

# Decoding CPU Performance

Cores, Clocks & Multithreading  
Final Presentation

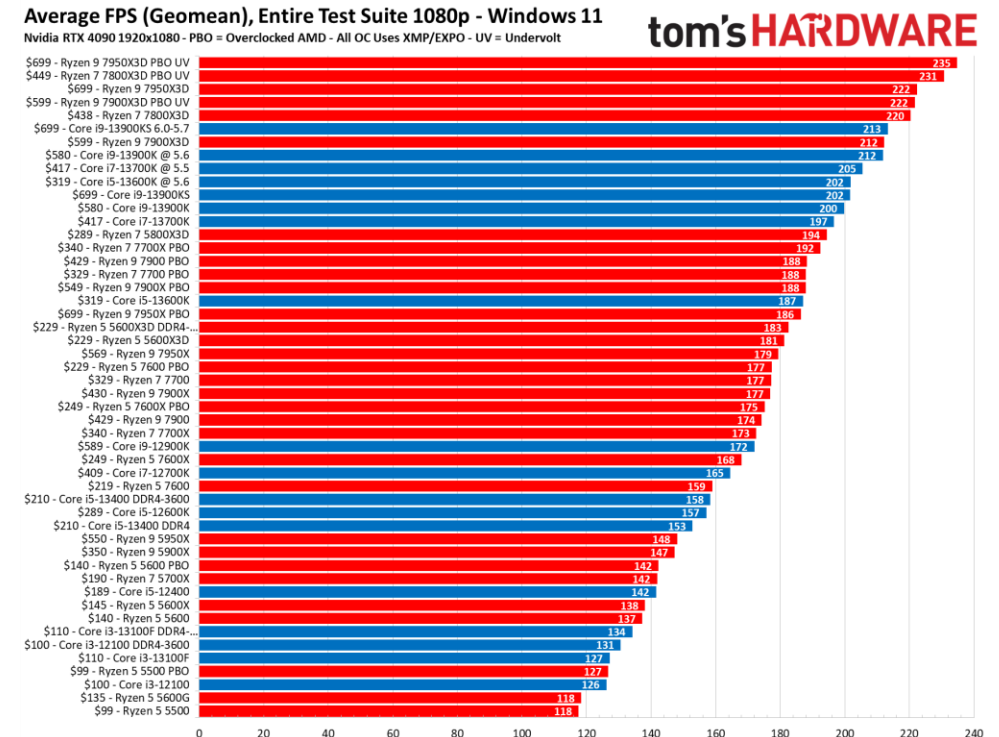
Malek Alsibai

# | Agenda

- |          |                                    |          |                         |
|----------|------------------------------------|----------|-------------------------|
| <b>3</b> | Core Concepts & Course Connections | <b>6</b> | Clock Speeds & Thermals |
| <b>4</b> | Our Test CPUs & Methodology        | <b>7</b> | Core Usage & Efficiency |
| <b>5</b> | Benchmark Scores                   | <b>8</b> | Discussion & Conclusion |

# Introduction: The Pillars Of CPU Performance

- **Cores:** The processor's "brains" for executing tasks. More cores = more parallelism.
- **Clock Speed (GHz):** how many cycles the CPU can complete per second, with a higher clock speed generally meaning faster processing. Faster clock = faster instruction execution.
- **SMT (Multithreading):** Allows one physical core to work on two tasks at once (e.g., 8 cores, 16 threads).



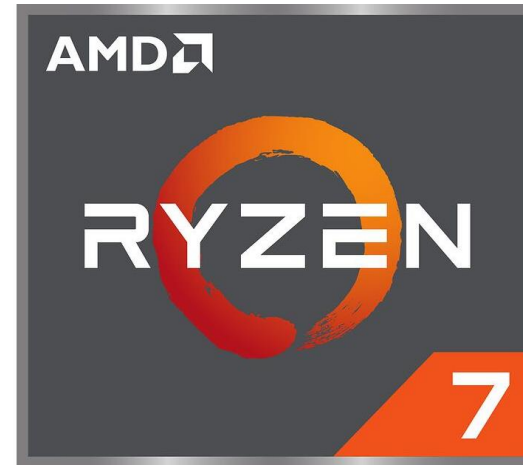
# Theoretical Framework: Connecting To Course Concepts

		Instruction Streams	
		one	many
Data Streams	one	<p style="text-align: center;"><b>SISD</b></p> <p>traditional von Neumann single CPU computer</p>	<p style="text-align: center;"><b>MISD</b></p> <p>May be pipelined Computers</p>
	many	<p style="text-align: center;"><b>SIMD</b></p> <p>Vector processors fine grained data Parallel computers</p>	<p style="text-align: center;"><b>MIMD</b></p> <p>Multi computers Multiprocessors</p>

- **Instruction Set Architecture (ISA):**
- Our CPUs use **x86-64**, a **CISC** (Complex) design.
- This contrasts with the **RISC** (Reduced) design of ARM processors from the lectures.
- **Flynn's Taxonomy:**
- Modern multi-core CPUs are prime examples of **MIMD** (Multiple Instruction, Multiple Data).

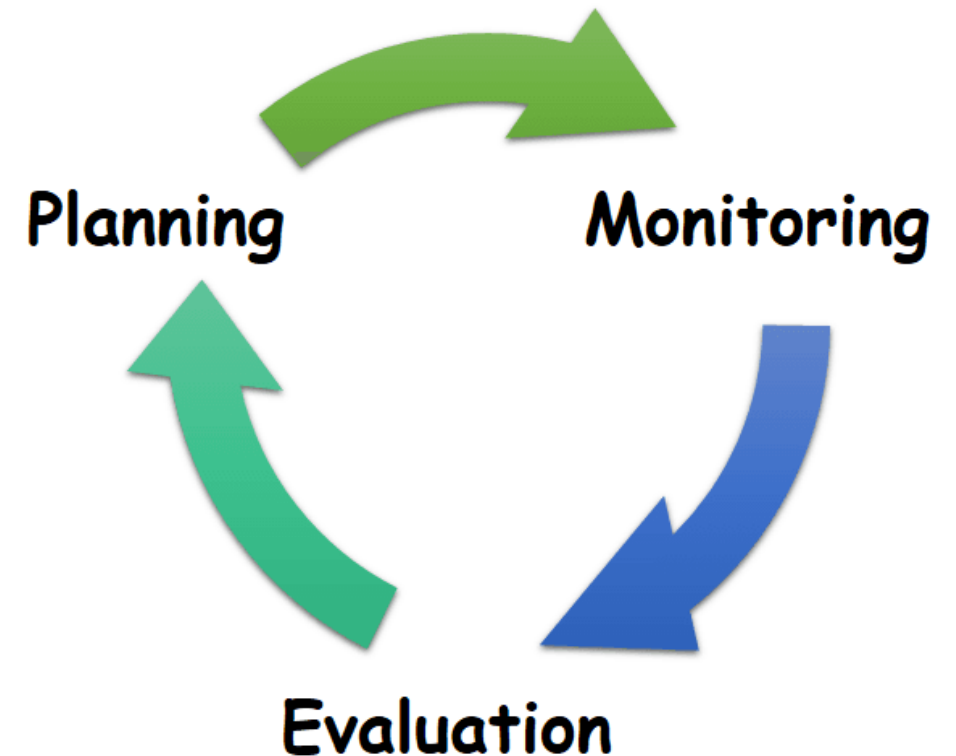
# |The Contenders: A Look At Our Test Architectures

