The impact of inter-arrivals times and execution times on the length of a simulation interval

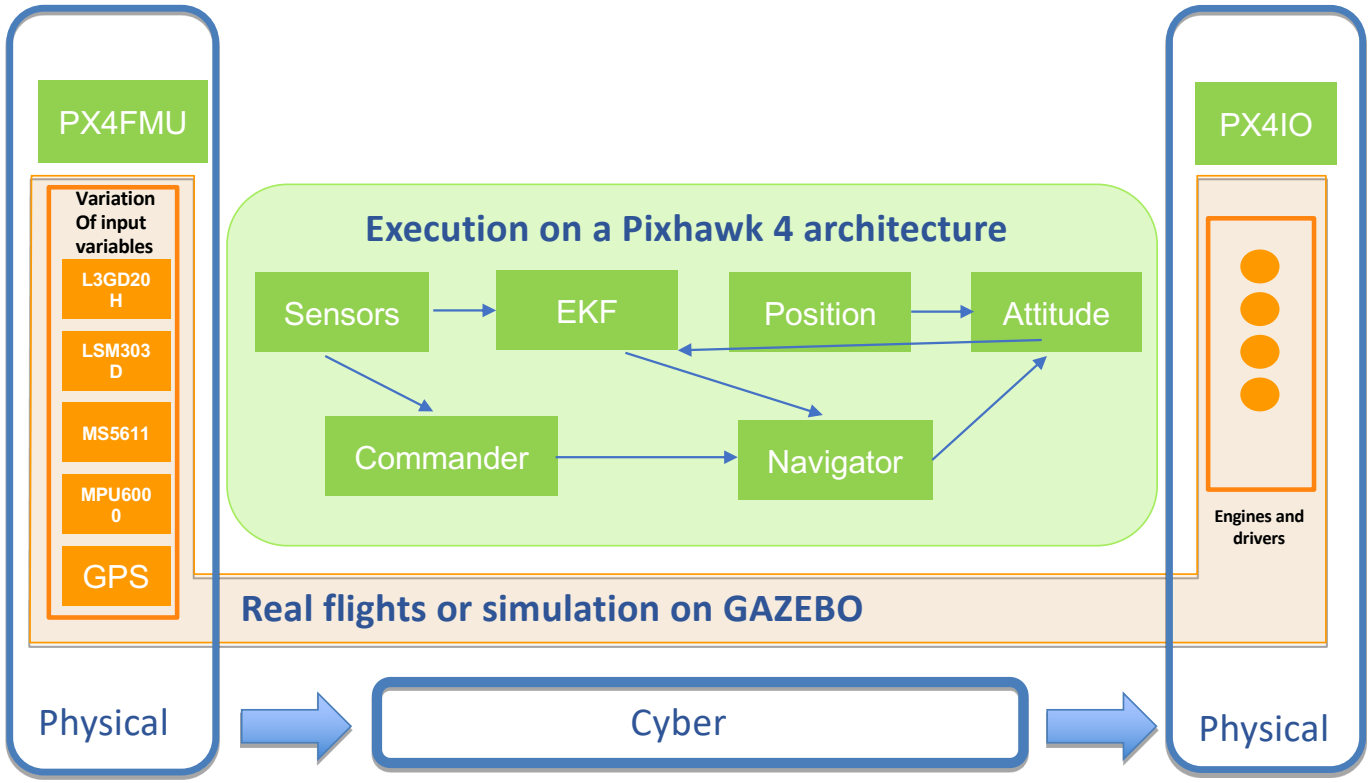
by Liliana Cucu-Grosjean

Inria
INVENTEURS DU MONDE NUMÉRIQUE

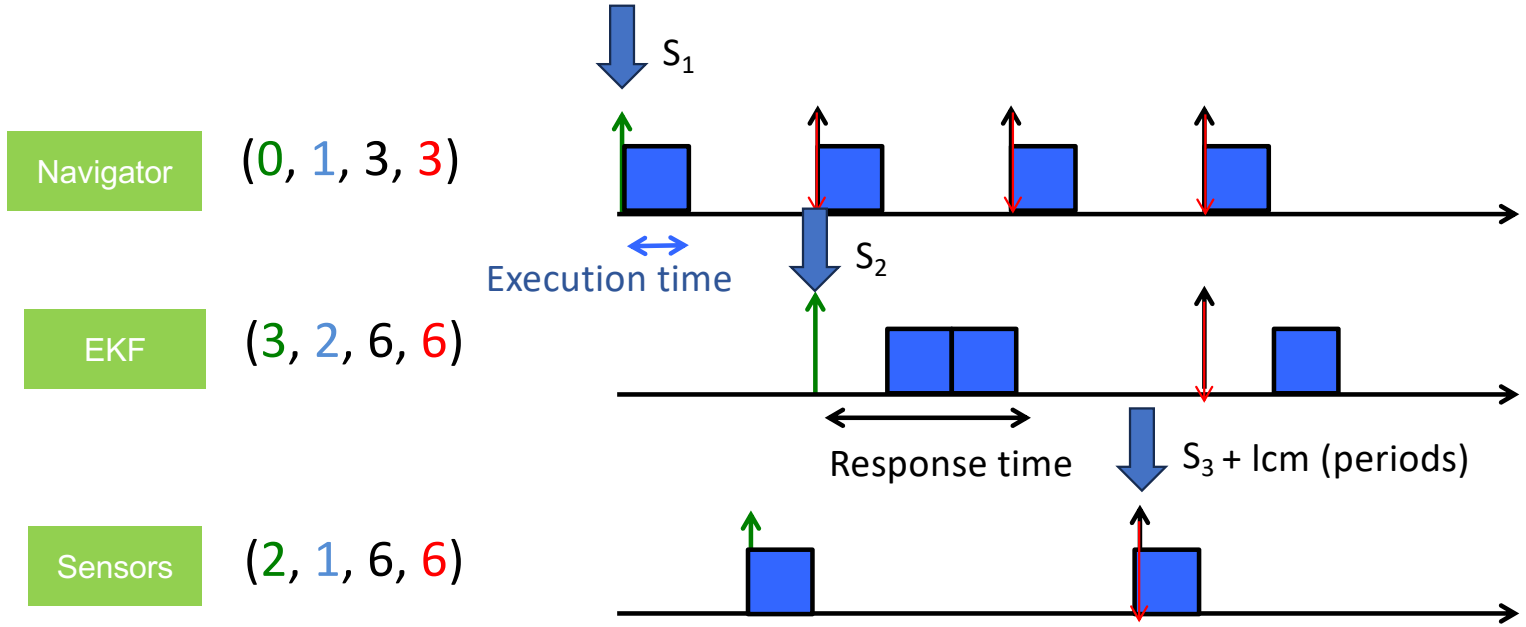
Outline

- The simulation interval – a worst-case reasoning notion
- Probabilistic and statistical (worst-case) execution times
- Different inter-arrival times produce different execution time distributions
- One formula

