# CMSC 11: Introduction to Computer Science

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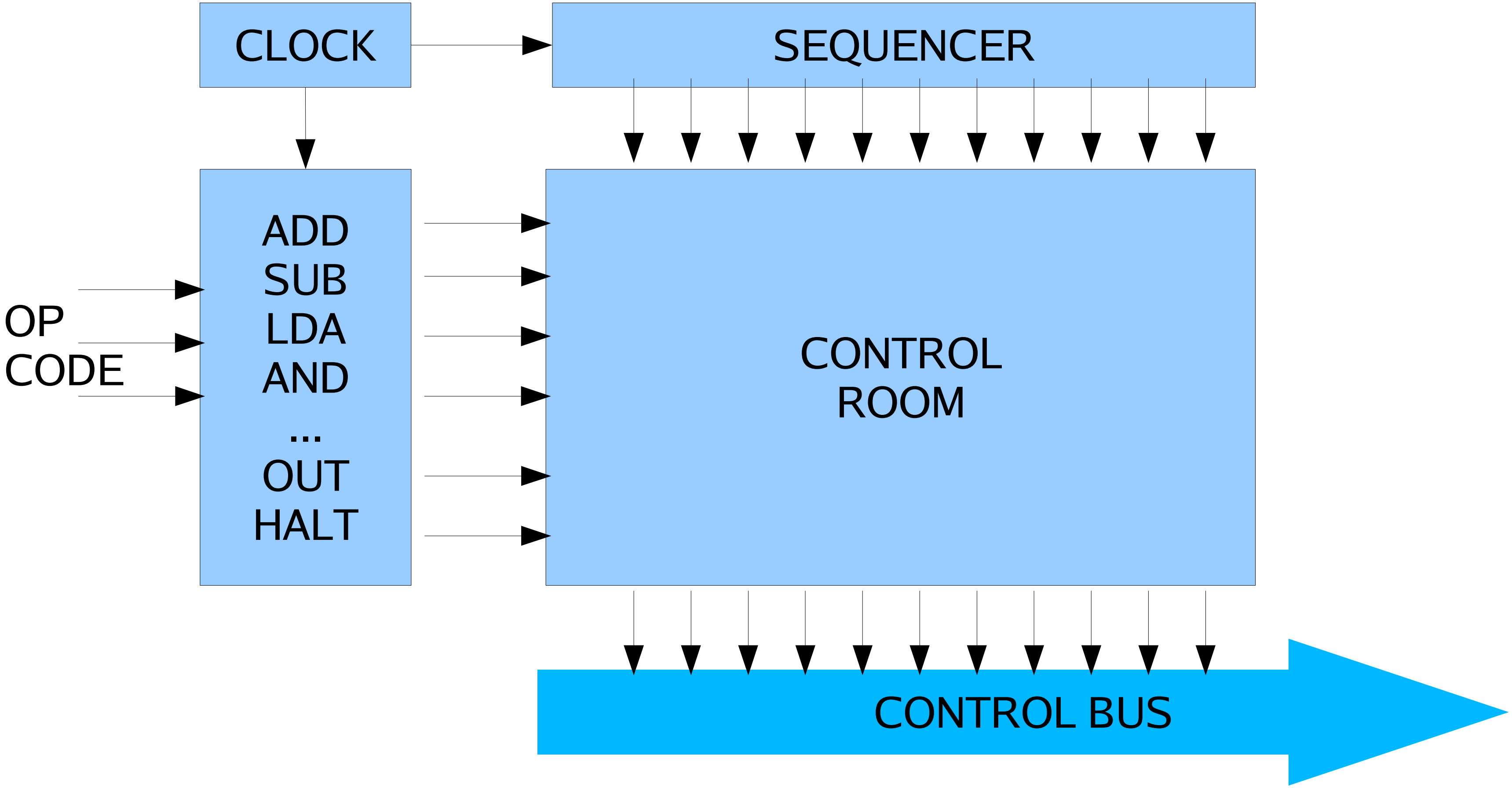
# Review

