

WORKSHOP CAPITAL: sCalable And Precise Timing
AnaLysis for multicore platforms
JUNIOR PRESENTATIONS

Use of machine learning for timing estimation: from single-core processors to multi-cores

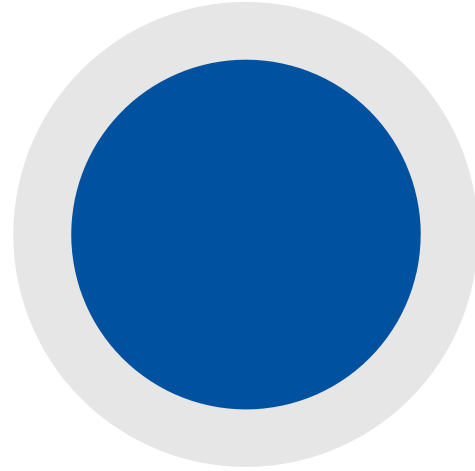
Supervisors :

- PUAUT Isabelle (PACAP team, IRISA)
- FROMONT Elisa (LACODAM team, IRISA)

PhD candidate :

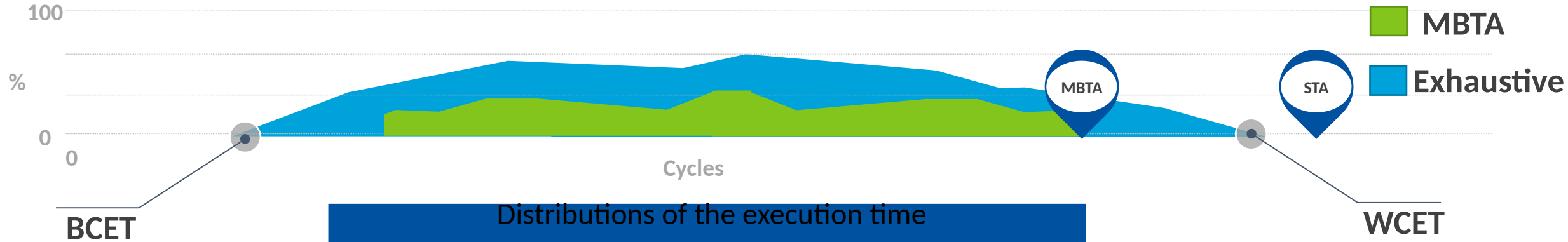
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04 June 2021