An example KDBench

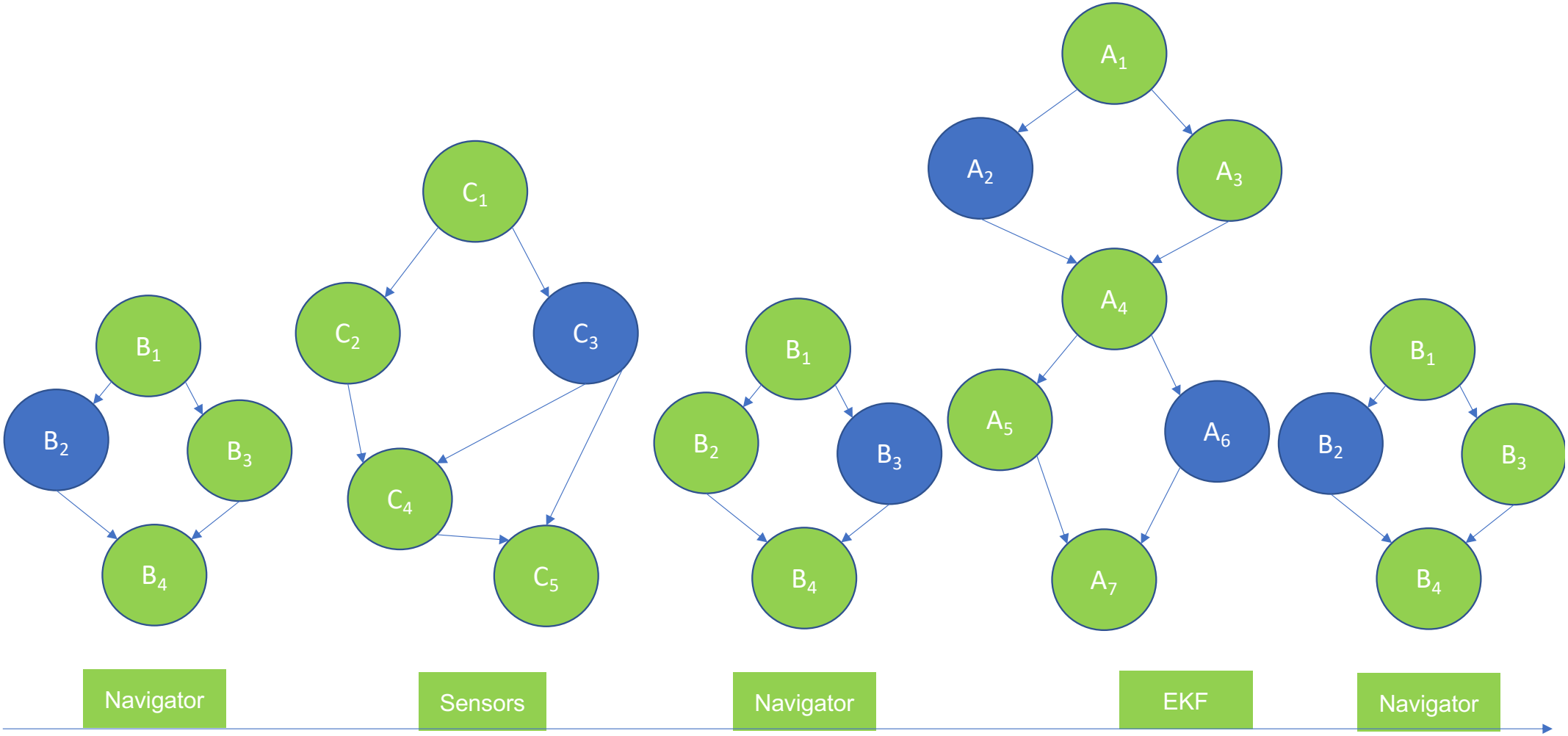


The simulation interval



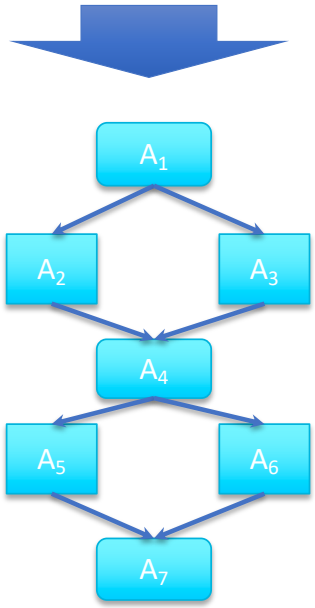
One core, fixed-priority scheduling algorithm

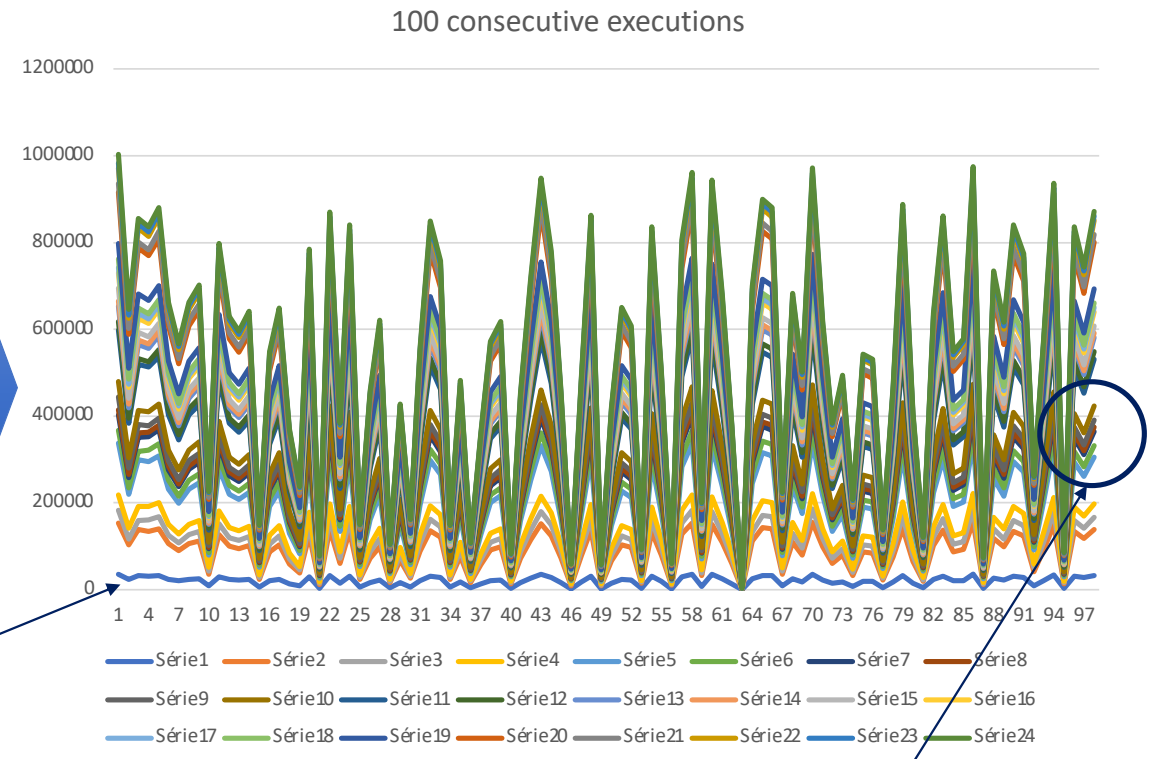
A deeper view within programs



Execution scenarios – for the same set of input variation

PROGRAM_executed on a 4 cores processor





Input variable

Two active cores

Outline

- The simulation interval – a worst-case reasoning notion
- Probabilistic and statistical (worst-case) execution times
- Different inter-arrival times produce different execution time distributions
- Conclusions

