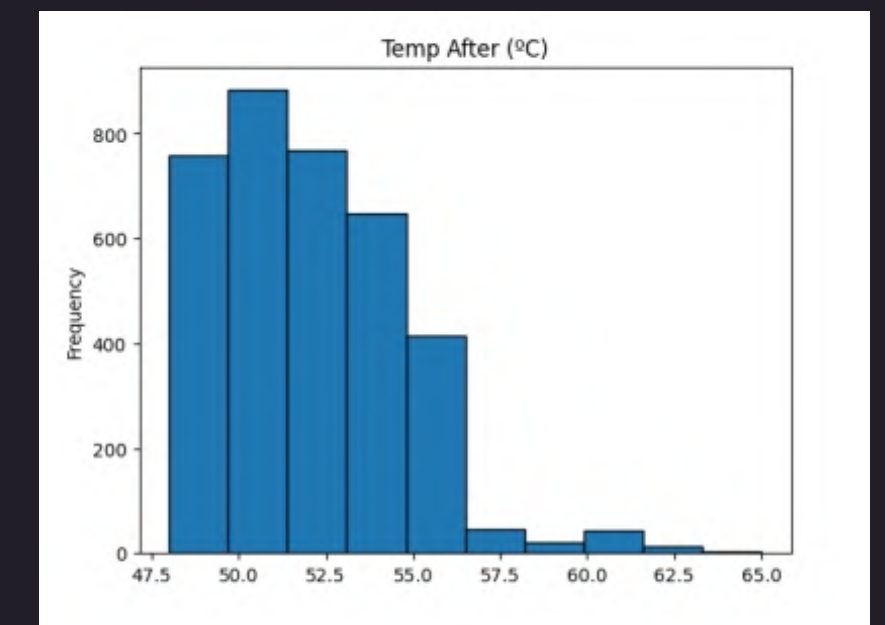been using at any one instant
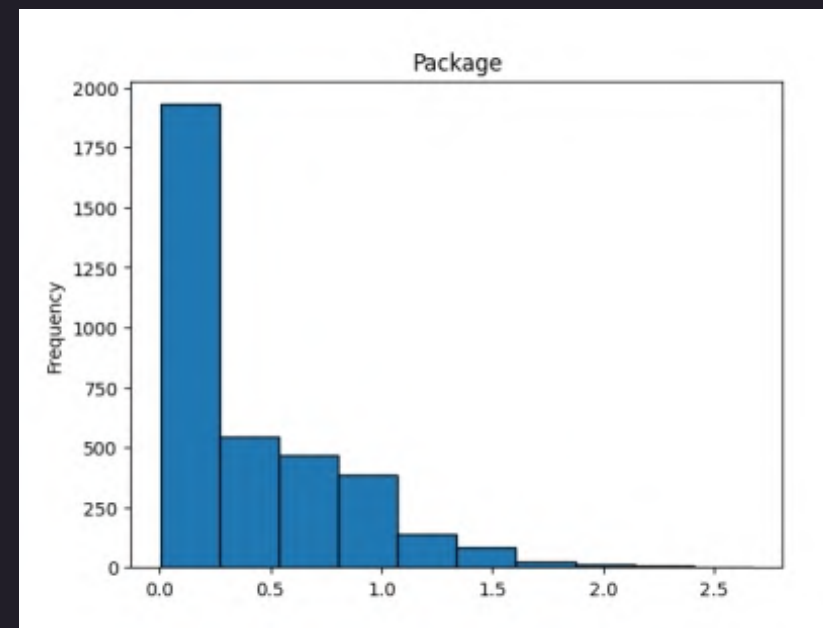
Package

