Milestone Overview

You will develop the Control Unit for the MIPSlite microprocessor.

This project milestone is worth 40 points. For full credit, your solution must be completed no later than Thursday, February 23. A 10% penalty will be applied for each day that your solution is late (based on the date when your files are submitted via the "handin" system).

Milestone Deliverables

The deliverables for this milestone are:

- ControlUnit.tables
- ControlUnit.c

Be sure to use the specified file names, and to submit your files for grading via the "handin" system.

Milestone Specifications

The MIPSlite microprocessor recognizes 31 machine language instructions:

- R-format shift instructions: {SLL, SLLV, SRL, SRLV, SRA, SRAV}
- R-format data manipulation: {ADD, SUB, AND, OR, XOR, NOR, SLT}
- I-format data manipulation: {ADDI, SLTI, ANDI, ORI, XORI, LUI}
- I-format data movement: {LW, SW}
- Control-transfer instructions: {JR, JALR, J, JAL, BEQ, BNE, BLTZ, BLEZ, BGTZ, BGEZ}

The Control Unit uses the bit pattern of a machine language instruction to generate control signals used by the other components of the microprocessor.

For this milestone, you will:

1. Specify the value of each control signal to be generated by the Control Unit.
2. Extend the instructor-supplied Control Unit to implement the control signals.

Create a new project subdirectory under your account and copy the following files:

```
/user/cse420/Project/Milestone04/ControlUnit*
```

Edit your copy of "ControlUnit.tables" and complete the table entries to specify the value of each control signal.

Edit your copy of "ControlUnit.c" (an incomplete version of the Control Unit) to implement the missing functionality.

To validate your Control Unit, remove "ControlUnit.o" and re-execute "ControlUnit.test.make". Examine the resulting output to verify that your Control Unit correctly generates the control signals.
MIPS-lite Instruction Set

The machine language instructions recognized by the MIPS-lite processor are given in the following table.