- **Intel i5-1135G7:** 4 Cores / 8 Threads @ 2.40 / 4.20 GHz
- **AMD Ryzen 5 3600:** 6 Cores / 12 Threads @ 3.60 / 4.20 GHz
- **AMD Ryzen 7 6800H:** 8 cores & 16 threads @ 3.20 GHz & 4.70 GHz
- **AMD Ryzen 9 5900HX:** 8 Cores / 16 Threads @ 3.30 / 4.60 GHz



# | Our Process: Systematic Benchmarking

- **Benchmarks:** Cinebench R23, Geekbench 6, Blender
- **Monitoring:** Precise logging with HWiNFO64
- **Method:** Multiple runs for statistical accuracy
- **Analysis:** Processed all data using custom Python scripts



# Our Process: Systematic Benchmarking

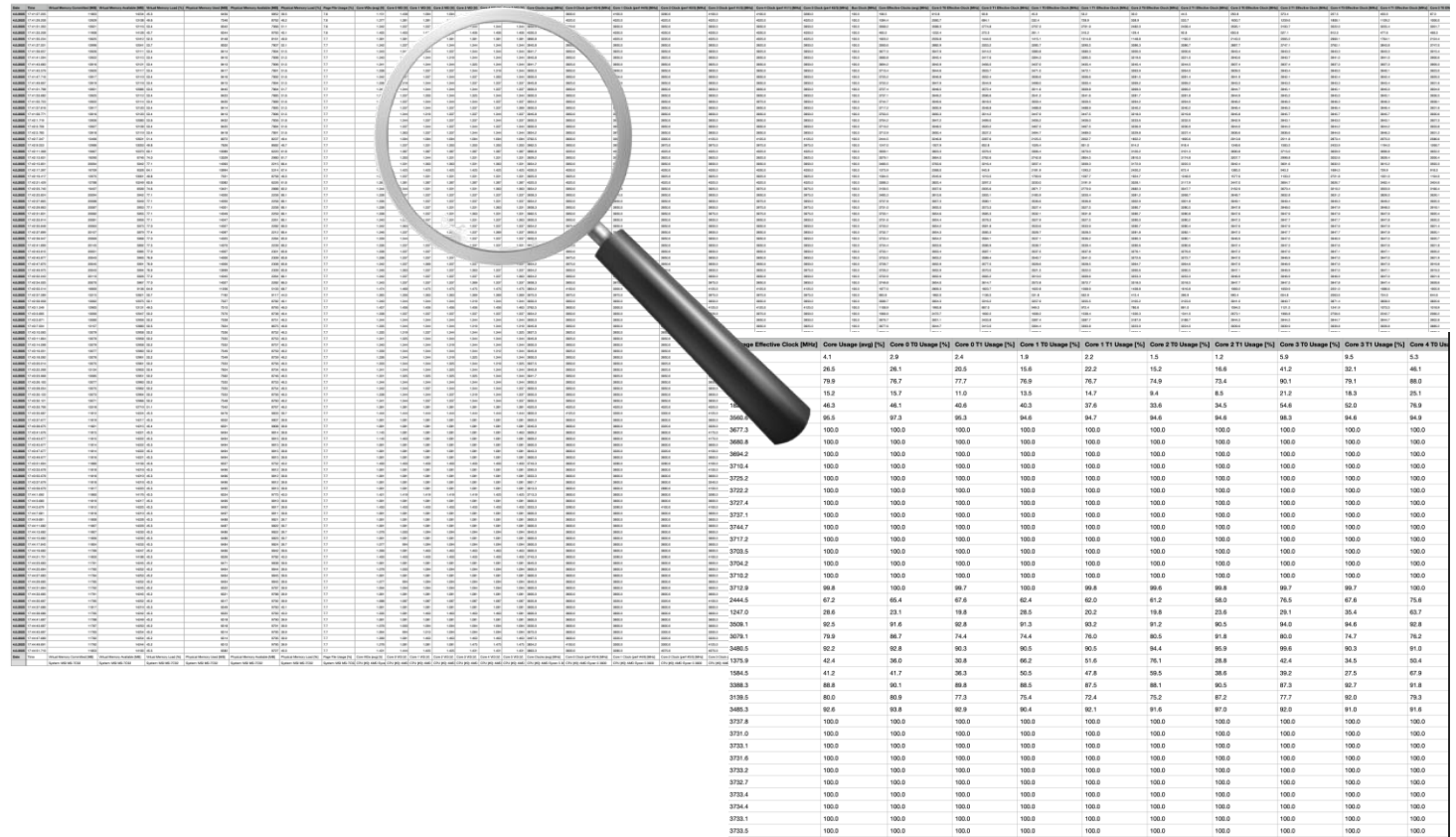
11th Gen Intel Core i5-...

Ryzen 5 3600

Ryzen 7 6800h

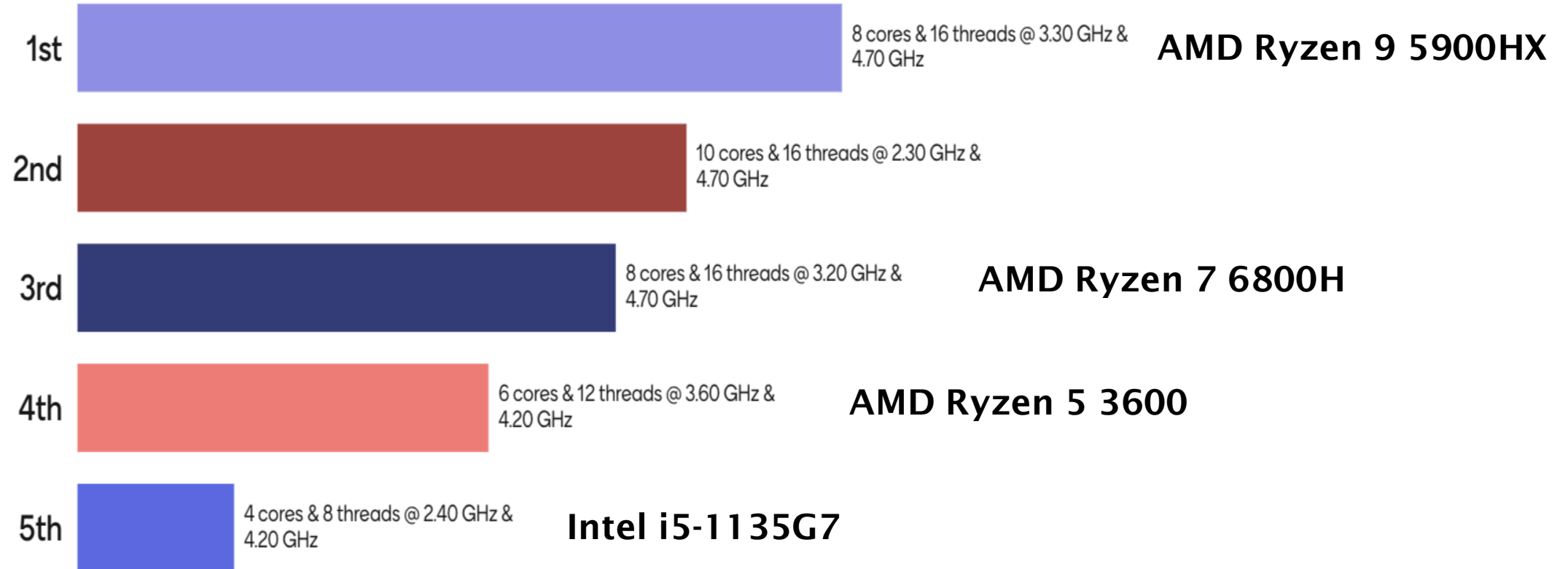
Ryzen 9 5900HX

- ryzen\_5\_3600\_blender\_balanced\_run1.CSV
- ryzen\_5\_3600\_blender\_balanced\_run2.CSV
- ryzen\_5\_3600\_blender\_high\_perf\_run1.CSV
- ryzen\_5\_3600\_blender\_high\_perf\_run2.CSV
- ryzen\_5\_3600\_cinnebench\_balanced\_run1.CSV
- ryzen\_5\_3600\_cinnebench\_balanced\_run2.CSV
- ryzen\_5\_3600\_cinnebench\_high\_perf\_run1.CSV
- ryzen\_5\_3600\_cinnebench\_high\_perf\_run2.CSV
- ryzen\_5\_3600\_geek\_balanced\_run1.CSV
- ryzen\_5\_3600\_geek\_balanced\_run2.CSV
- ryzen\_5\_3600\_geek\_high\_perf\_run1.CSV
- ryzen\_5\_3600\_geek\_high\_perf\_run2.CSV