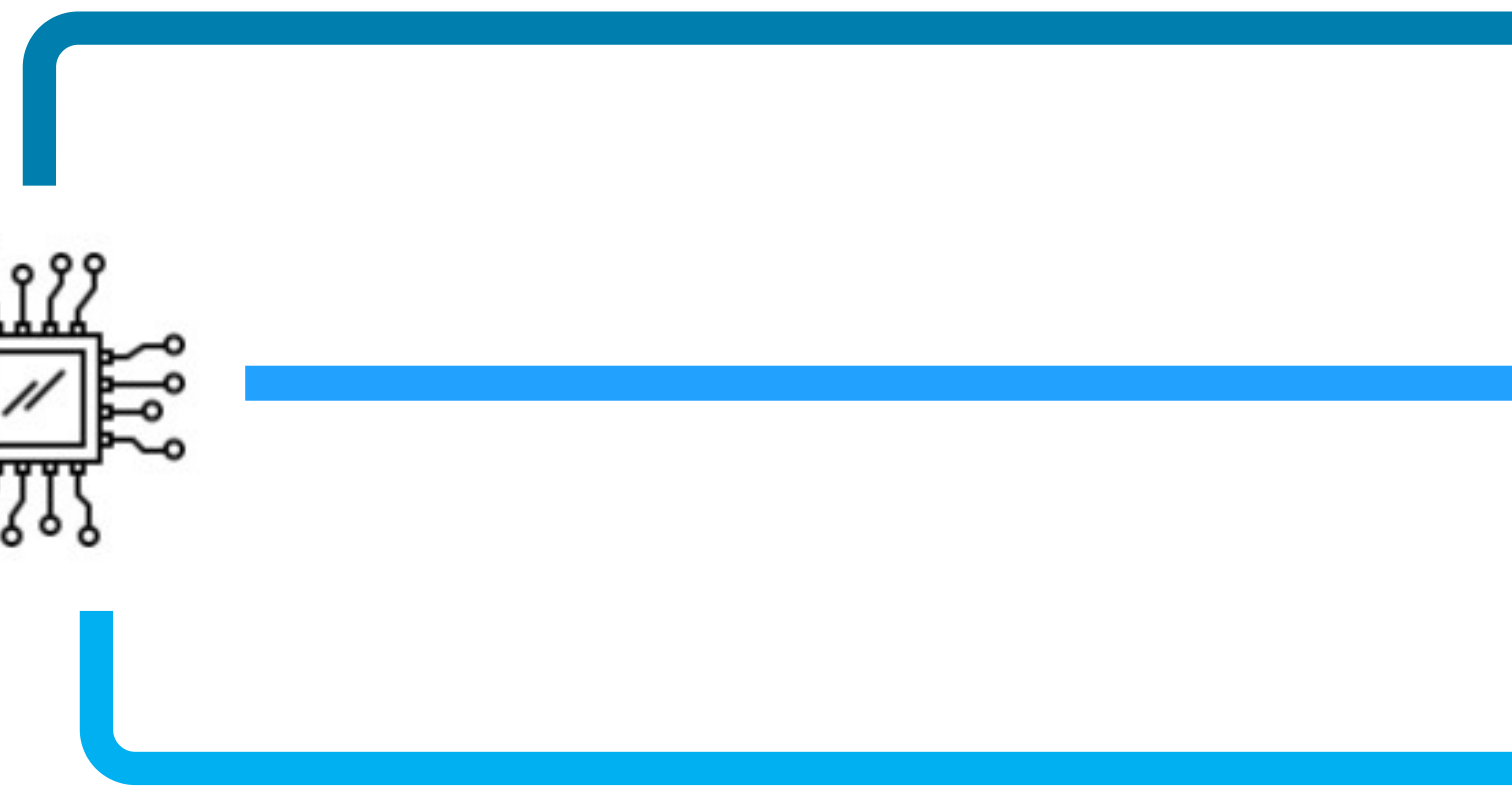
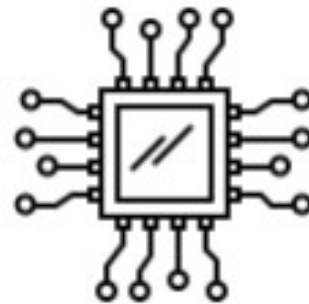
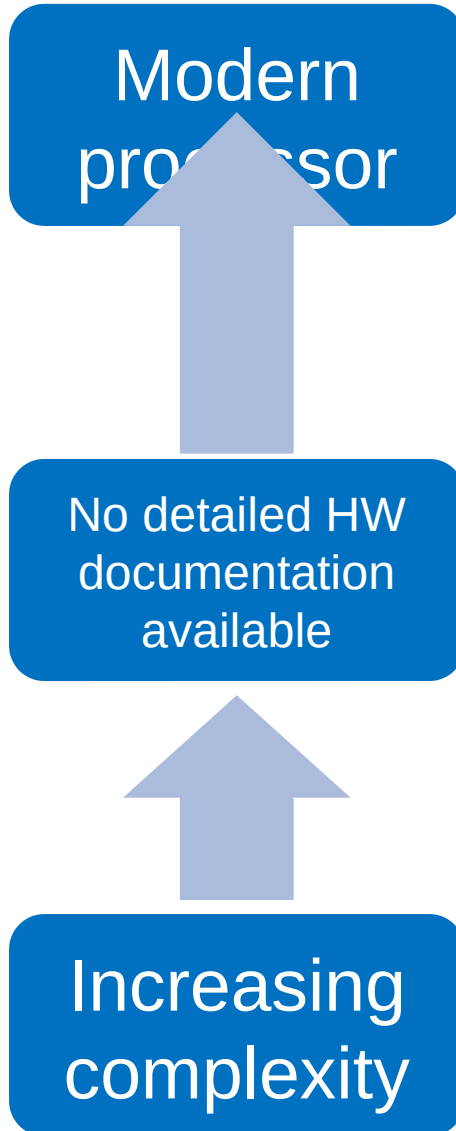
**{ Timing estimation of
the WCET }**