Probabilistic (and statistical) worst-case execution times

- The probabilistic execution time of a program describes the probability that the execution time of the instance is equal to a given value (Tia, 1995)

$$\mathscr{C}_i^j = \begin{pmatrix} 2 & 3 & 5 & 6 & 105 \\ 0.7 & 0.2 & 0.05 & 0.04 & 0.01 \end{pmatrix}$$

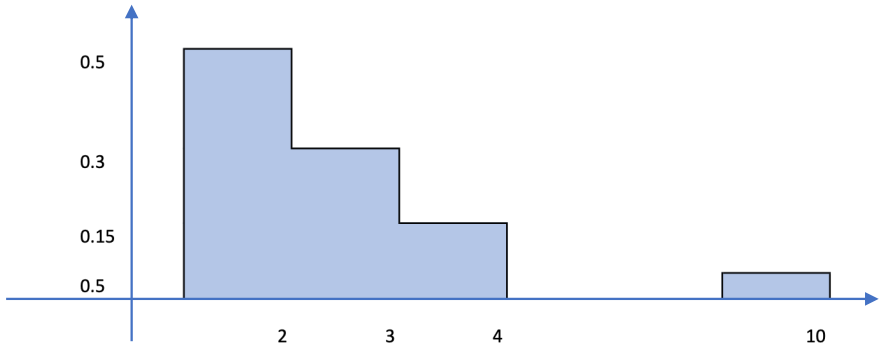
- The probabilistic worst-case execution time of a program describes the probability that the worst-case execution time of the program is equal to a given value (Bernat, 2002)

$$\mathscr{C}_2 = \begin{pmatrix} 2 & 3 & 105 \\ 0.75 & 0.20 & 0.05 \end{pmatrix}$$

