

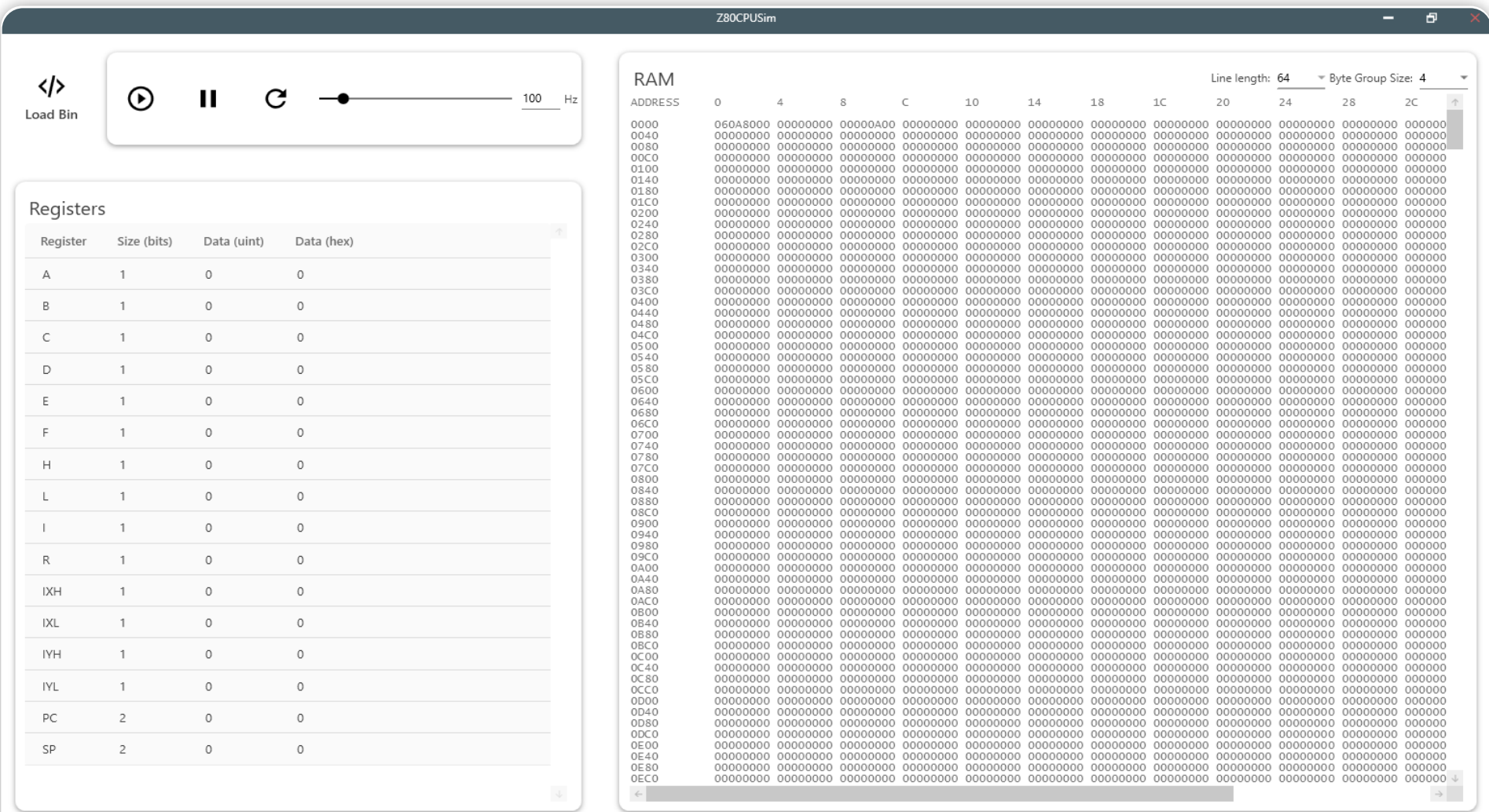
Developing a CPU Simulator For Education

Aim: Simulate the Zilog Z80 CPU in software

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Why?

Many tools already exist to demonstrate the fundamental concepts of a CPU, such as JASP, however, none of them use real architectures, and so never fully demonstrate the capabilities and operations of modern CPUs in the real world. This can limit a student's understanding when faced with real-world architectures. This simulator removes that restriction by using a real architecture, and simulating it exactly as it runs on actual hardware. This also allows the more complex internal CPU of a real architecture to be demonstrated.



