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# Framework for stochastic analysis of mixed-criticality scheduling

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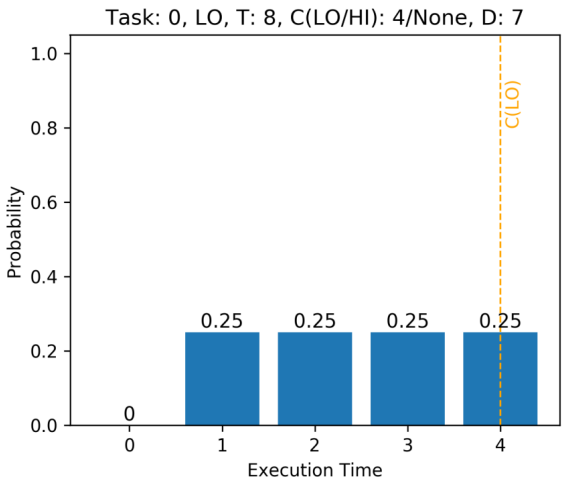
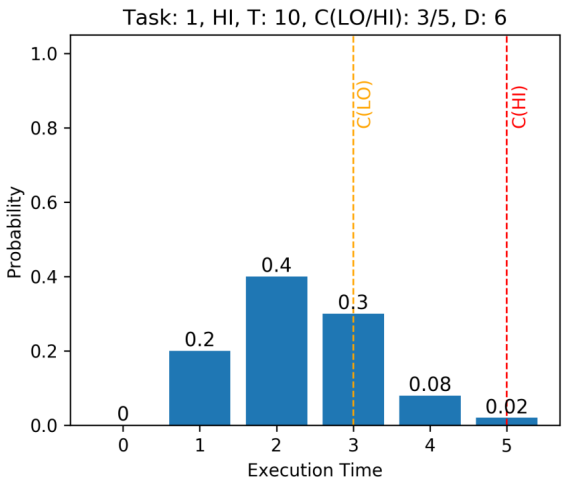
## Mixed Criticality

- Task = $\tau_i$(
  $\chi_i$: 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

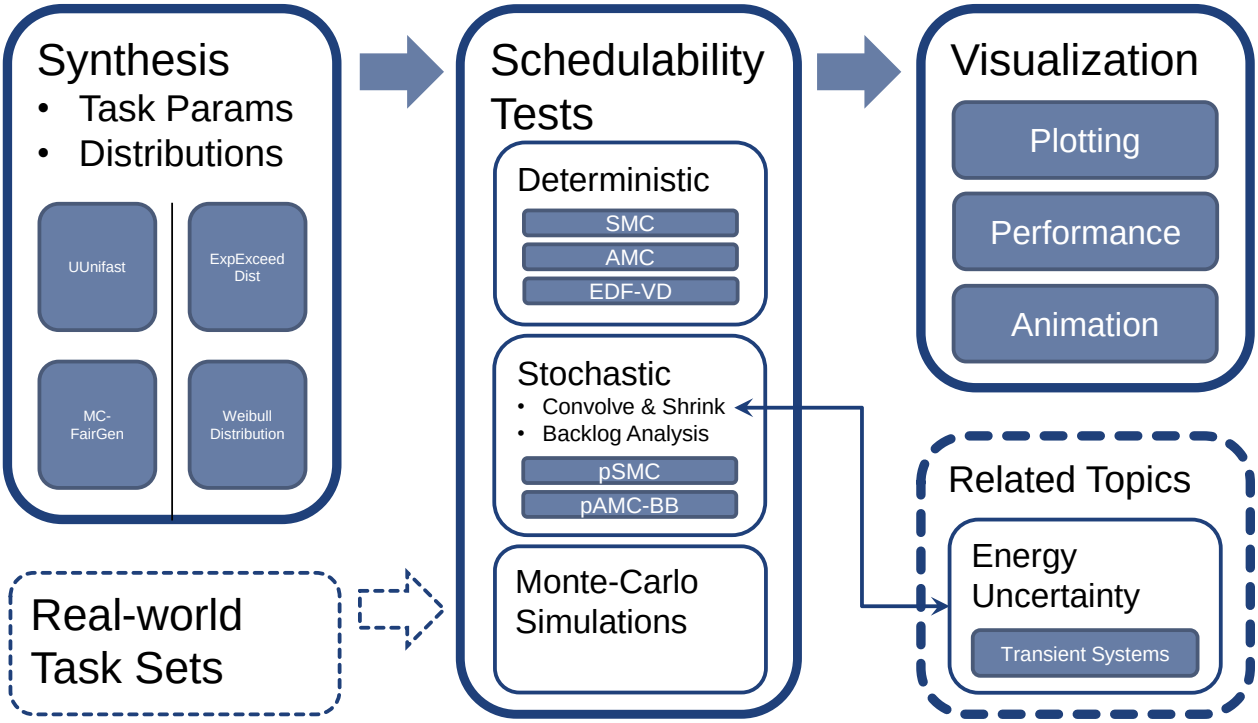
- «Build an extensible framework

  offering a wide range of analysis tools,

  covering and comparing different scheduling

  schemes.»

