计算机组成原理实验报告

一、CPU 设计方案综述

（一）总体设计概述

本 CPU 为 Logisim 实现的单周期 MIPS-CPU，支持的指令集包含{lw、sw、lb、lbu、sb、lh、lhu、sh、add、addu、sub、subu、and、or、slt、nor、xor、sll、srl、sra、sllv、srlv、srav、sltu、beq、bne、bgtz、blez、bltz、bgez、addi、addiu、andi、ori、xori、lui、slti、sltiu、j、jr、jal、jalr}共 42 条，其中 add 和 sub 不支持溢出中断，但会输出溢出信号。为了实现这些功能，CPU 主要包含了 instruction_memory、data_memory、centrol_processing_unit、program_counter、register_file、control_unit、bit_entender、arithmetic_logical_unit、upper_six、lower_six、middle_five，这些模块分成三级，第一级模块为 instruction_memory、data_memory、centrol_processing_unit，centrol_processing_unit 中包含了第二级模块 program_counter、register_file、control_unit、bit_entender、arithmetic_logical_unit，control_unit 包含了第三级模块 upper_six、lower_six、middle_five。

（二）关键模块定义及内部逻辑实现

1. instruction_memory

模块定义：

序号	功能名称	数据方向	功能描述
1.	输入地址	输入	32 位，输入的地址
2.	输出指令	输出	32 位，输出的指令

注：

1.如果需要改变地址位宽可直接修改 splitter 来实现。

2.如果需要改变初始指令位置可以修改减法器的减数配合修改 PC 中初始化的值实现。

内部逻辑：

采用 Logisim 自带的 ROM 即可实现。

2. data_memory

模块定义：

序号	功能名称	数据方向	功能描述
1.	时钟信号	输入	1 位，上跳沿更新内存的值
2.	异步复位信号	输入	1 位，信号为 1 时将此模块复位
3.	写使能信号	输入	1 位，信号为 1 时数据对 DM 的写入有效
4.	LS 类型选择	输入	3 位，对 LS 按 W/H/B 等进行选择
5.	LS 内存地址	输入	32 位，写入下述数据的地址
6.	写入数据	输入	32 位，写入到上述地址的数据
7.	输出数据	输出	32 位，上述地址对应的数据

注：

1.LS 类型选择信号的高两位选择 load 和 write 针对 word(信号的高两位为 0)half(信号的高两位为 1)还是 byte(信号的高两位为 2)，LS 类型选择信号的最低位仅对 load 有效，当 load half 或 load byte 时用以选择零扩展(0)或符号扩展(1)。

2.如果需要改变地址位宽可直接修改 splitter 来实现。

3.写使能信号为 1 时，输出数据无意义，为高阻态，若两个选择信号中有非法(3)的情况，写入或输出的数据为 0x7fffffff。

内部逻辑：

采用 Logisim 自带的 RAM 实现，同时按照 word/half/byte 和零扩展/符号扩展进行处理，用数据选择器实现对 LS 类型选择的支持。

3. centrol_processing_unit

模块定义：

序号	功能名称	数据方向	功能描述
1.	时钟信号	输入	1 位，上跳沿更新其中 PC 和 GRF 的值
2.	异步复位信号	输入	1 位，信号为 1 时将其中的 PC 和 GRF 复位
3.	输入指令	输入	32 位，由 IM 给出的当前指令地址的指令

4.	输入数据	输入	32 位，由 DM 给出的当前数据地址的数据
5.	输出指令地址	输出	32 位，下一条输入指令在 IM 中的地址
6.	GRF 写使能信号	输出	1 位，信号为 1 时数据对 GRF 的写入有效(输出此信号以使 OJ 评判 CPU 正确性)
7.	GRF 写入地址	输出	5 位，对 GRF 写入下述数据的地址(输出此信号以使 OJ 评判 CPU 正确性)
8.	GRF 写入数据	输出	32 位，对 GRF 写入到上述地址的数据(输出此信号以使 OJ 评判 CPU 正确性)
9.	ALU 溢出信号	输出	1 位，当前指令为 add 或 sub 且结果发生溢出时，此信号为 1
10.	DM 写使能信号	输出	1 位，信号为 1 时数据对 DM 的写入有效
11.	DM 的 LS 类型选择	输出	32 位，对 LS 按 W/H/B 等进行选择
12.	DM 的 LS 内存地址	输出	32 位，DM 写入下述数据的地址
13.	DM 的写入数据	输出	32 位，DM 上述地址对应的数据

注：

1.本 CPU 的 IM 和 DM 指令均采用 24 位，顶层模块在输出 DM 的 LS 内存地址时需使用 splitter 截取第二位到第六位输出。

内部逻辑：

包含了 program_counter、register_file、control_unit、bit_entender、arithmetic_logical_unit 等模块，对输入的指令提取指定位在 control_unit 中进行译码，得到控制信号输入给 program_counter、register_file、bit_entender、arithmetic_logical_unit 等模块或输出，并通过 PC 给出下一条指令的地址，各模块详细的内部逻辑实现如下文所述。