energy consumption of the **entire
socket**, including the consumption of
all the cores, integrated graphics and
also the uncore components (last
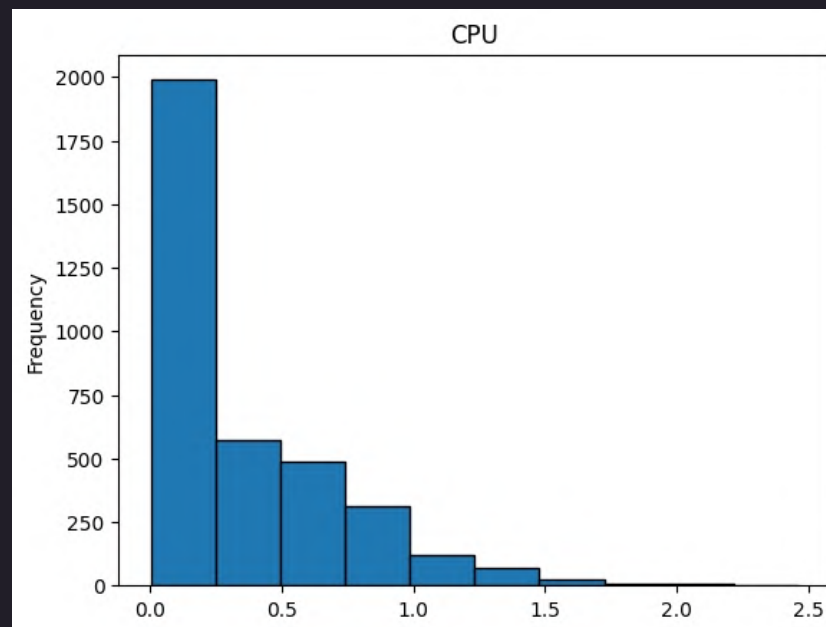level caches, memory controller) and
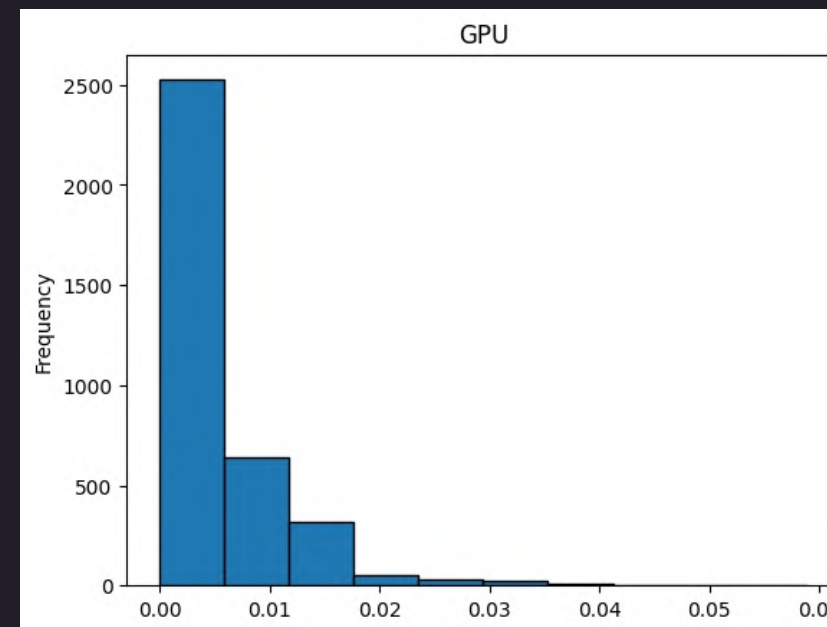it has the following distribution
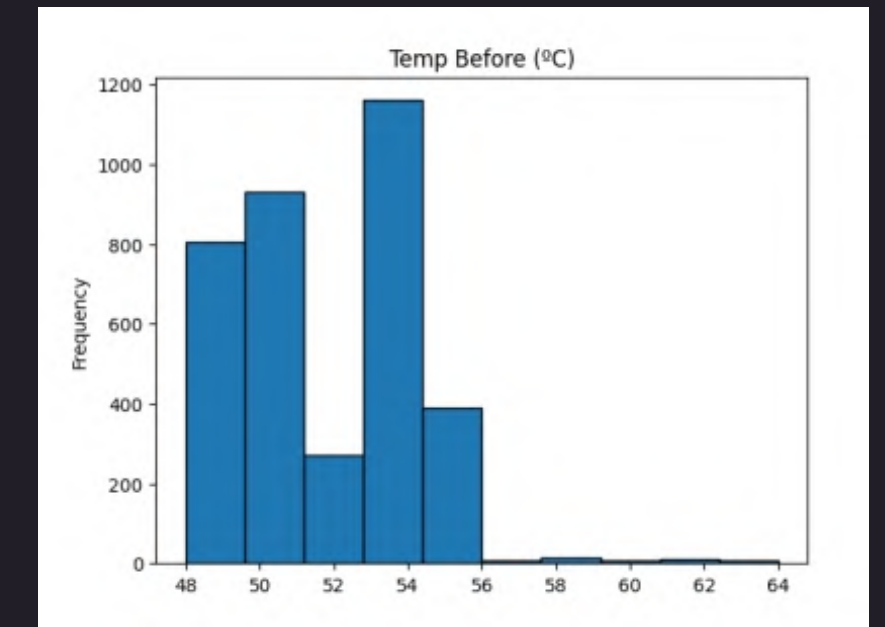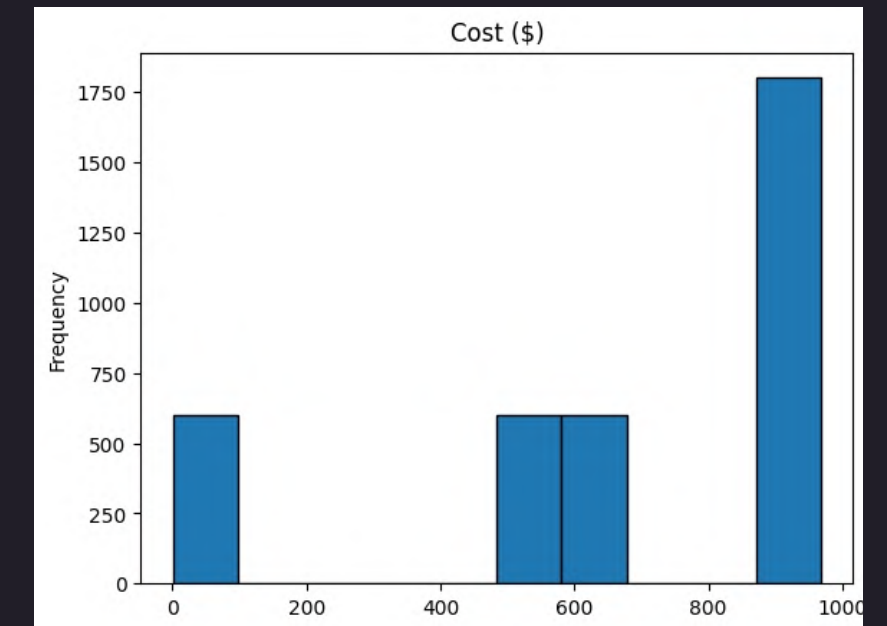

