



Framework for stochastic analysis of mixed-criticality scheduling

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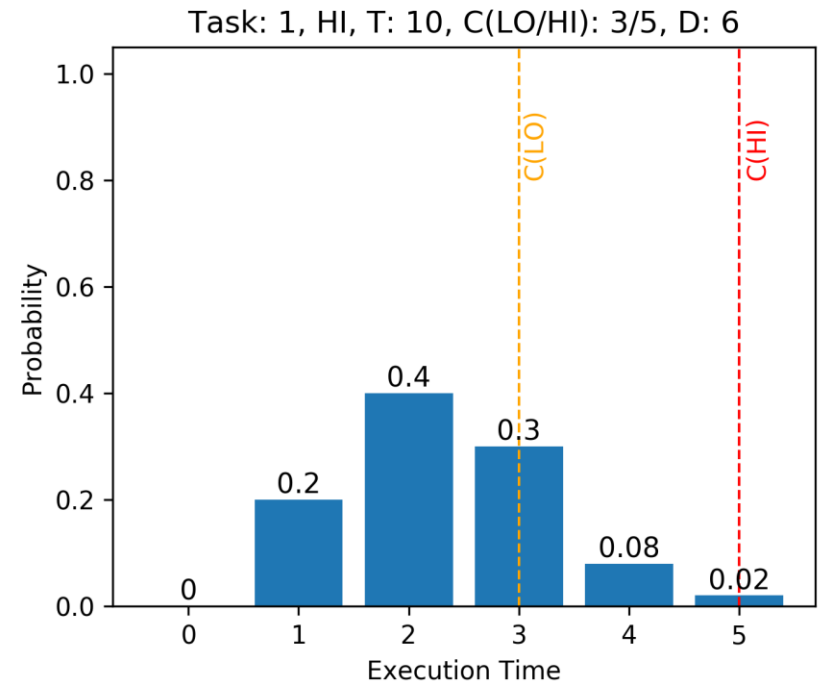
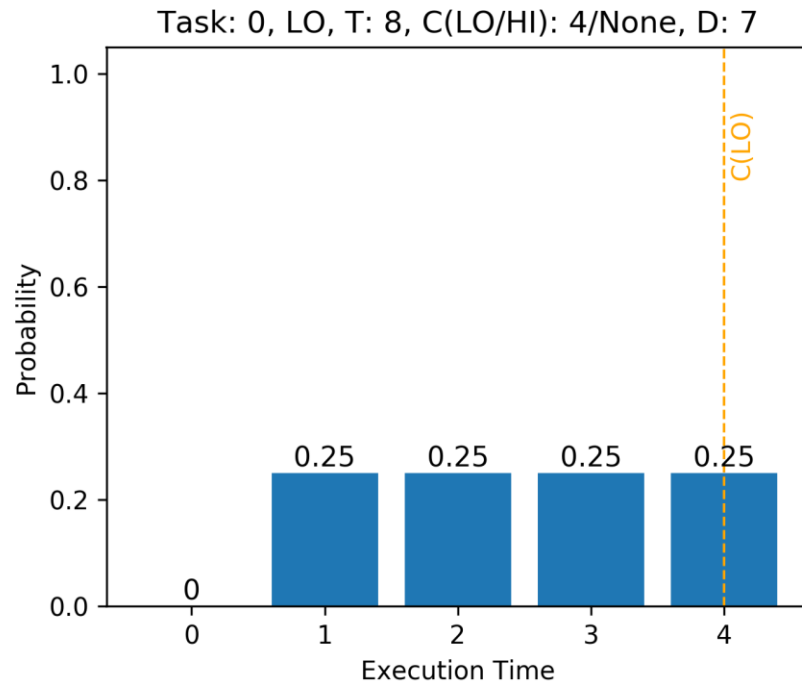
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Supervising Professor: Prof. Dr. Lothar Thiele,
Computer Engineering and Networks Laboratory

Mixed Criticality

- Task = τ_i (
 χ_i : Criticality $\in \{LO, HI\}$
 T_i : Period,
 $C(LO)$: *LO*-mode Worst-case execution time (WCET),
 $C(HI)$: *HI*-mode WCET,
 D_i : Deadline)