Processor	Task	Effective Clock [MHz]	Core Usage [avg] [%]	Core 0 TT Usage [%]	Core 1 TT Usage [%]	Core 2 TT Usage [%]	Core 3 TT Usage [%]	Core 4 TT Usage [%]	Core 5 TT Usage [%]	Core 6 TT Usage [%]	Core 7 TT Usage [%]	Core 8 TT Usage [%]	Core 9 TT Usage [%]	
Ryzen 5 3600	ryzen_5_3600_blender_balanced_run1	4.1	2.9	2.4	1.9	2.2	1.5	1.2	1.9	8.5	5.3			
	ryzen_5_3600_blender_balanced_run2	26.5	28.1	28.5	22.2	16.6	11.2	16.6	41.2	32.1	48.1			
	ryzen_5_3600_blender_high_perf_run1	79.9	76.7	77.7	76.9	76.7	74.9	73.4	90.1	78.1	88.0			
	ryzen_5_3600_blender_high_perf_run2	15.9	16.7	17.0	13.5	14.7	9.4	8.6	21.2	18.3	25.1			
	ryzen_5_3600_cinnebench_balanced_run1	45.3	46.1	45.6	42.3	37.6	33.5	34.5	54.6	52.0	75.9			
	ryzen_5_3600_cinnebench_balanced_run2	356.0	95.5	97.3	95.3	94.6	94.7	94.6	94.6	98.3	94.8	94.9		
	ryzen_5_3600_cinnebench_high_perf_run1	3677.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
	ryzen_5_3600_cinnebench_high_perf_run2	3689.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
	ryzen_5_3600_geek_balanced_run1	2494.2	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
	ryzen_5_3600_geek_balanced_run2	3716.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
	ryzen_5_3600_geek_high_perf_run1	3726.2	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
	ryzen_5_3600_geek_high_perf_run2	3722.2	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
Ryzen 7 6800h	ryzen_7_6800h_blender_balanced_run1	3737.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
	ryzen_7_6800h_blender_balanced_run2	3737.1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
	ryzen_7_6800h_cinnebench_balanced_run1	3746.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
	ryzen_7_6800h_cinnebench_balanced_run2	3717.2	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
	ryzen_7_6800h_cinnebench_high_perf_run1	3720.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
	ryzen_7_6800h_cinnebench_high_perf_run2	3704.2	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
	ryzen_7_6800h_geek_balanced_run1	3710.2	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
	ryzen_7_6800h_geek_balanced_run2	3713.9	99.8	100.0	99.7	100.0	99.8	99.8	99.8	99.7	99.7	100.0		
	ryzen_7_6800h_geek_high_perf_run1	3444.5	87.2	86.4	87.6	82.4	82.0	81.2	84.3	87.6	87.6	87.6		
	ryzen_7_6800h_geek_high_perf_run2	3447.0	89.6	89.1	91.8	83.0	82.2	81.8	83.5	88.4	83.7	83.7		
	Ryzen 9 5900HX	ryzen_9_5900hx_blender_balanced_run1	3006.1	92.5	91.6	92.8	91.3	91.2	90.5	94.0	94.8	92.8		
		ryzen_9_5900hx_blender_balanced_run2	3079.1	79.9	86.7	74.4	74.4	76.0	80.5	91.8	80.0	74.7	76.2	
ryzen_9_5900hx_cinnebench_balanced_run1		3480.5	92.2	92.8	90.3	90.3	94.4	95.9	99.6	90.3	91.0	91.0		
ryzen_9_5900hx_cinnebench_balanced_run2		3179.9	42.4	26.0	26.8	49.2	31.6	38.1	42.4	34.3	53.4	53.4		
ryzen_9_5900hx_cinnebench_high_perf_run1		1584.5	41.2	41.7	36.3	30.5	47.8	59.5	36.6	39.2	27.5	67.9		
ryzen_9_5900hx_cinnebench_high_perf_run2		3388.3	88.8	90.1	89.8	88.5	87.5	88.1	90.5	87.3	92.7	91.8		
ryzen_9_5900hx_geek_balanced_run1		3139.5	80.0	80.9	77.3	73.4	72.4	73.2	87.2	77.7	80.0	79.3		
ryzen_9_5900hx_geek_balanced_run2		3483.5	92.6	93.8	93.9	93.4	91.6	92.1	92.5	92.5	91.0	91.8		
ryzen_9_5900hx_geek_high_perf_run1		3737.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
ryzen_9_5900hx_geek_high_perf_run2		3731.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
ryzen_9_5900hx_geek_high_perf_run3		3731.1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
ryzen_9_5900hx_geek_high_perf_run4		3732.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		