<table>
<thead>
<tr>
<th>R-format instructions</th>
<th>name</th>
<th>31:26</th>
<th>25:21</th>
<th>20:16</th>
<th>15:11</th>
<th>10:6</th>
<th>5:0</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLL</td>
<td>000000</td>
<td>00000</td>
<td>rt</td>
<td>rd</td>
<td>imm-5</td>
<td>000000</td>
<td></td>
</tr>
<tr>
<td>SRL</td>
<td>000000</td>
<td>00000</td>
<td>rt</td>
<td>rd</td>
<td>imm-5</td>
<td>000010</td>
<td></td>
</tr>
<tr>
<td>SRA</td>
<td>000000</td>
<td>00000</td>
<td>rt</td>
<td>rd</td>
<td>imm-5</td>
<td>000011</td>
<td></td>
</tr>
<tr>
<td>SLLV</td>
<td>000000</td>
<td>rs</td>
<td>rt</td>
<td>rd</td>
<td>00000</td>
<td>000100</td>
<td></td>
</tr>
<tr>
<td>SRLV</td>
<td>000000</td>
<td>rs</td>
<td>rt</td>
<td>rd</td>
<td>00000</td>
<td>000110</td>
<td></td>
</tr>
<tr>
<td>SRAV</td>
<td>000000</td>
<td>rs</td>
<td>rt</td>
<td>rd</td>
<td>00000</td>
<td>000111</td>
<td></td>
</tr>
<tr>
<td>JR</td>
<td>000000</td>
<td>rs</td>
<td>00000</td>
<td>00000</td>
<td>00000</td>
<td>001000</td>
<td></td>
</tr>
<tr>
<td>JALR</td>
<td>000000</td>
<td>rs</td>
<td>00000</td>
<td>rd</td>
<td>00000</td>
<td>001001</td>
<td></td>
</tr>
<tr>
<td>ADD</td>
<td>000000</td>
<td>rs</td>
<td>rt</td>
<td>rd</td>
<td>00000</td>
<td>100000</td>
<td></td>
</tr>
<tr>
<td>SUB</td>
<td>000000</td>
<td>rs</td>
<td>rt</td>
<td>rd</td>
<td>00000</td>
<td>100010</td>
<td></td>
</tr>
<tr>
<td>AND</td>
<td>000000</td>
<td>rs</td>
<td>rt</td>
<td>rd</td>
<td>00000</td>
<td>100100</td>
<td></td>
</tr>
<tr>
<td>OR</td>
<td>000000</td>
<td>rs</td>
<td>rt</td>
<td>rd</td>
<td>00000</td>
<td>100101</td>
<td></td>
</tr>
<tr>
<td>XOR</td>
<td>000000</td>
<td>rs</td>
<td>rt</td>
<td>rd</td>
<td>00000</td>
<td>100110</td>
<td></td>
</tr>
<tr>
<td>NOR</td>
<td>000000</td>
<td>rs</td>
<td>rt</td>
<td>rd</td>
<td>00000</td>
<td>100111</td>
<td></td>
</tr>
<tr>
<td>SLT</td>
<td>000000</td>
<td>rs</td>
<td>rt</td>
<td>rd</td>
<td>00000</td>
<td>101010</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>I-format instructions</th>
<th>name</th>
<th>31:26</th>
<th>25:21</th>
<th>20:16</th>
<th>15:0</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADDI</td>
<td>001000</td>
<td>rs</td>
<td>rt</td>
<td>immediate-16</td>
<td></td>
</tr>
<tr>
<td>SLTI</td>
<td>001010</td>
<td>rs</td>
<td>rt</td>
<td>immediate-16</td>
<td></td>
</tr>
<tr>
<td>ANDI</td>
<td>001100</td>
<td>rs</td>
<td>rt</td>
<td>immediate-16</td>
<td></td>
</tr>
<tr>
<td>ORI</td>
<td>001101</td>
<td>rs</td>
<td>rt</td>
<td>immediate-16</td>
<td></td>
</tr>
<tr>
<td>XORI</td>
<td>001110</td>
<td>rs</td>
<td>rt</td>
<td>immediate-16</td>
<td></td>
</tr>
<tr>
<td>LUI</td>
<td>001111</td>
<td>rs</td>
<td>00000</td>
<td>immediate-16</td>
<td></td>
</tr>
<tr>
<td>LW</td>
<td>100011</td>
<td>rs</td>
<td>rt</td>
<td>immediate-16</td>
<td></td>
</tr>
<tr>
<td>SW</td>
<td>101011</td>
<td>rs</td>
<td>rt</td>
<td>immediate-16</td>
<td></td>
</tr>
<tr>
<td>BLTZ</td>
<td>000001</td>
<td>rs</td>
<td>00000</td>
<td>immediate-16</td>
<td></td>
</tr>
<tr>
<td>BGEZ</td>
<td>000001</td>
<td>rs</td>
<td>00001</td>
<td>immediate-16</td>
<td></td>
</tr>
<tr>
<td>BEQ</td>
<td>000100</td>
<td>rs</td>
<td>rt</td>
<td>immediate-16</td>
<td></td>
</tr>
<tr>
<td>BNE</td>
<td>000101</td>
<td>rs</td>
<td>rt</td>
<td>immediate-16</td>
<td></td>
</tr>
<tr>
<td>BLEZ</td>
<td>000110</td>
<td>rs</td>
<td>00000</td>
<td>immediate-16</td>
<td></td>
</tr>
<tr>
<td>BGTZ</td>
<td>000111</td>
<td>rs</td>
<td>00000</td>
<td>immediate-16</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>J-format instructions</th>
<th>name</th>
<th>31:26</th>
<th>25:0</th>
</tr>
</thead>
<tbody>
<tr>
<td>J</td>
<td>000010</td>
<td>immediate-26</td>
<td></td>
</tr>
<tr>
<td>JAL</td>
<td>000011</td>
<td>immediate-26</td>
<td></td>
</tr>
</tbody>
</table>