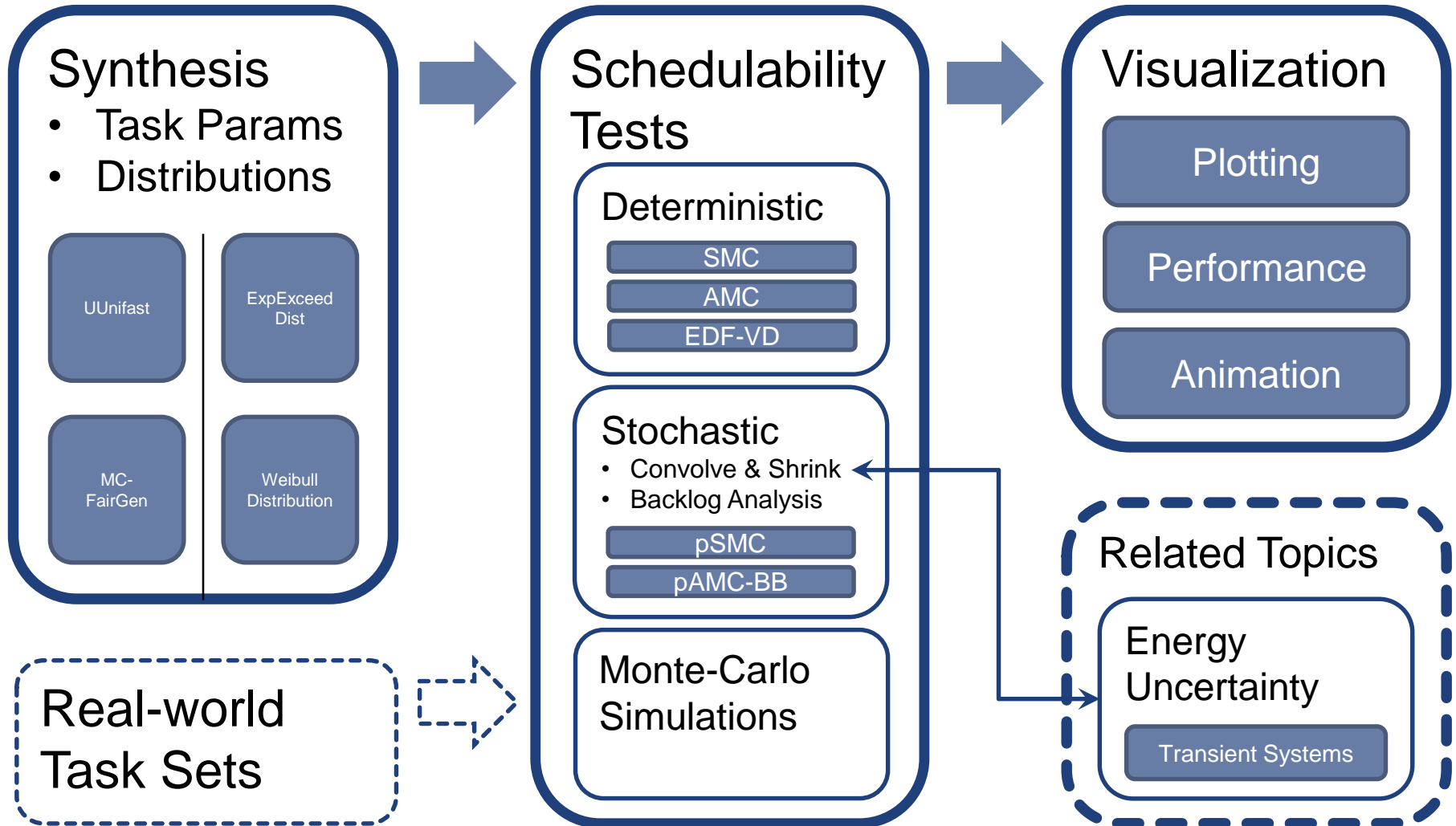
Stochastic Analysis



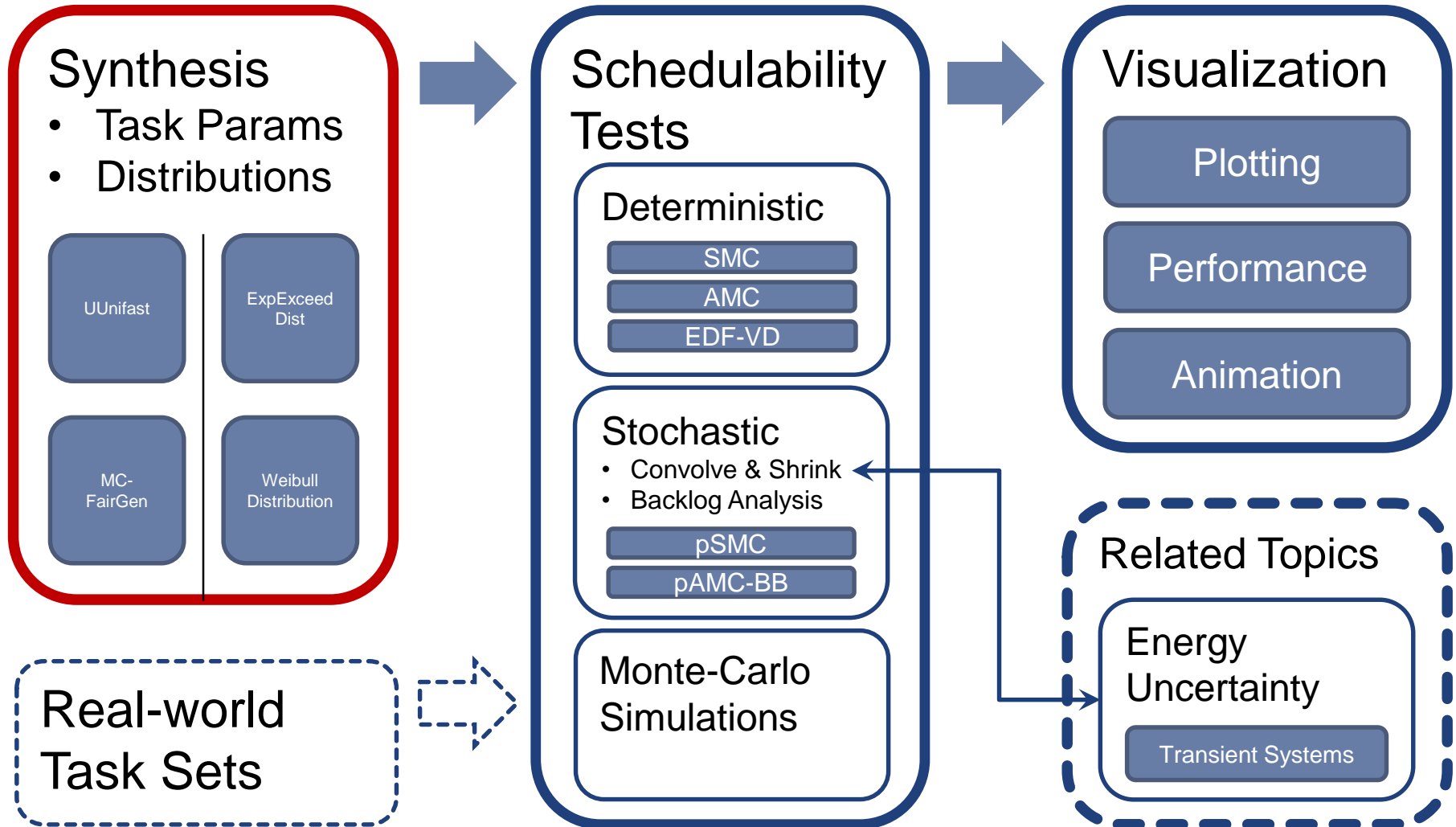
Motivation

- «Build an extensible framework
offering a wide range of analysis tools,
covering and comparing different scheduling
schemes.»

The Framework



Task Set Synthesis



Task Set Synthesis

Deterministic Parameters

UUnifast

MC-FairGen

...

