

#### Machine learning for timing estimation

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# Machine learning for timing estimation





#### 1. CONTEXT

The execution time is calculated in specific cases depending on the needed application domain, (e.g, worst case execution for realtime applications, average case for compiler optimization).

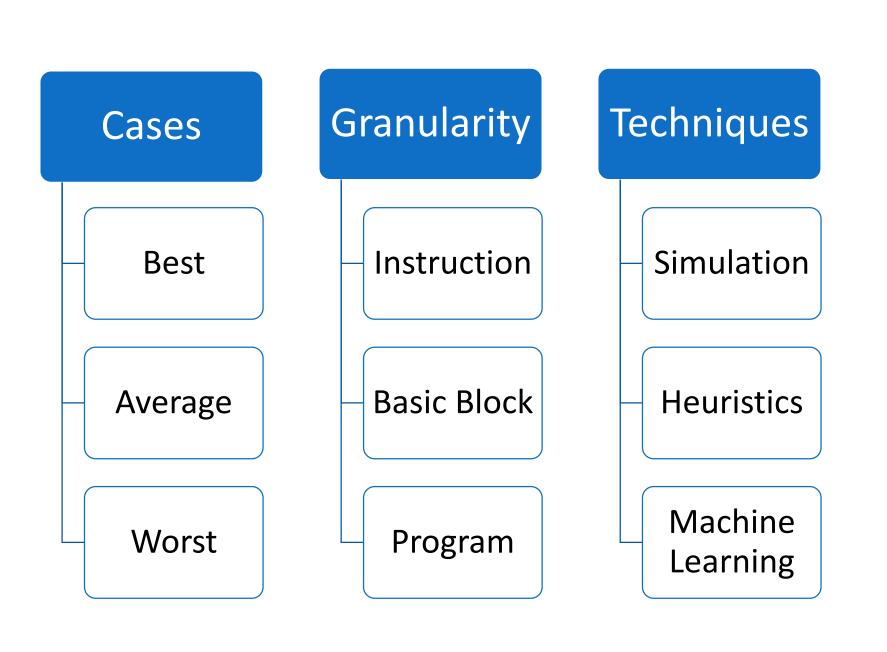


Figure 1 Execution time estimation classification

Challenges of using Machine Learning for timing estimation :

- Context-awareness (Cache and Pipline).
- Representativity of training data.
- Reliability of the estimations.

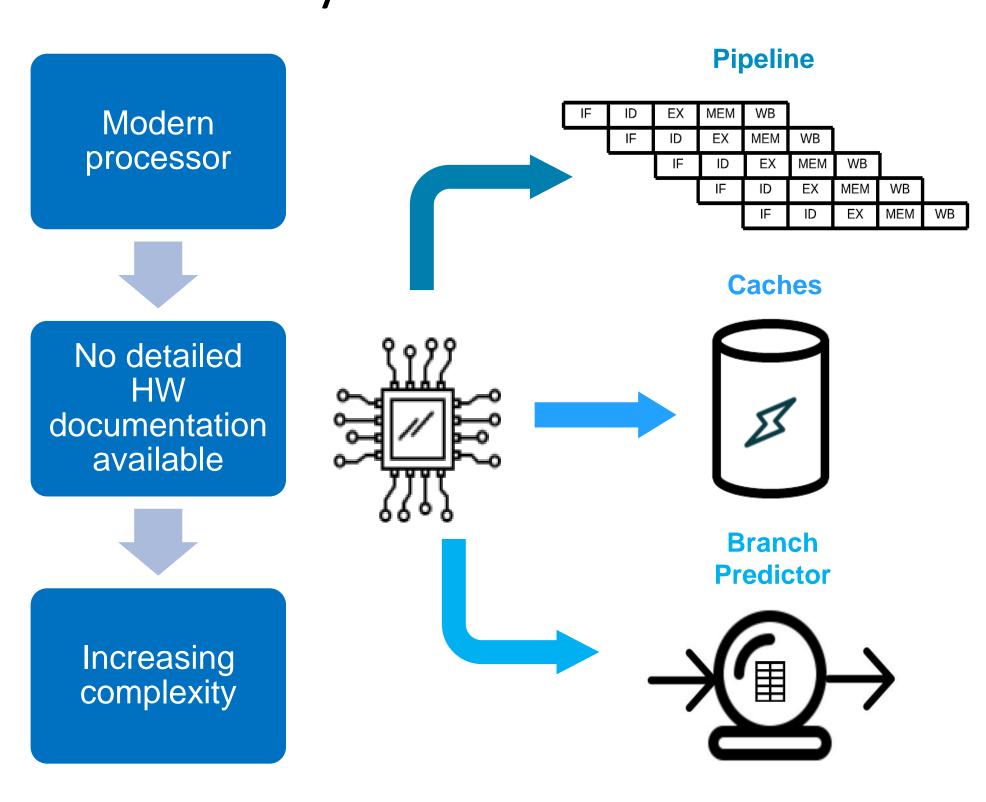
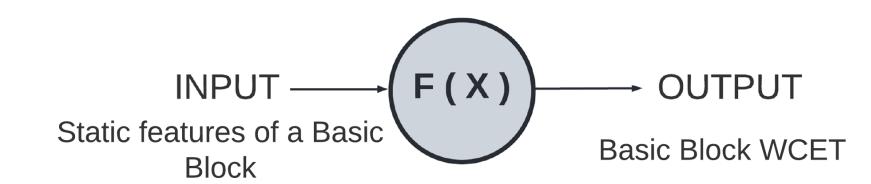