Temp After

Benchmarking

Cost

Core
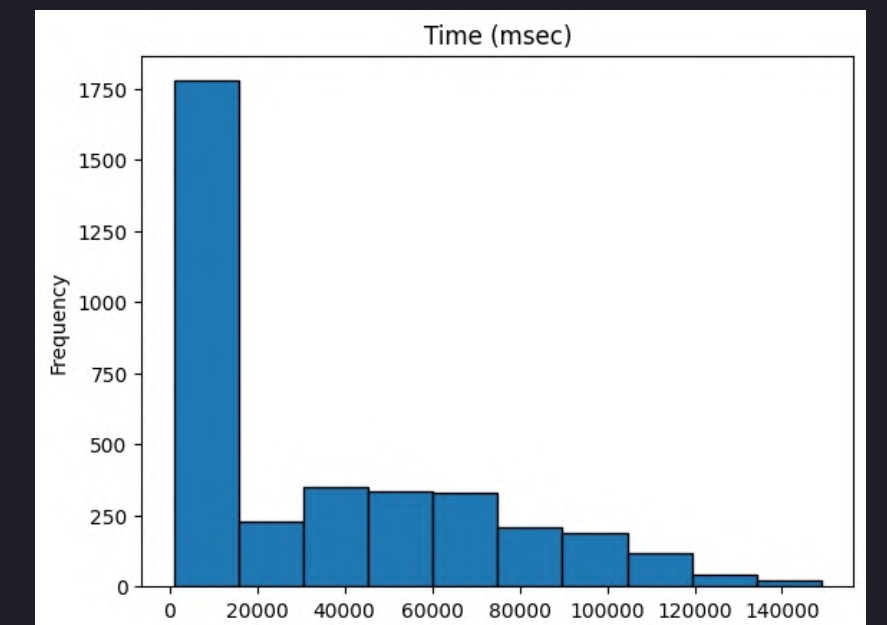
the energy consumed by all cores and caches