4. program_counter

模块定义：

序号	功能名称	数据方向	功能描述
1.	时钟信号	输入	1 位，上跳沿更新当前指令地址为下一条指令地址
2.	异步复位信号	输入	1 位，信号为 1 时将当前指令恢复到初始化时的值

3.	立即数分支地址	输入	32 位，处理 b 类指令时得到的已处理的跳转地址，配合分支选择信号实现分支
4.	立即数跳转地址	输入	24 位，处理 j 和 jal 指令时得到的未处理的跳转地址，配合跳转选择信号实现跳转
5.	寄存器跳转地址	输入	32 位，处理 jr 和 jalr 指令时得到的来自寄存器的跳转地址，配合跳转选择信号实现跳转
6.	分支选择信号	输入	1 位，用来选择下一条指令，如果是 0 就选择当前指令加四，否则选择立即数分支地址
7.	跳转选择信号	输入	2 位，用来选择下一条指令，如果是 0 就选择经过分支选择信号选择的信号，如果是 1 就选择经过处理的立即数跳转地址，如果是 2 就选择寄存器跳转地址
8.	当前指令地址	输出	32 位，当前指令的地址
9.	下一条指令地址	输出	32 位，当前指令加四，即没有分支或跳转的情况下，下一条指令应该的地址

注：

1.如果需要改变地址位宽可直接修改 splitter 来实现。

2.如果需要改变初始指令地址可以修改初始化的值配合修改 IM 中减法器的减数实现。

3.处理 B 类指令时得到的已处理的跳转地址是指已经对立即数进行了零扩展，左移两位和加下一条地址。

4.处理 j 和 jal 指令时得到的未处理的跳转地址是指来自当前指令 0 到 25 位的立即数。

5.经过处理的立即数跳转地址是指对 4 中立即数零扩展到 28 位，左移两位作为低 28 位，下一条地址的高 4 位作为高 4 位得到的地址。

6.若跳转选择信号非法(3)，下一条指令的地址为 0x7fffffff。

内部逻辑：

通过一个寄存器存储当前指令并在时钟上跳沿更新其中内容，同时计算出上述立即数分支地址，立即数跳转地址，寄存器跳转地址和下一条指令地址，通过数据选择器选择需要存入的下一条指令，使用一个计数器配合数据选择器实现对第一条指令地址的初始化。

5. register_file

模块定义：

序号	功能名称	数据方向	功能描述
1.	时钟信号	输入	1 位，上跳沿更新内存的值
2.	异步复位信号	输入	1 位，信号为 1 时将此模块复位
3.	写使能信号	输入	1 位，信号为 1 时数据对 GRF 的写入有效
4.	写 31 号寄存器	输入	1 位，信号为 1 时如果写入数据，数据写入到$31
5.	读取地址 1	输入	5 位，读取到下述输出数据 1 的数据的地址
6.	读取地址 2	输入	5 位，读取到下述输出数据 2 的数据的地址
7.	写入地址 3	输入	5 位，写入下述输入数据的地址
8.	输入数据	输入	32 位，上述写入地址 3 需要写入的数据
9.	输出数据 1	输出	32 位，上述读取地址 1 对应的数据
10.	输出数据 2	输出	32 位，上述读取地址 2 对应的数据

注：

1.为实现 jal 单独增加了 31 号寄存器的控制信号，因此输出写寄存器的地址时需要考虑这一点，当 31 号寄存器的控制信号为 1 时输出 0x1f。

内部逻辑：

采用解码器和数据选择器将 5 位地址对应到 32 个寄存器之一。

6. control_unit

模块定义：

序号	功能名称	数据方向	功能描述
1.	第一段输入指令	输入	6 位，当前指令的高六位，以此判断指令类型
2.	第二段输入指令	输入	6 位，当前指令的低六位，若高六位全零，说明是 R 类型指令，以此判断指令类型
3.	第三段输入指令	输入	5 位，当前指令的第 16 到 20 位，处理 bltz 和 bgez 指令时用以判断指令类型

4.	寄存器写入选择	输出	1 位，选择将 ALU 的结果写入寄存器(0)还是从 DM 中取出数据写入寄存器(1)
5.	内存写入使能	输出	1 位，信号为 1 时数据对 DM 的写入有效
6.	分支控制信号	输出	1 位，信号为 1 时若 ALU 输出为 0 则进行分支跳转
7.	ALU 功能选择信号	输出	5 位，控制 ALU 进行不同的运算操作，详细定义见 ALU 部分
8.	ALU 输入选择信号	输出	2 位，选择 ALU 的输入，高位用以选择第一个操作数来自 GRF 第一个输出(0)还是立即数(1)，低位用以选择第二个操作数来自 GRF 第二个输出(0)还是立即数(1)
9.	寄存器写入地址选择	输出	1 位，选择 GRF 的写入地址来自指令[20:16](0)还是[15:11](1)
10.	寄存器使能信号	输出	1 位，信号为 1 时数据对 GRF 的写入有效
11.	LS 类型选择信号	输出	3 位，在 DM 对 LS 按 W/H/B 等进行选择
12.	位扩展选择信号	输出	2 位，控制对立即数的扩展方式，分为符号扩展(0)，零扩展(1)和部分位零扩展(2)
13.	判断溢出信号	输出	1 位，当前指令为 add、sub 时有效，用以与 ALU 的溢出信号，得到溢出信号
14.	31 号寄存器写入	输出	1 位，信号为 1 时如果写入数据到 GRF，数据写入到 31 号寄存器
15.	PC 跳转选择信号	输出	2 位，用来选择下一条指令，详见 PC 部分的说明
16.	PC 跳转链接信号	输出	1 位，用以选择写入 GRF 的数据，为 1 时将下一条指令地址写入 GRF 实现跳转并链接