The Worst-Case Execution Time



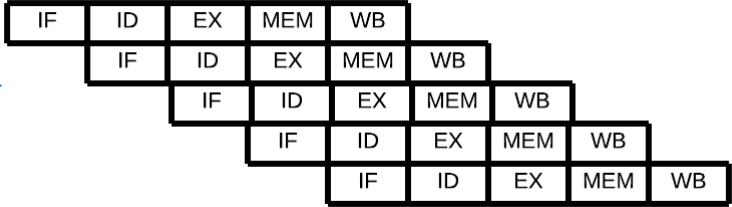
Reinhard Wilhelm & al. The worst-case execution-time problem overview of methods and survey of tools. ACM Transactions on Embedded Computing Systems (TECS), 7(3):36, 2008.

Motivation (1/2)



Motivation (2/2)

Pipeline



Instructions
sequence
impact

Caches

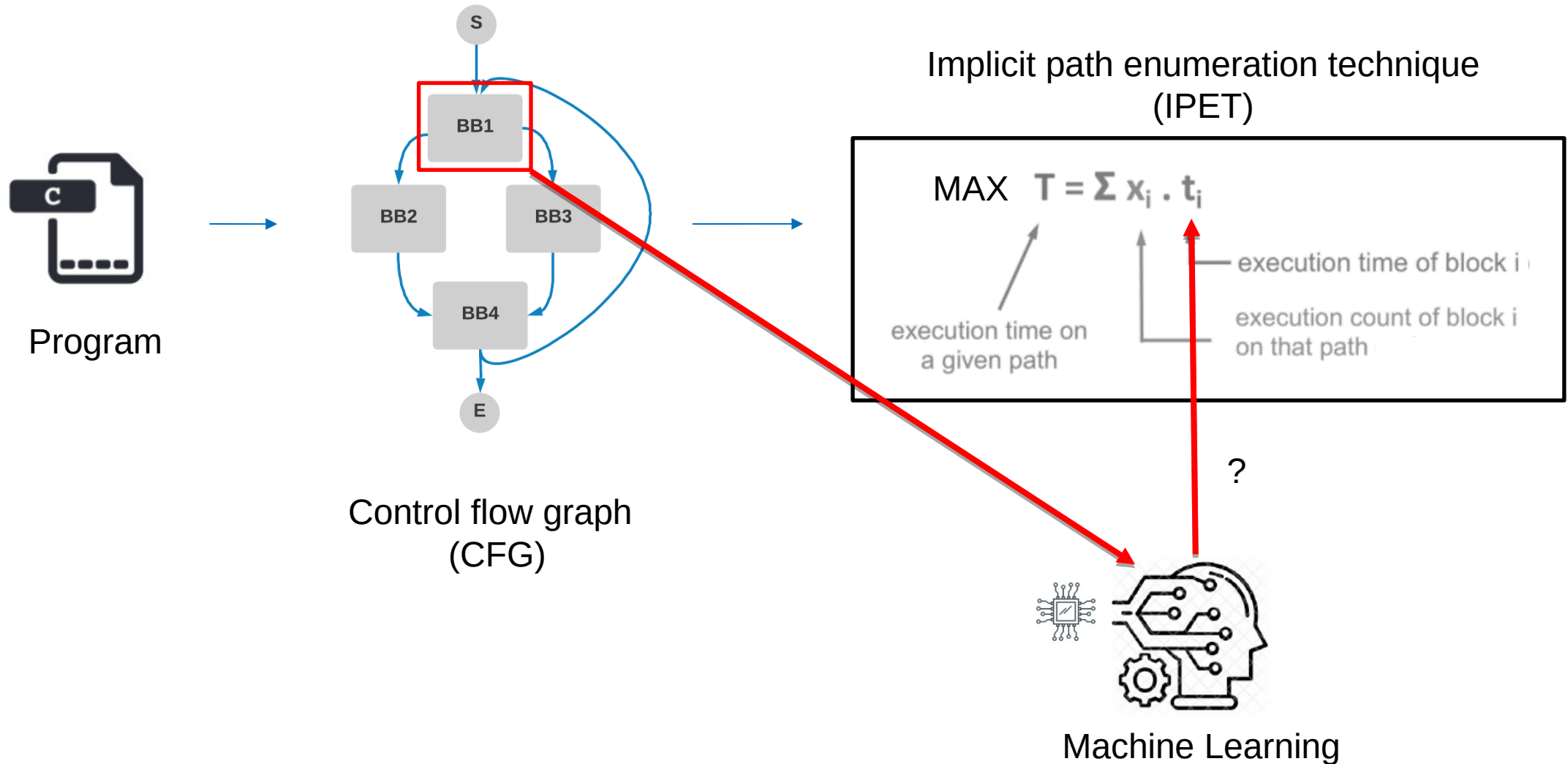


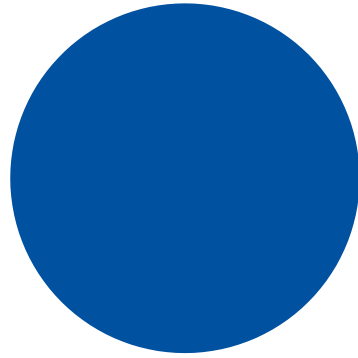
Loops and
information
reusing

Branch Predictor



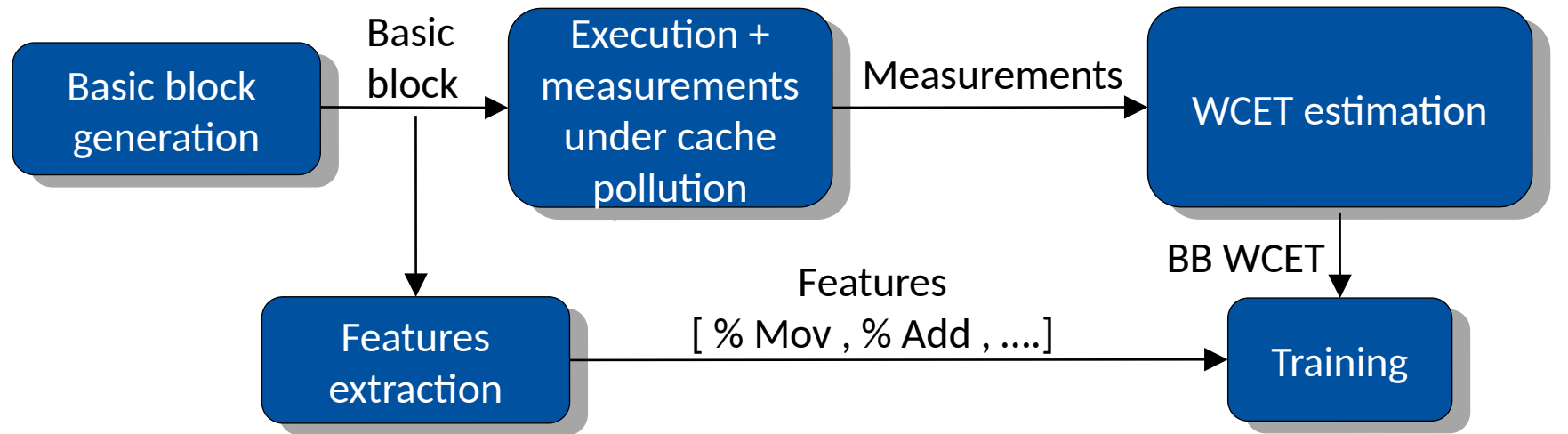
Machine Learning for WCET estimation





Preliminary work
WE-HML : Hybrid WCET
estimation using Machine
Learning for architectures
with caches