GPU

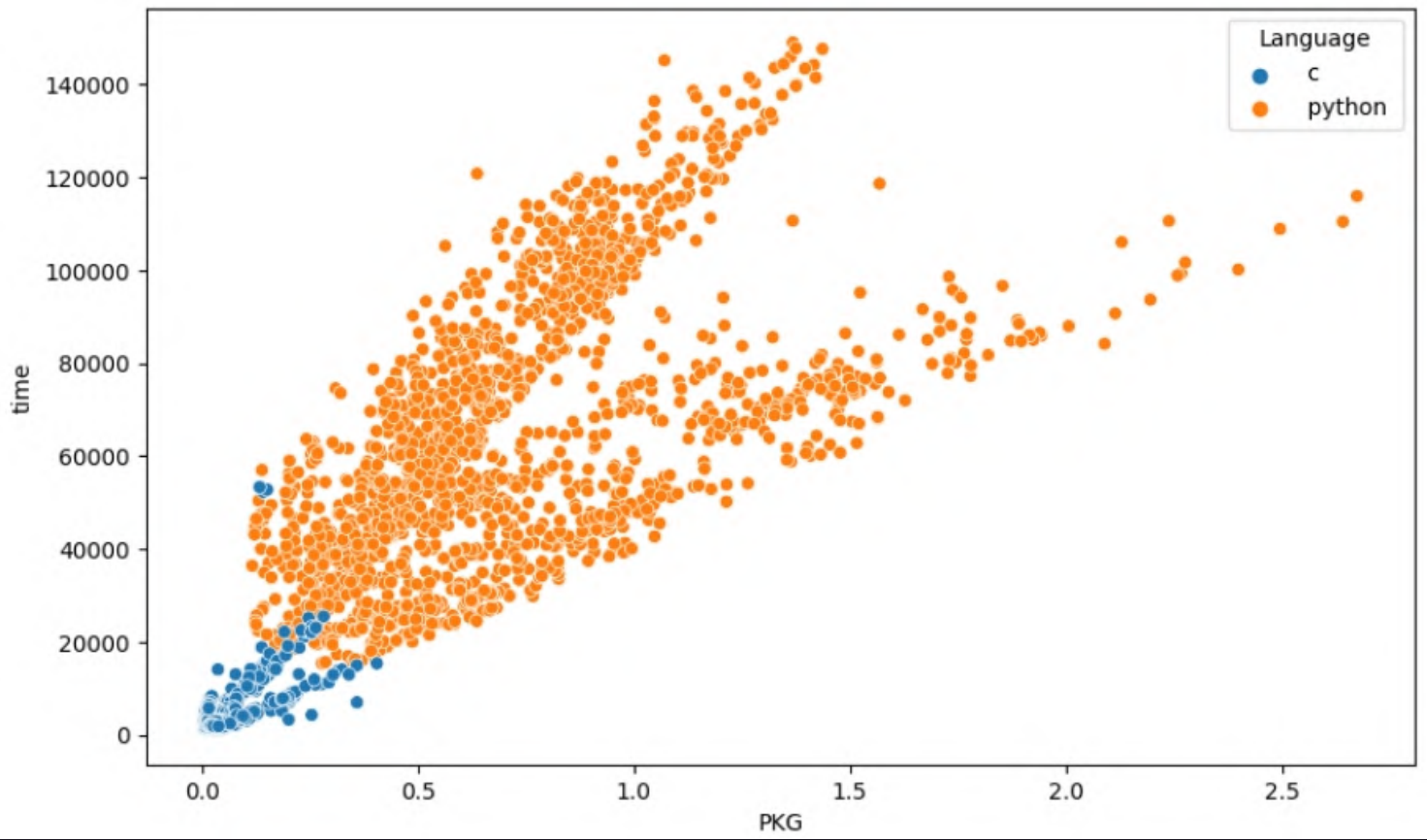the energy consumed by the GPU
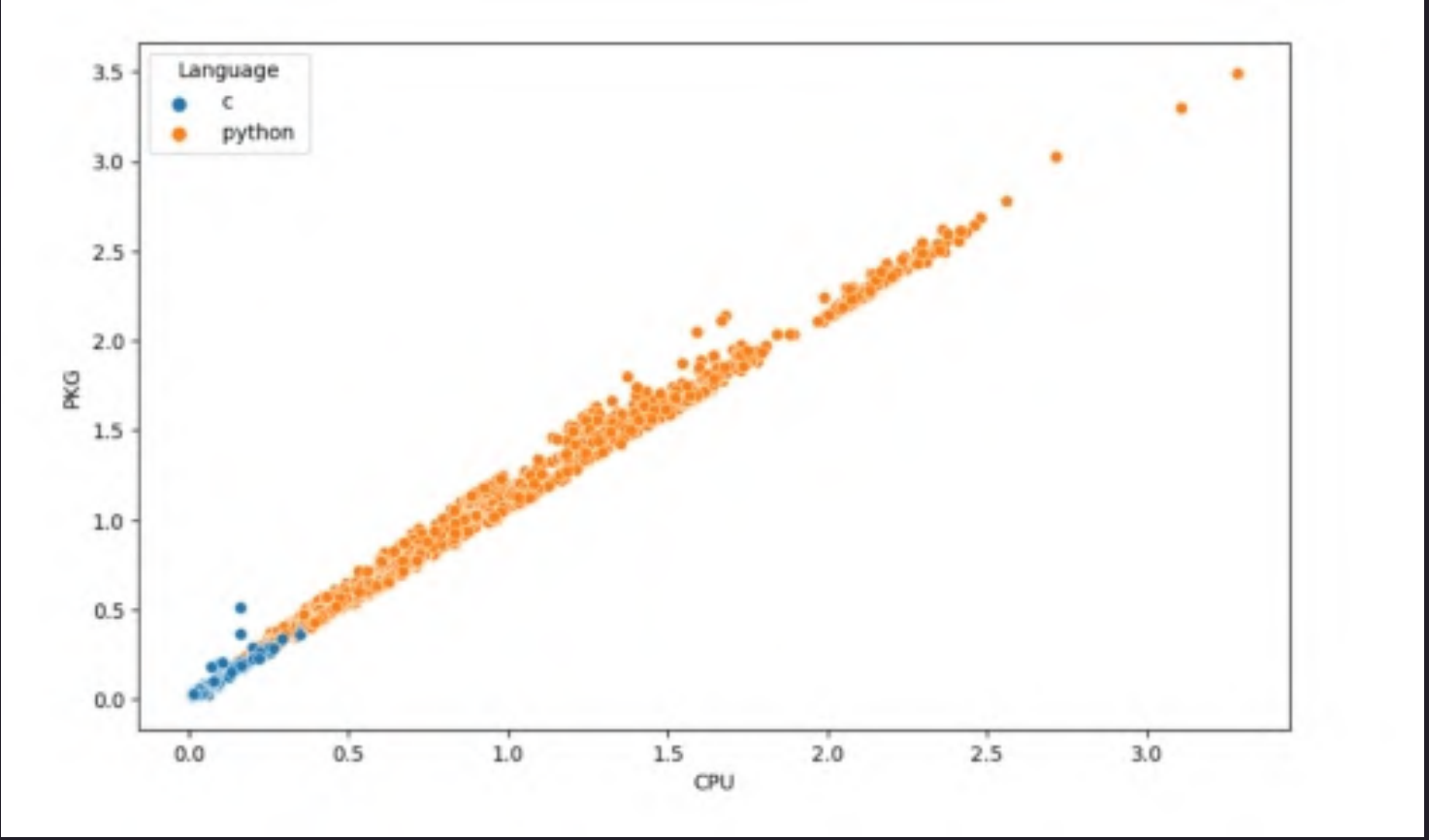