Probability Distributions

ExpExceedDist

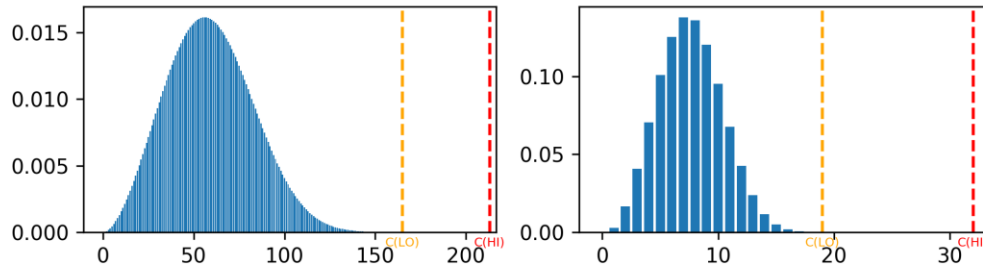
Weibull Distribution

...

MC-FairGen with Weibull Distributions

Task Set 0: #Tasks LO/HI: (2/4) Utils LO/HI/Avg: (0.8/0.601/0.273)

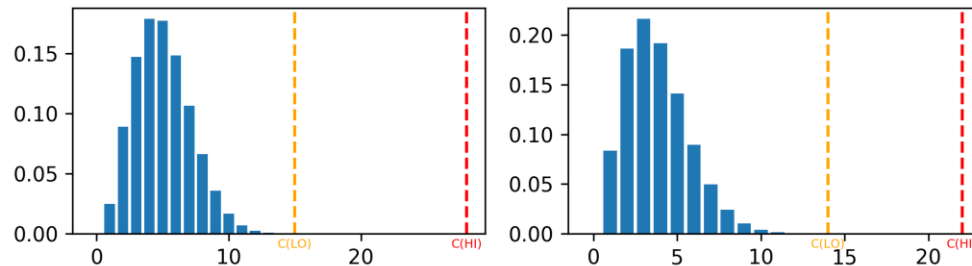
Task: 0, HI, T: 1000, C(LO/HI): 165/213, D: 546 Task: 1, HI, T: 200, C(LO/HI): 19/32, D: 75



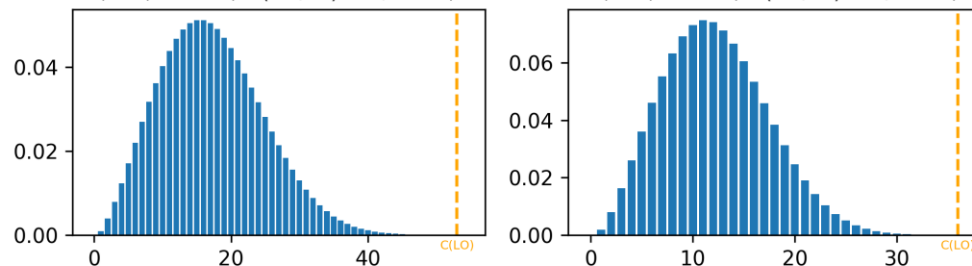
Exceedance Probabilities

- $C(LO): 10^{-5}$
- $C(HI): 10^{-9}$

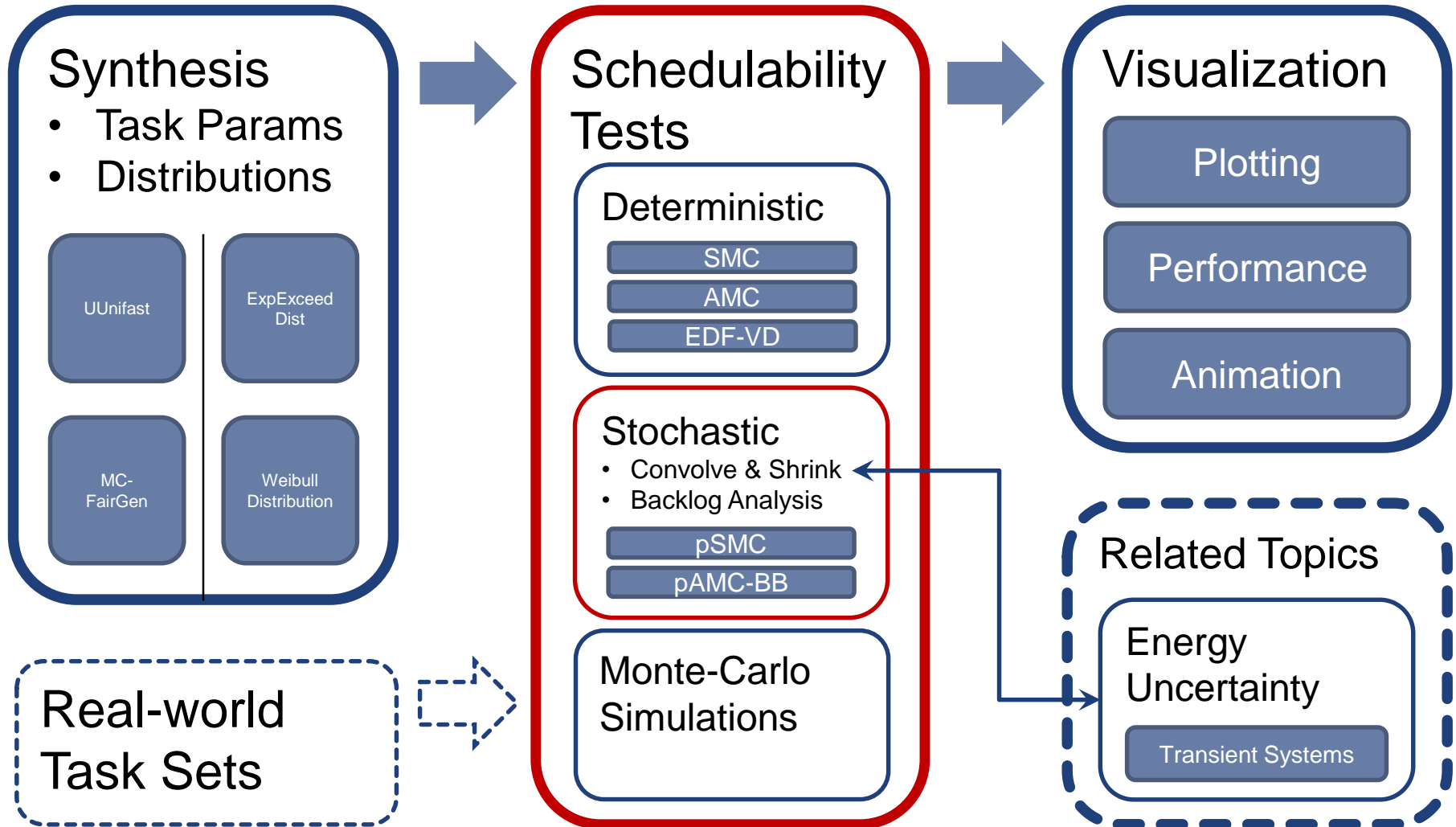
Task: 2, HI, T: 200, C(LO/HI): 15/28, D: 93 Task: 3, HI, T: 250, C(LO/HI): 14/22, D: 33