Training workflow of regression models



Supervised learning :

$$F(X) = Y$$

X is [%Mov , %Add , ...]

Y is BB WCET

F is { Linear regression, Random Forest, Multilayer perceptron...}

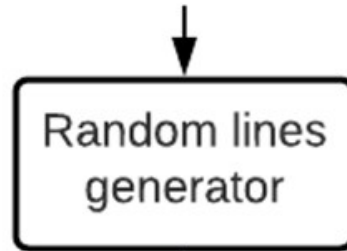
A. Amalou, I. Puaut, and G. Muller, 'WE-HML: hybrid WCET estimation using machine learning for architectures with caches', 2021, RTCSA.

First attempt on context awareness : Cache pollution

0- DATA Cache before pollution

0	x bytes
1	data
⋮	data
509	data
510	data
511	data

1- input : pollution factor p



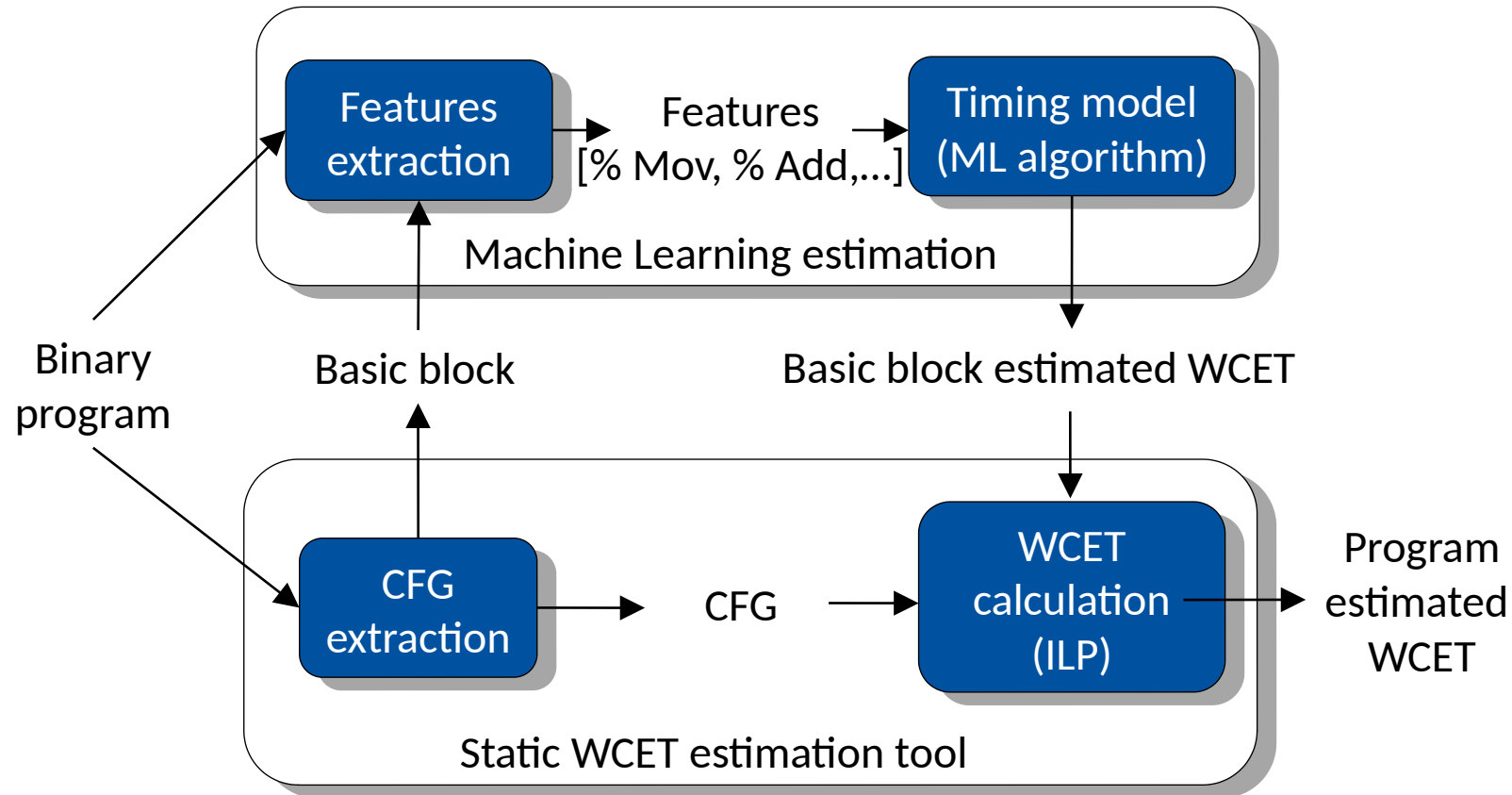
2- set of lines { e.g $p=2$ result : 1 and 509 }