Time

Towards a Ranking of Sorting Algorithms

Basic Statistics


Scatterplot PKG by Time

Scatterplot CPU by Package

Basic Statistics

	Language	Temperature Increase
Medium Array Size + PowerCap=25	C	0.22
	Python	0.74
Big Array Size + PowerCap=25	C	0,33
	Python	0,69
Medium Array Size + PowerCap=10	C	0
	Python	0,077

	Language	PKG	CPU
Medium Array Size + PowerCap=25	C	0,041	0.0358
	Python	0.724	0.6412
Big Array Size + PowerCap=25	C	0,0549	0,0464
	Python	1.2121	1.0951
Medium Array Size + PowerCap=10	C	0,041	0,0334
	Python	0,661	0,5411

	Language	Memory	Time
Medium Array Size + PowerCap=25	C	961	2662
	Python	13029	50691
Big Array Size + PowerCap=25	C	974	3708
	Python	17482	74649
Medium Array Size + PowerCap=10	C	961	4436
	Python	13021	78912

Histograms
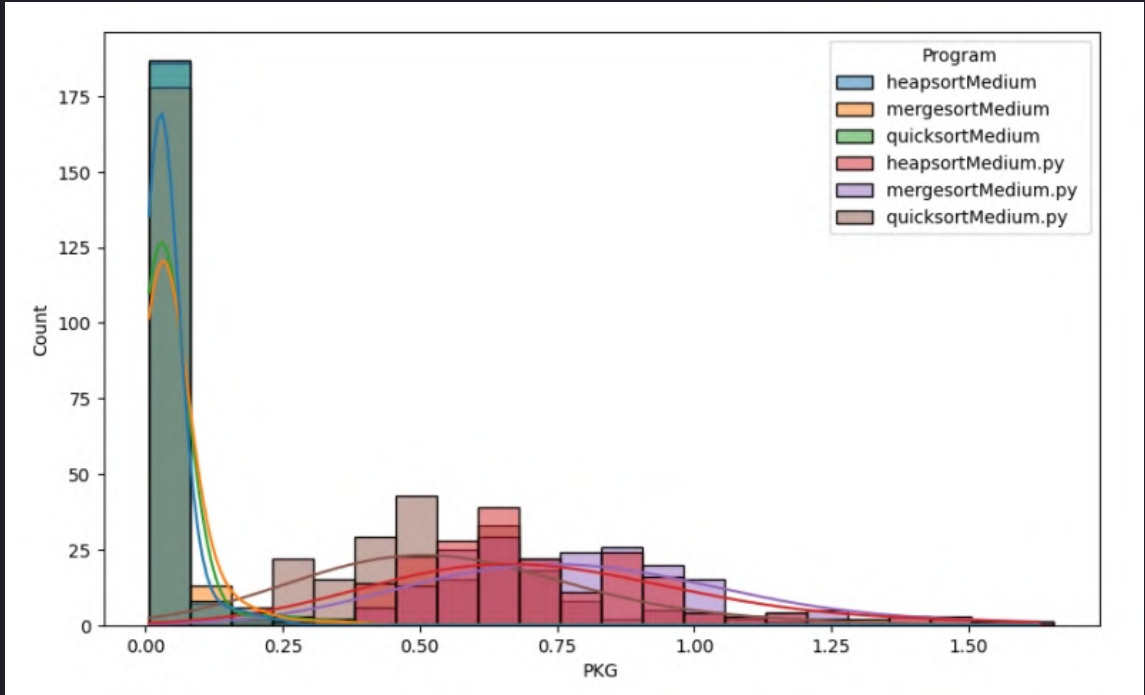
Histogram by Input Size
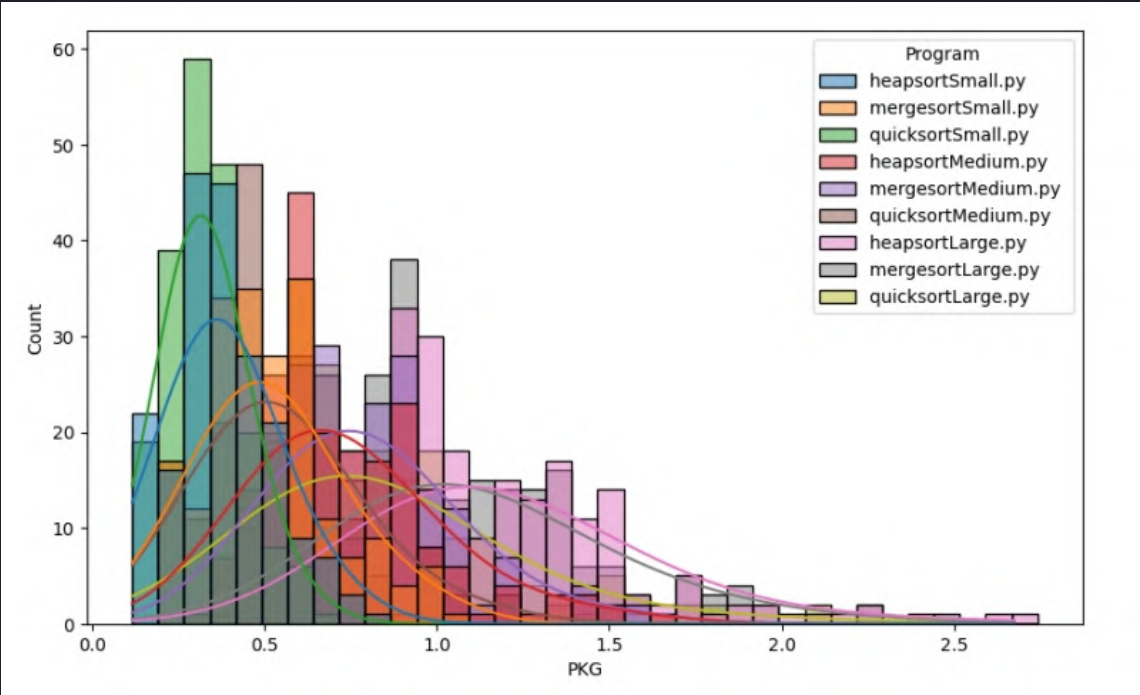
Histogram By Program
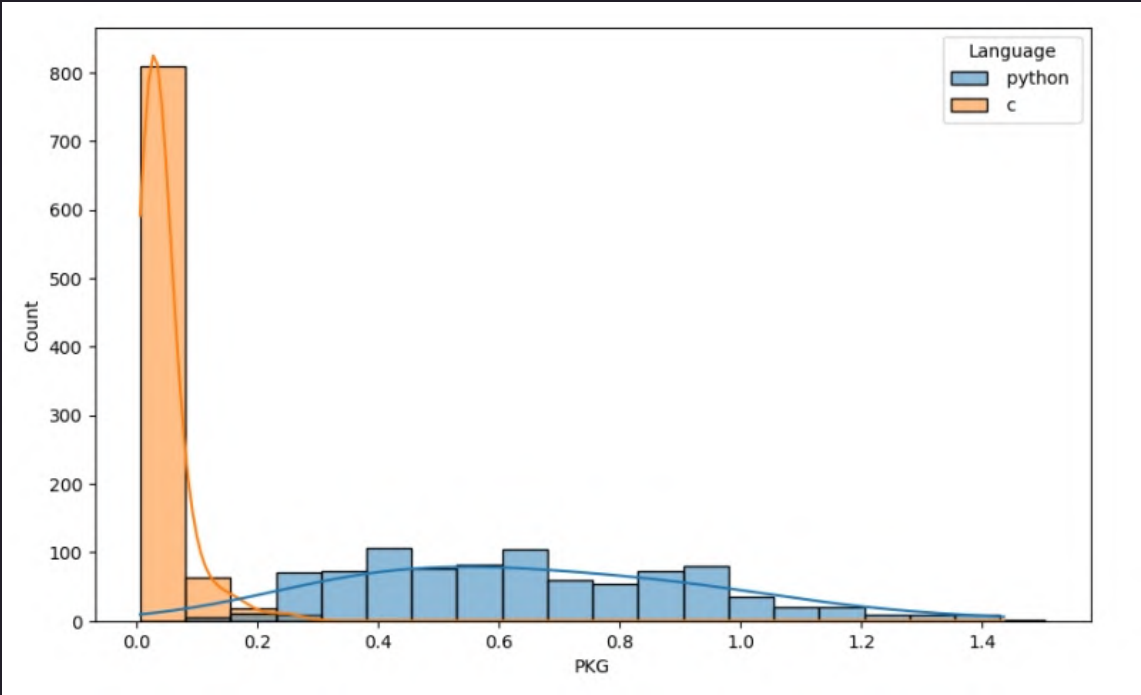
Histogram by Language
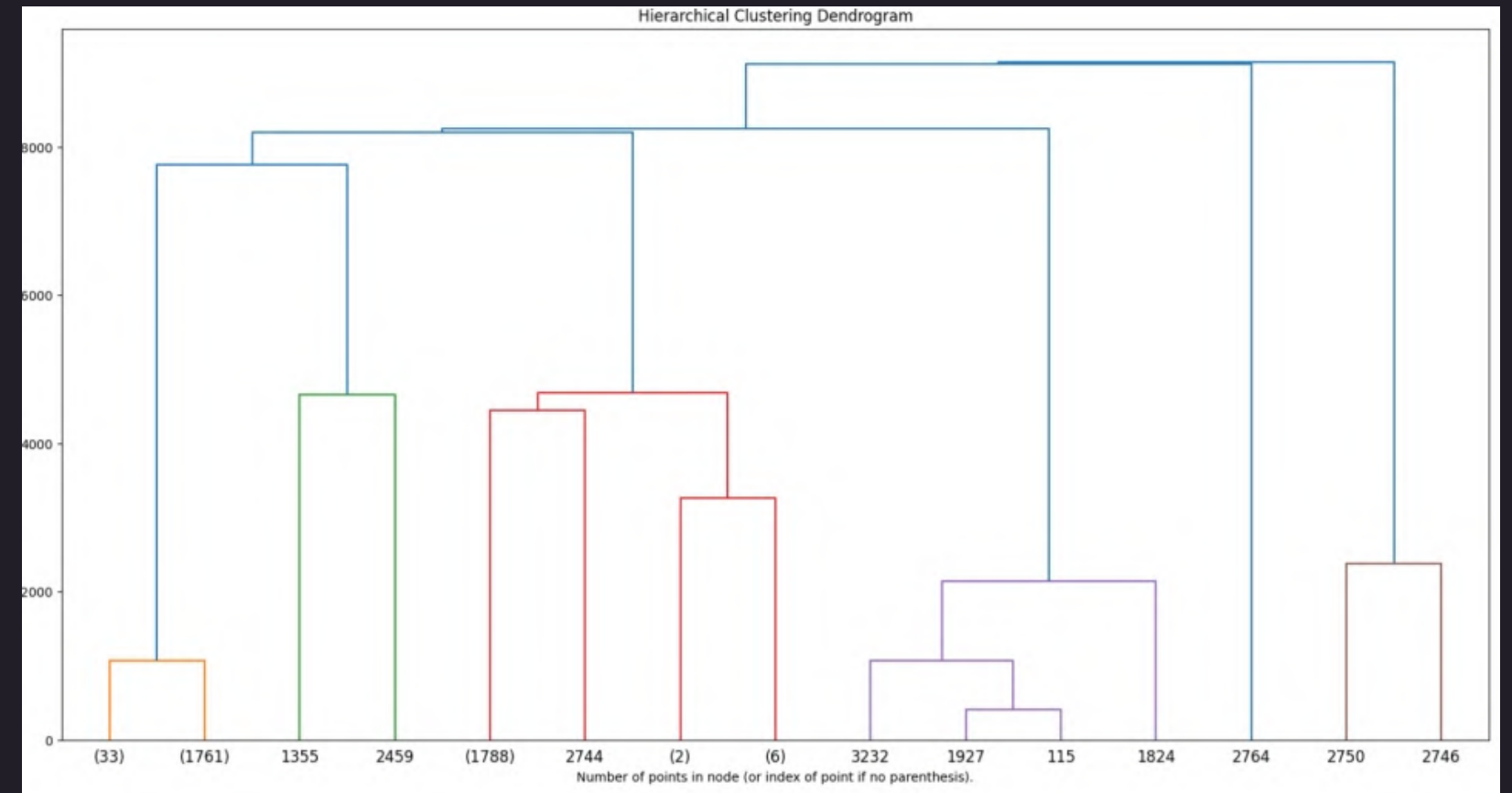
Correlations

