EECS 151/251A Discussion 1

January 19, 2024

Problem 1: Moore's Law Implications

Let's imagine an alternate history for a moment. Back in 1908, the Ford Motor Company introduced the Model T to the world as the first affordable automotive. This pioneering vehicle sported a 4-cylinder engine outputting 20 horsepower and came in any color you wanted as long as it was black! While working on developing the next generation of automobiles in 1910, one of the engineers at the company noticed that if they shrank the pistons in the engines of the cars, they could get the same performance out of the engine while using a leaner fuel-air mixture. This would mean each engine block could now fit even more pistons, and therefore output more power. Upon hearing of this, Henry Ford made the prediction that every 2 years the number of pistons in automobile engines would double, a notion that became known as "Ford's Law". Following this trend, how many pistons would today's gas-powered cars have if this were a real phenomenon in the automotive industry? Is this a realistic number of pistons to have in an engine? Barring the issues with sizing the piston (assume this world could make infinitesimally small pistons), what are some additional issues with having this many pistons in one engine?

Problem 2: Dennard Scaling

Imagine that we still live in the world of ideal Dennard scaling. You designed a brilliant laptop microprocessor that runs at 5GHz, but dissipates 40W. What would be its power and performance in the next technology node, with features that are scaled by a factor of 0.75?

Problem 3: Pareto Optimal Frontier

(a) **Tradeoffs for Automobiles** Look up a few car models (gas-operated!) and note their cost, speed (Horsepower), and fuel efficiency (MPG). Plot these as points on a cost vs. speed and speed vs. efficiency plot. Try to find a few extremes and balanced points.

(b) **Pareto-Optimality** John did a design space exploration for his design of a digital widget and came up with the following table of results for maximum frequency in GHz, energy efficiency in nanoJoules per operation, and cost as chip area in mm^2. Circle those rows that represent design points that lie on the Pareto optimal frontier.

f_{max}	Energy	Cost
2.0	20	1.5
1.5	10	1.5
1.5	20	1.5
1.5	20	1.0
1.0	10	1.5
1.0	20	1.0
1.0	10	1.5
1.0	20	1.0