RISC-16 ISA

Designed by Josh, some modifications by William

Class	Format	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
IMM		1	op	imm[7:4]			rs			rd			imm[4:0] (signed)				
addi	addi rd, rs, imm		0	rd ← rs + imm													
nandi	nandi rd, rs, imm		1	rd ← rs nand imm													
ALU		0	1	opcode			rs			rd			ro			?	?
swb	swb rd, rs			0	0	0	rd ← byteswap(rs)										
nand	nand rd, rs, ro			0	0	1	rd ← rs nand ro										
sl	sl rd, rs			0	1	0	rd ← rs << 1										
sr	sr rd, rs			0	1	1	rd ← rs >> 1										
add	add rd, rs, ro			1	0	0	rd ← rs + ro										
JUMP		0	0	0	0	0	rs			rd			?	?	?	?	?
jalr	jalr rd, rs	rd ← pc + 2; pc = rs															
BR		0	0	1	opcode		rs			imm (signed)							
bn	bn rs, label				0	1	pc += imm if rs < 0										
bz	bz rs, label				1	0	pc += imm if rs == 0										
bp	bp rs, label				1	1	pc += imm if rs > 0										
MEM		0	0	0	1	op	rs			rd			imm (signed)				
lw	lw rd, offset(rs)					0	rd ← mem[rs+imm]										
sw	sw rd, offset(rs)					1	mem[rs+imm] ← rd										

Notes

- jal exists independent of jalr and bz because it links (unlike bz)
  - and has an 8-bit immediate (unlike jalr)
- To jump to arbitrary places, put offset in rs and call jalr
- Immediate values for br-type and mem-type have last bit chopped off because they're always even

CPU design

- Four 16-bit registers: zero, stack pointer, a0, a1
- Memory:
  - two 256kbit, byte-addressed RAMs (in parallel)
  - two 64kbit, byte-addressed ROMs (in parallel)
- Two 16-bit output registers
  - Can be used to multiplex LED dot matrix

Questions

- Can it be single-cycle or do I need two cycles to fetch instruction → execute
- Memory considerations
  - With 2x 64kbit ROMs, gives 8k instructions
  - Is that enough to make Tetris with this stripped-down architecture
  - How to bootload
- Faster shifting?
- jal instruction immediates are 8 bits so you can only jump +/- 128 instructions. Is that enough?
- Where does the stack usually start
- How fast will this run if use discrete transistors
- Resources for learning to write compilers

Compiler

- Subset of C