注：

1.部分位零扩展指处理 sll、srl、sra 的时候将[10:6]进行零扩展。

内部逻辑：

将输入信号分为三类处理，先将输出合并成 22 位信号以方便进行选择，再在选择后分离

成需要输出的信号，详见重要机制实现方法-控制模块设计。

7. bit_entender

模块定义：

序号	功能名称	数据方向	功能描述
1.	待扩展数据	输入	16 位，来自当前指令的低 16 位
2.	扩展模式选择	输入	2 位，符号扩展(0)，零扩展(1)和用于 sll、srl、sra 指令的部分位零扩展(2)
3.	扩展后数据	输出	32 位，按选择信号要求扩展后的数据

注：

1.若选择信号非法(3)，输出为 0x7fffffff。

内部逻辑：

分别进行三种扩展，后用数据选择器从扩展结果中选择需要的。

8. arithmetic_logical_unit

模块定义：

序号	功能名称	数据方向	功能描述
1.	操作数 1	输入	32 位，传入 ALU 的第一个操作数
2.	操作数 2	输入	32 位，传入 ALU 的第二个操作数
3.	操作类型信号	输入	5 位，ALU 操作类型选择信号
4.	溢出信号	输出	1 位，ALU 结果溢出信号(未判断操作类型)
5.	结果为零信号	输出	1 位，ALU 的计算结果为 0 时此信号为 1
6.	运算结果	输出	32 位，两个操作数运算的结果

注：

1.溢出判断基于两个运算数符号相同且与结果符号不同，因此需要另行确定当前进行的是 add 或 sub 运算，这个信号从 control_unit 引出。

2.最多支持 32 种不同的运算，现已定义了前 17 种运算，如果进行未定义的运算，得到的结果是 0x7fffffff。

3.ALU 支持的运算定义表：

序号	输入信号	执行的操作
1.	0	两个操作数按位与
2.	1	两个操作数按位或
3.	2	两个操作数做加法
4.	3	两个操作数按位异或
5.	4	第一个操作数大于 0 时输出 0
6.	5	第一个操作数小于 0 时输出 0
7.	6	两个操作数做减法
8.	7	两个操作数符号比较，第一个操作数更小时输出 1
9.	8	第一个操作数大于等于 0 时输出 0
10.	9	第二个操作数逻辑左移第一个操作数位
11.	10	第二个操作数逻辑右移第一个操作数位
12.	11	第二个操作数算术右移第一个操作数位
13.	12	两个操作数按位或非
14.	13	两个操作数不相等时输出 0
15.	14	两个操作数无符号比较，第一个操作数更小时输出 1
16.	15	第一个操作数小于等于 0 时输出 0
17.	16	将第二个操作数的低 16 位作为输出的高 16 位，其余位输出 0

内部逻辑：

同时进行所有支持的运算，然后将所有运算的结果接入数据选择器选择需要的结果，并进行 0 和溢出判断。

9. upper_six

模块定义：

序号	功能名称	数据方向	功能描述
1.	当前指令 31 位	输入	1 位，输入信号，用来进行组合逻辑运算以得到 22 位控制信号的每一位
2.	当前指令 30 位	输入	1 位，输入信号，用来进行组合逻辑运算以得到

			22 位控制信号的每一位
3.	当前指令 29 位	输入	1 位，输入信号，用来进行组合逻辑运算以得到 22 位控制信号的每一位
4.	当前指令 28 位	输入	1 位，输入信号，用来进行组合逻辑运算以得到 22 位控制信号的每一位
5.	当前指令 27 位	输入	1 位，输入信号，用来进行组合逻辑运算以得到 22 位控制信号的每一位
6.	当前指令 26 位	输入	1 位，输入信号，用来进行组合逻辑运算以得到 22 位控制信号的每一位
7.	合并的控制信号	输出	22 位，输出的控制信号

注：

1.为便于后续选择而将 22 个输出信号全部合并输出。

2.本模块适用的指令为：lw、sw、lb、lbu、sb、lh、lhu、sh、beq、bne、bgtz、blez、addi、andi、ori、xori、lui、slti、sltiu、j、jal。

内部逻辑：

纯与或非门实现的组合逻辑电路，由 Logisim 分析电路功能直接生成。

10. lower_six

模块定义：

序号	功能名称	数据方向	功能描述
1.	当前指令 5 位	输入	1 位，输入信号，用来进行组合逻辑运算以得到 22 位控制信号的每一位
2.	当前指令 4 位	输入	1 位，输入信号，用来进行组合逻辑运算以得到 22 位控制信号的每一位
3.	当前指令 3 位	输入	1 位，输入信号，用来进行组合逻辑运算以得到 22 位控制信号的每一位
4.	当前指令 2 位	输入	1 位，输入信号，用来进行组合逻辑运算以得到 22 位控制信号的每一位