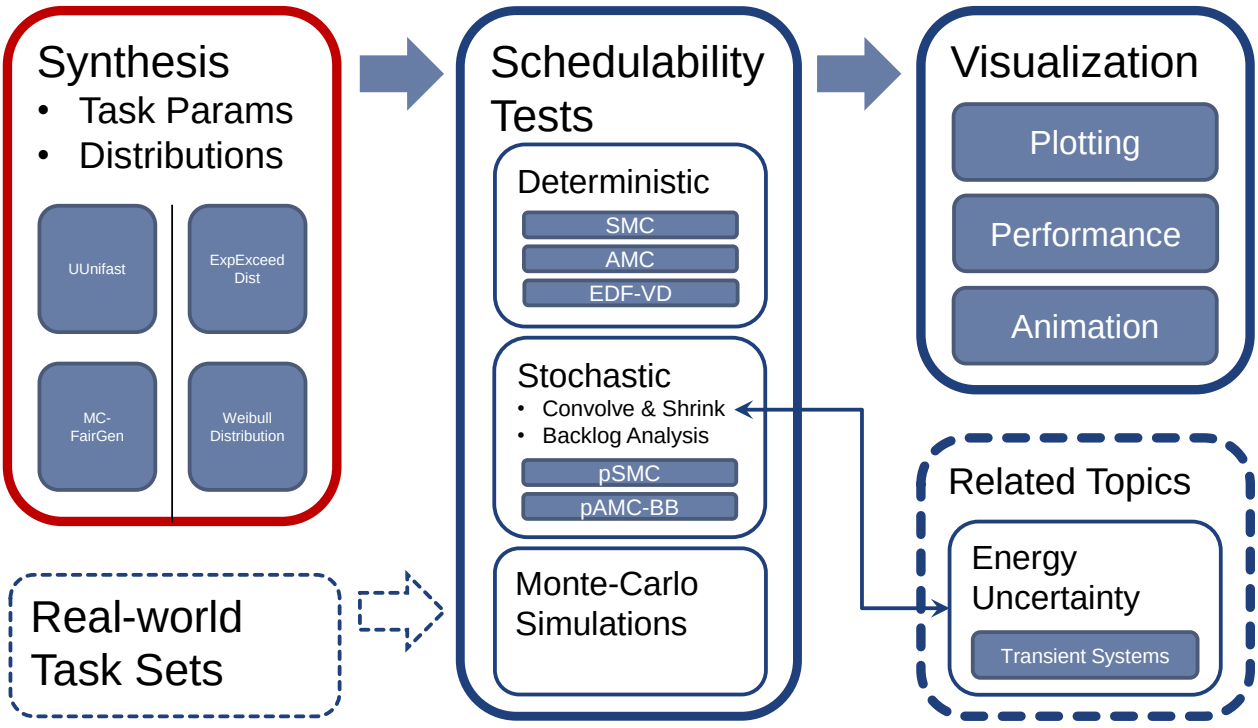
# The Framework



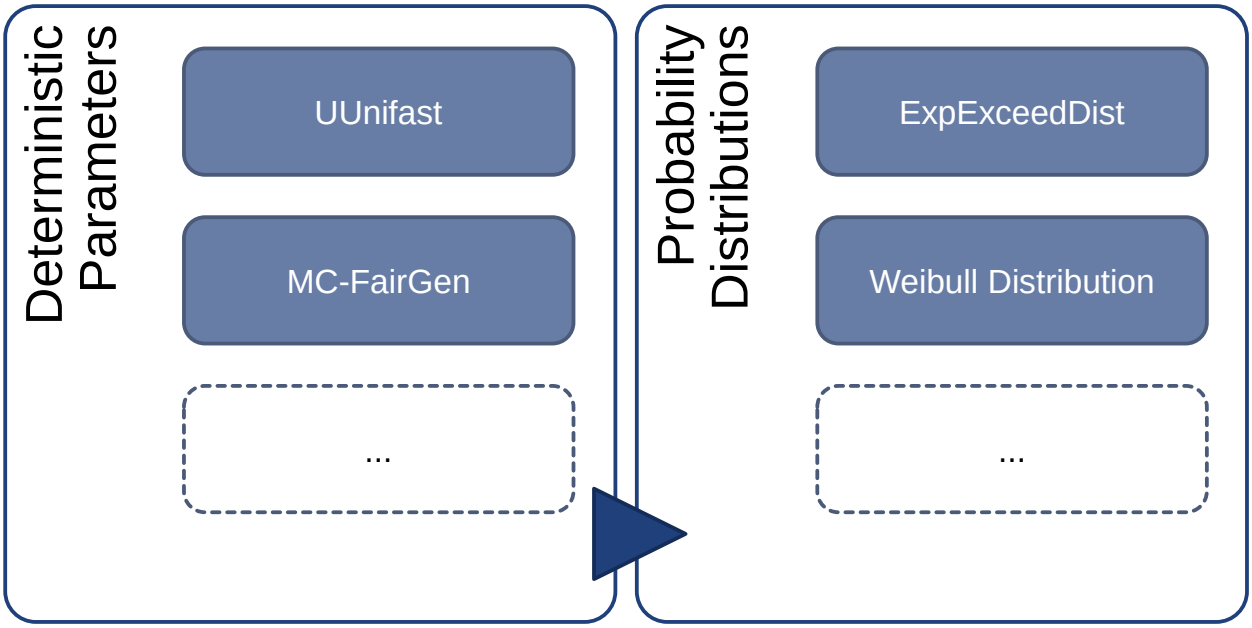





# Task Set Synthesis



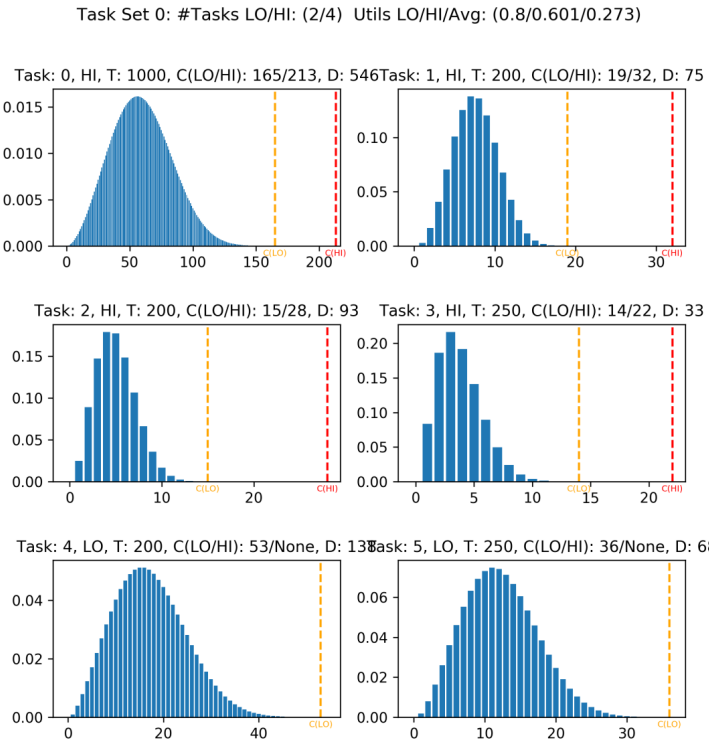
# Task Set Synthesis







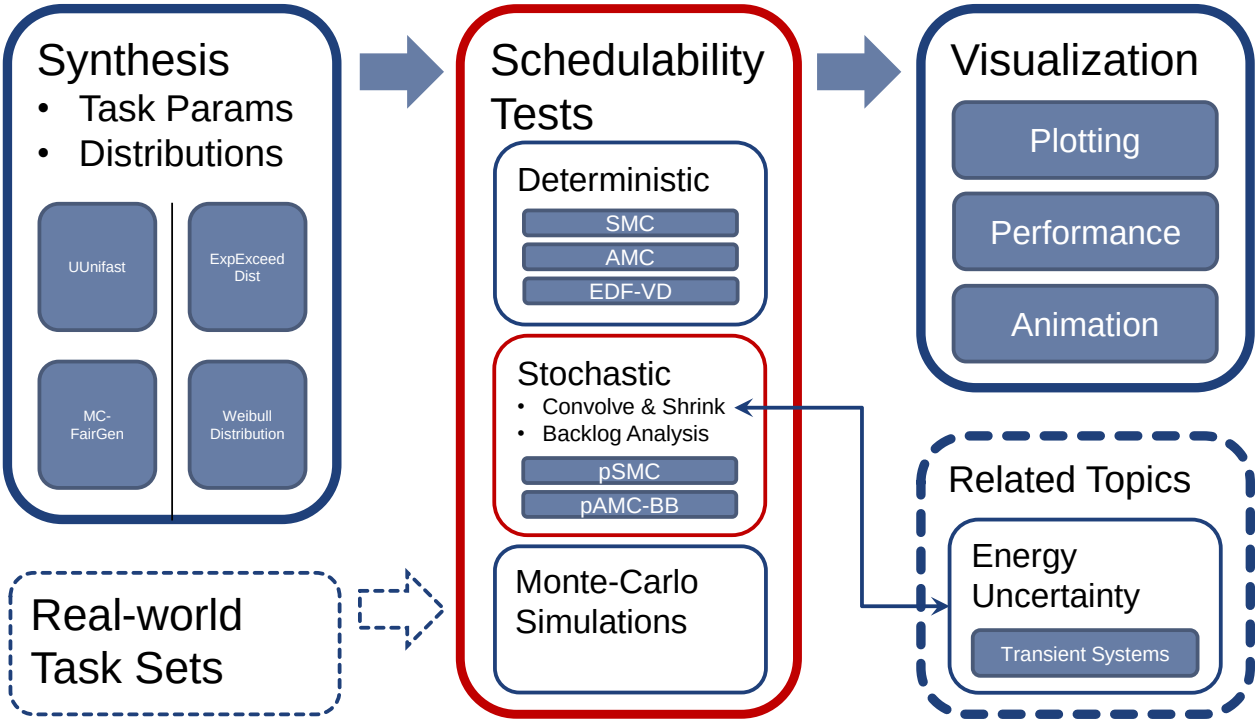