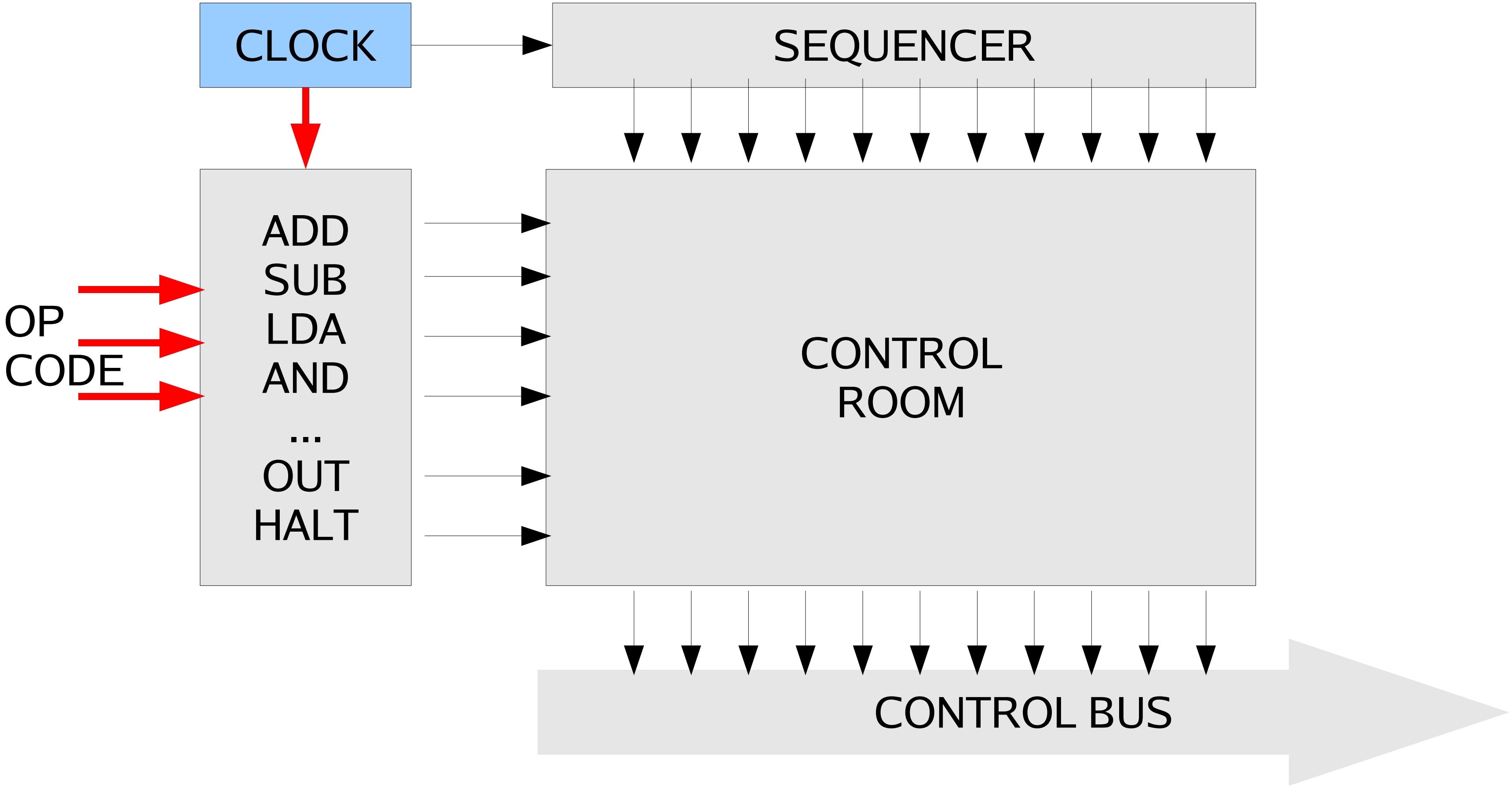
- Controlling a program
- Machine language op-code
- Running a program via machine's microinstructions

# More control

- Without too many details (as in last lecture), you can think of control roughly like this:

