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A Look at Computer Architecture Methodologies

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Why evaluation methodologies?

1. Is computer architecture an art or a science?
   - Experimental Data
   - Reproducibility

2. How have evaluated metrics changed over the years?

Scope of the Survey

- 44 ISCA Proceedings
  - 1973-2017
  - Too many papers (over 1600)

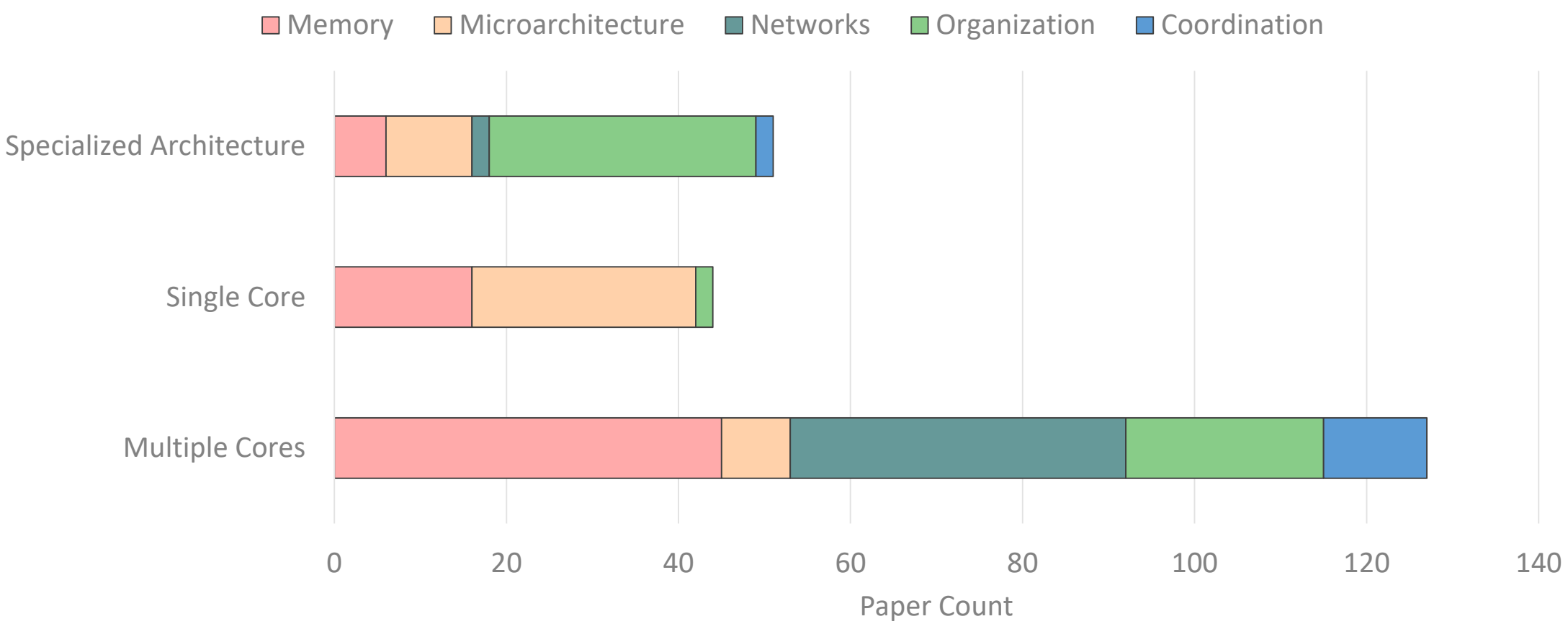
- Select papers from each proceeding across topics
  - Bias selection to impactful papers
  - 4-7 papers per proceeding
  - 222 papers total

Paper Topics

Axis #1	Description
Single Core	A conventional general purpose processor with one core
Multiple Core	More than one conventional processor
Specialized Architecture	An unconventional processor (e.g., accelerator, GPU)