Figure 2 Challenges to estimate the execution time of modern processor

### 2. TIMING WORST CASE



WE-HML [1] (WCET Estimation using an Hybrid Machine-Learning based technique) estimates the WCET for processors that have caches.

- Learning phase: Training on Basic Block and WCET.
- Estimation phase: ILP for longest path combined with ML model.

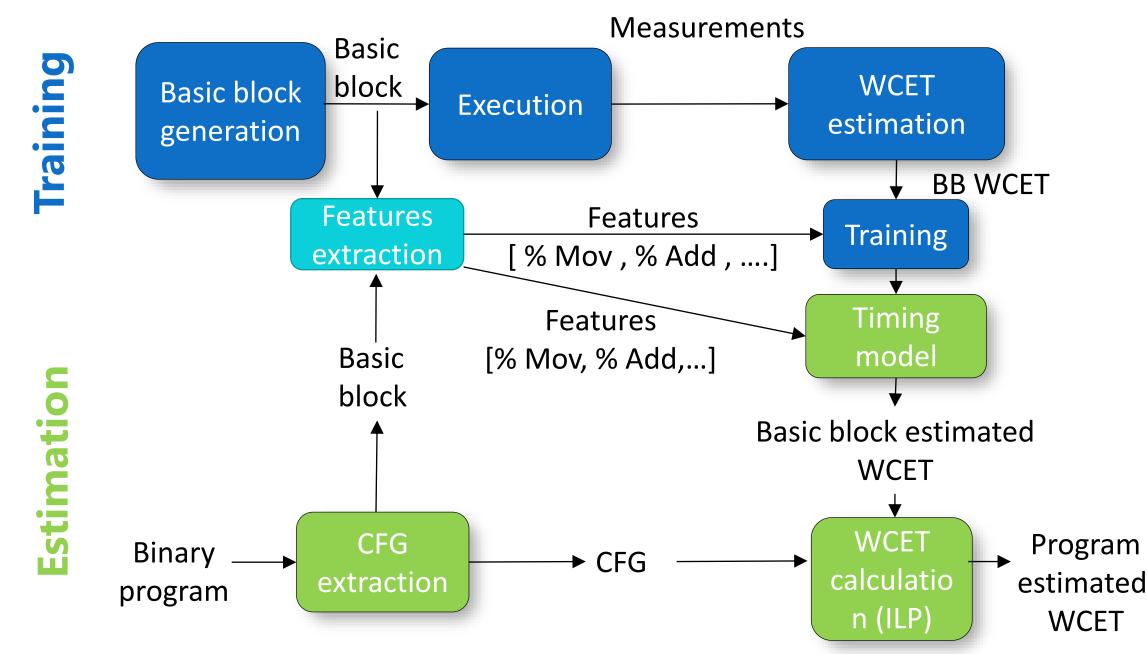
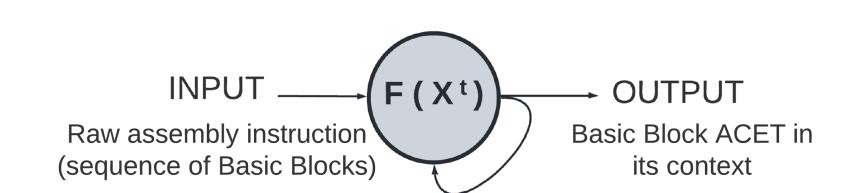