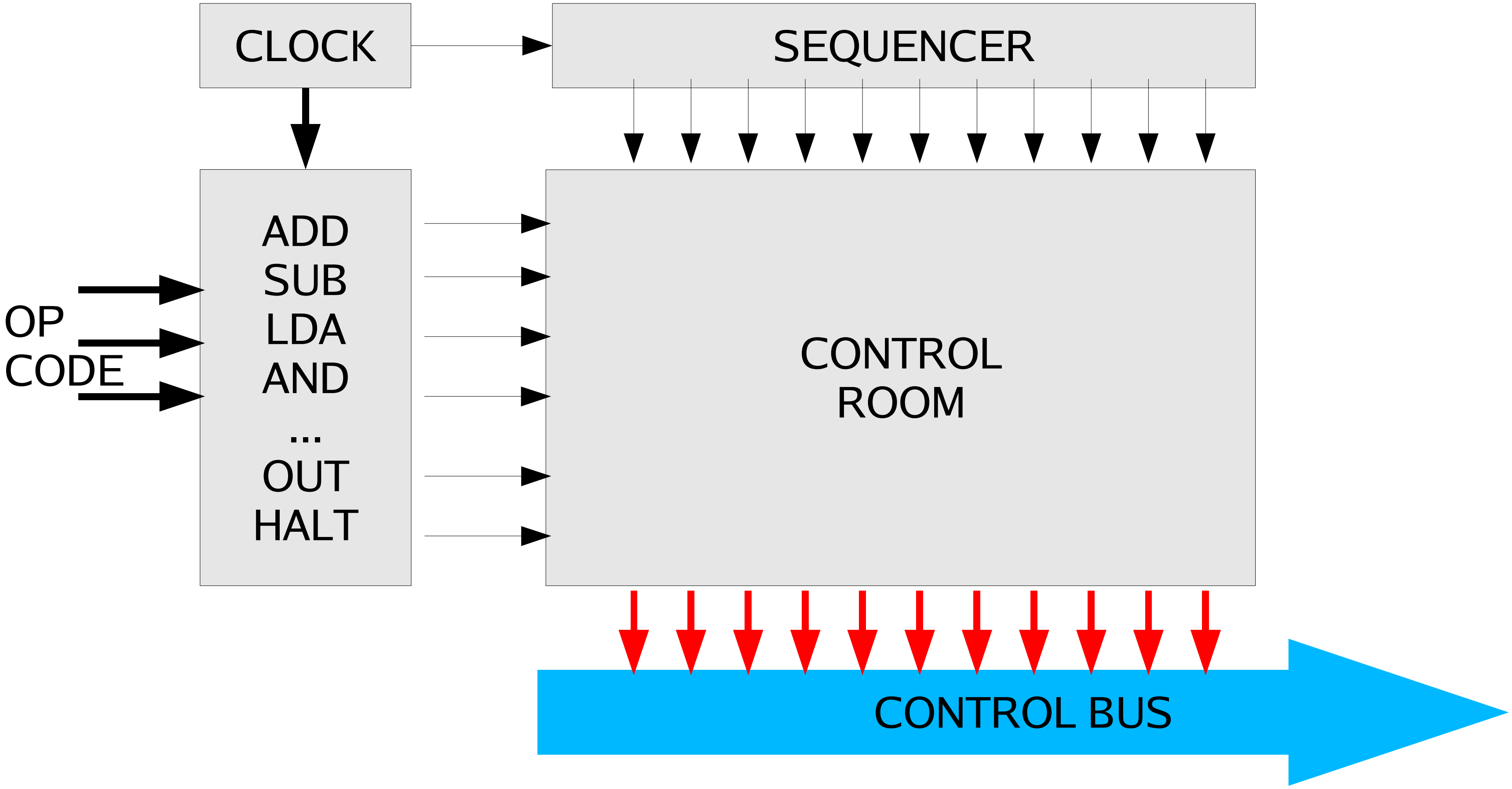


# More control