Axis #2	Description or Examples
Microarchitecture	e.g., branch prediction, simultaneous multithreading
Memory	e.g., cache replacement, phase change memory, cache coherence, memory consistency
Networks	e.g., bus, crossbar, network-on-chip, network interface
Organization	The overall design of multiple components
Coordination	The management of multiple components to achieve a goal

Surveyed Papers Along Both Axes



Types of Evaluations

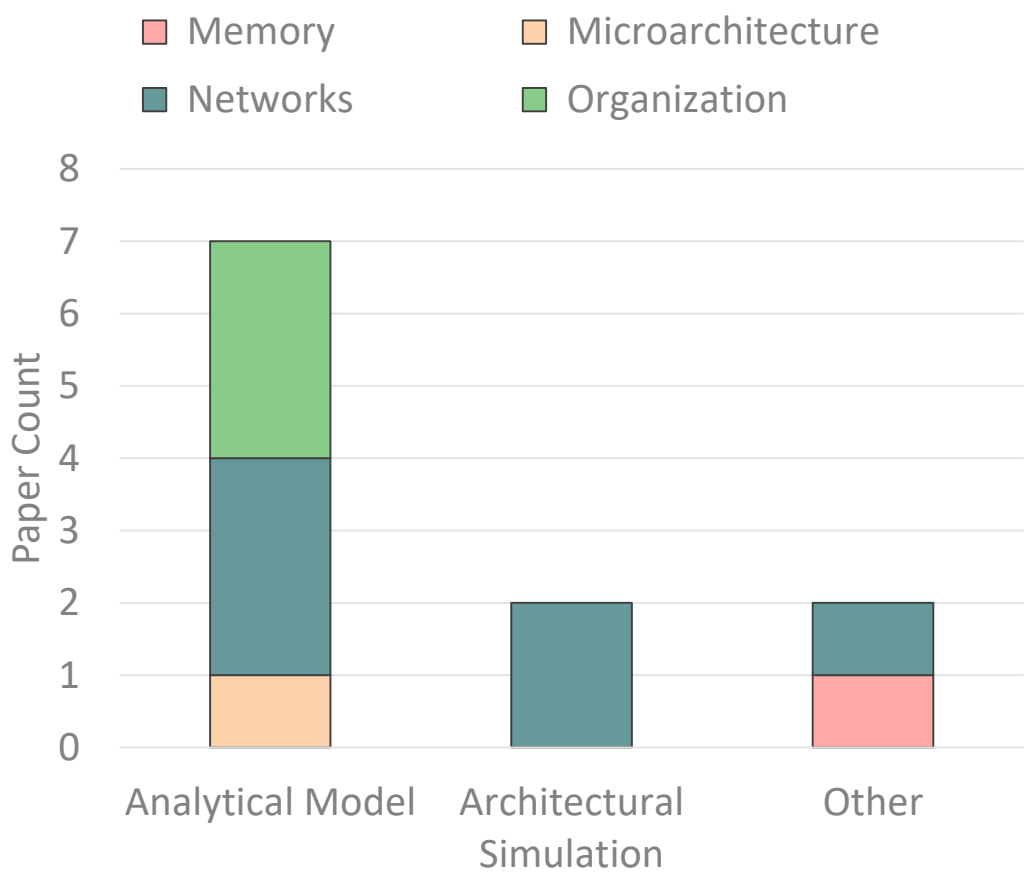
- None
- Qualitative
- Theoretical
- Quantitative
  - Experimental data

We Focus on Quantitative Evaluations

- None
- Qualitative
- Theoretical
- Quantitative
  - Experimental data
  - Analytical Model
  - Prototype
  - Simulation
    - Architectural
    - Circuit-level
    - Other

