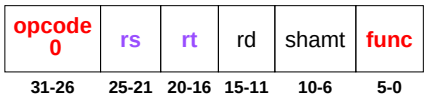
Control Unit

CPU hardware that controls instruction execution

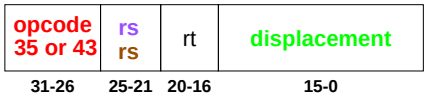
- sends signals to the datapath to operate it
- specifies what operations to perform, what data to move, when to move it, where to move it

Control Signals

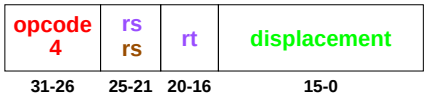
Many **control signals** driven by the instruction



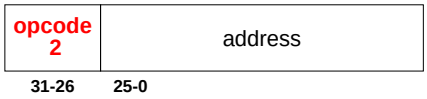
R-type



load/store



branch



jump

Regularity of the MIPS formats

- **opcode** always in bits 31-26 (Op[5-0])
- **source registers** are always rs & rt
- **base register** always rs
- **branch offset** always bits 15-0

Our R2000 Control Signals

Register file

- register write signal: **RegWrite**
  asserted for R-type instructions & load
- register destination field: **RegDst**
  rt or rd
- results value: **MemToReg**
  loaded value or R-type instruction result
- all generated by the opcode

ALU

- type of the second operand: **ALUSrc**
  register or immediate
  - generated by the opcode
- ALU operation: **ALUOp**
  add, subtract, and, or, set-on-less-than
  - generated by a small control unit
    - inputs: opcode & func field
    - output: ALU operation
    - examples:
      lw/sw ⇒ add
      beq ⇒ subtract
      R-type instruction ⇒ func value

Our R2000 Control Signals

Memory

- read signal: **MemRead**
- write signal: **MemWrite**
  - both generated by the opcode

Branch control

- new PC value: **PCSrc**
  incremented PC or target address
  - generated by the opcode AND'd with Zero

Jump control

- new PC value: **Jump**
  incremented PC or target address, or jump address
  - generated by the opcode

Changing the Implementation

How should you approach a problem in which you had to redesign the implementation to include another instruction?

- What does the instruction do?
- What parts of the datapath does it need?
  - Can it use what is there already?
  - What new logic or registers does it need?
- How is the datapath activated?
  - What control lines does it need
  - Where should the control lines come from?
  - Do we need a new control line?
  - Does an existing control line need to be enlarged?