5.	当前指令 1 位	输入	1 位，输入信号，用来进行组合逻辑运算以得到 22 位控制信号的每一位
6.	当前指令 0 位	输入	1 位，输入信号，用来进行组合逻辑运算以得到 22 位控制信号的每一位
7.	合并的控制信号	输出	22 位，输出的控制信号

注：

1.为便于后续选择而将 22 个输出信号全部合并输出。

2.本模块适用的指令为：add、sub、and、or、slt、nor、xor、sll、srl、sra、sllv、srlv、srav、sltu、jr、jalr。

内部逻辑：

纯与或非门实现的组合逻辑电路，由 Logisim 分析电路功能直接生成。

11. middle_five

模块定义：

序号	功能名称	数据方向	功能描述
1.	当前指令 20 位	输入	1 位，输入信号，用来进行组合逻辑运算以得到 22 位控制信号的每一位
2.	当前指令 19 位	输入	1 位，输入信号，用来进行组合逻辑运算以得到 22 位控制信号的每一位
3.	当前指令 18 位	输入	1 位，输入信号，用来进行组合逻辑运算以得到 22 位控制信号的每一位
4.	当前指令 17 位	输入	1 位，输入信号，用来进行组合逻辑运算以得到 22 位控制信号的每一位
5.	当前指令 16 位	输入	1 位，输入信号，用来进行组合逻辑运算以得到 22 位控制信号的每一位
6.	合并的控制信号	输出	22 位，输出的控制信号

注：

1.为便于后续选择而将 22 个输出信号全部合并输出。

2.本模块适用的指令为：bltz、bgez。

内部逻辑：

纯与或非门实现的组合逻辑电路，由 Logisim 分析电路功能直接生成。

（三）控制模块设计

1. 控制模块真值表

为便于表格呈现，将表格分为四部分，将确定 bltz、bgez 的 20-16 位填在 4-0 位的位置，并以前导/进行区分。

第一部分：

name	31	30	29	28	27	26	5	4	3	2	1	0	MemtoReg	MemWrite	Branch	ALU[4]	ALU[3]	ALU[2]
lw	1	0	0	0	1	1	X	X	X	X	X	X	1	0	0	0	0	0
sw	1	0	1	0	1	1	X	X	X	X	X	X	X	1	0	0	0	0
lb	1	0	0	0	0	0	X	X	X	X	X	X	1	0	0	0	0	0
lbu	1	0	0	1	0	0	X	X	X	X	X	X	1	0	0	0	0	0
sb	1	0	1	0	0	0	X	X	X	X	X	X	X	1	0	0	0	0
lh	1	0	0	0	0	1	X	X	X	X	X	X	1	0	0	0	0	0
lhu	1	0	0	1	0	1	X	X	X	X	X	X	1	0	0	0	0	0
sh	1	0	1	0	0	1	X	X	X	X	X	X	X	1	0	0	0	0
add	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
addu	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
sub	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1
subu	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	1
and	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
or	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0
slt	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	1
nor	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0	1	1
xor	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0

name	31	30	29	28	27	26	5	4	3	2	1	0	ALU[1]	ALU[0]	ALUSrc[1]	ALUSrc[0]	RegDst	RegWrite
sll	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
srl	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
sra	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0
sllv	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0
srlv	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0
srav	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	1	0
sltu	0	0	0	0	0	0	1	0	1	0	1	1	0	0	0	0	1	1
beq	0	0	0	1	0	0	X	X	X	X	X	X	X	0	1	0	0	0
bne	0	0	0	1	0	1	X	X	X	X	X	X	X	0	1	0	1	1
bgtz	0	0	0	1	1	1	X	X	X	X	X	X	X	0	1	0	0	1
blez	0	0	0	1	1	0	X	X	X	X	X	X	X	0	1	0	1	1
bltz	0	0	0	0	0	1	\N	\0	\0	\0	\0	\0	X	0	1	0	0	1
bgez	0	0	0	0	0	1	\N	\0	\0	\0	\0	\1	X	0	1	0	1	0
addi	0	0	1	0	0	0	X	X	X	X	X	X	0	0	0	0	0	0
addiu	0	0	1	0	0	1	X	X	X	X	X	X	0	0	0	0	0	0
andi	0	0	1	1	0	0	X	X	X	X	X	X	0	0	0	0	0	0
ori	0	0	1	1	0	1	X	X	X	X	X	X	0	0	0	0	0	0
xori	0	0	1	1	1	0	X	X	X	X	X	X	0	0	0	0	0	0
lui	0	0	1	1	1	1	X	X	X	X	X	X	0	0	0	1	0	0
slti	0	0	1	0	1	0	X	X	X	X	X	X	0	0	0	0	0	1
sltiu	0	0	1	0	1	1	X	X	X	X	X	X	0	0	0	0	1	1
j	0	0	0	0	1	0	X	X	X	X	X	X	X	0	X	X	X	X
jr	0	0	0	0	0	0	0	0	1	0	0	0	X	0	X	X	X	X
jal	0	0	0	0	1	1	X	X	X	X	X	X	0	0	X	X	X	X
jalr	0	0	0	0	0	0	0	0	1	0	0	1	0	0	X	X	X	X