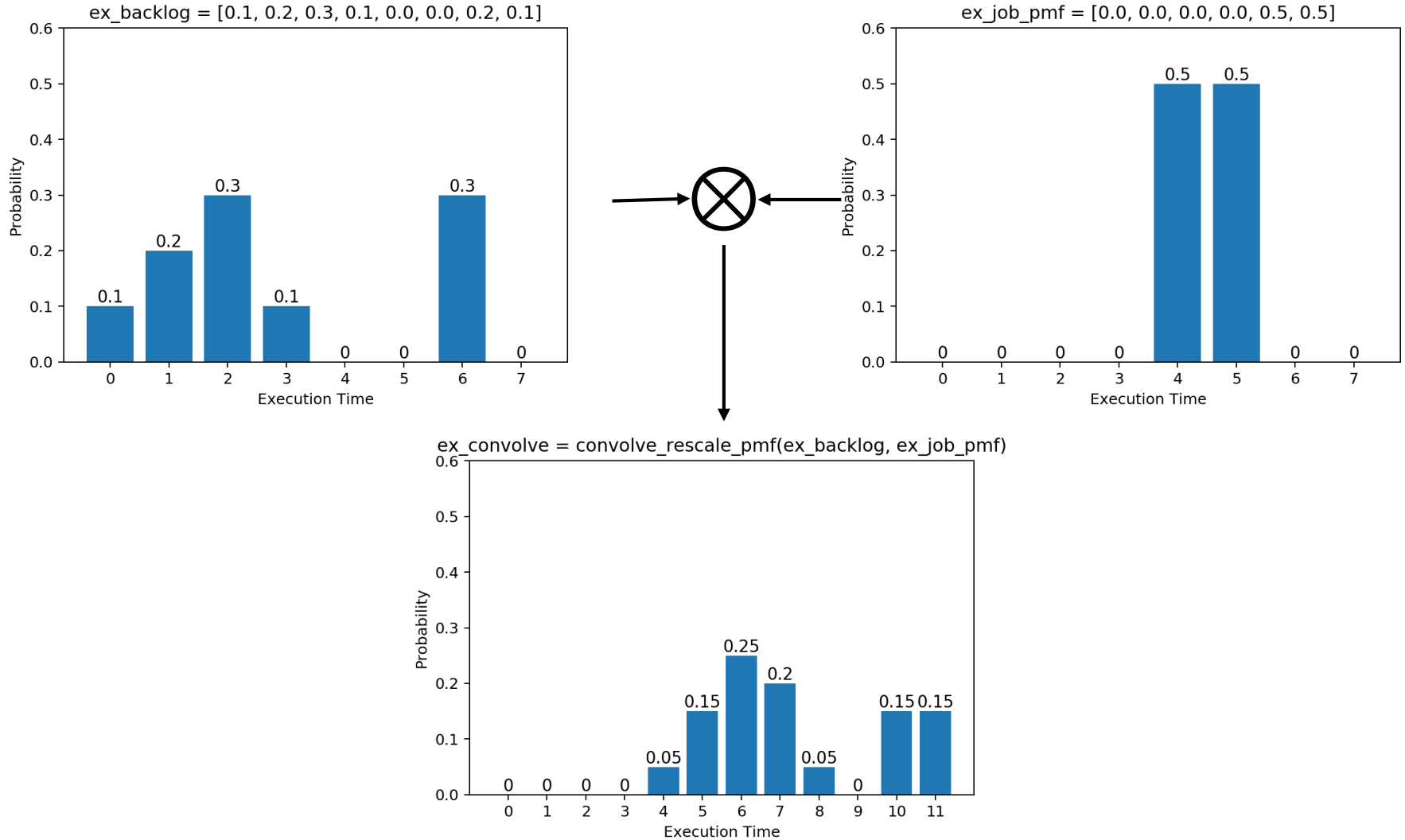
Task: 4, LO, T: 200, C(LO/HI): 53/None, D: 138 Task: 5, LO, T: 250, C(LO/HI): 36/None, D: 68



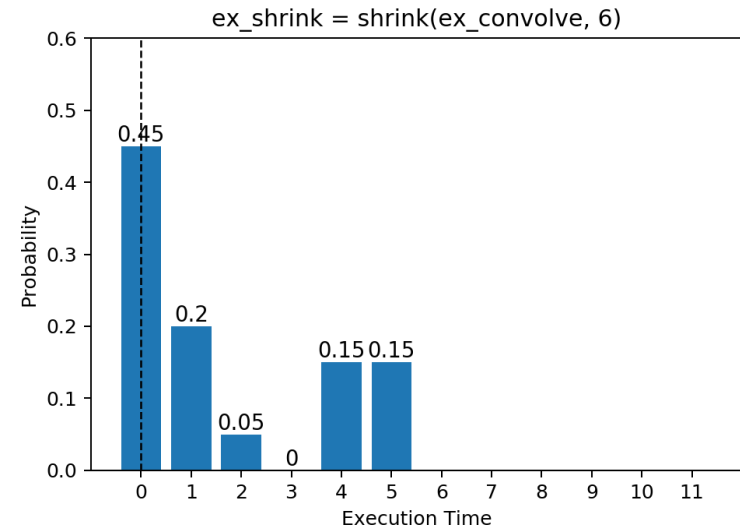
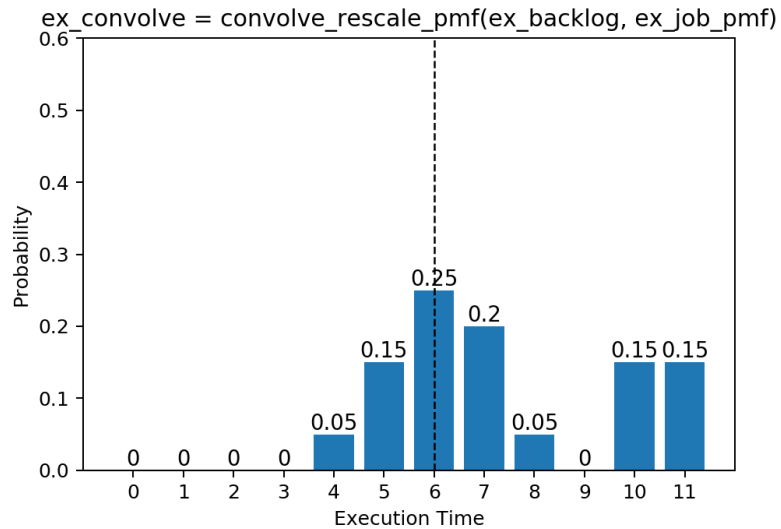
Stochastic Analysis