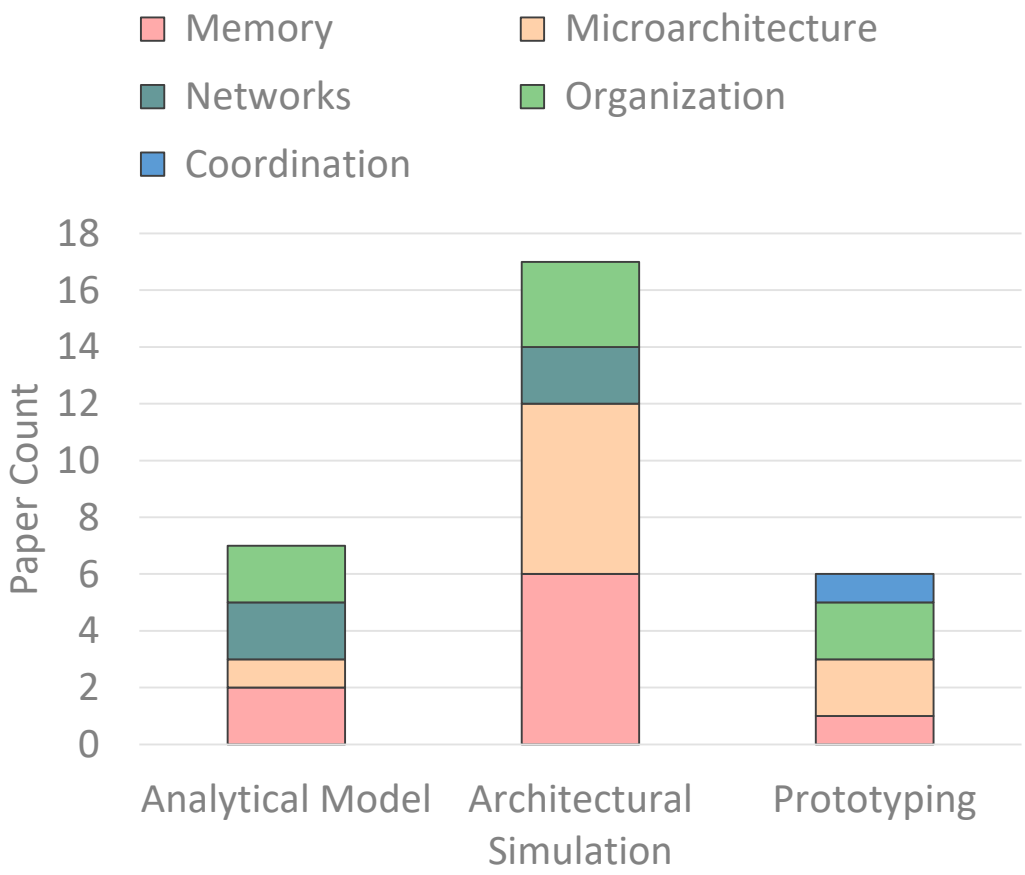
The 1970s – 27 papers

- Quantitative Evaluations: 40%
- Evaluated Metrics
  - Performance
  - Proxies for area
- Analytical Models
  - e.g., assume ideal parallelism
  - e.g., performance projections