From a distribution to a cumulative fonction*

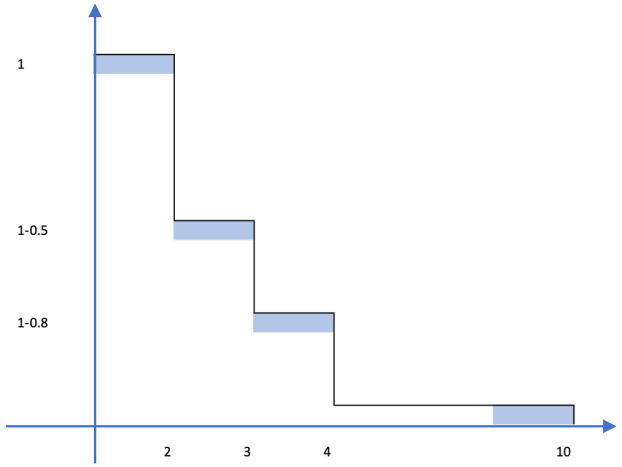
- What is a distribution function?

$$\mathcal{C}_i = \begin{pmatrix} 2 & 3 & 4 & 10 \\ 0.5 & 0.3 & 0.15 & 0.05 \end{pmatrix}$$



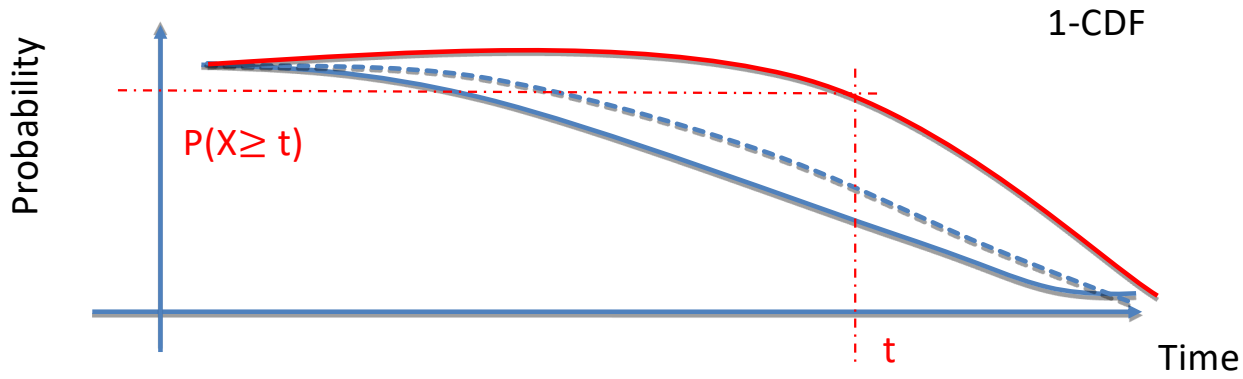
- What is a 1 - cumulative function?

$$\text{1-CDF} = \begin{pmatrix} 2 & 3 & 4 & 10 \\ 1 & 1\text{-}0.5 & 1\text{-}0.8 & 0.05 \end{pmatrix}$$

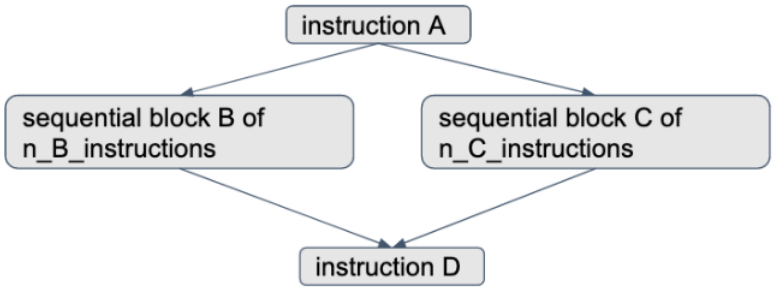


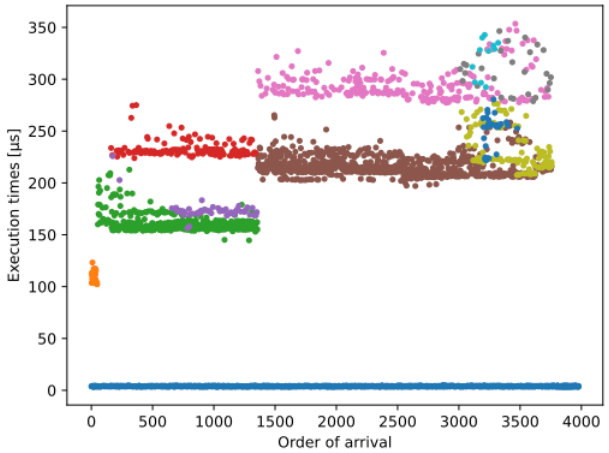
* Fonction de répartition

The probabilistic (or statistical) WCET is a bound



For how long do we monitor ?