第二部分：

name	31	30	29	28	27	26	5	4	3	2	1	0	ALU[1]	ALU[0]	ALUSrc[1]	ALUSrc[0]	RegDst	RegWrite

lw	1	0	0	0	1	1	X	X	X	X	X	X	1	0	0	1	0	1
sw	1	0	1	0	1	1	X	X	X	X	X	X	1	0	0	1	X	0
lb	1	0	0	0	0	0	X	X	X	X	X	X	1	0	0	1	0	1
lbu	1	0	0	1	0	0	X	X	X	X	X	X	1	0	0	1	0	1
sb	1	0	1	0	0	0	X	X	X	X	X	X	1	0	0	1	X	0
lh	1	0	0	0	0	1	X	X	X	X	X	X	1	0	0	1	0	1
lhu	1	0	0	1	0	1	X	X	X	X	X	X	1	0	0	1	0	1
sh	1	0	1	0	0	1	X	X	X	X	X	X	1	0	0	1	X	0
add	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	1
addu	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	1
sub	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	1	1
subu	0	0	0	0	0	0	1	0	0	0	1	1	1	0	0	0	1	1
and	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	1
or	0	0	0	0	0	0	1	0	0	1	0	1	0	1	0	0	1	1
slt	0	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	1	1
nor	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0	1	1
xor	0	0	0	0	0	0	1	0	0	1	1	0	1	1	0	0	1	1
sll	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1
srl	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	1	1
sra	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	1
sllv	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	1
srlv	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	1	1
srav	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	1	1
sltu	0	0	0	0	0	0	1	0	1	0	1	1	1	0	0	0	1	1
beq	0	0	0	1	0	0	X	X	X	X	X	X	1	1	0	0	X	0
bne	0	0	0	1	0	1	X	X	X	X	X	X	0	1	0	0	X	0
bgtz	0	0	0	1	1	1	X	X	X	X	X	X	0	0	0	0	X	0

blez	0	0	0	1	1	0	*X*	*X*	*X*	*X*	*X*	*X*	1	1	0	0	*X*	0
bltz	0	0	0	0	0	1	\N	\0	\0	\0	\0	\0	0	1	0	0	*X*	0
bgez	0	0	0	0	0	1	\N	\0	\0	\0	\0	\1	0	0	0	0	*X*	0
addi	0	0	1	0	0	0	*X*	*X*	*X*	*X*	*X*	*X*	1	0	0	1	0	1
addiu	0	0	1	0	0	1	*X*	*X*	*X*	*X*	*X*	*X*	1	0	0	1	0	1
andi	0	0	1	1	0	0	*X*	*X*	*X*	*X*	*X*	*X*	0	0	0	1	0	1
ori	0	0	1	1	0	1	*X*	*X*	*X*	*X*	*X*	*X*	0	1	0	1	0	1
xori	0	0	1	1	1	0	*X*	*X*	*X*	*X*	*X*	*X*	1	1	0	1	0	1
lui	0	0	1	1	1	1	*X*	*X*	*X*	*X*	*X*	*X*	0	0	0	1	0	1
slti	0	0	1	0	1	0	*X*	*X*	*X*	*X*	*X*	*X*	1	1	0	1	0	1
sltiu	0	0	1	0	1	1	*X*	*X*	*X*	*X*	*X*	*X*	1	0	0	1	0	1
j	0	0	0	0	1	0	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	0
jr	0	0	0	0	0	0	0	0	1	0	0	0	*X*	*X*	*X*	*X*	*X*	0
jal	0	0	0	0	1	1	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	1
jalr	0	0	0	0	0	0	0	0	1	0	0	1	*X*	*X*	*X*	*X*	1	1

第三部分：

name	31	30	29	28	27	26	5	4	3	2	1	0	*HAndD*[2]	*HAndD*[1]	*HAndD*[0]	*Extend*[1]	*Extend*[0]	*JL*[1]
lw	1	0	0	0	1	1	*X*	*X*	*X*	*X*	*X*	*X*	0	0	*X*	0	0	0
sw	1	0	1	0	1	1	*X*	*X*	*X*	*X*	*X*	*X*	0	0	*X*	0	0	0
lb	1	0	0	0	0	0	*X*	*X*	*X*	*X*	*X*	*X*	1	0	1	0	0	0
lbu	1	0	0	1	0	0	*X*	*X*	*X*	*X*	*X*	*X*	1	0	0	0	0	0
sb	1	0	1	0	0	0	*X*	*X*	*X*	*X*	*X*	*X*	1	0	*X*	0	0	0
lh	1	0	0	0	0	1	*X*	*X*	*X*	*X*	*X*	*X*	0	1	1	0	0	0
lhu	1	0	0	1	0	1	*X*	*X*	*X*	*X*	*X*	*X*	0	1	0	0	0	0
sh	1	0	1	0	0	1	*X*	*X*	*X*	*X*	*X*	*X*	0	1	*X*	0	0	0
add	0	0	0	0	0	0	1	0	0	0	0	0	*X*	*X*	*X*	*X*	*X*	0
add	0	0	0	0	0	0	1	0	0	0	0	1	*X*	*X*	*X*	*X*	*X*	0