Convolution



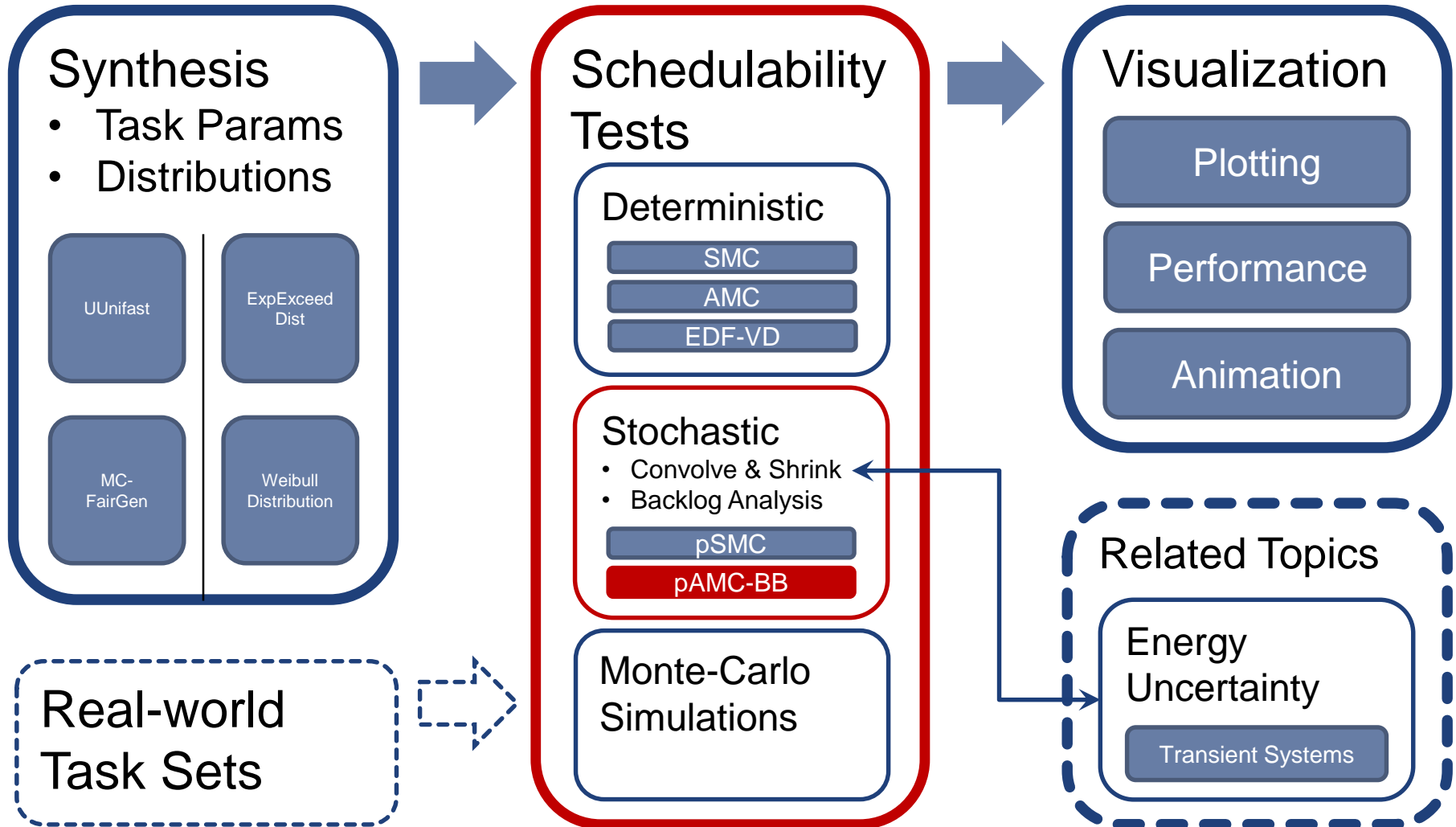
Shrinking



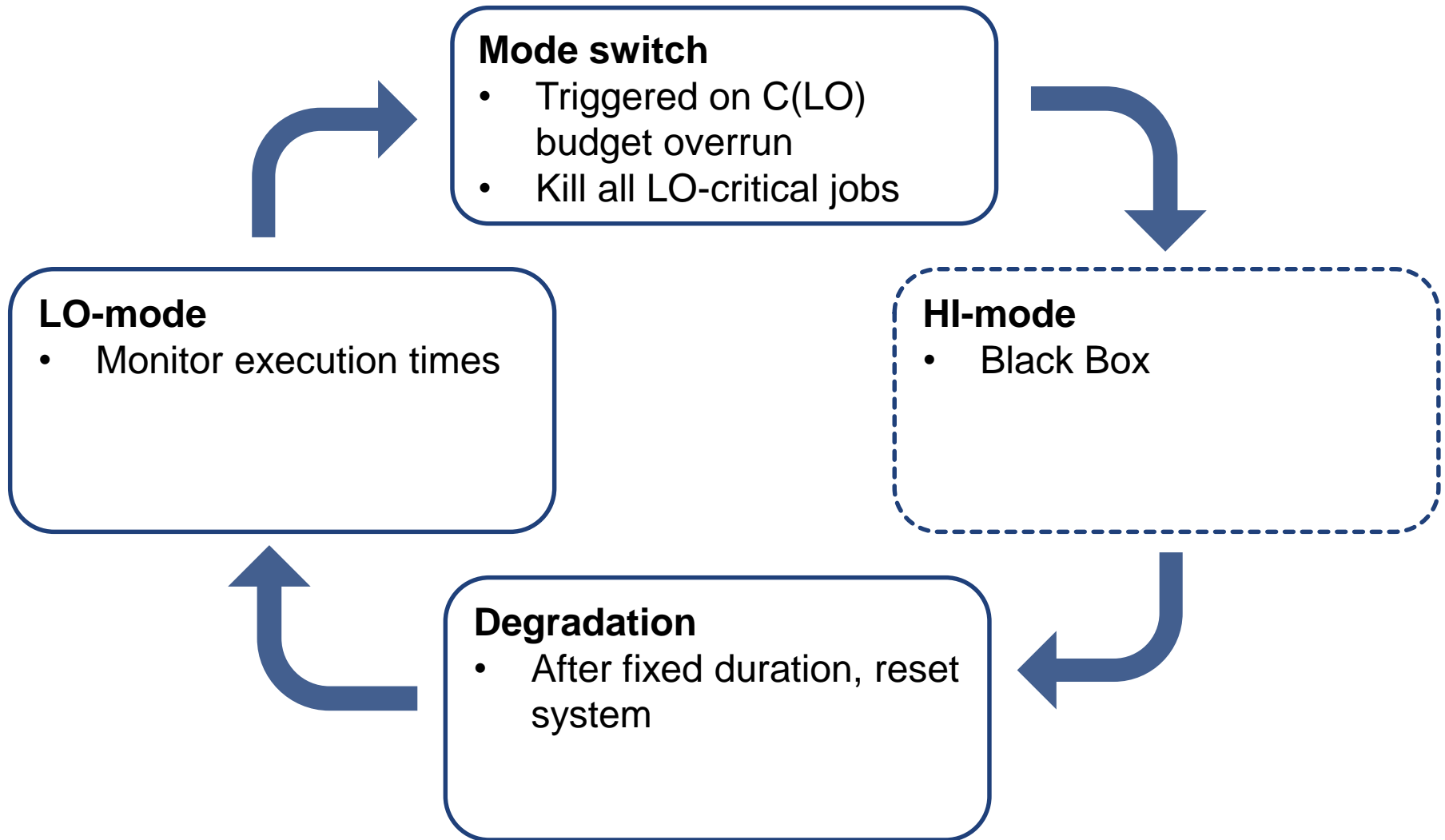
Backlog Analysis