# MC-FairGen with Weibull Distributions




**Exceedance Probabilities**

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

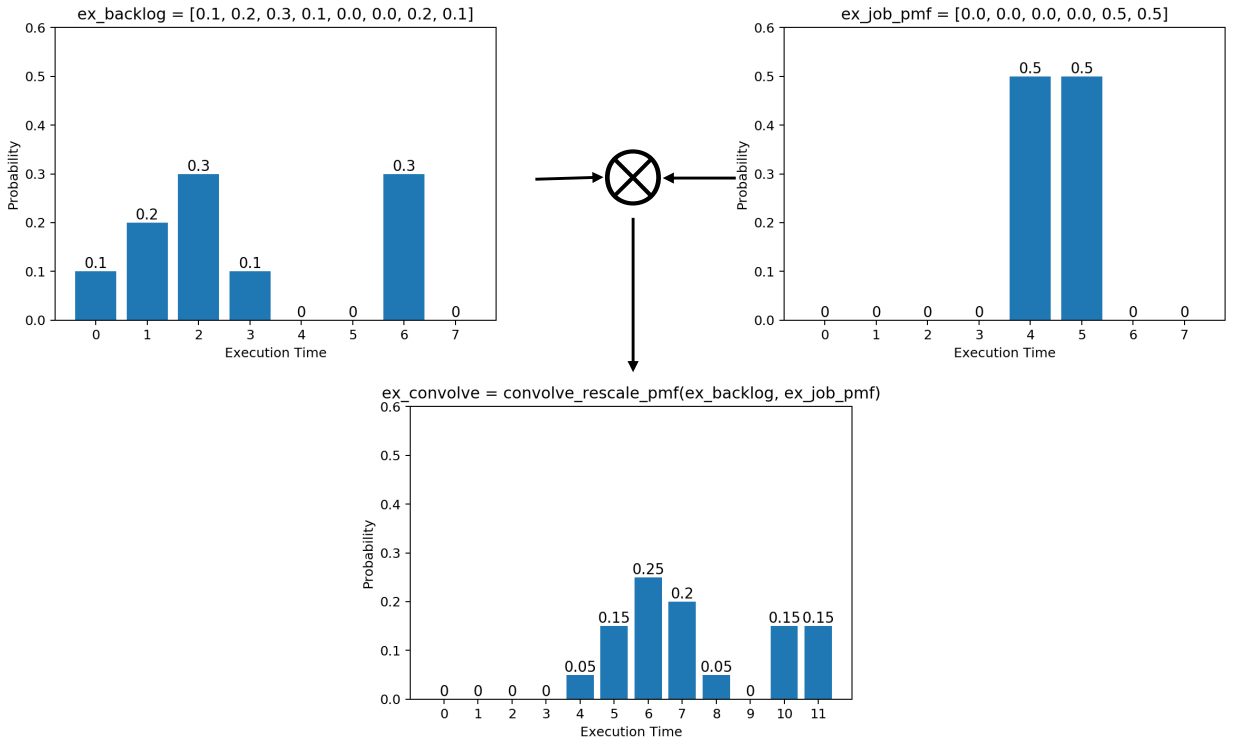