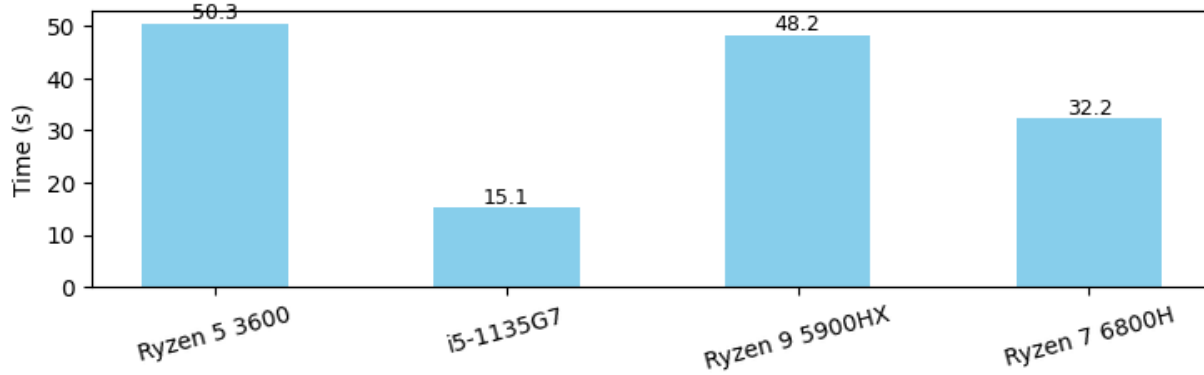
# | Predictions vs reality



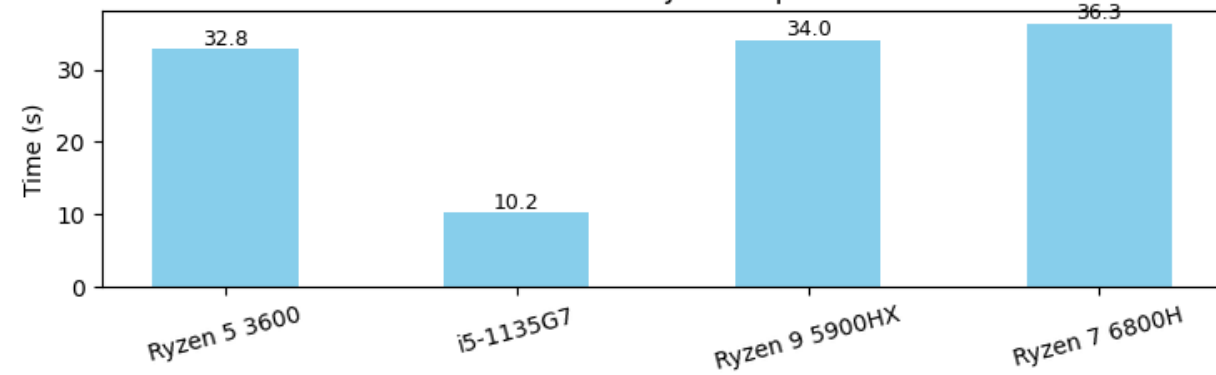
# Results: The Big Picture - Benchmark Scores