→ Animation: Iterative backlog computation

pAMC-BB



pAMC-BB



pAMC-BB

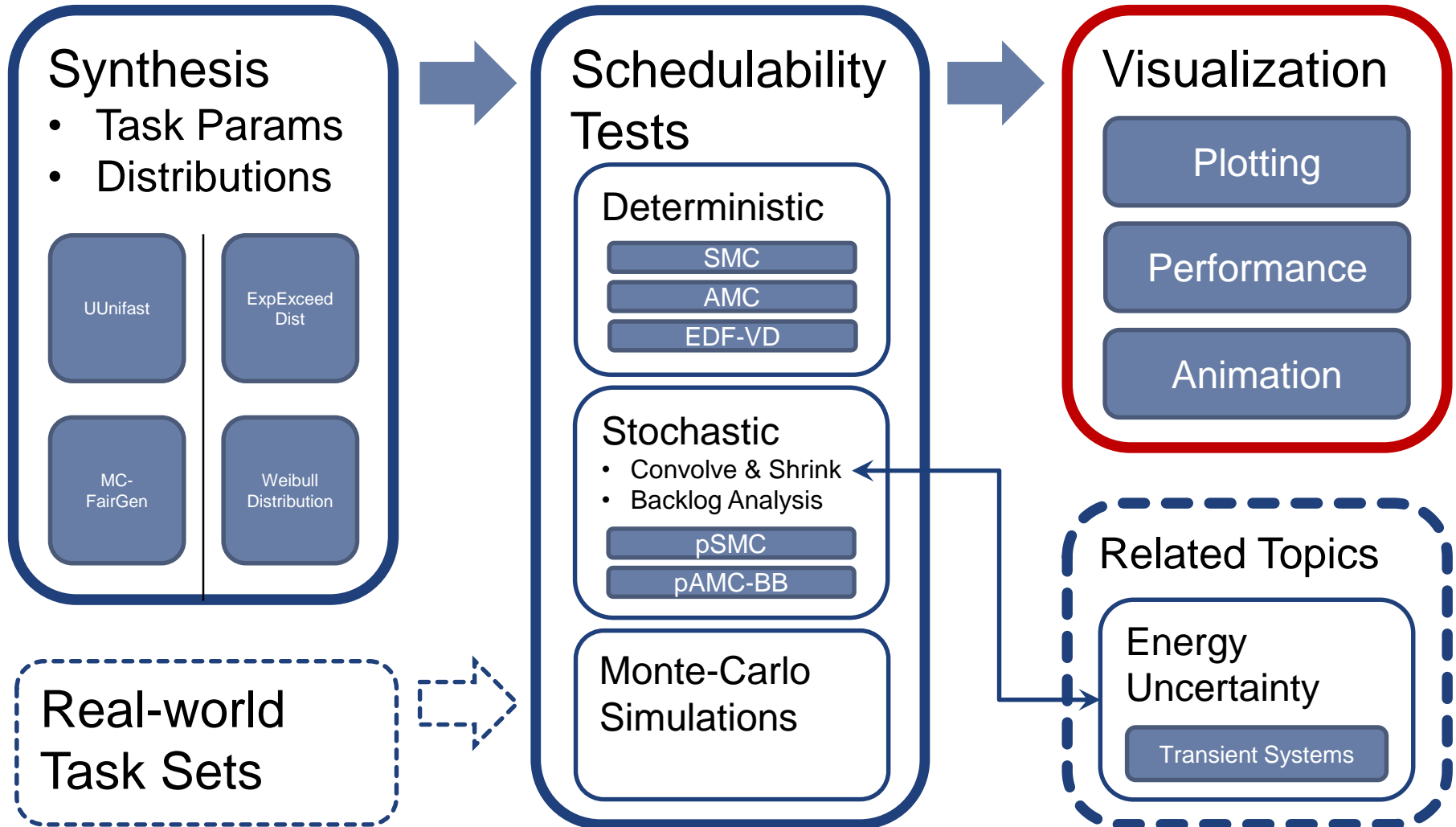
Analysis:

