Data Dependencies

- Consider the code:
  
<table>
<thead>
<tr>
<th>Operation</th>
<th>Register 1</th>
<th>Register 2</th>
<th>Register 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQRT</td>
<td>r5</td>
<td>r5</td>
<td></td>
</tr>
<tr>
<td>MUL</td>
<td>r6</td>
<td>r5</td>
<td>r17</td>
</tr>
<tr>
<td>ORI</td>
<td>r2</td>
<td>r0</td>
<td>-1</td>
</tr>
<tr>
<td>ADD</td>
<td>r3</td>
<td>r2</td>
<td>r6</td>
</tr>
<tr>
<td>bneid</td>
<td>r3</td>
<td>label</td>
<td></td>
</tr>
</tbody>
</table>

- Suppose SQRT takes 10 cycles
  - How many data dependence stalls?
Data Dependencies

Can we do better?

SQRT \( r_5 - r_5 \)

MUL \( r_6 - r_5 - r_{17} \)

ORI \( r_2 - r_0 - 1 \)

ADD \( r_3 - r_2 - r_6 \)

bneid \( r_3 - \text{label} \)

Stall 9 cycles

\( = \text{write} \)

\( = \text{read} \)
Data Dependencies

☐ Any dependencies violated?

SQRT r5 r5
ORI r2 r0 -1
MUL r6 r5 r17
ADD r3 r2 r6
bneid r3 label

9 cycles, 8 stalls
(1 usefull)
Data Dependencies

- Most instructions follow the form:
  - `OP dst, src1, src2`
  - But not all!

- `https://code.google.com/p/simtrax/wiki/ISA`
Example

FPINVSQRT r11, r11
ORI r12, r0, 1065353216
FPDIV r11, r12, r11
FPNEG r12, r4
FPRSUB r27, r11, r12
ORI r12, r0, 869711765
FPLE r22, r27, r12
Rewritten

FPINVSQRT r11, r11
ORI    r12, r0, 1065353216
FPDIV  r11, r12, r11
FPNEG  r27, r4
ORI    r12, r0, 869711765
FPRSUB r27, r11, r27
FPLE   r22, r27, r12

- Note that FPNEG writes its result to r27 now, so ORI can fit between FPDIV and FPRSUB.
Guidelines

- In the original code, r27 is written, but not read.

- It is therefore safe to overwrite r27 prior to the original write, as long as we maintain its correct final write.