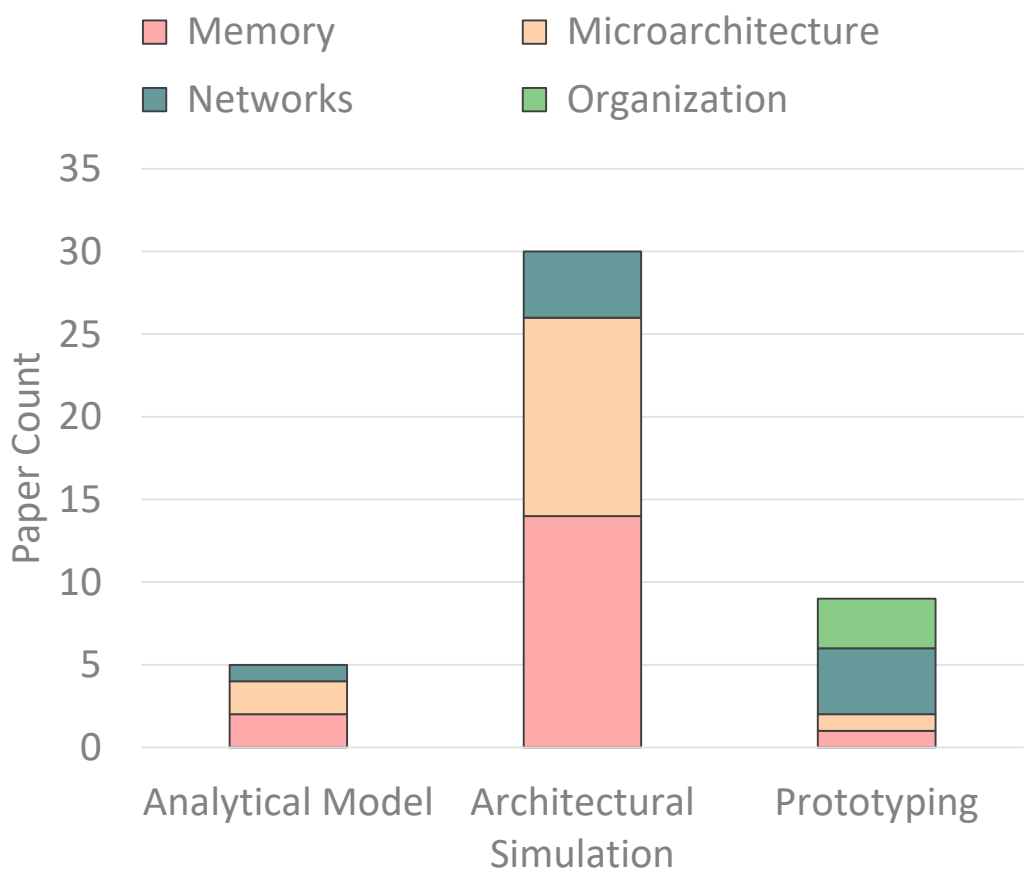
The 1980s – 46 papers

- Quantitative Evaluations: 60%
- Reduced costs of memory and CPU
  - Single core processors
  - Prototyping
- Trace-driven simulation