1. Find response time distribution for every job using convolution and shrinking.
2. Compare resulting response time PMF with job deadline to get job-specific deadline miss probability.
3. For every task, check:

$$reltime_{LO} \times DMP_{LO} + reltime_{HI} \times DMP_{BB} \leq Threshold$$

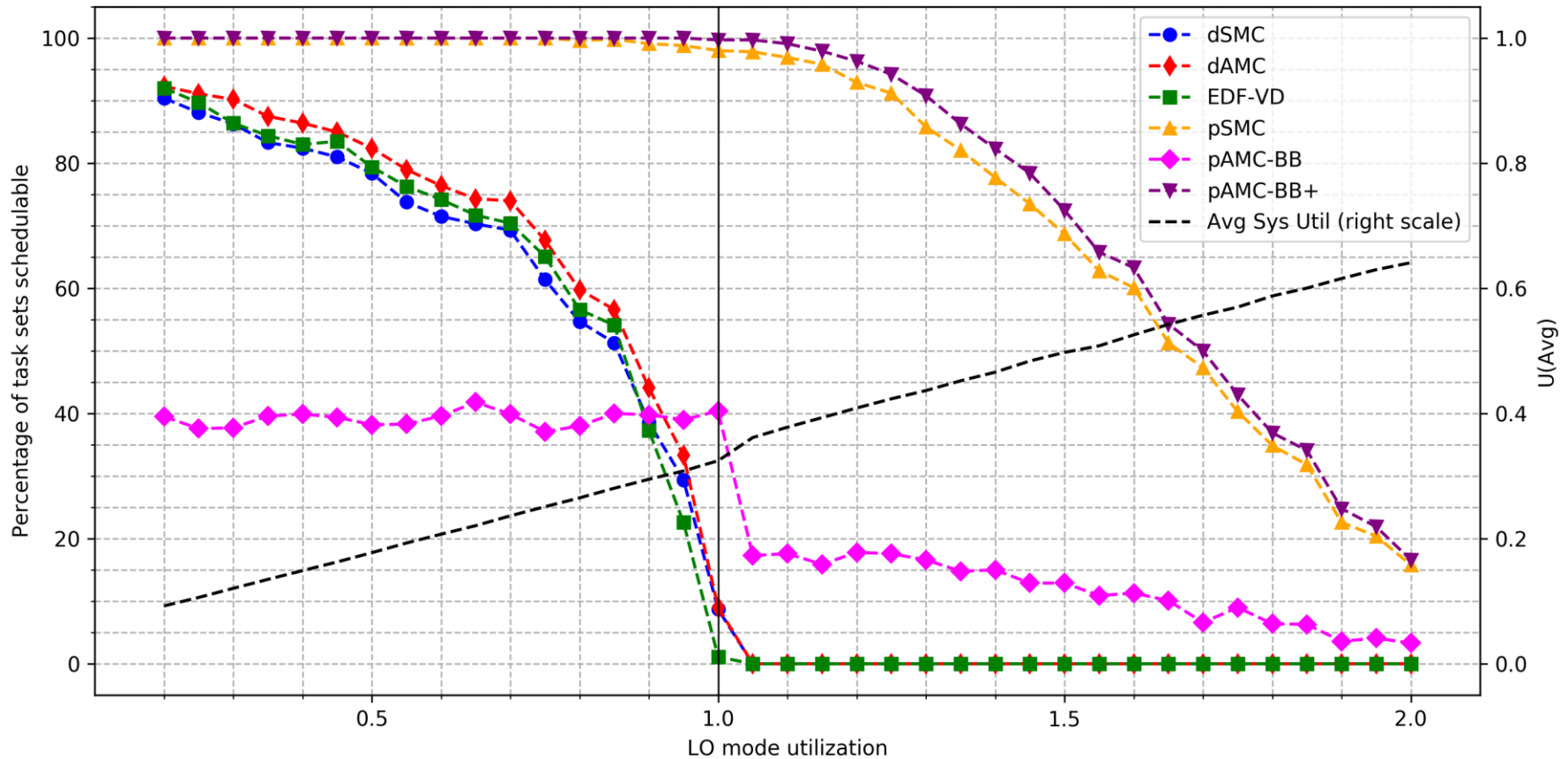
Lines of Python Code: ~30 + reusable methods

Visualization



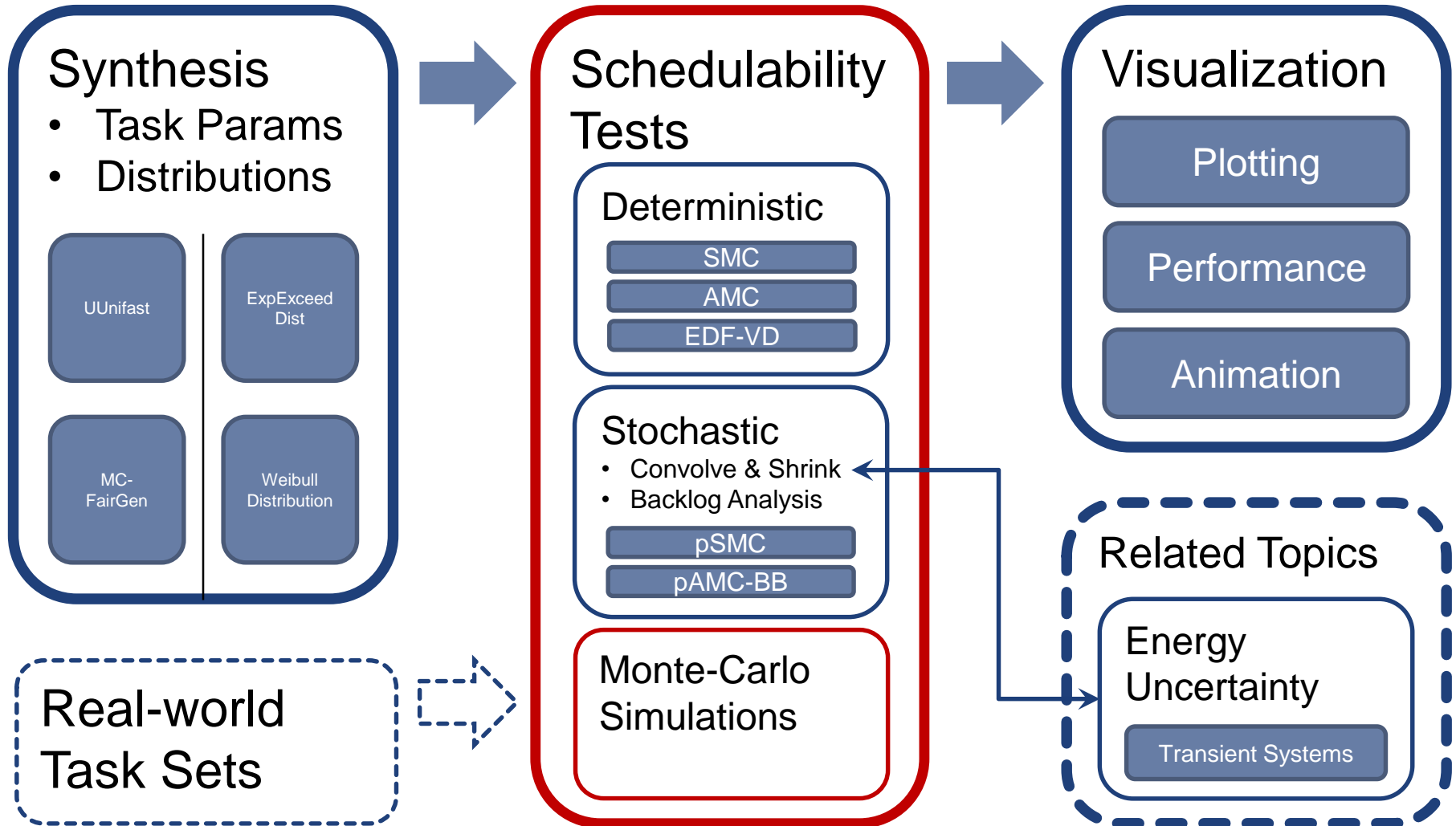
Visualization: Deterministic vs. Probabilistic