# Stochastic Analysis



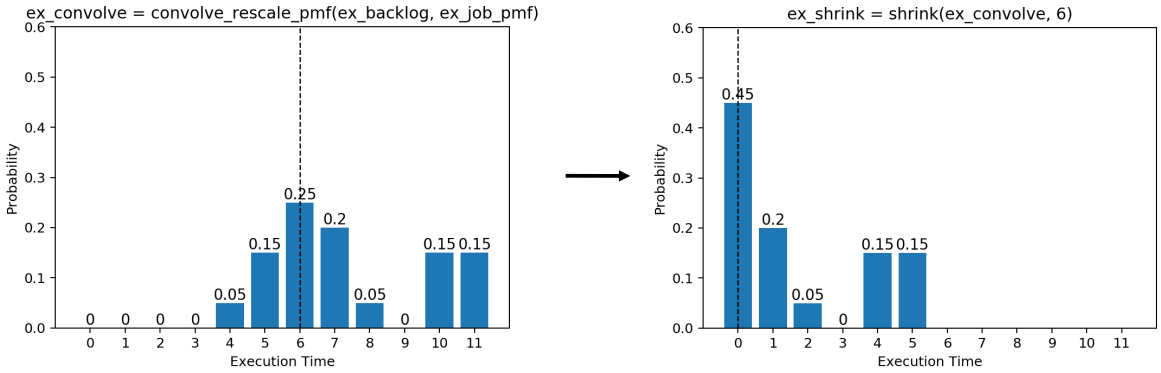





# Convolution



# Shrinking



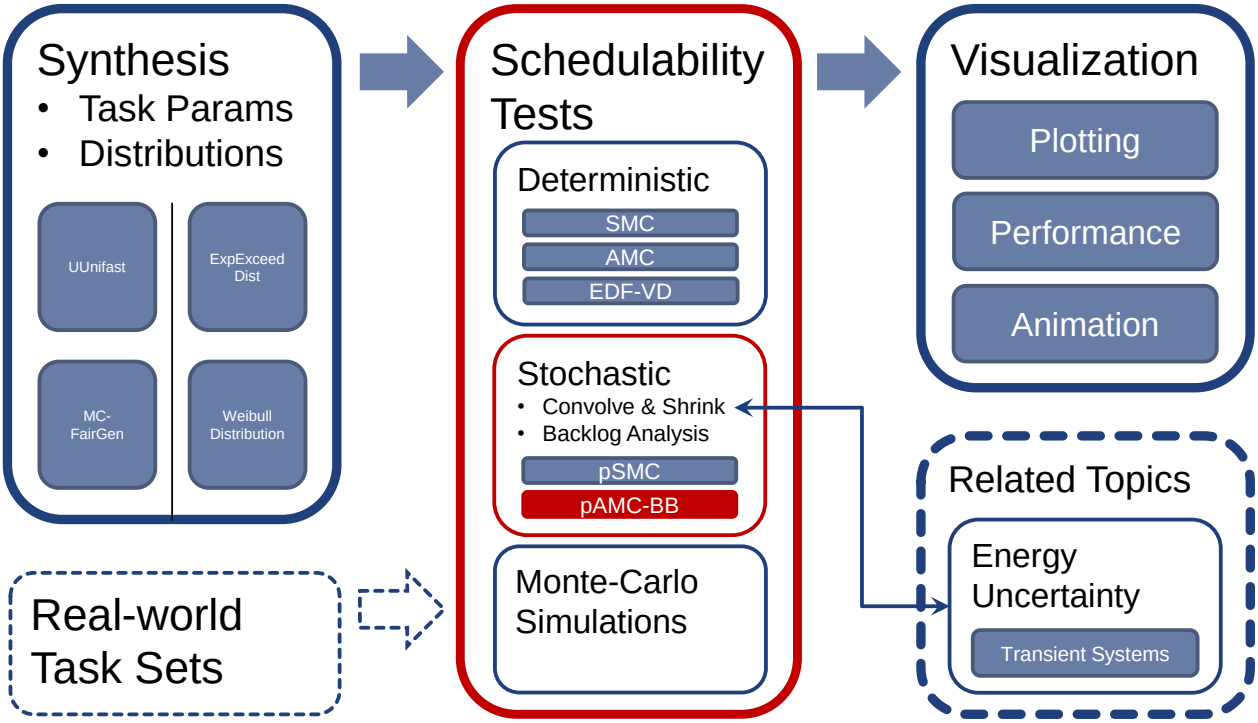





# Backlog Analysis

→ Animation: Iterative backlog computation