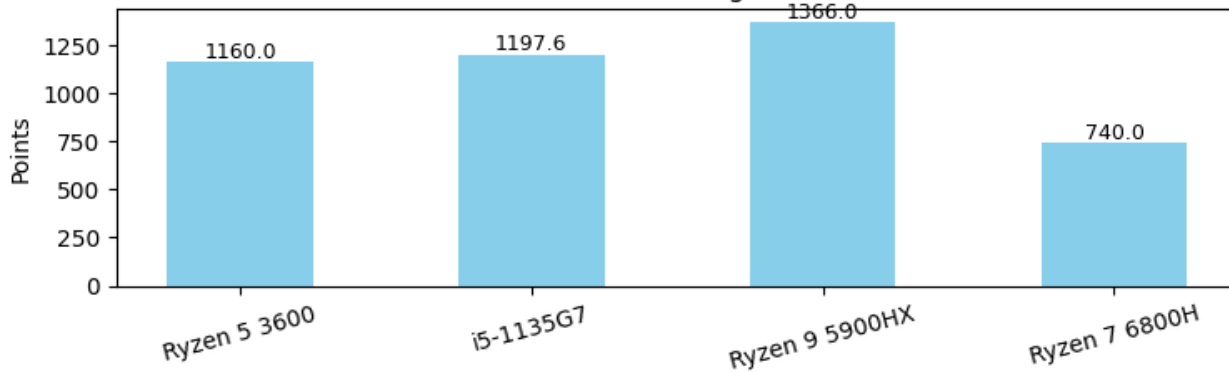
### Blender - Monster



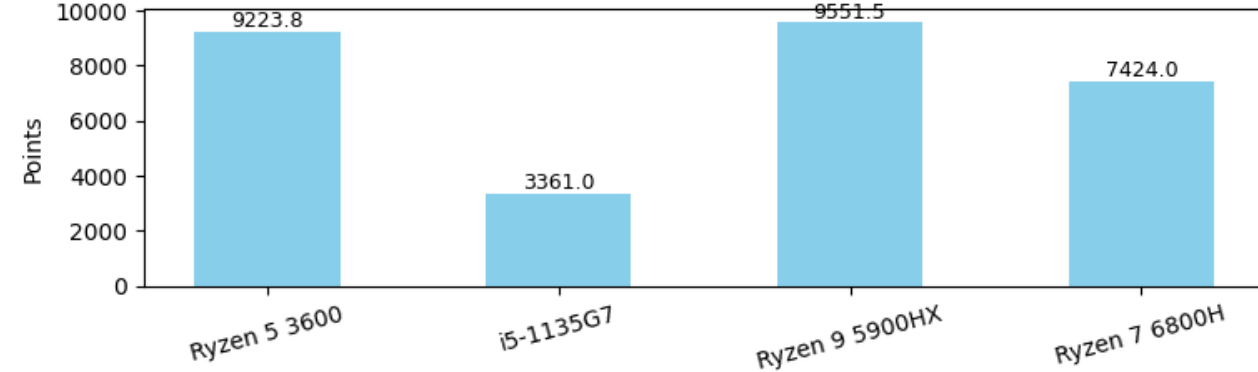
### Blender - Junkshop



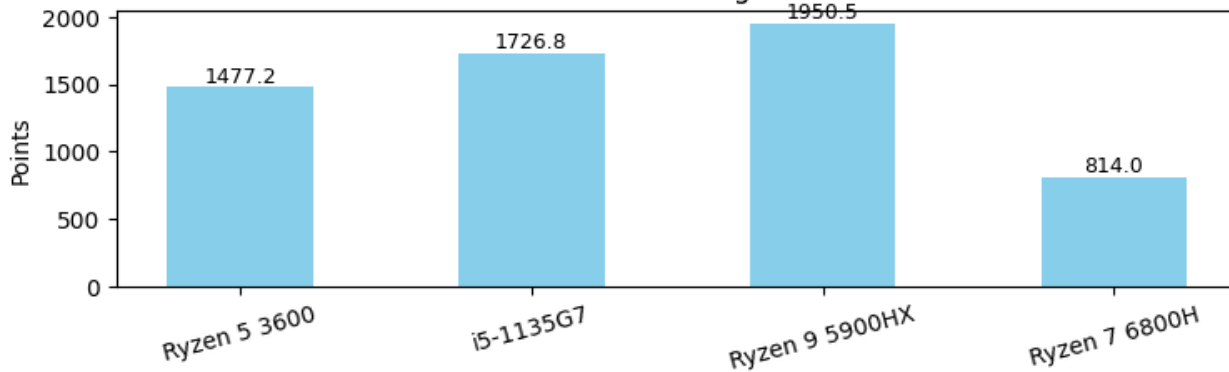
### Cinebench - Single Core



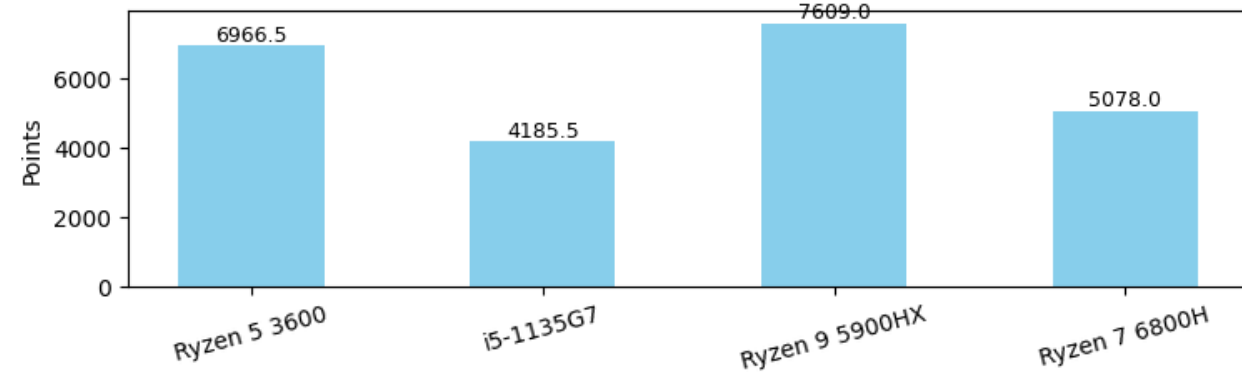
### Cinebench - Multi Core



### Geekbench - Single Core

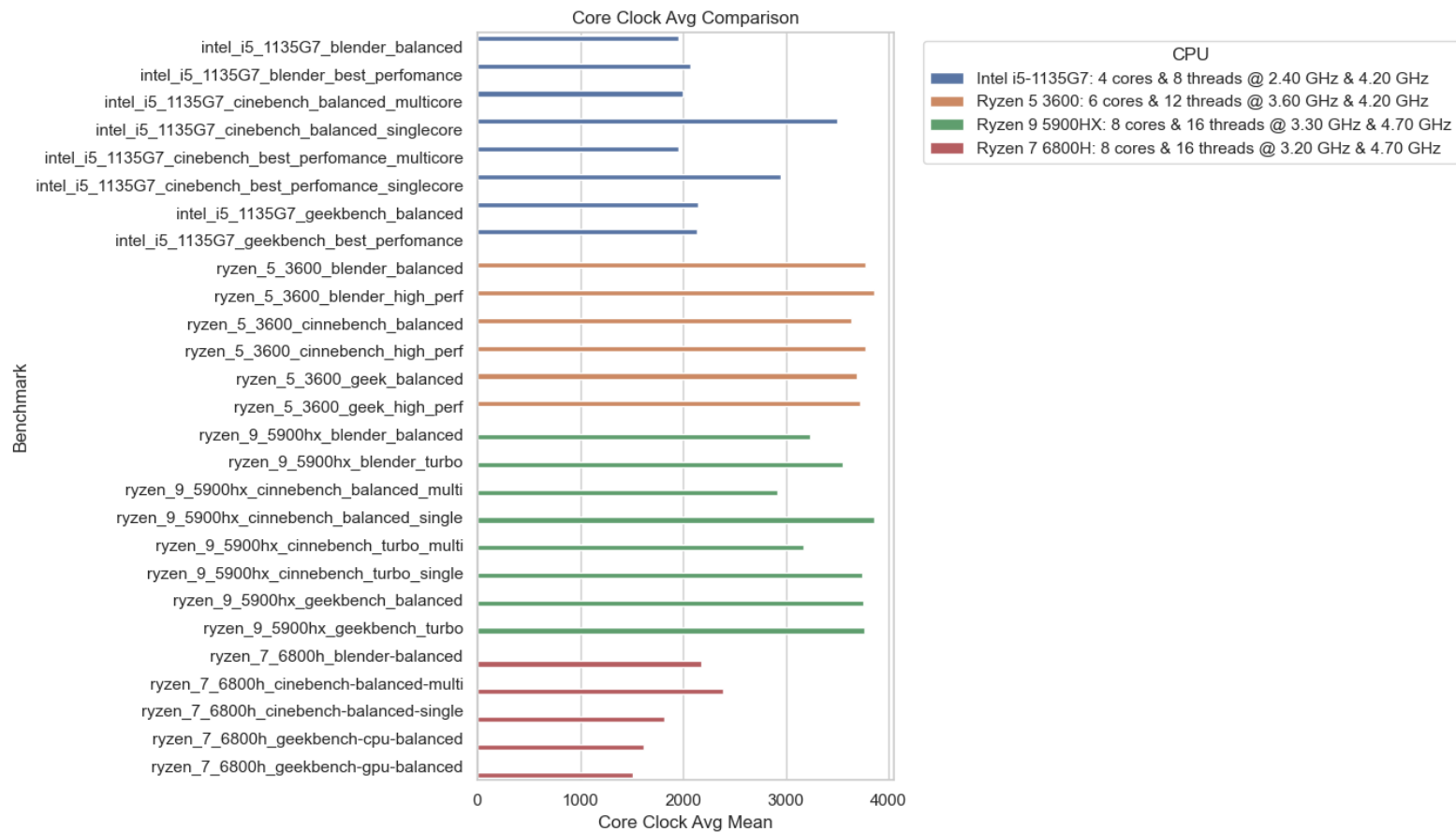


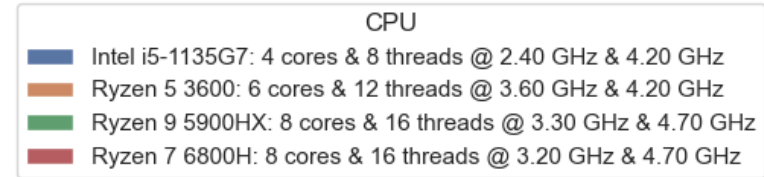
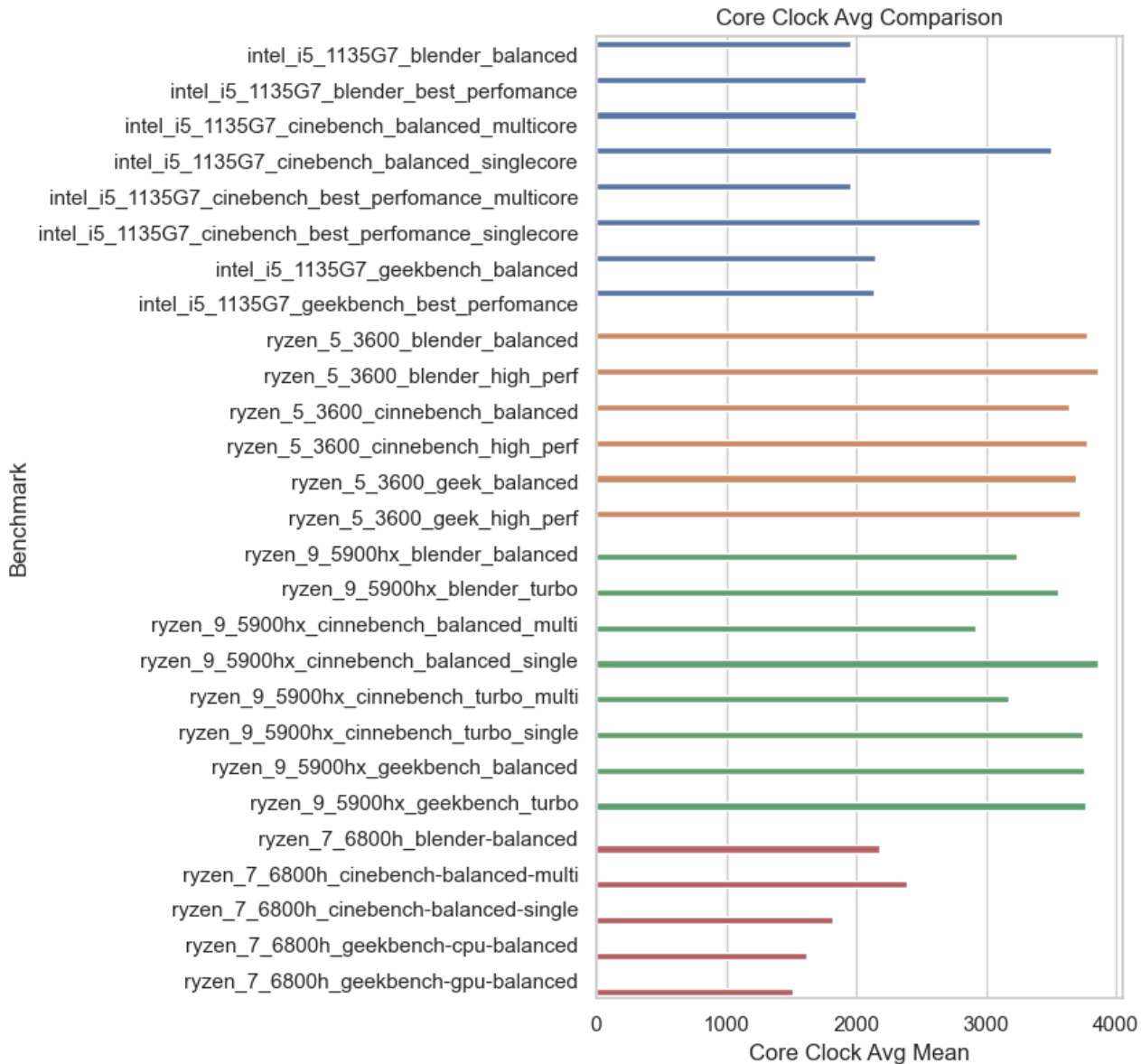
### Geekbench - Multi Core