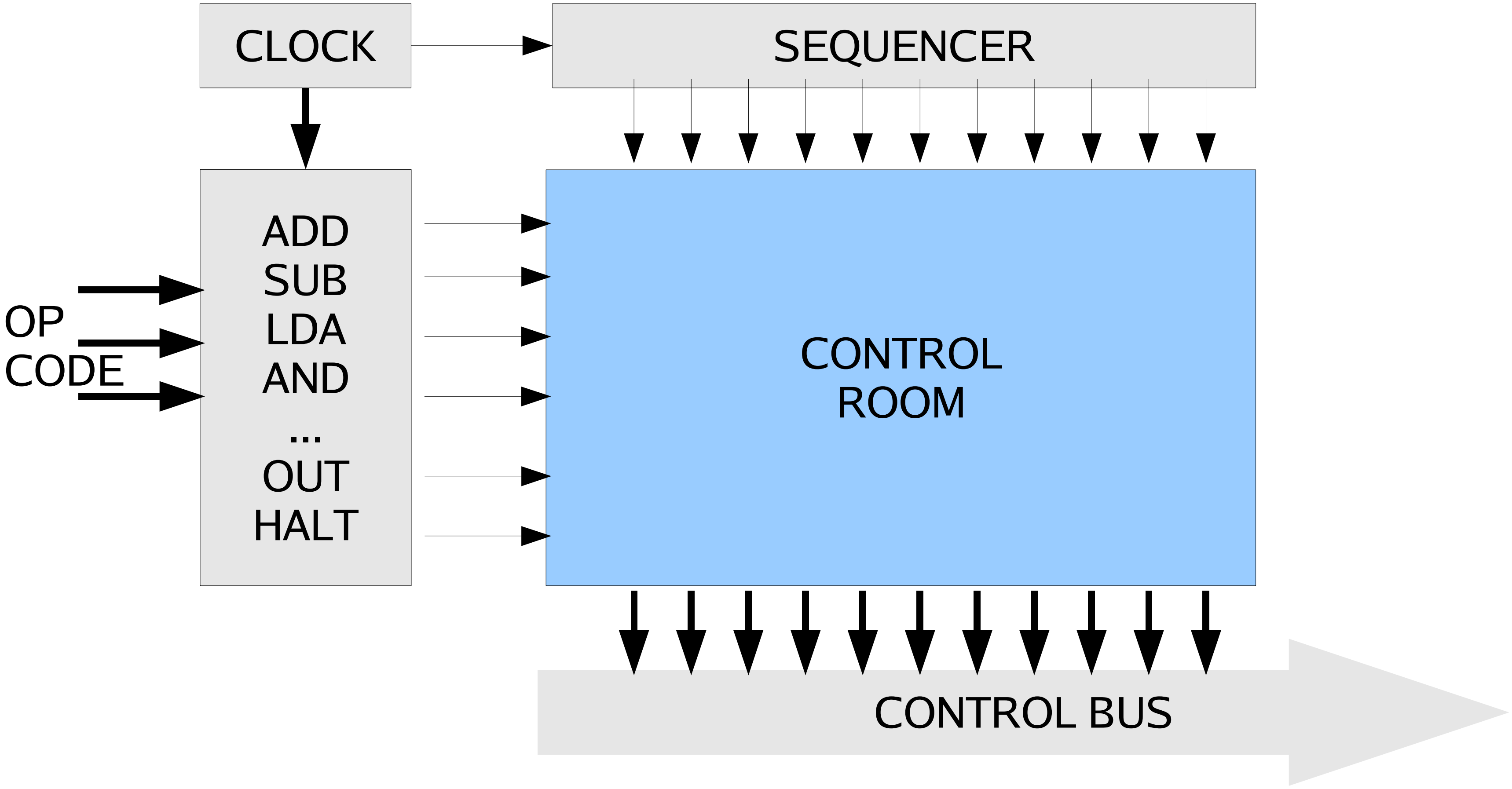
- Its input consists of clock pulses and op-codes