4- DATA Cache after pollution

0	x bytes
1	██████████
⋮	data
509	██████████
510	data
511	data

A. Amalou, I. Puaut, and G. Muller, 'WE-HML: hybrid WCET estimation using machine learning for architectures with caches', 2021, RTCSA.

WCET prediction of a program



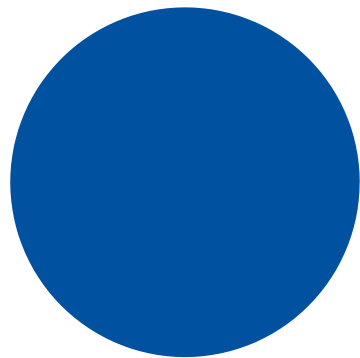
A. Amalou, I. Puaut, and G. Muller, 'WE-HML: hybrid WCET estimation using machine learning for architectures with caches', 2021, RTCSA.

Challenges

Context-awareness

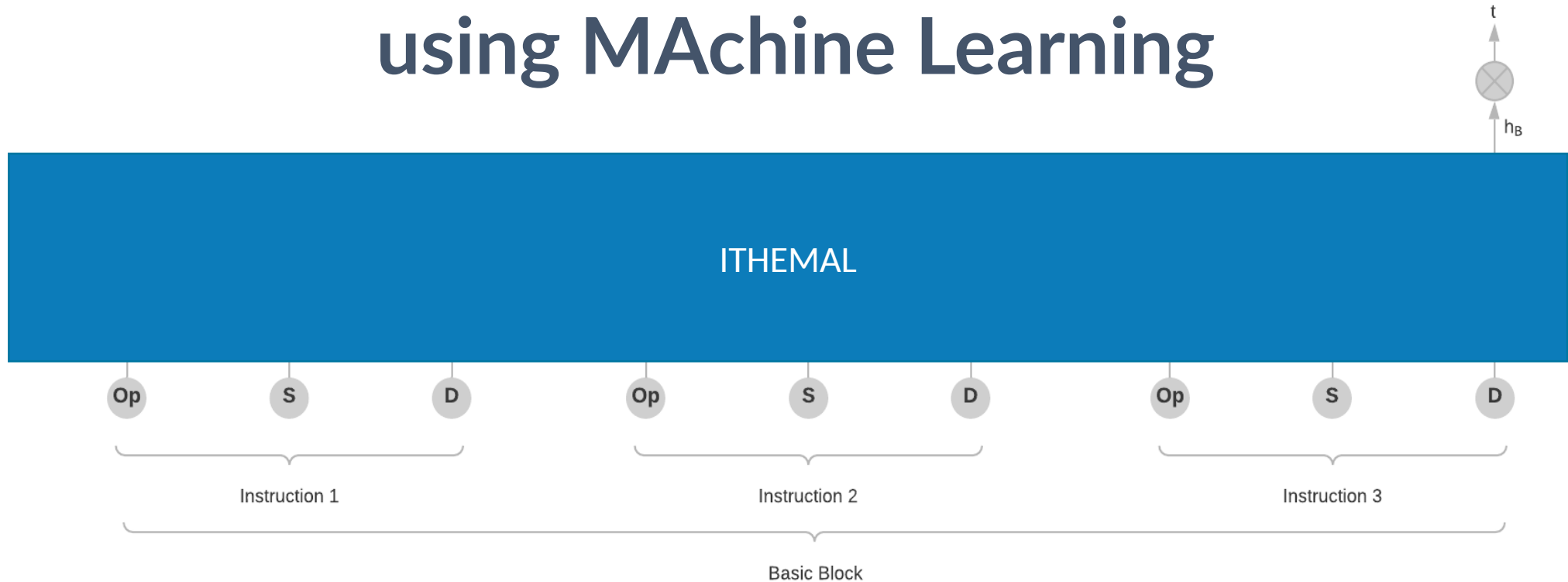
Representativity of training data

Comparison with reference tools



**Ongoing work ML technique
inspired by ITHEMAL**

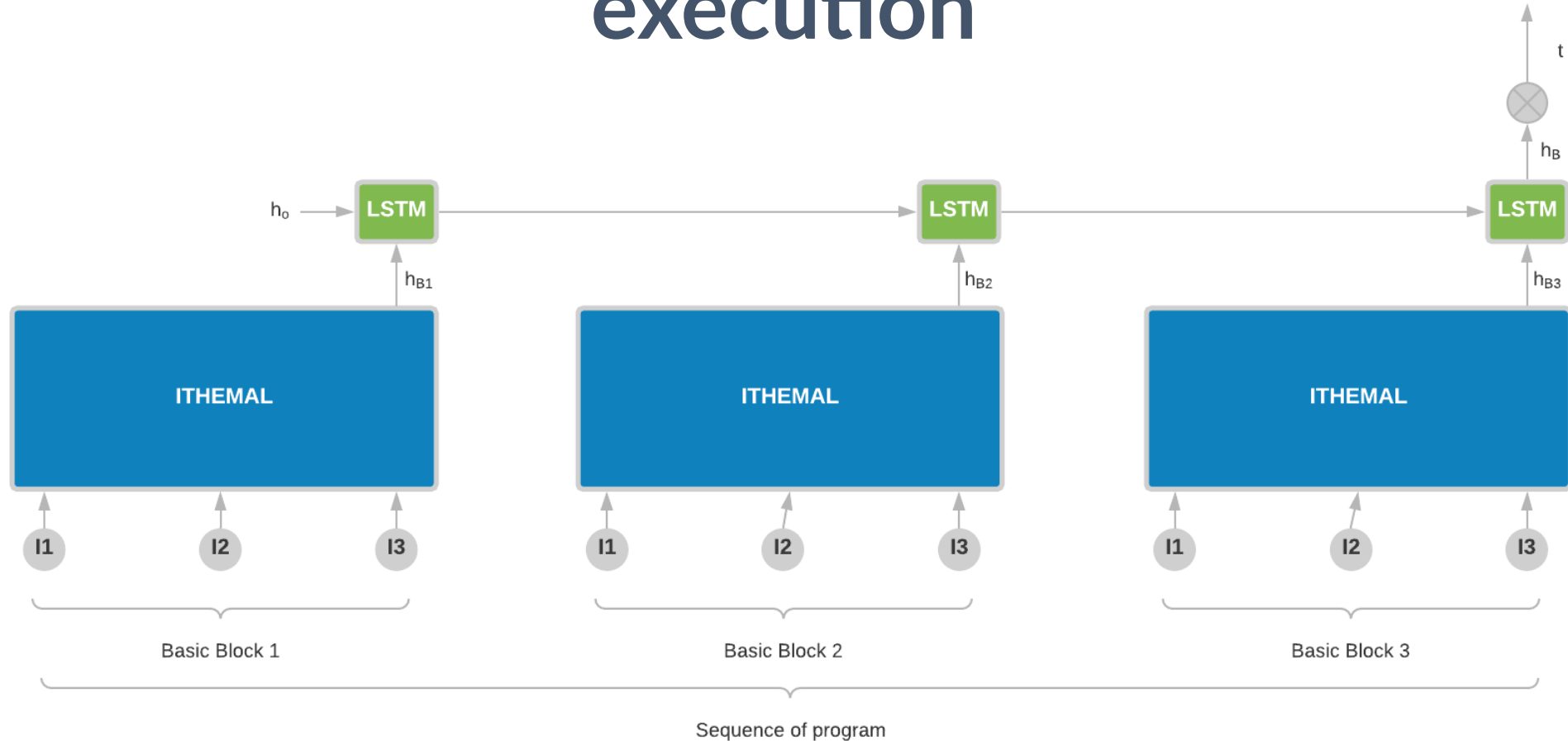
ITHEMAL : Instruction THroughput Estimator using MACHine Learning