Figure 3 Training/Estimation workflow of WE-HML

#### 3. TIMING AVERAGE CASE



- ITHEMAL [3] uses 2 stacked LSTMs layers to estimate the execution time for a BB in isolation.
- CATREEN [2] improves ITHEMAL to estimate the execution time of a BB in its context.
  - Instruction == Word.
  - Basic block == Sentence.
  - Sequence of basic blocks == Paragraph.

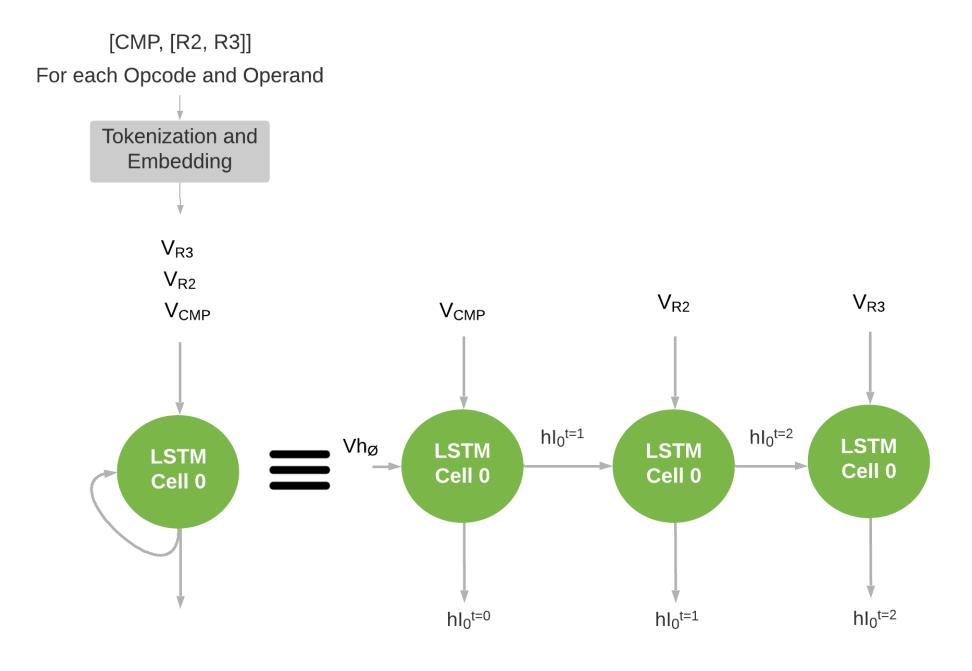
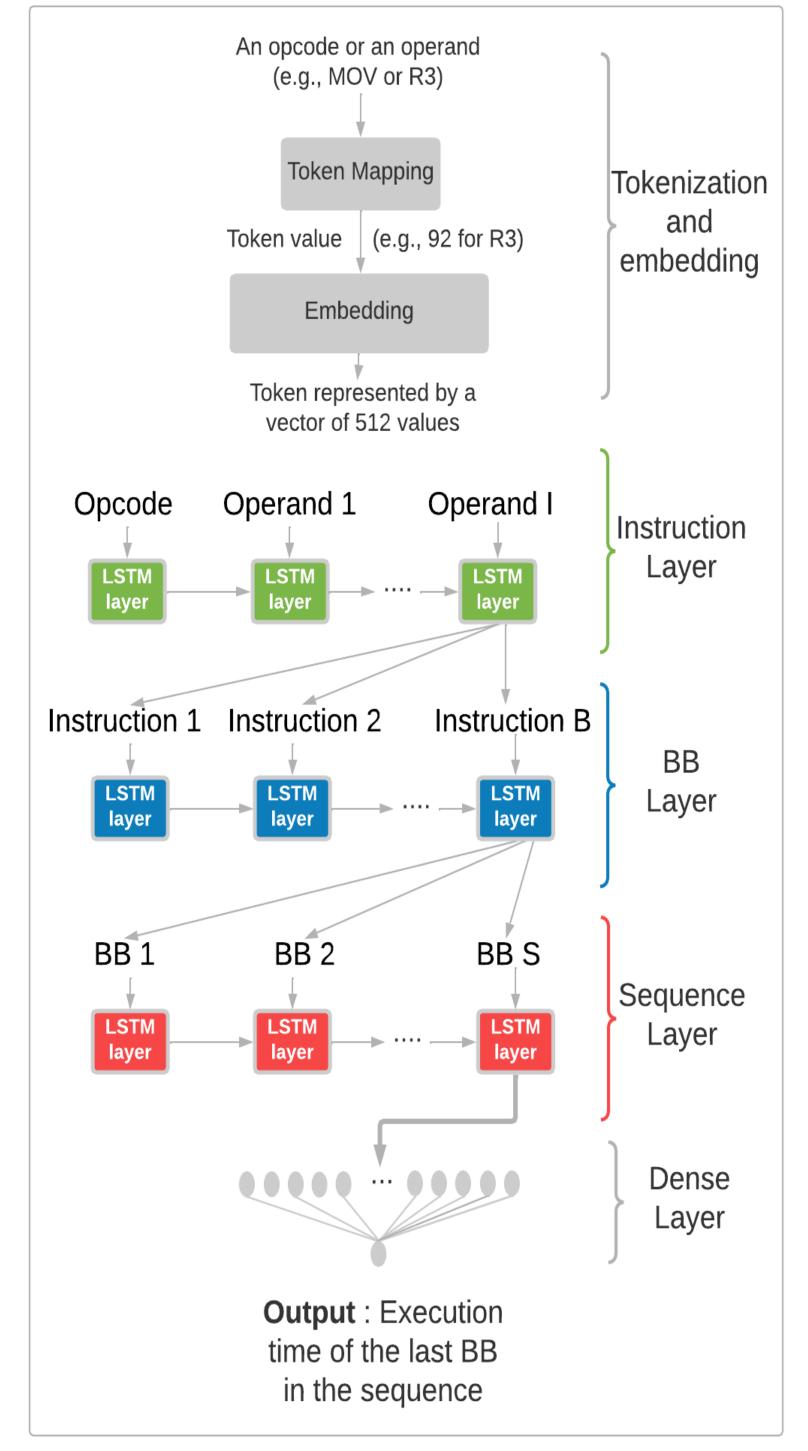