# More control



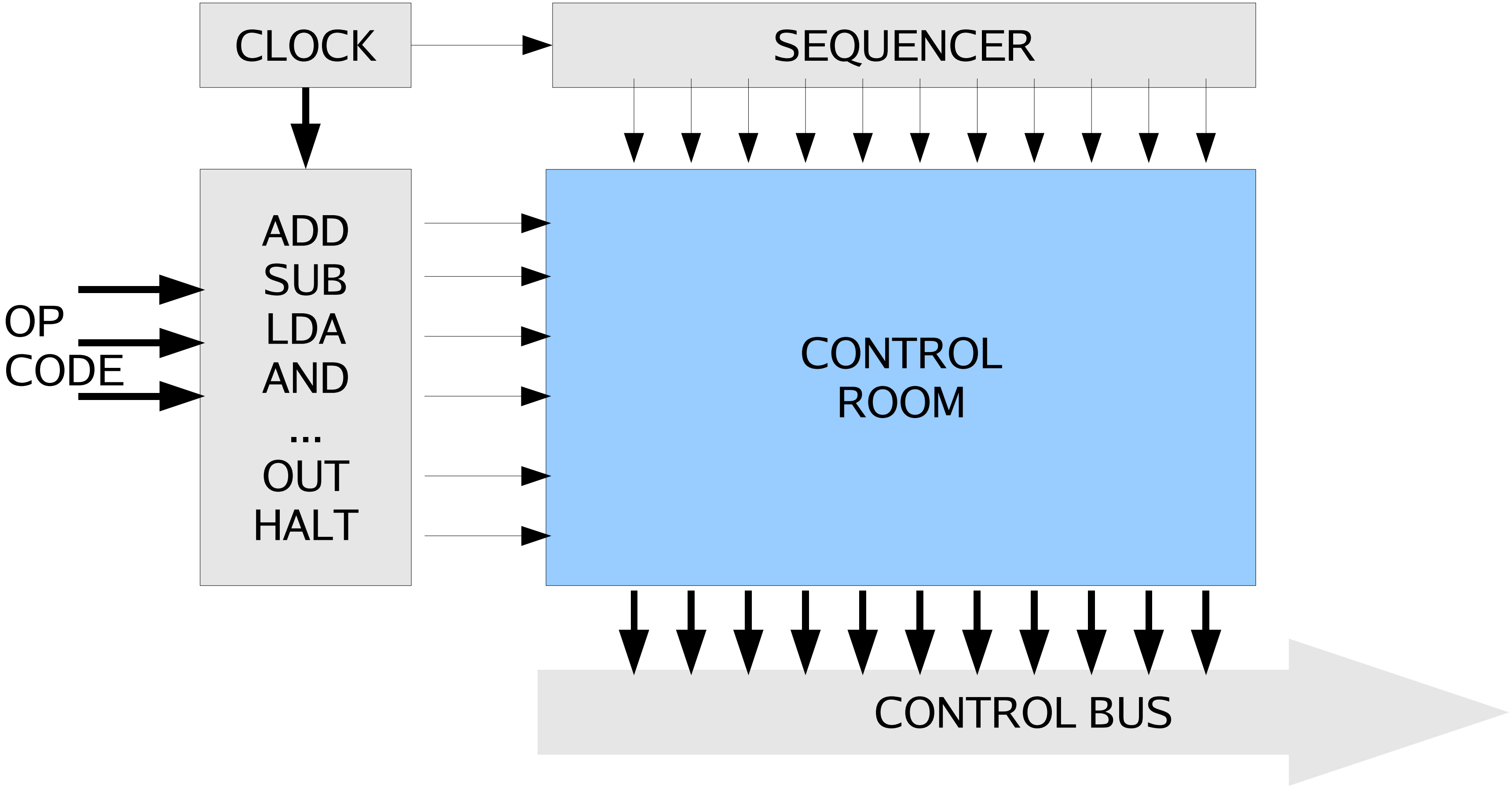
- Its output consists of a sequence of signals to the registers, counters, ALU, and memory

# More control



- The microprogram connects the inputs to the proper output combinations.