Reccurent Neural Network that predicts the BCET of a basic block (In isolation)

C. Mendis, A. Renda, S. Amarasinghe, and M. Carbin, 'Ithemal: Accurate, portable and fast basic block throughput estimation using deep neural networks', in *International Conference on machine learning*, 2019, pp. 4505–4515.

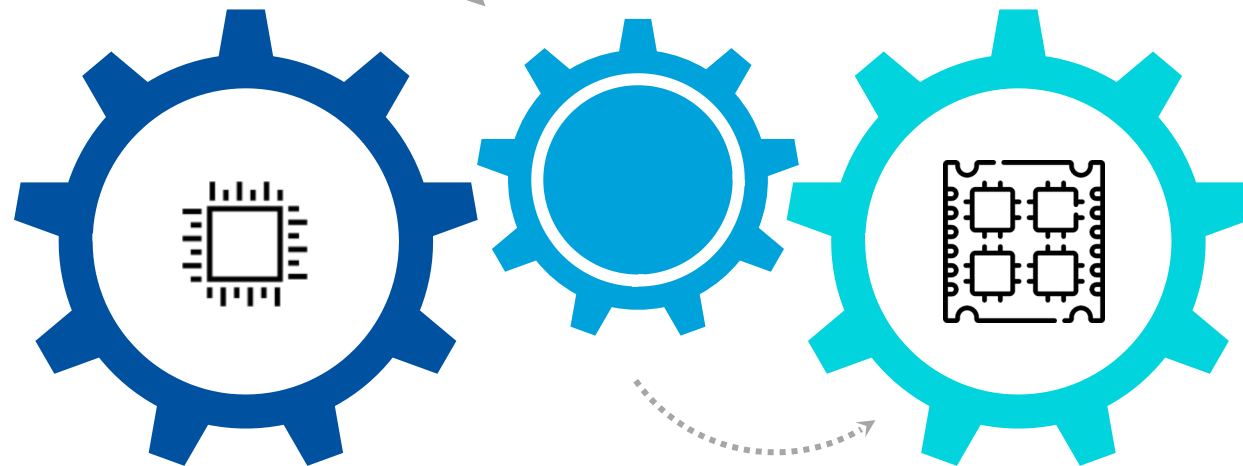
Context-awareness of the basic blocks execution



Extension to multi-core



Shared bus



Single-core

Multi-cores

Thank you for your attention

Questions ?