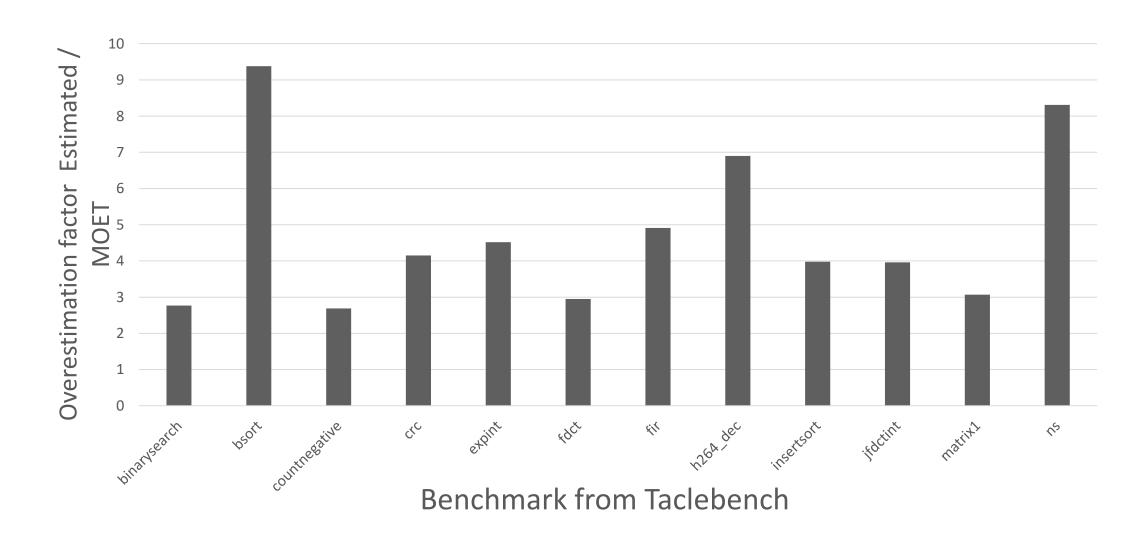
Figure 4 Unfolding of a LSTM cell of the instruction layer on a machine instruction