sub	0	0	0	0	0	0	1	0	0	0	1	0	*X*	*X*	*X*	*X*	*X*	0
subu	0	0	0	0	0	0	1	0	0	0	1	1	*X*	*X*	*X*	*X*	*X*	0
and	0	0	0	0	0	0	1	0	0	1	0	0	*X*	*X*	*X*	*X*	*X*	0
or	0	0	0	0	0	0	1	0	0	1	0	1	*X*	*X*	*X*	*X*	*X*	0
slt	0	0	0	0	0	0	1	0	1	0	1	0	*X*	*X*	*X*	*X*	*X*	0
nor	0	0	0	0	0	0	1	0	0	1	1	1	*X*	*X*	*X*	*X*	*X*	0
xor	0	0	0	0	0	0	1	0	0	1	1	0	*X*	*X*	*X*	*X*	*X*	0
sll	0	0	0	0	0	0	0	0	0	0	0	0	*X*	*X*	*X*	1	0	0
srl	0	0	0	0	0	0	0	0	0	0	1	0	*X*	*X*	*X*	1	0	0
sra	0	0	0	0	0	0	0	0	0	0	1	1	*X*	*X*	*X*	1	0	0
sllv	0	0	0	0	0	0	0	0	0	1	0	0	*X*	*X*	*X*	*X*	*X*	0
srlv	0	0	0	0	0	0	0	0	0	1	1	0	*X*	*X*	*X*	*X*	*X*	0
srav	0	0	0	0	0	0	0	0	0	1	1	1	*X*	*X*	*X*	*X*	*X*	0
sltu	0	0	0	0	0	0	1	0	1	0	1	1	*X*	*X*	*X*	*X*	*X*	0
beq	0	0	0	1	0	0	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	0	0	0
bne	0	0	0	1	0	1	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	0	0	0
bgtz	0	0	0	1	1	1	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	0	0	0
blez	0	0	0	1	1	0	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	0	0	0
bltz	0	0	0	0	0	1	\N	\0	\0	\0	\0	\0	*X*	*X*	*X*	0	0	0
bgez	0	0	0	0	0	1	\N	\0	\0	\0	\0	\1	*X*	*X*	*X*	0	0	0
addi	0	0	1	0	0	0	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	0	0	0
addiu	0	0	1	0	0	1	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	0	0	0
andi	0	0	1	1	0	0	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	0	1	0
ori	0	0	1	1	0	1	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	0	1	0
xori	0	0	1	1	1	0	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	0	1	0
lui	0	0	1	1	1	1	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	0	0	0
slti	0	0	1	0	1	0	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	0	0	0

name																		
sltiu	0	0	1	0	1	1	X	X	X	X	X	X	X	X	X	0	0	0
j	0	0	0	0	1	0	X	X	X	X	X	X	X	X	X	X	X	0
jr	0	0	0	0	0	0	0	0	1	0	0	0	X	X	X	X	X	1
jal	0	0	0	0	1	1	X	X	X	X	X	X	X	X	X	X	X	0
jalr	0	0	0	0	0	0	0	0	1	0	0	1	X	X	X	X	X	1

第四部分：

name	31	30	29	28	27	26	5	4	3	2	1	0	JL[0]	JR	To31	Overflow
lw	1	0	0	0	1	1	X	X	X	X	X	X	0	0	0	0
sw	1	0	1	0	1	1	X	X	X	X	X	X	0	X	X	0
lb	1	0	0	0	0	0	X	X	X	X	X	X	0	0	0	0
lbu	1	0	0	1	0	0	X	X	X	X	X	X	0	0	0	0
sb	1	0	1	0	0	0	X	X	X	X	X	X	0	X	X	0
lh	1	0	0	0	0	1	X	X	X	X	X	X	0	0	0	0
lhu	1	0	0	1	0	1	X	X	X	X	X	X	0	0	0	0
sh	1	0	1	0	0	1	X	X	X	X	X	X	0	X	X	0
add	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
addu	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0
sub	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1
subu	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0
and	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
or	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0
slt	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0
nor	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0
xor	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0
sll	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
srl	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
sra	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0