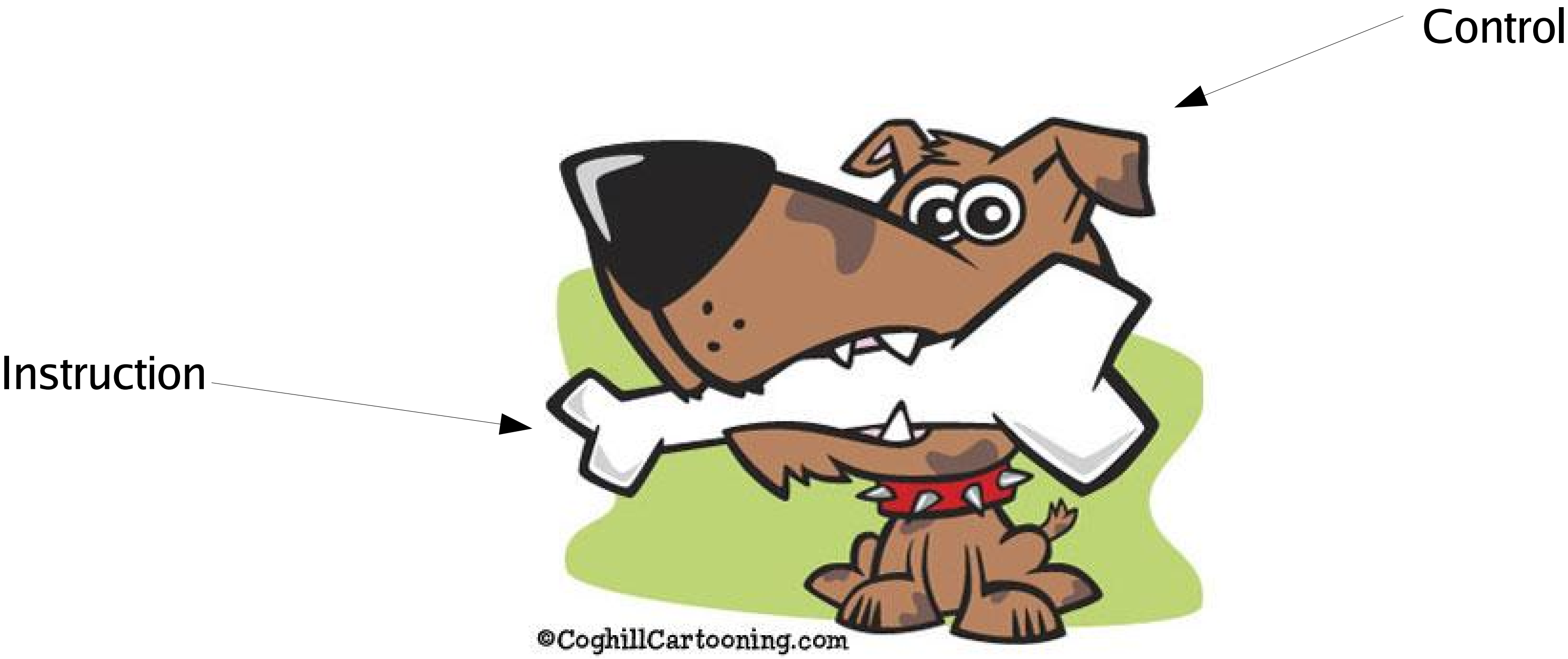
# More control



- The microprogram is stored in a ROM dedicated strictly to this purpose.

# More control

- The first couple of clock pulses cause control to fetch an instruction



# More control

- The remaining pulses cause control to execute the instruction.

Instruction?

Control

# Real-life instruction set

- In real life, the situation is more complicated in detail but the same in principle.
  - There are more registers
  - Op-codes are longer than three bits
- These allow control to respond to a much larger set of instructions
- Next slide shows the instruction set of a genuine processor: the Motorola 6800.

# Motorola 6800

MOTOROLA
M6800 Microprocessor Applications Manual
M6800
M6800 Microprocessor Applications Manual

# Motorola 6800 instruction set

- Arithmetic
  - Add
  - Add with carry
  - Subtract
  - Subtract with carry
  - Increment
  - Decrement
  - Compare
  - Negate

- Logical
  - And
  - Or
  - Exclusive Or
  - Not
  - Shift Right
  - Shift Left
  - Shift Right Arithmetic
  - Rotate left/right

# Motorola 6800 instruction set

- Data Transfer
  - Load
  - Store
  - Move
  - Clear
  - Clear carry
  - Clear overflow
  - Set carry
  - Set overflow

- And a lot, lot more:
  - Branch has 19 instructions
  - Subroutine call has 1 instruction
  - Subroutine return has 2 instructions
  - 8 other miscellaneous instructions

# Branch or Jump

- One group of these intructions deserves special mention: the branch or jump instructions.

**JMP 123**

- “JMP 123” causes control to enter 123 in the program counter… and proceed with the program from there.

# Branch or Jump

- Even “smarter” are conditional jumps
- They transfer control IF some condition is satisfied

**JZ 123**

Otherwise,
don't jump!

- For instance: “Jump if zero” means jump if the accumulator holds 0.

# Tyranny by control?

- SO you see, control is no tyrant at all
- It only does what it's told

# Tyranny by control?

- If you really want to imagine the control sections personality, think of a perfectly efficient BUREAUCRAT, acting in a strict obedience to the computer's real boss: THE PROGRAM

# Next week

- Software