

# Lecture 13: Control Hazards

Wednesday, February 6, 2019 9:13 AM

## Outline

- Finish data hazards and scheduling
- Control hazards
- Other hazards

Push back lab 3  
due date

## Data hazard examples

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
add a1, a2, a3	F	D	E	M	W										
sub t1, t0, a1		F	D	E	M	W									
lw a1, 24(t1)			F	D	E	M	W								
add s0, a1, zero				F	D	E	M	W							
or a3, a2, t0					F	D	E	M	W						
addi a3, a3, 12						F	D	E	M	W					
auipc t2, 4096							F	D	E	M	W				
sw t2, 12(s0)								F	D	E	M	W			

data dependencies

bubble required for load to use hazard

no other hazards though we do have dependencies

gic - march-native = 200

hazards

could also move or

static scheduling

## Control hazards/dependencies

	1	2	3	4	5	6	7	8	9	10	11	12
add a1, a2, a3	F	D	E	M	W							
sub t0, t1, t2		F	D	E	M	W						
blt a1, t0, #12			F	D	E	M	W					
lw a2, 0(a1)				F	D	E	M	W				
j 8					F	D	E	M	W			
lw a2, 0(t0)						F	D	E	M	W		

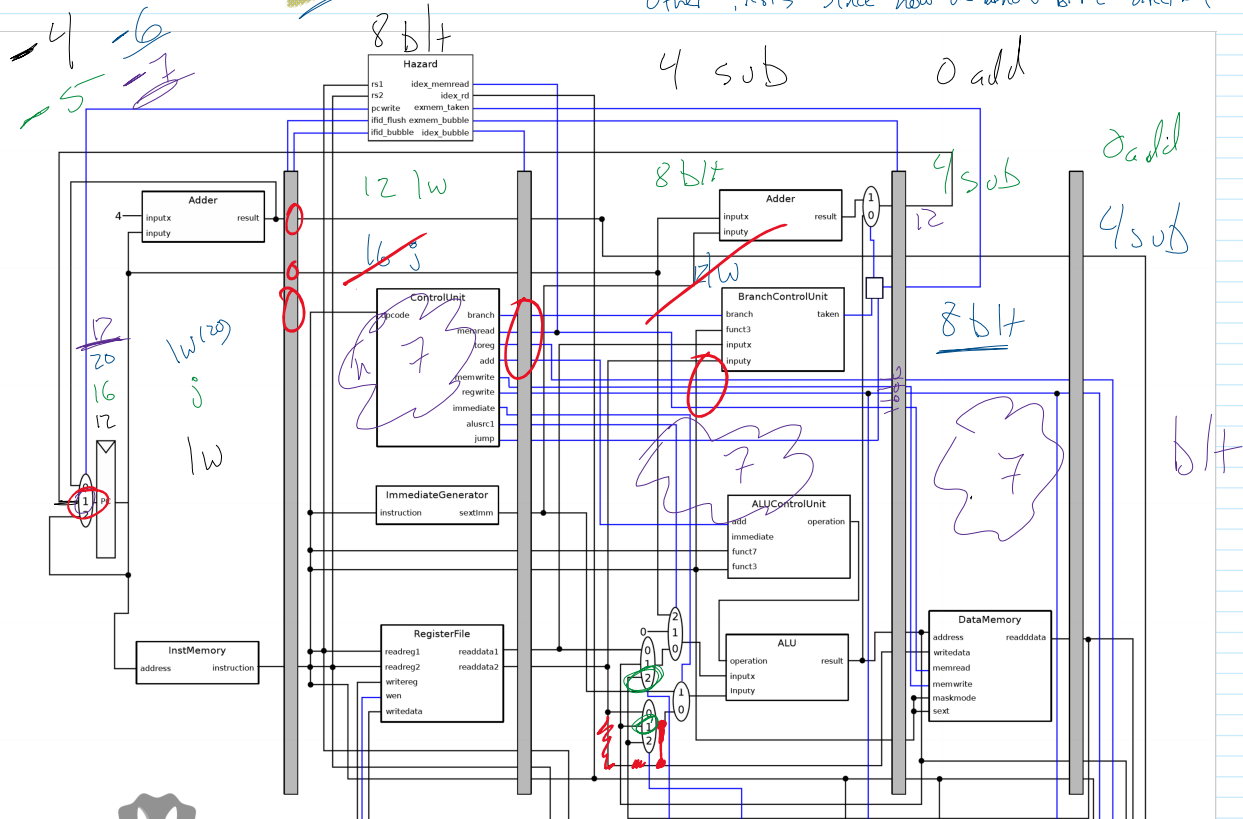
flush

these insts

shush

cycle 6 med to "rewind" or "unroll"

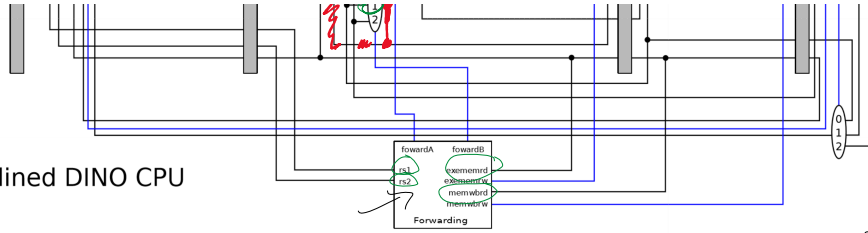
other insts since now we know branch direction



same logic



Pipelined DINO CPU



Save logic  
as P types

## Improving performance of control hazards

avoid  
 $R[rd] = PC + 4$

how to know the  
next store data?  
 $M[R[rs1]] = R[rs2]$

if  $rs2$  in EX  
== rd in mem

## Other hazards

## Summary of hazards

Three types of hazards and how to improve performance of each