sllv	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
srlv	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
srav	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0
sltu	0	0	0	0	0	0	1	0	1	0	1	1	0	0	0	0
beq	0	0	0	1	0	0	*X*	*X*	*X*	*X*	*X*	*X*	0	*X*	*X*	0
bne	0	0	0	1	0	1	*X*	*X*	*X*	*X*	*X*	*X*	0	*X*	*X*	0
bgtz	0	0	0	1	1	1	*X*	*X*	*X*	*X*	*X*	*X*	0	*X*	*X*	0
blez	0	0	0	1	1	0	*X*	*X*	*X*	*X*	*X*	*X*	0	*X*	*X*	0
bltz	0	0	0	0	0	1	\N	\0	\0	\0	\0	\0	0	*X*	*X*	0
bgez	0	0	0	0	0	1	\N	\0	\0	\0	\0	\1	0	*X*	*X*	0
addi	0	0	1	0	0	0	*X*	*X*	*X*	*X*	*X*	*X*	0	0	0	1
addiu	0	0	1	0	0	1	*X*	*X*	*X*	*X*	*X*	*X*	0	0	0	0
andi	0	0	1	1	0	0	*X*	*X*	*X*	*X*	*X*	*X*	0	0	0	0
ori	0	0	1	1	0	1	*X*	*X*	*X*	*X*	*X*	*X*	0	0	0	0
xori	0	0	1	1	1	0	*X*	*X*	*X*	*X*	*X*	*X*	0	0	0	0
lui	0	0	1	1	1	1	*X*	*X*	*X*	*X*	*X*	*X*	0	0	0	0
slti	0	0	1	0	1	0	*X*	*X*	*X*	*X*	*X*	*X*	0	0	0	0
sltiu	0	0	1	0	1	1	*X*	*X*	*X*	*X*	*X*	*X*	0	0	0	0
j	0	0	0	0	1	0	*X*	*X*	*X*	*X*	*X*	*X*	1	*X*	*X*	0
jr	0	0	0	0	0	0	0	0	1	0	0	0	0	*X*	*X*	0
jal	0	0	0	0	1	1	*X*	*X*	*X*	*X*	*X*	*X*	1	1	1	0
jalr	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0

2. 对真值表的处理

考虑到以上指令分三类，lw、sw、lb、lbu、sb、lh、lhu、sh、beq、bne、bgtz、blez、addi、andi、ori、xori、lui、slti、sltiu、j、jal 以[31:26]进行编码，add、sub、and、or、slt、nor、xor、sll、srl、sra、sllv、srlv、srav、sltu、jr、jalr[31:26]全为 0，以[5:0]编码，bltz、bgez[31:26]仅第 26 位为 1，以[20:16]编码，因此可将指令分为上述三类分别进行处理(即上文中的 upper_six、

lower_six、middle_five 三个模块)，并用数据选择器选择最终的控制信号，以使控制器简洁且有条理。下给出三个模块实际的真值表(为上述真值表的子集，且为便于补全真值表的程序的处理进行了简化)。

upper_six：

```
1 0 0 0 1 1 -> 1 0 0 0 0 0 1 0 0 1 0 1 0 0 X 0 0 0 0 0 0 0

1 0 1 0 1 1 -> X 1 0 0 0 0 1 0 0 1 X 0 0 0 X 0 0 0 0 X X 0

1 0 0 0 0 0 -> 1 0 0 0 0 0 1 0 0 1 0 1 1 0 1 0 0 0 0 0 0 0

1 0 0 1 0 0 -> 1 0 0 0 0 0 1 0 0 1 0 1 1 0 0 0 0 0 0 0 0 0

1 0 1 0 0 0 -> X 1 0 0 0 0 1 0 0 1 X 0 1 0 X 0 0 0 0 X X 0

1 0 0 0 0 1 -> 1 0 0 0 0 0 1 0 0 1 0 1 0 1 1 0 0 0 0 0 0 0

1 0 0 1 0 1 -> 1 0 0 0 0 0 1 0 0 1 0 1 0 1 0 0 0 0 0 0 0 0

1 0 1 0 0 1 -> X 1 0 0 0 0 1 0 0 1 X 0 0 1 X 0 0 0 0 X X 0

0 0 0 1 0 0 -> X 0 1 0 0 0 1 1 0 0 X 0 X X X 0 0 0 0 X X 0

0 0 0 1 0 1 -> X 0 1 0 1 1 0 1 0 0 X 0 X X X 0 0 0 0 X X 0

0 0 0 1 1 1 -> X 0 1 0 0 1 0 0 0 0 X 0 X X X 0 0 0 0 X X 0

0 0 0 1 1 0 -> X 0 1 0 1 1 1 1 0 0 X 0 X X X 0 0 0 0 X X 0

0 0 1 0 0 0 -> 0 0 0 0 0 0 1 0 0 1 0 1 X X 0 0 0 0 0 0 0 1

0 0 1 0 0 1 -> 0 0 0 0 0 0 1 0 0 1 0 1 X X 0 0 0 0 0 0 0 0

0 0 1 1 0 0 -> 0 0 0 0 0 0 0 0 0 1 0 1 X X X 0 1 0 0 0 0 0

0 0 1 1 0 1 -> 0 0 0 0 0 0 0 1 0 1 0 1 X X X 0 1 0 0 0 0 0

0 0 1 1 1 0 -> 0 0 0 0 0 0 1 1 0 1 0 1 X X X 0 1 0 0 0 0 0

0 0 1 1 1 1 -> 0 0 0 1 0 0 0 0 0 1 0 1 X X X 0 0 0 0 0 0 0

0 0 1 0 1 0 -> 0 0 0 0 0 0 1 1 1 0 1 0 1 X X X 0 0 0 0 0 0 0

0 0 1 0 1 1 -> 0 0 0 0 0 1 1 1 0 0 1 0 1 X X X 0 0 0 0 0 0 0

0 0 0 0 1 0 -> X 0 X X X X X X X X 0 X X X X X 0 1 X X 0

0 0 0 0 1 1 -> 0 0 X X X X X X X X X 1 X X X X X 0 1 1 1 0
```