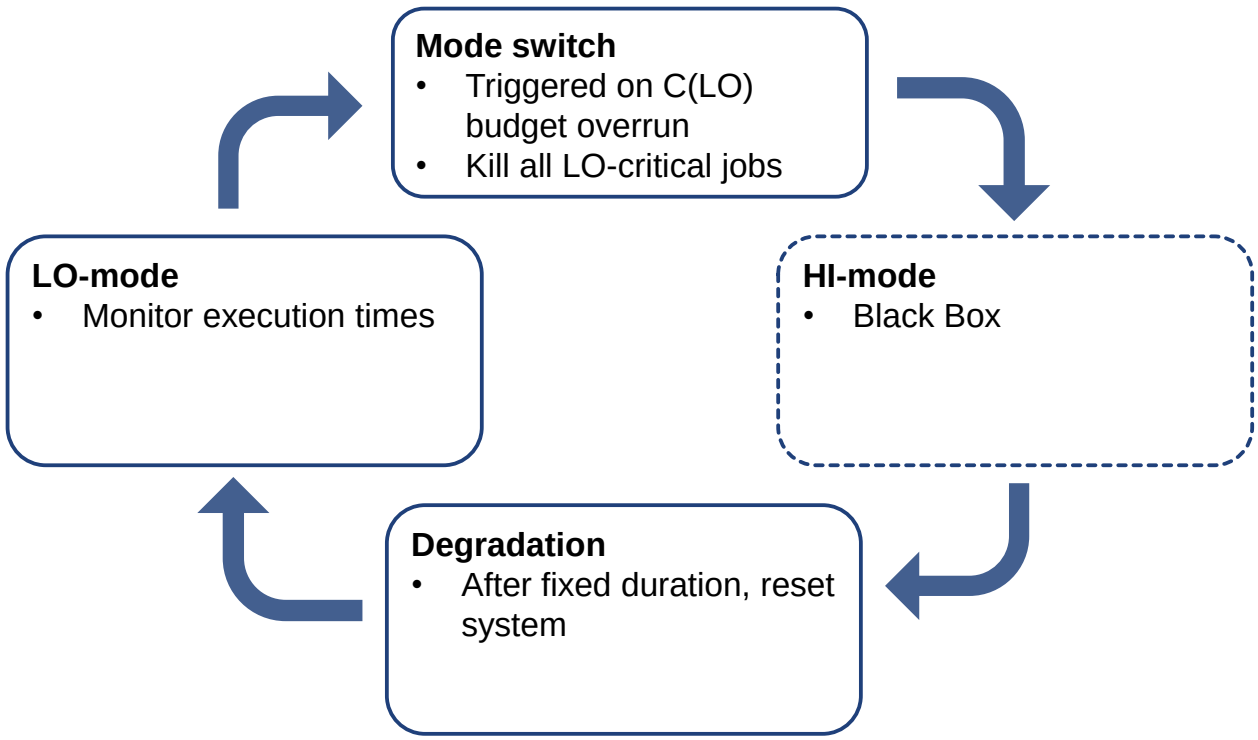
# pAMC-BB








# pAMC-BB



# pAMC-BB

**Analysis:**

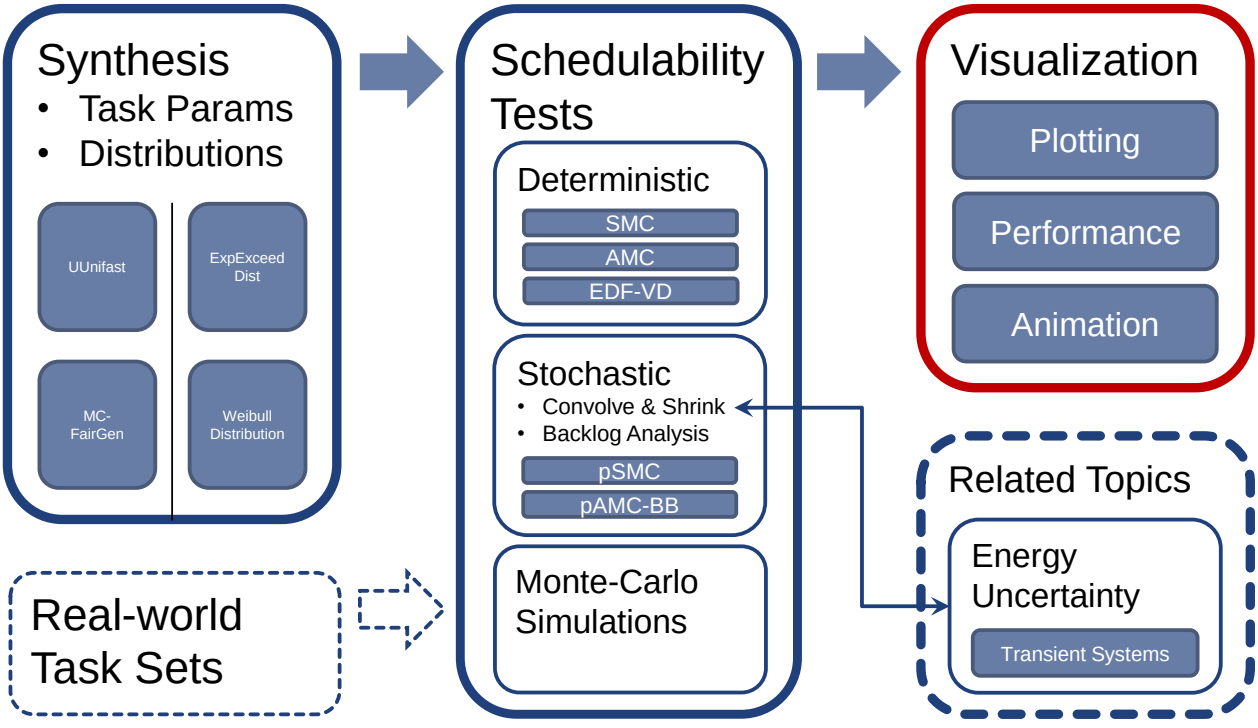
1. Find response time distribution for every job using convolution and shrinking.
2. Compare resulting response time PMF with job deadline to get job-specific deadline miss probability.
3. For every task, check:
   $reltime_{LO} \times DMP_{LO} + reltime_{HI} \times DMP_{BB} \leq Threshold$