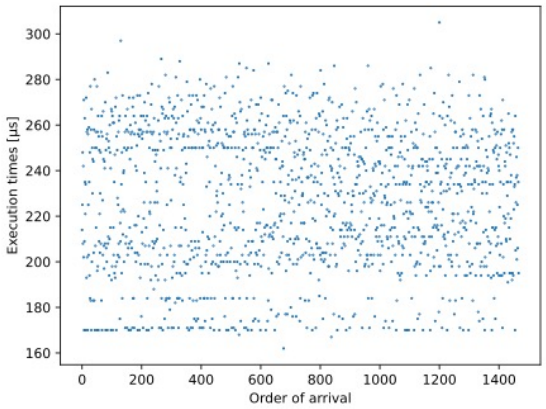


The notion of similar paths reduces the complexity

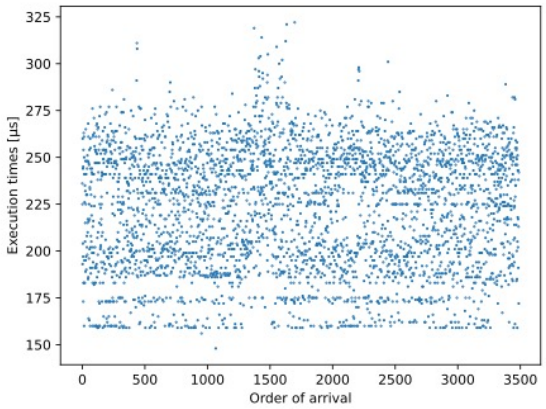
Flight manager

Figures from the PhD thesis of Ismail Hawila (https://theses.hal.science/tel-05599445)

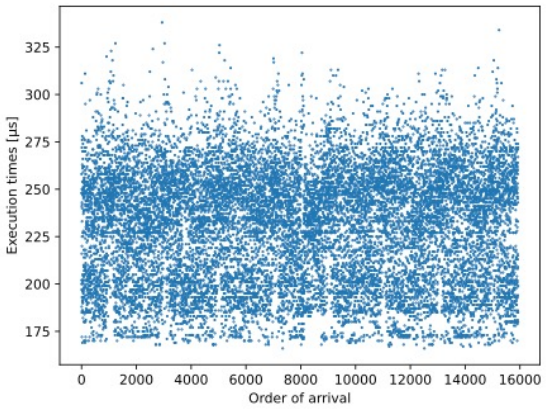
What is a pattern ?



(a) short scenario



(b) medium scenario

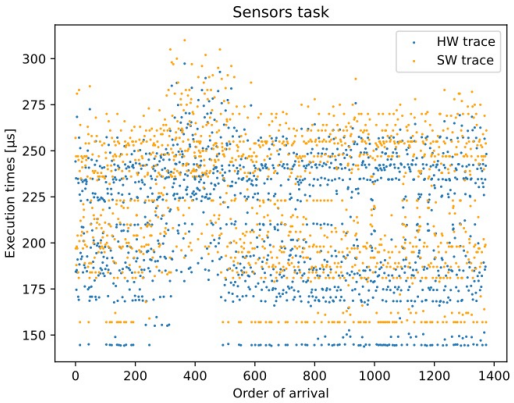


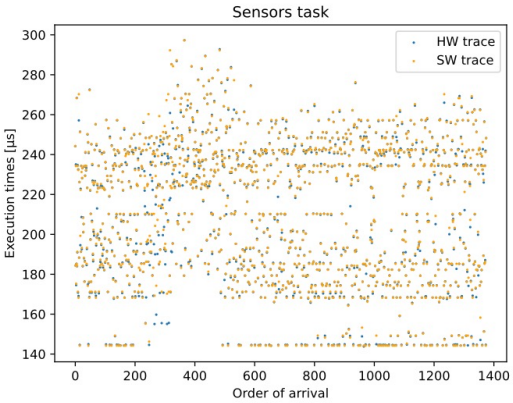
(c) long scenario

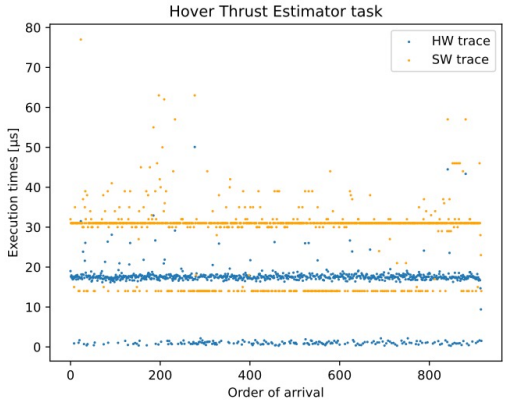
Sensors

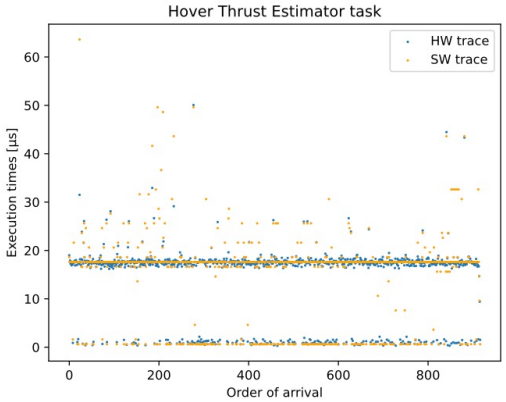
Where do we measure ?