	Value	pValue
Pearson Coefficient	0,997	0,0
Spearman Coefficient	0,99	0,0
Kendall Coefficient	0,93	0,0

Clustering
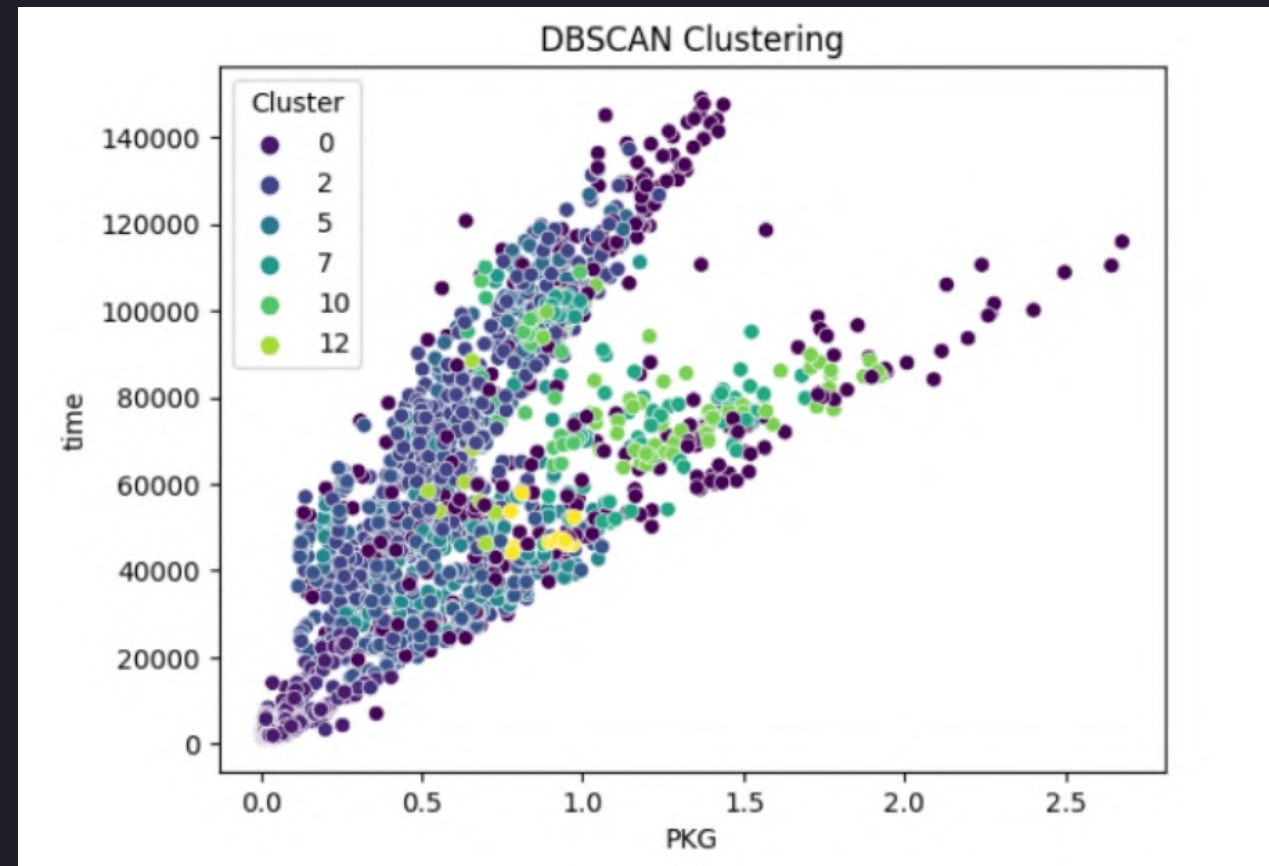
DBSCAN

Agglomerative

(bottom-up construction)

Multicriteria Optimization

Scenario	Best Option C	2nd Best C	Best Option Python	2nd Best Pytho
Small Input Cap On	Mergesort	Quicksort	Quicksort	Heapsort
Small Input Cap Off	Quicksort	Heapsort	Quicksort	Heapsort
Medium Input Cap On	Quicksort(tie)	Heapsort(tie)	Quicksort	Heapsort
Medium Input Cap Off	Heapsort	Quicksort	Quicksort	Heapsort
Large Input Cap On	Quicksort	Heapsort	Quicksort	Mergesort
Large Input Cap Off	Quicksort	Heapsort	Quicksort	Mergesort

Conclusão