Evaluation: MC-Fairgen (n=1000)



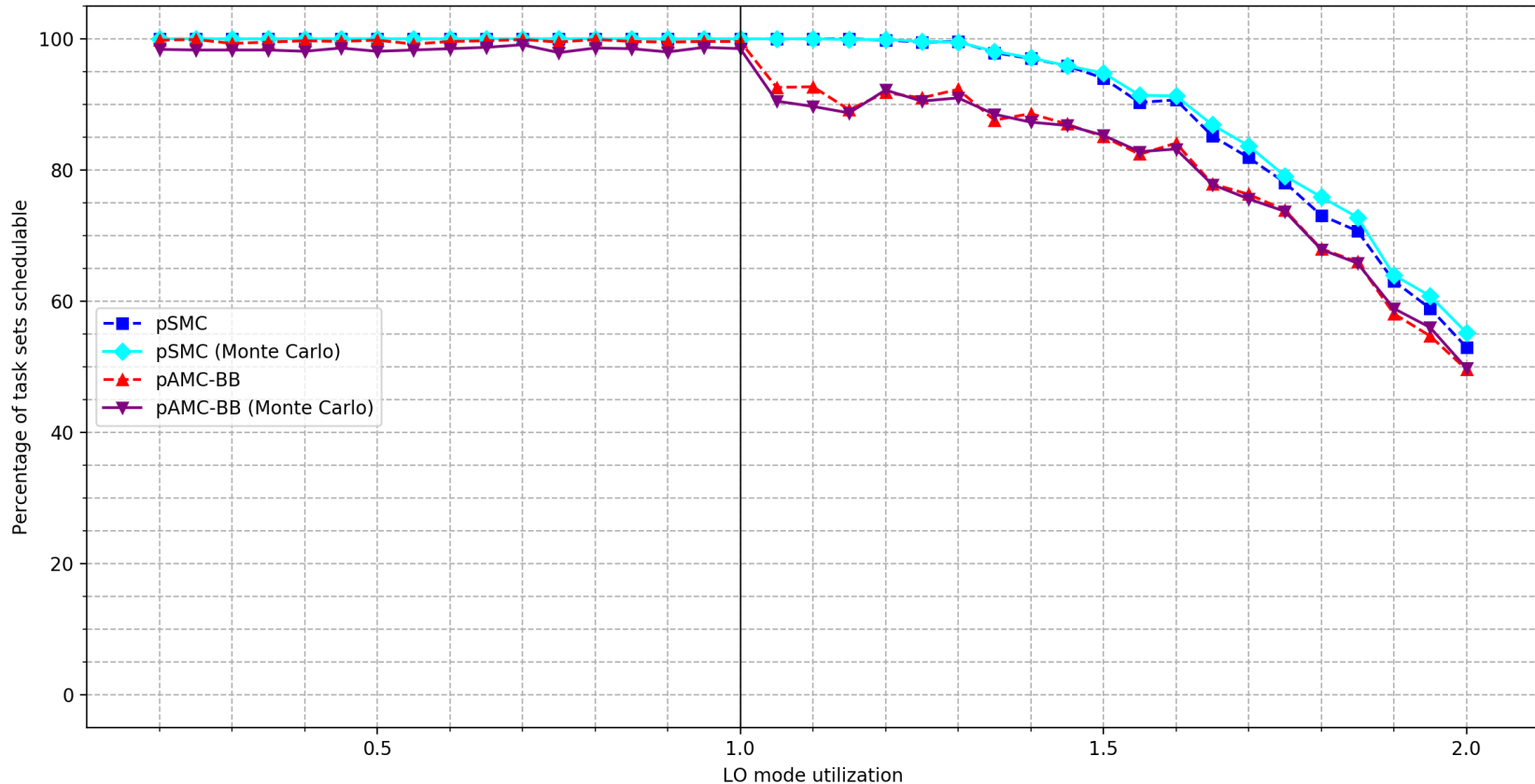
Time measured: 1h 21min 28s, Intel i5-7600K, 4 cores @ 3.8 GHz

Monte-Carlo Simulation



Visualization: Monte-Carlo Simulation

Evaluation: Monte Carlo Schemes (n=1000)



Time measured: 23h 20min 13s, Intel i5-7600K, 4 cores @ 3.8 GHz

Conclusion

- **Still at the beginning!**
- Future work:
 - Task Set Synthesis (distributions, influence of different parameters)
 - Stochastic HI-mode analysis
 - Expand on related topics (e.g. energy uncertainty)

Discussion