- ✓OS presence
- ✓Barre metal









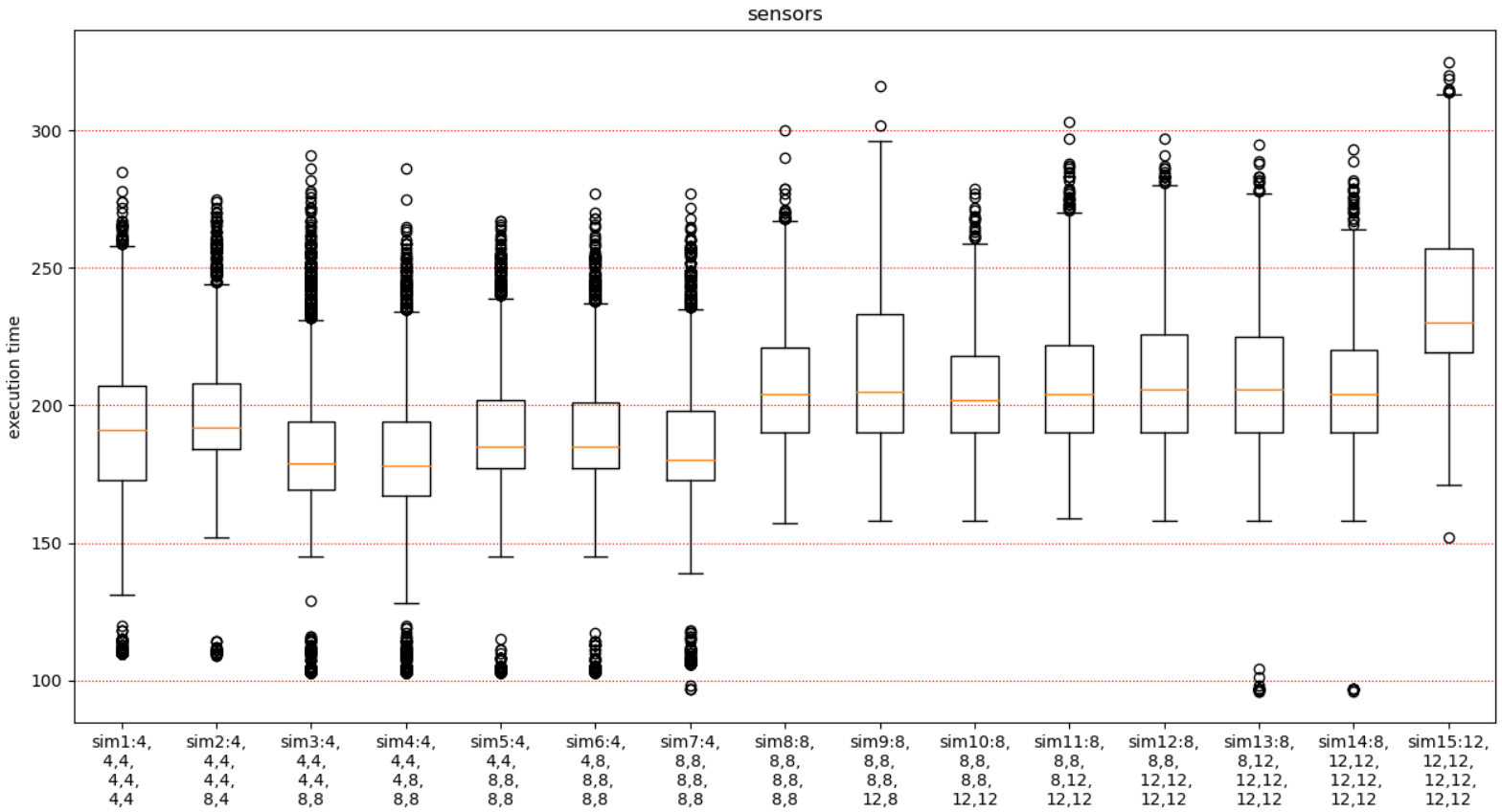


(left HW, right SW)