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**Figure 5** Architecture of CATREEN

## 4. RESULTS



**Figure 6** Estimated WCET WE-HML versus Maximum Observed Execution Time (MOET)

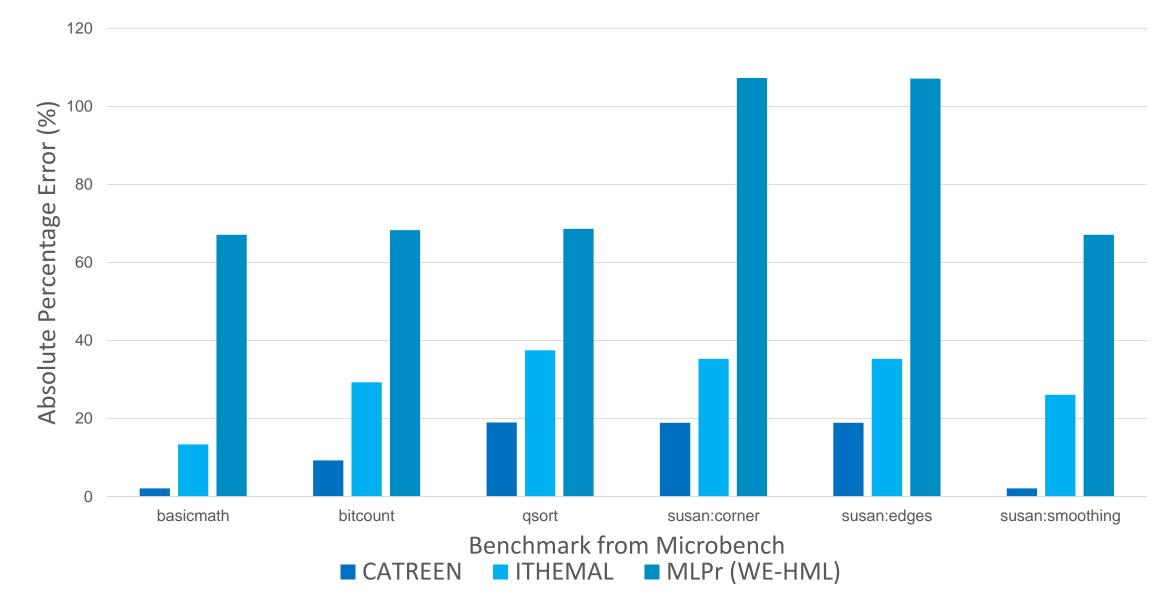
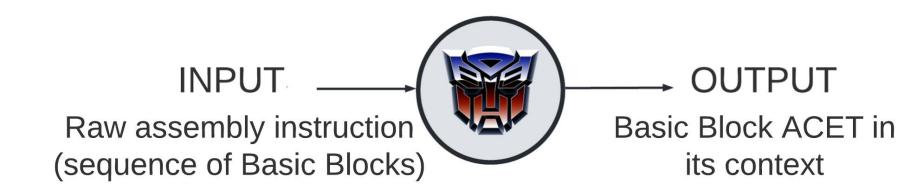


Figure 7 Absolute Percentage Error on MiBench for CATREEN, ITHEMAL and MLP regressor

## 5. PERSPECTIVE



• Transformers [4] are able to handle sequential data, but this is done in parallel, which drastically reduces both training and inference times.

#### Bibliography

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