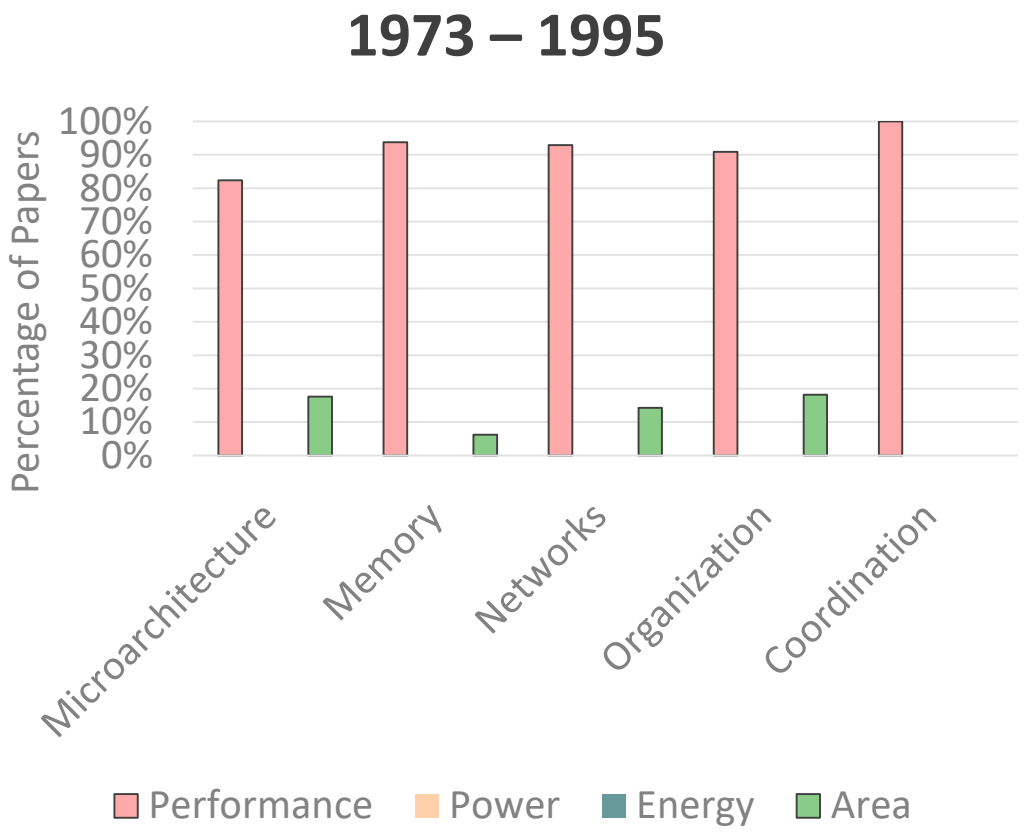


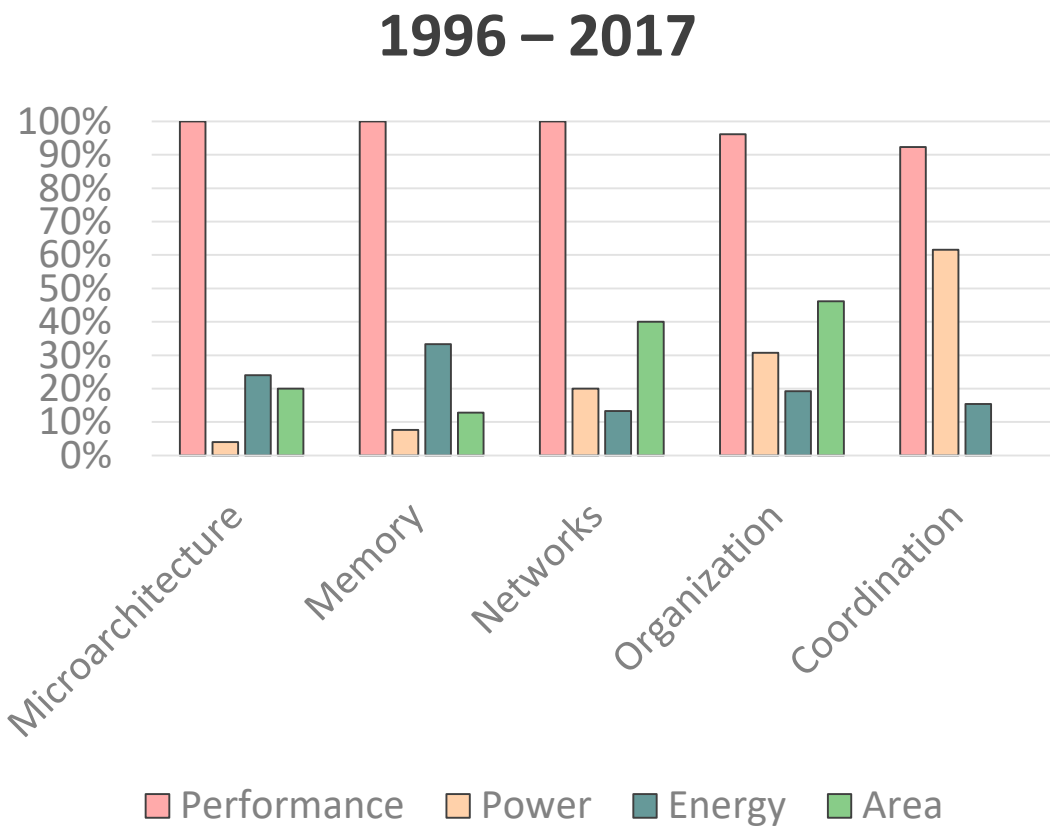
The 1990s – 47 papers

- Quantitative Evaluations: 85%
- Introduction of many simulators
  - SimpleScalar
- Introduction of CACTI
  - Catches on in the next decade
- Power/energy is considered