# DEEP DIVE 2: CLOCK SPEED UNDER PRESSURE

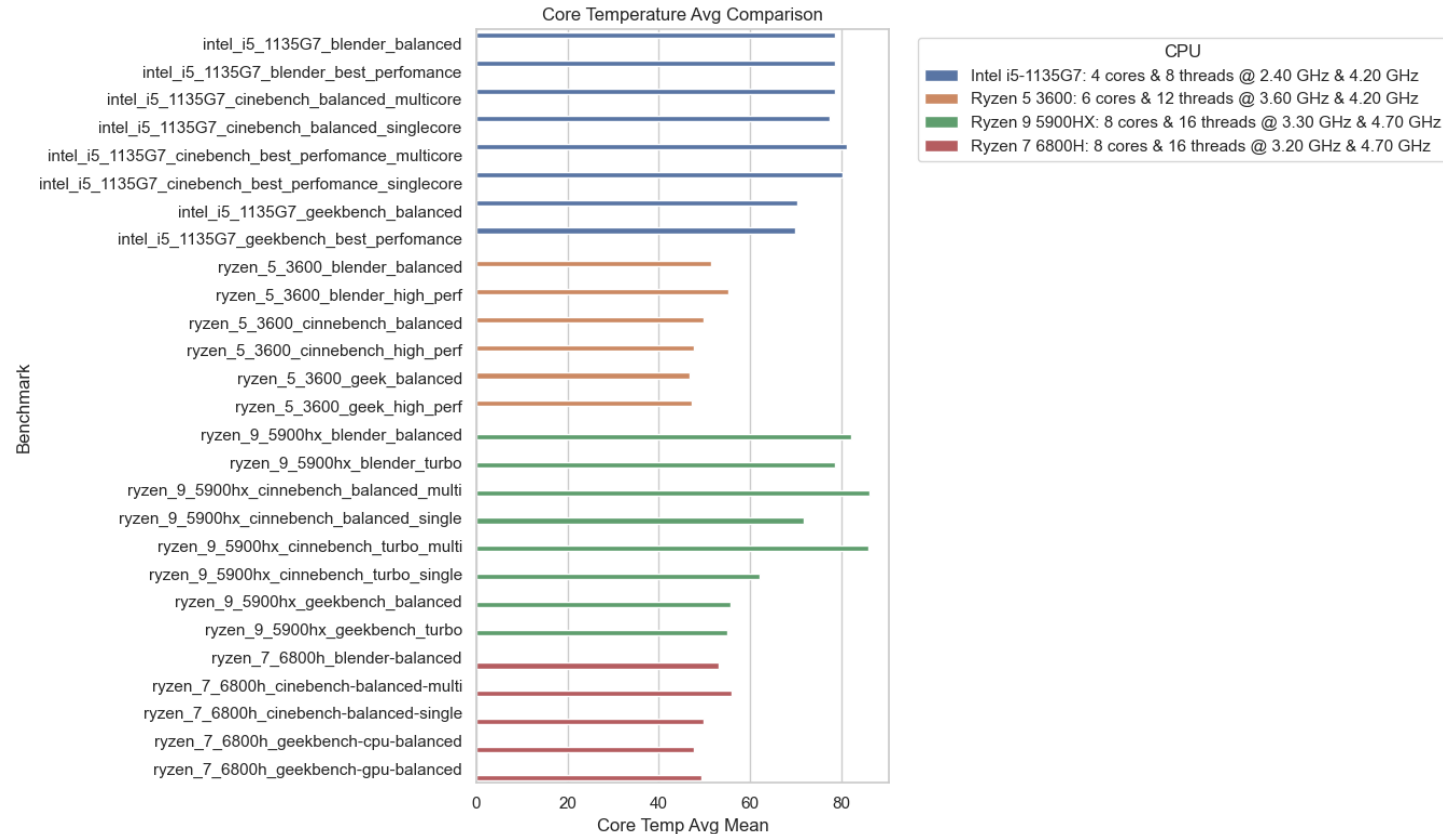
- **Question:** Do CPUs maintain their "boost clocks" in reality?
- **Observation:** They adjust constantly based on load and heat.