Outline

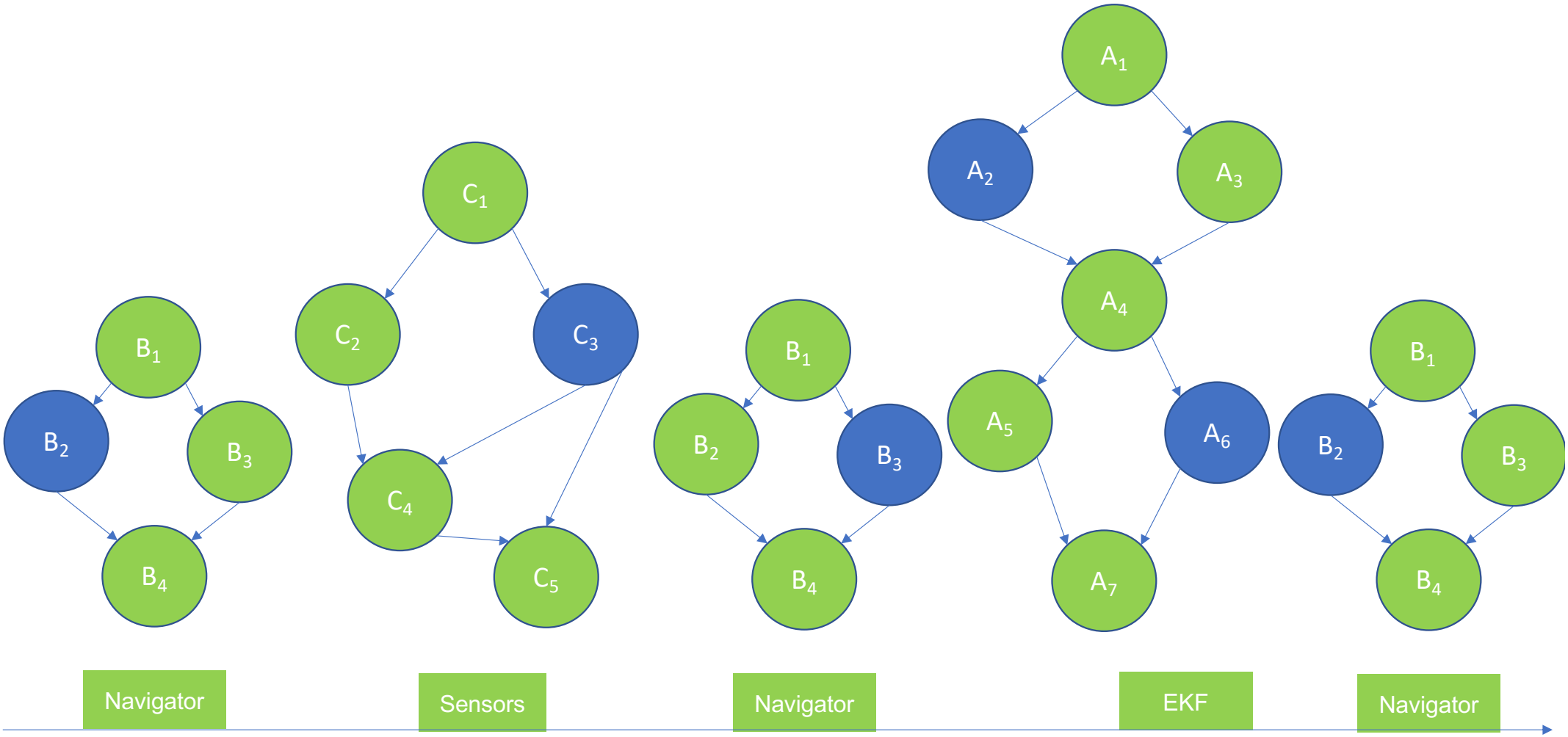
- The simulation interval – a worst-case reasoning notion
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Different inter-arrival times …



Figures from the PhD thesis of Ismail Hawila (https://theses.hal.science/tel-05599445)

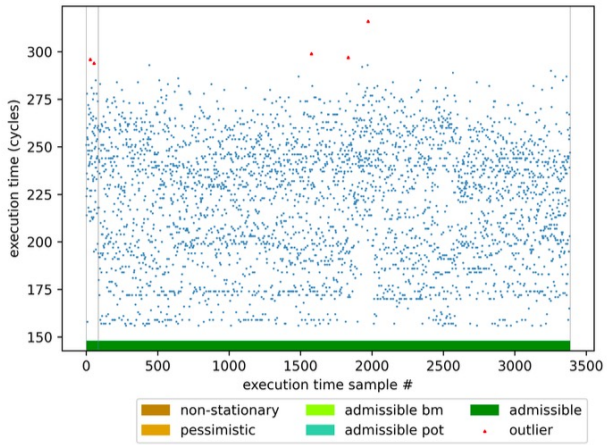
Paths vary within programs



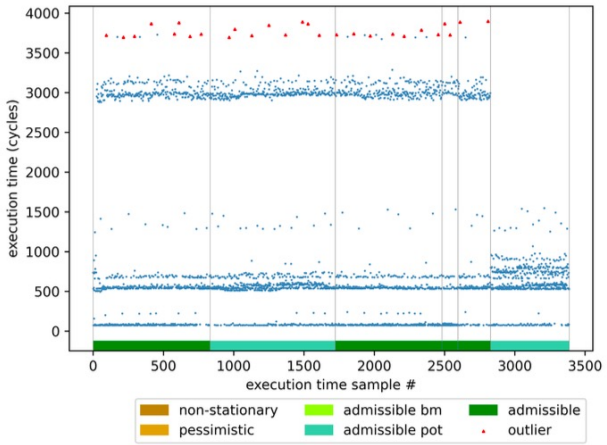
One existing formula of (C, T) [K. Zagalo, PhD thesis, 2023,4.3]

A steady real-time system: a real-time system is said steady when there exists a sequence of distributions bounding (worst-case) response times repeating indefinitely.