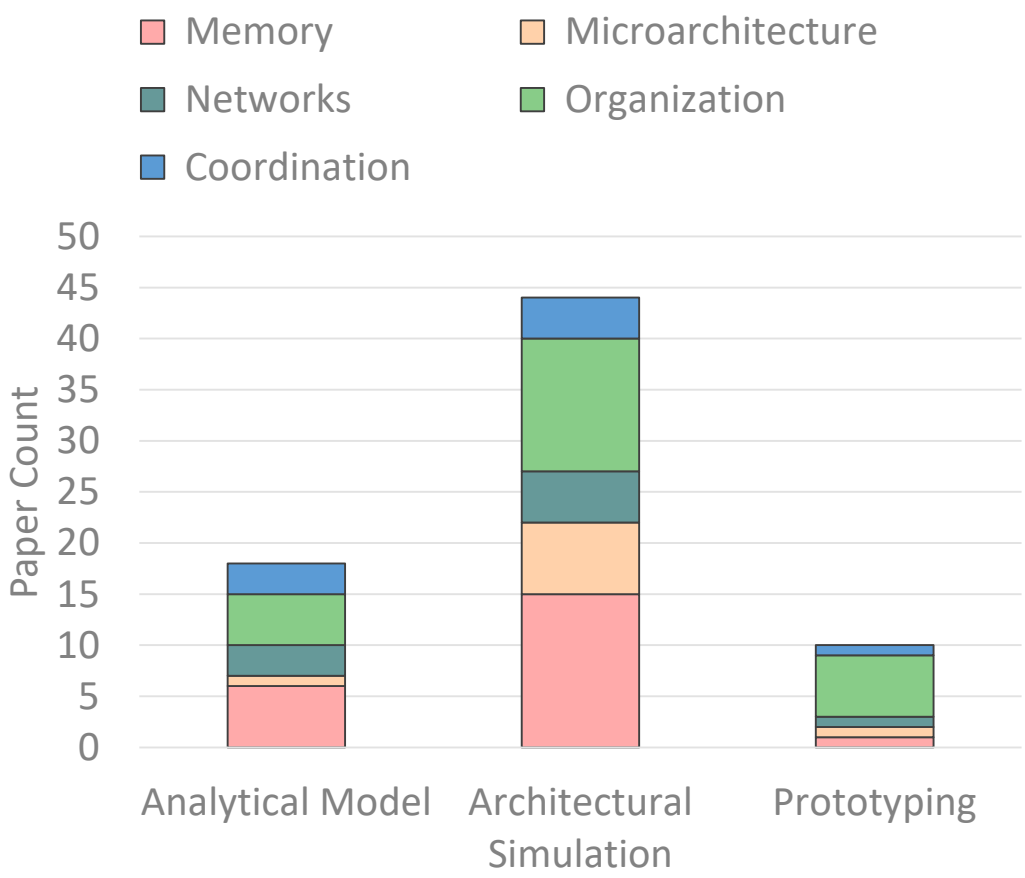
A Brief Interlude: Evaluated Metrics





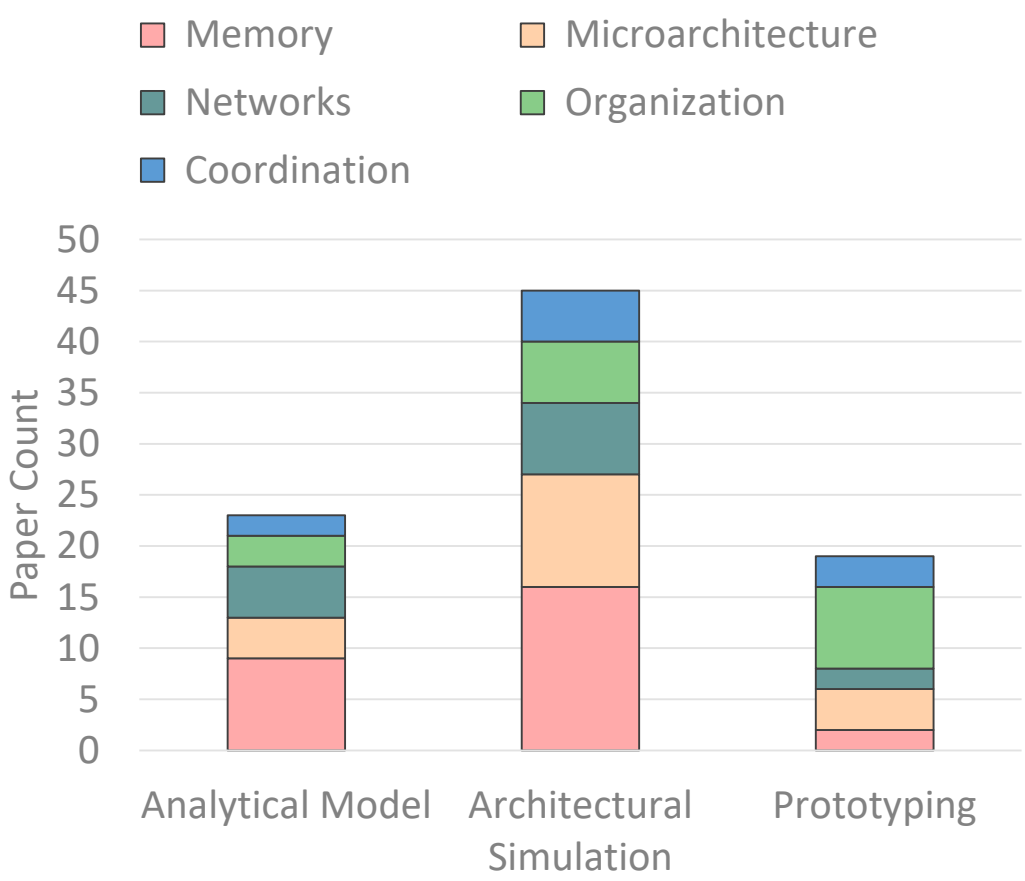
The 2000s – 50 papers

- Quantitative Evaluations: 98%
- Models for power, energy, thermal
  - Wattch, HotSpot, Orion, McPAT
  - CACTI gains popularity
- More simulator options
  - Pin, Simics
- Tools to reduce simulation time
  - SimPoint, PinPoint, SMARTS



The 2010s – 52 papers

- Models and prototypes used more
- More tools
  - Raised levels of abstraction
  - Design space exploration



Summarizing Tool Use – 1973 - 2017

Computer Architecture: Art or Science?

- Strong push to quantitative evaluations
- Designs are evaluated with more metrics
- Many tools developed to generate data
- Reproducibility?

The Increasingly Complex “Methodology”

- Methodology section prominent in mid-to-late 90s
- Methodologies grow very complex
  - More tools are used
- Page real estate
  - Less used for methodology
  - More used for experimental data
- Methodologies do not provide enough information

Conclusion: Towards a Scientific Method

Architects

- Better methodology section
- Relevant experimental data
- Release your evaluation
  - Docker
  - GitHub
  - Other technologies

Tools Developers

- Caution against limitations
- Output ‘artifacts’ that
  - Can be redistributed
  - Can be re-used as inputs
  - Can be analyzed

Our Data is Open Source

https://github.com/mariobadr/survey-wp3

License: Apache 2.0

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