The Simulator

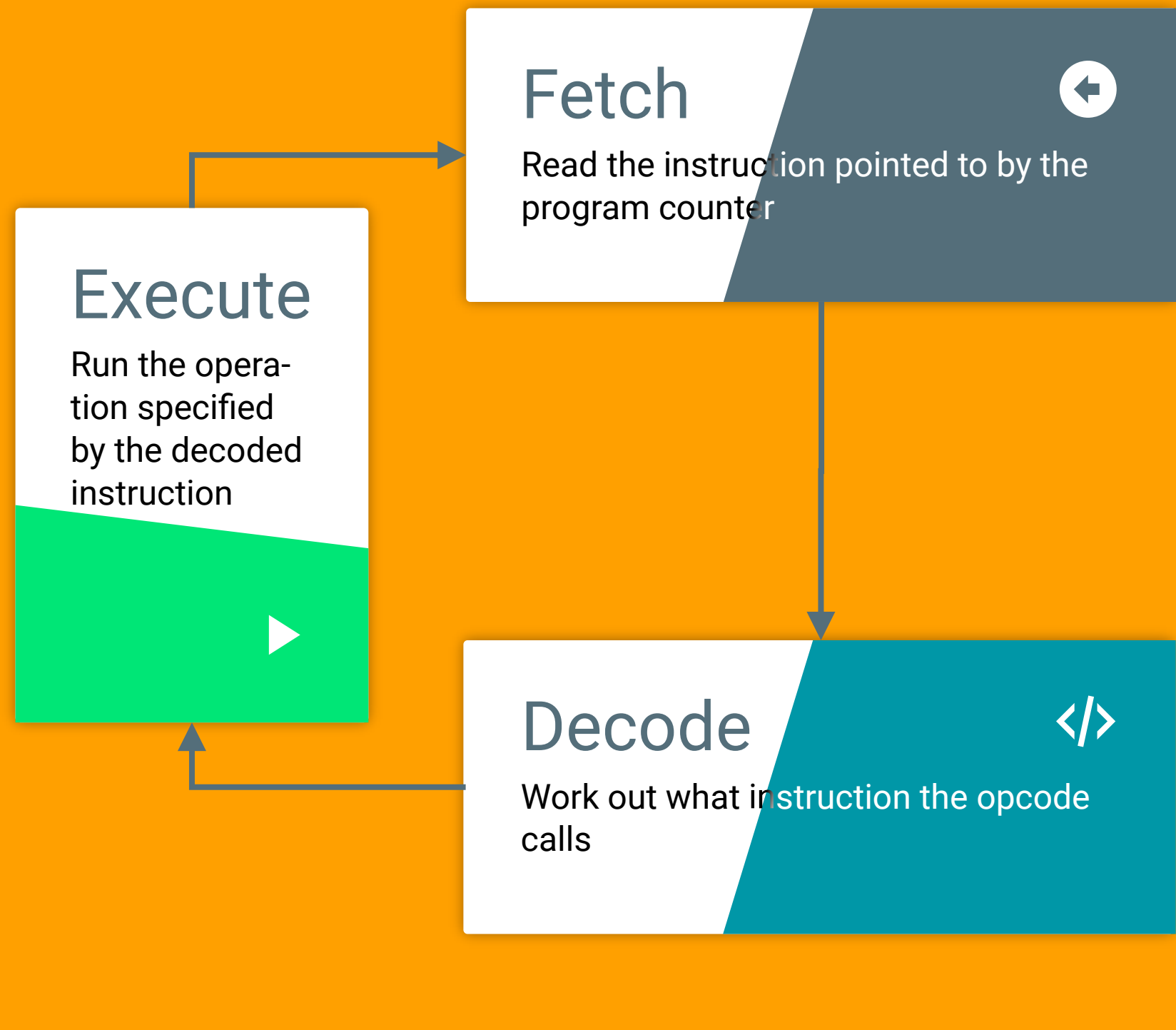
3 core areas are used to demonstrate the concepts of a CPU, the first, is the control unit and clock, in the top left corner, the second is the registers, and finally, the RAM. They are presented to the user in a way that shows the exact internal state of all the components of the CPU that would be exposed to a programmer, allowing for state changes as a program runs to be observed and linked to the line of code running at any given time.

Concepts

CONTROL UNIT AND CLOCK

A fundamental part of any CPU is its ability to execute instructions, this is handled by the control unit. The control unit can be considered as the part of the CPU that tells the rest of it what to do. Another important aspect is the clock, this ensures that components are synchronised, and that the CPU can actually execute instructions, the clock triggers the control unit, which in turn triggers the FDE cycle.

These concepts are demonstrated by the simulator by allowing the user to start, and stop, and change the execution speed of a running program. Allowing them to inspect the state of registers and RAM at any given time during the FDE cycle. The ability to intricately inspect the state of the CPU allows a user to understand how the control unit calls the operations in other components, and the ability to inspect the registers and RAM, shows them the impact of the operations.



RAM AND REGISTERS

Another important concept to understand about a CPU is how RAM and registers are used to store data for a running program. RAM stores the bits of the program in use at the current time, and registers are used to temporarily store data being used by the CPU in the operations it is currently performing.

The simulator shows the user the roles of these components, by displaying all the data in the RAM, and all the registers, allowing them to learn exactly how the data is moved around the CPU, and to what addresses and registers based on the instruction it is executing. Not only that, but to show the user what instruction the CPU is executing, a pointer identifies the memory address currently being read.