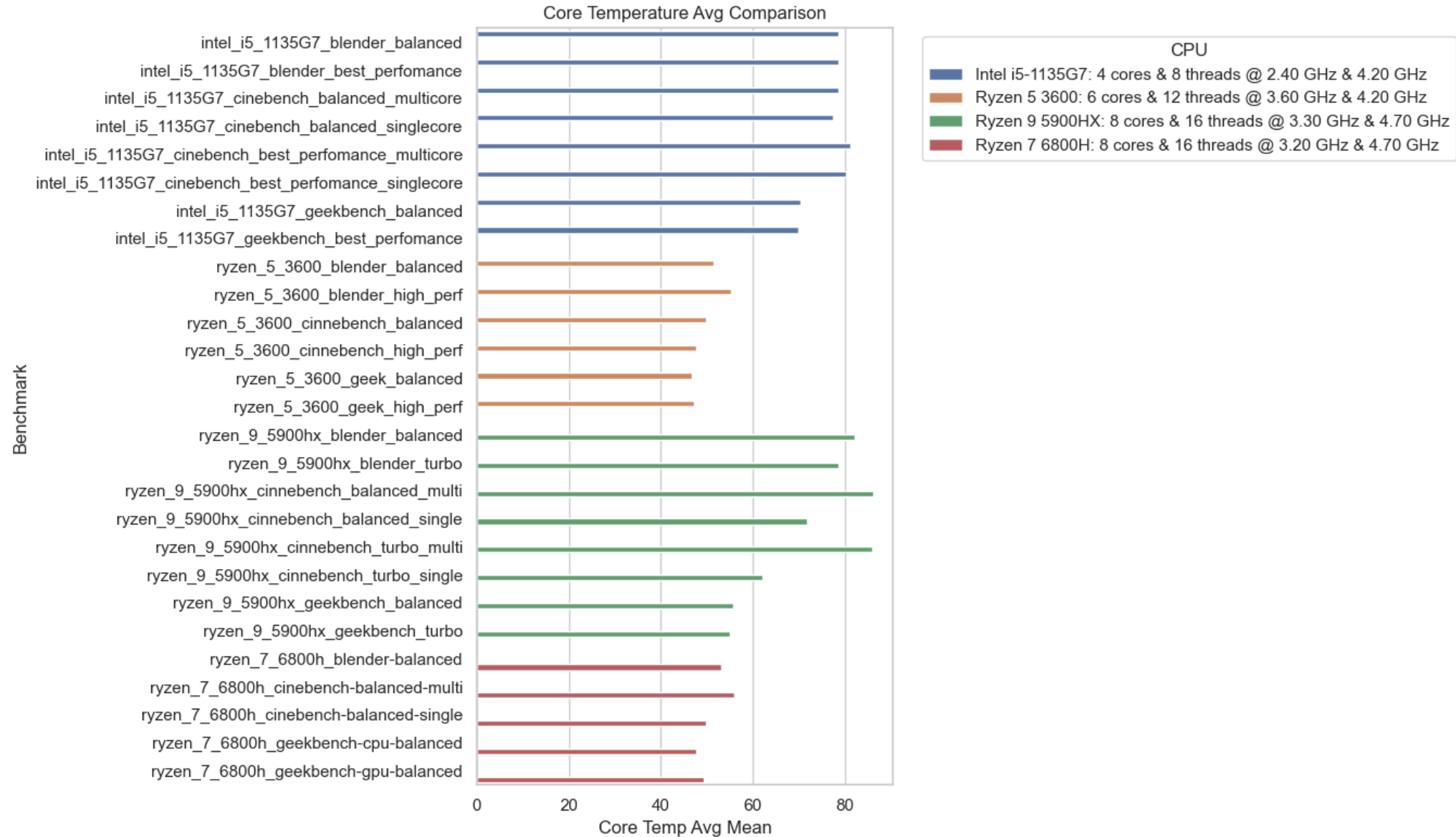




# DEEP DIVE 3: THE HEAT OF BATTLE - THERMAL PERFORMANCE

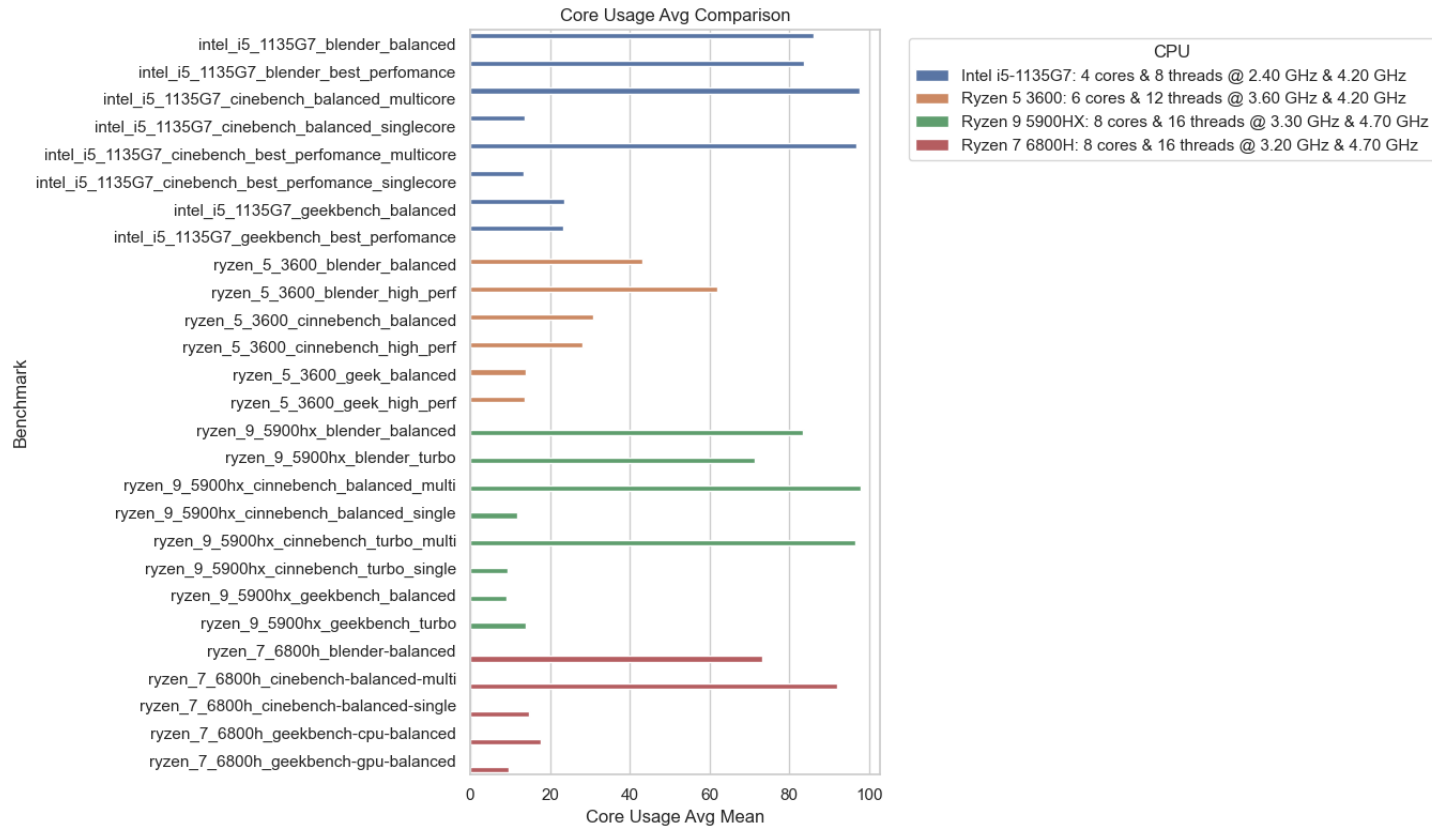
- **Observation:** Higher clock speeds generate more heat.
- **Connection:** This is **Thermal Design Power (TDP)** in action. Performance is limited by heat