**Lines of Python Code: ~30 + reusable methods**

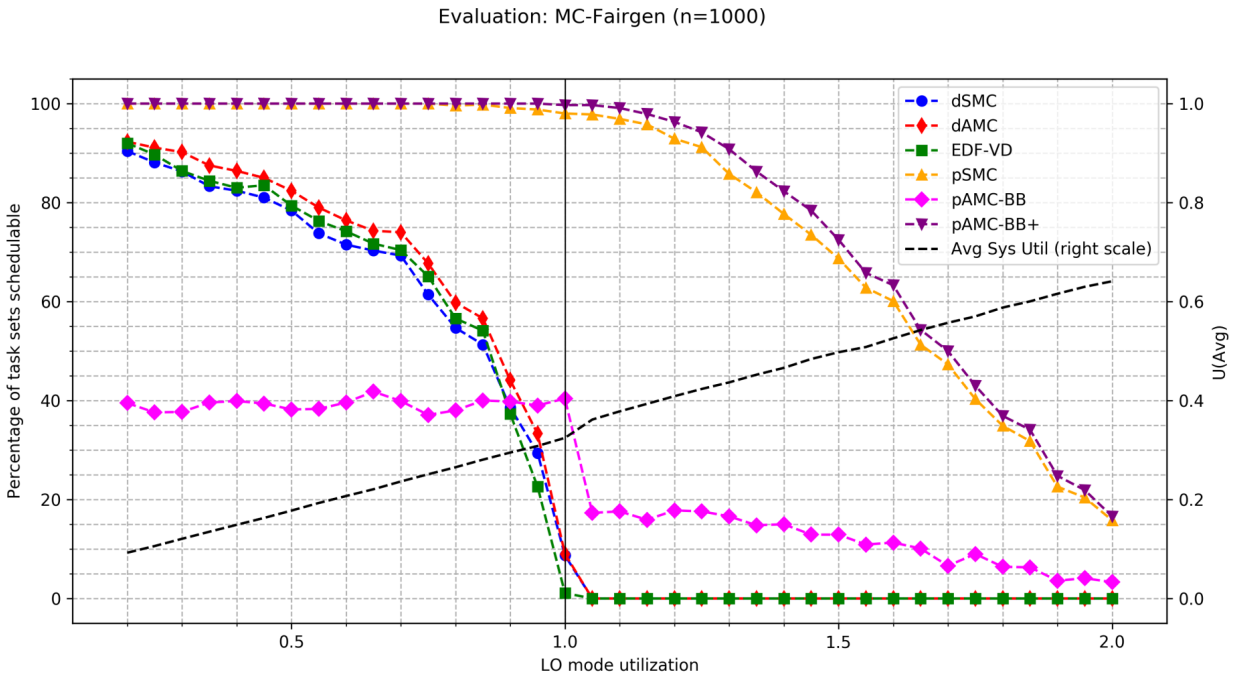




# Visualization



# Visualization: Deterministic vs. Probabilistic

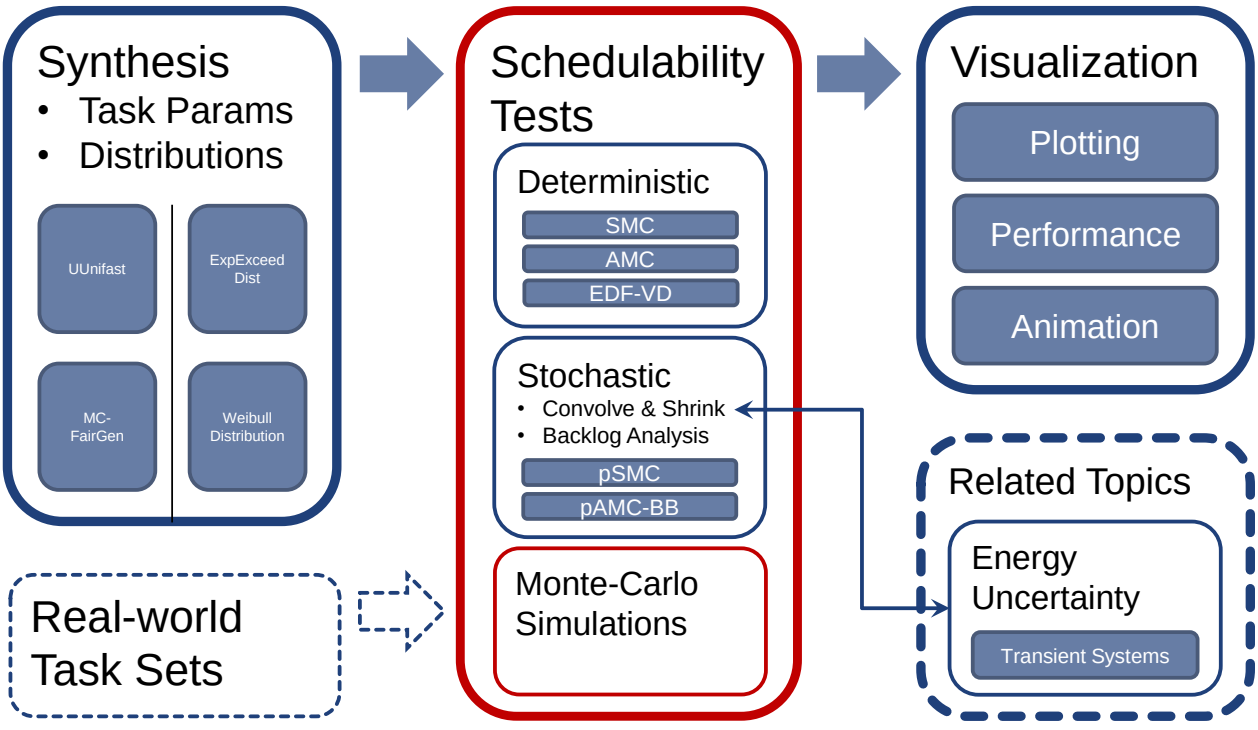



**Time measured: 1h 21min 28s**, Intel i5-7600K, 4 cores @ 3.8 GHz

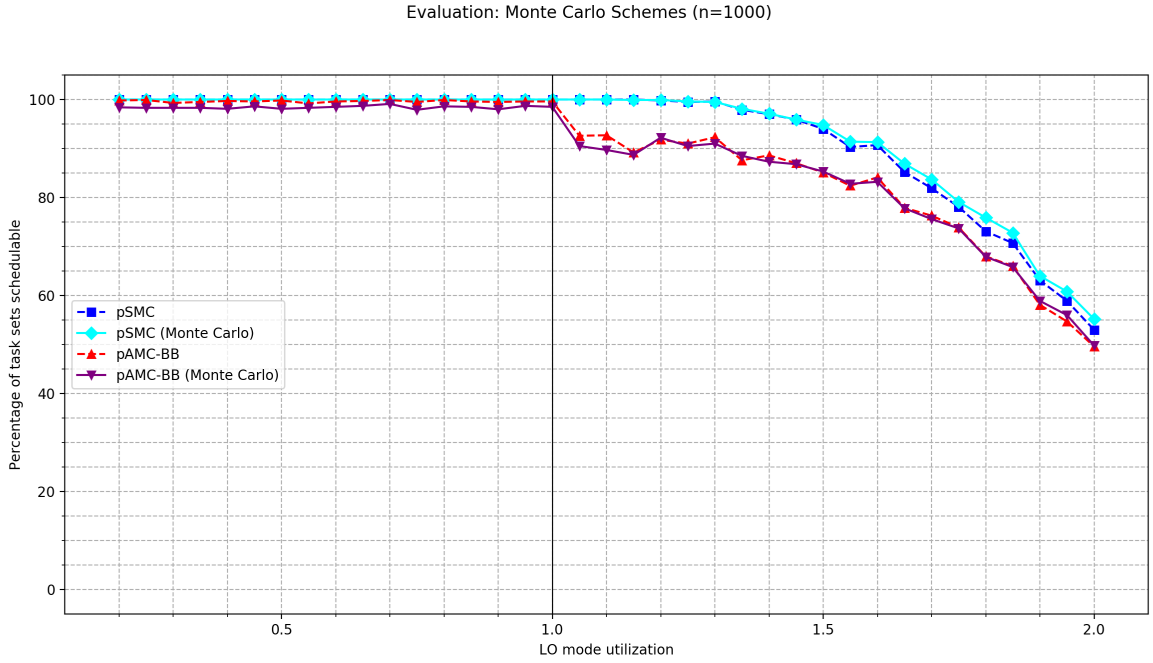




# Monte-Carlo Simulation



# Visualization: Monte-Carlo Simulation




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