A maximum utilisation smaller than 1 and the existence of a first idle time from which a system is steady with a given probability



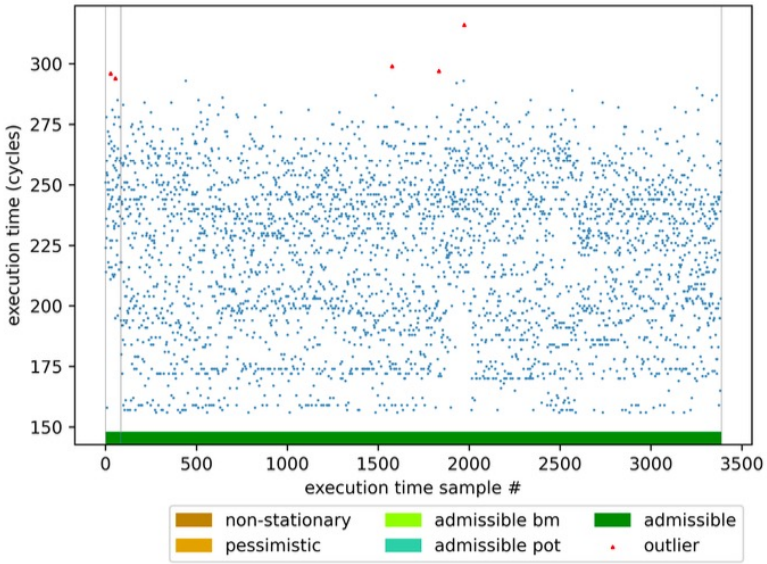
(a) Sensors



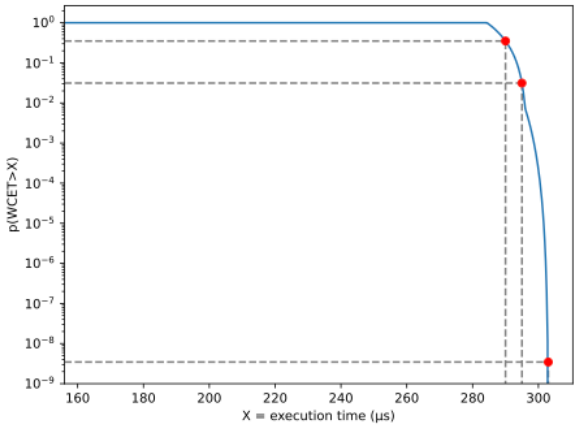
(b) EKF2

Figures from the PhD thesis of Ismail Hawila (https://theses.hal.science/tel-05599445) and Marwan Wehaiba (https://theses.hal.science/tel-04999351)

The impact of the steady property



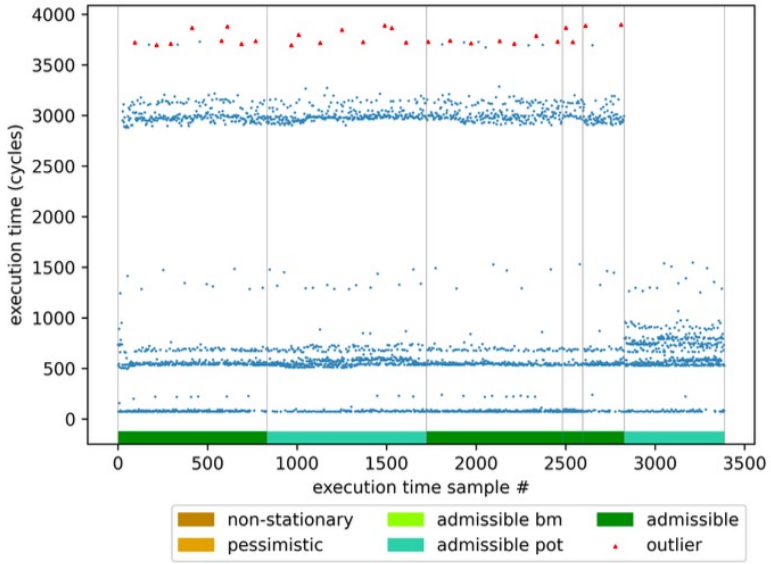
(a) Sensors



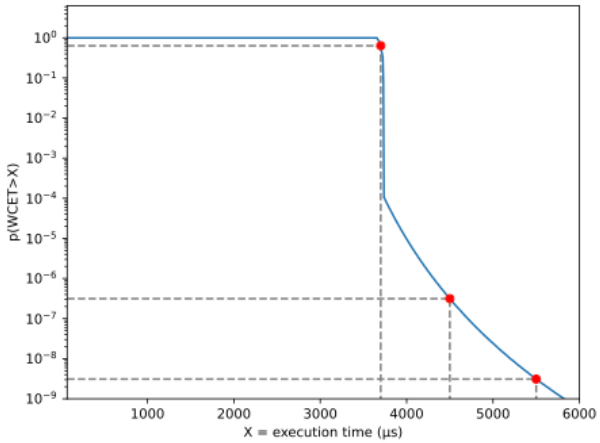
(a) Sensors

Figures from the PhD thesis of Ismail Hawila (https://theses.hal.science/tel-05599445) and Marwan Wehaiba (https://theses.hal.science/tel-04999351)

The impact of the steady property (2)



(b) EKF2



(b) EKF2

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Outline

- ✓ The simulation interval – a worst-case reasoning notion
- ✓ Probabilistic and statistical (worst-case) execution times
- ✓ Different inter-arrival times produce different execution time distributions
- ✓ One formula for the lenght of a simulation interval

Thank you for your attention



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