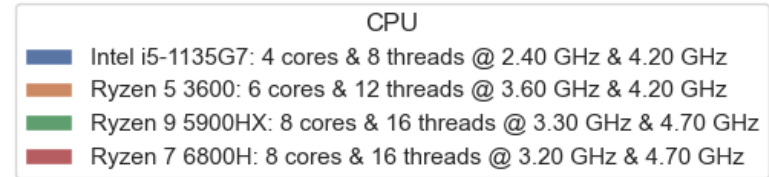
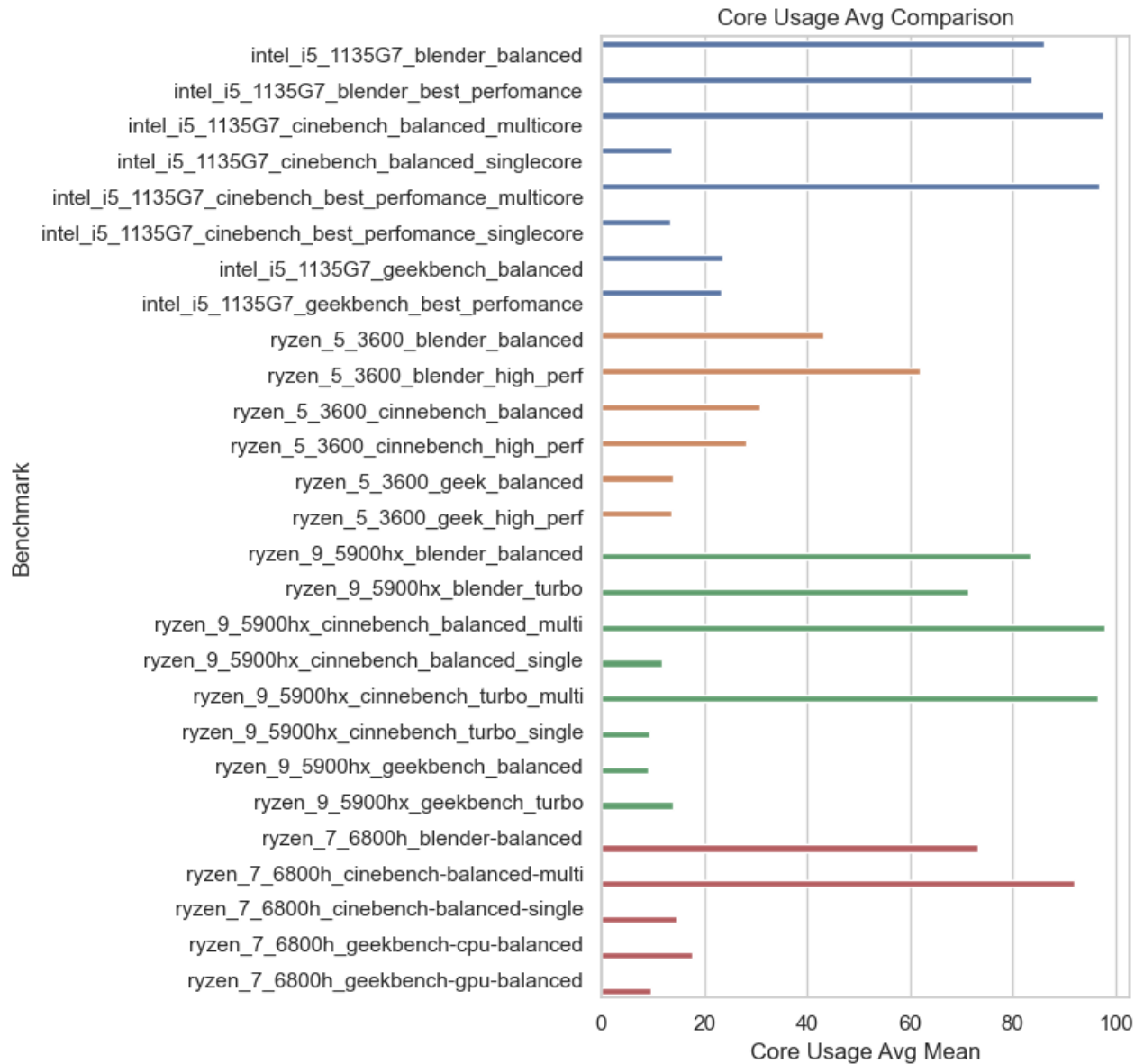




# DEEP DIVE 4: PUTTING CORES TO WORK - USAGE & EFFICIENCY

- **Observation:** A perfect visual of a **MIMD** system at work.
- **Limitation:** Never 100% usage, hinting at **Amdahl's Law**.





# User Stories

## | CS Student

- As a student developing software and running builds frequently, I want to understand whether clock speed or core count affects compile time more, so that I can choose a laptop that compiles faster and saves me time during project deadlines.
- Decision:
- Chooses CPU with high single-core clock, high usage in Cinebench
- AMD Ryzen 9 5900HX

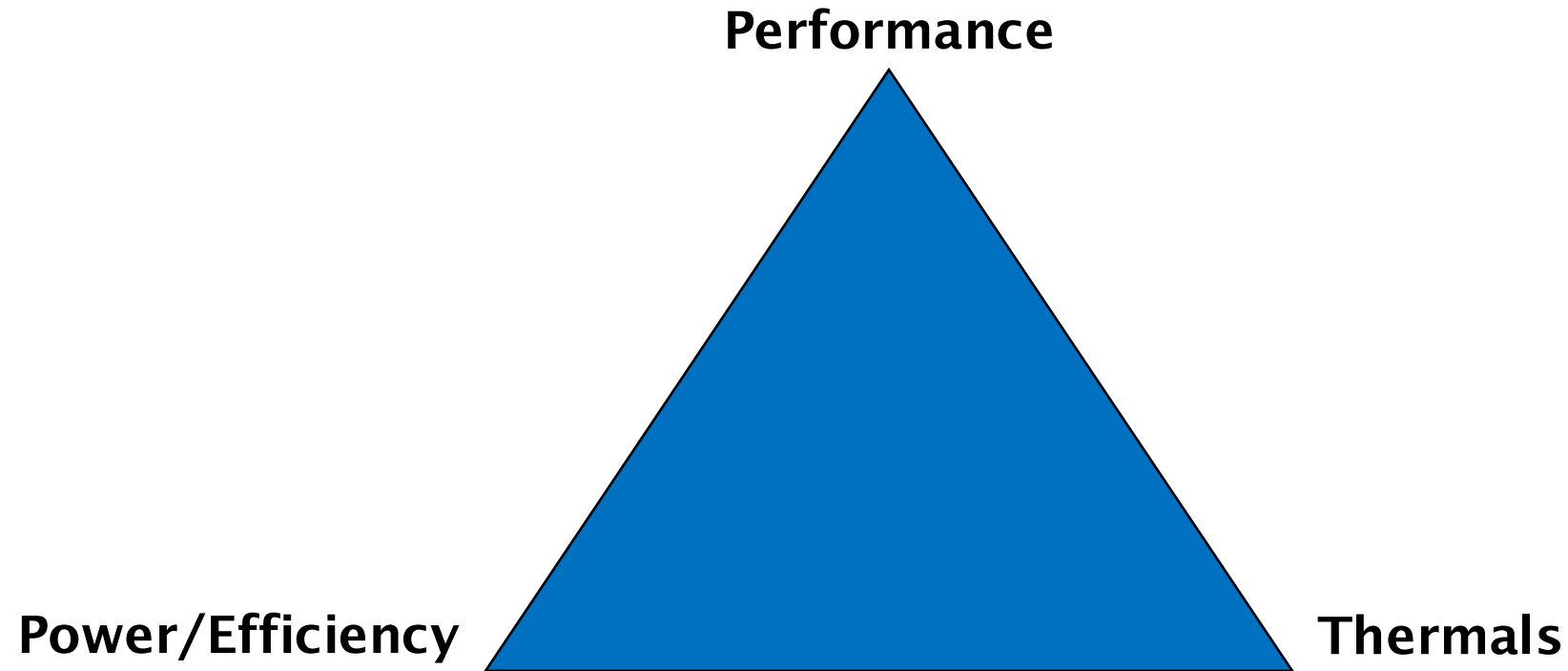
## | Video Editor

- As an editor who edits videos for social media or company projects, I want to test how CPU features like SMT or frequency scaling affect performance, so that I can render high-quality videos faster without overheating or delays.
- Decision:
- High usage and clock speed in Blender runs
- AMD Ryzen 9 5900HX or the Ryzen 7 680h if you are on a budget

## | Gamer

- As a tech-savvy gamer or multitasker, I want to know if disabling cores or changing CPU frequency affects real-world app performance, so that I can tweak settings for better battery life, thermals, or speed in daily use.
- Decision:
- Performance (clock speed or app benchmarks) doesn't drop significantly with fewer cores or lower frequency
- AMD Ryzen 5 3600

# | DISCUSSION: THE CPU TRADE-OFF TRIANGLE



- You can't change one without affecting the others.
- There is no single "best" CPU.

# | DISCUSSION: TYING IT ALL BACK TO THEORY

- **Amdahl's Law in Action:**
  - More cores help, but with diminishing returns due to sequential tasks.
- **TDP & Dynamic Frequency Scaling:**
  - Our logs show CPUs boosting until they hit their thermal limit (TDP), then throttling.

# | CONCLUSION

- **Conclusion:**
  - Proved the real-world impact of core count in MIMD systems.
  - Demonstrated the critical trade-off between performance, power, and heat.
  - Found that software (like the OS Power Plan) doesn't play a huge role as we expected

Thank You!

Questions?