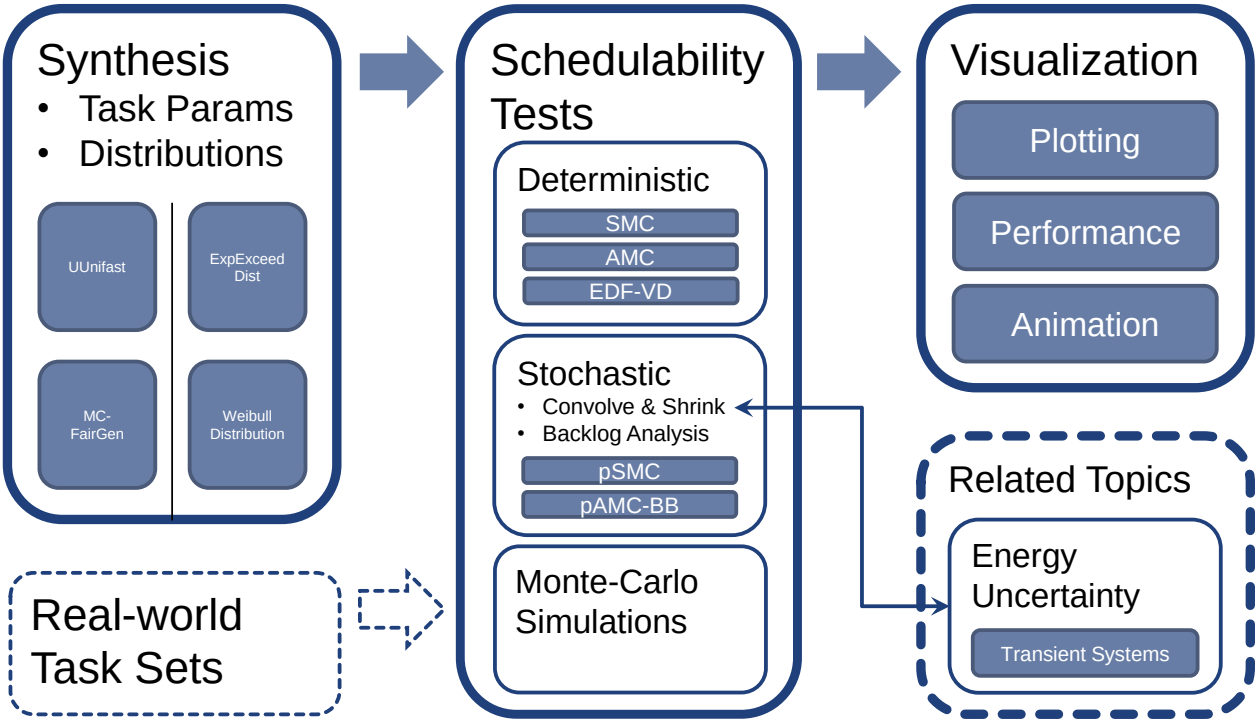




# Conclusion

- **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


Synthesis
• Task Params
• Distributions
UUnifast
ExpExceed Dist
MC-FairGen
Weibull Distribution
Real-world Task Sets
Schedulability Tests
Deterministic
SMC
AMC
EDF-VD
Stochastic
• Convolve & Shrink
• Backlog Analysis
pSMC
pAMC-BB
Monte-Carlo Simulations
Visualization
Plotting
Performance
Animation
Related Topics
Energy Uncertainty
Transient Systems