lower_six：

```
1 0 0 0 0 1 -> 0 0 0 0 0 0 1 0 0 0 0 1 1 X X X X 0 0 0 0 0
```

```
1 0 0 0 1 0 -> 0 0 0 0 0 1 1 0 0 0 1 1 X X X X 0 0 0 0 1
1 0 0 0 1 1 -> 0 0 0 0 0 1 1 0 0 0 1 1 X X X X 0 0 0 0 0
1 0 0 1 0 0 -> 0 0 0 0 0 0 0 0 0 0 1 1 X X X X 0 0 0 0 0
1 0 0 1 0 1 -> 0 0 0 0 0 0 0 1 0 0 1 1 X X X X 0 0 0 0 0
1 0 1 0 1 0 -> 0 0 0 0 0 1 1 1 0 0 1 1 X X X X 0 0 0 0 0
1 0 0 1 1 1 -> 0 0 0 0 1 1 0 0 0 0 1 1 X X X X 0 0 0 0 0
1 0 0 1 1 0 -> 0 0 0 0 0 0 1 1 0 0 1 1 X X X X 0 0 0 0 0
0 0 0 0 0 0 -> 0 0 0 0 1 0 0 1 1 0 1 1 X X 1 0 0 0 0 0 0
0 0 0 0 1 0 -> 0 0 0 0 1 0 1 0 1 0 1 1 X X 1 0 0 0 0 0 0
0 0 0 0 1 1 -> 0 0 0 0 1 0 1 1 1 0 1 1 X X 1 0 0 0 0 0 0
0 0 0 1 0 0 -> 0 0 0 0 1 0 0 1 0 0 1 1 X X X X 0 0 0 0 0
0 0 0 1 1 0 -> 0 0 0 0 1 0 1 0 0 0 1 1 X X X X 0 0 0 0 0
0 0 0 1 1 1 -> 0 0 0 0 1 0 1 1 0 0 1 1 X X X X 0 0 0 0 0
1 0 1 0 1 1 -> 0 0 0 0 1 1 1 0 0 0 1 1 X X X X 0 0 0 0 0
0 0 1 0 0 0 -> X 0 X X X X X X X X 0 X X X X X 1 0 X X 0
0 0 1 0 0 1 -> 0 0 X X X X X X X X 1 1 X X X X 1 0 1 0 0
```

middle_five：

```
0 0 0 0 0 -> X 0 1 0 0 1 0 1 0 0 X 0 X X X 0 0 0 0 X X 0
0 0 0 0 1 -> X 0 1 0 1 0 0 0 0 0 X 0 X X X 0 0 0 0 X X 0
```

3. 辅助搭建电路的程序

我们需要将上述三个真值表转换为电路实现，手工搭建是一件痛苦的事情，因此考虑使用 Logisim 的分析电路功能，由于手动修改真值表也是一件痛苦的事情，考虑将上述不完整的真值表补全(即没有定义的输入输出均为 X)，从而可以直接将真值表粘贴到 Logisim 中，以高效的生成电路。

采用 c 语言编程补全真值表，算法为建立一棵 0-1 Tire 树，将真值表插入这棵树，最后遍历这棵树，如果某种输入没有被插入则输出全为 X，程序代码如下：

```
#include <stdio.h>
#include <stdlib.h>
```

```
typedef struct node
{
    bool vis;
    char data[15];
    struct node *s[2];
} stu,*ptr;

ptr root=NULL;
int max,datanum;
unsigned char stk[15];

ptr bulid(int num)
{
    if (num==max) return NULL;
    ptr now=(ptr)malloc(sizeof(stu));
    now->vis=0;
    now->s[0]=bulid(num+1);
    now->s[1]=bulid(num+1);
    return now;
}

bool add()
{
    int num;
    char tmps[3];
    ptr now=root;
    for (int i=0;i<max-1;i++)
```

```
    {
        if (scanf("%d",&num)==-1) return 0;
        now=now->s[num];
    }
    now->vis=1;
    getchar(),getchar(),getchar();
    for (int i=0;i<datanum;i++)
    {
        if (scanf("%s",tmps)==-1) return 0;
        if (tmps[0]=='X') tmps[0]='x';
        now->data[i]=tmps[0];
    }
    return 1;
}

void dfs(ptr now,int num)
{
    if (now==NULL) return;
    if (num==max-1)
    {
        for (int i=0;i<max-1;i++)
            printf("%d ",stk[i]);
        for (int i=0;i<datanum;i++)
            if (now->vis) printf("%c ",now->data[i]);
            else printf("x ");
        puts(""); return;
    }
    stk[num]=0;
```

```
        dfs(now->s[0],num+1);

        stk[num]=1;

        dfs(now->s[1],num+1);

        return;

    }


    int main()

    {

    scanf("%d %d",&max,&datanum);

    max++,root=bulid(0);

    while (add());

    dfs(root,0);

    return 0;

    }
```

　　从而我们可以得到可粘贴在 Logisim 分析电路中的真值表，此外，由于 Logisim 的分析电路功能单次最大支持 12 个输出，我们需要将 22 个输出分两次生成，为此我们可以新建一个临时模块，将 22 个输出的前 12 个生成电路，将电路粘贴到目标模块中，然后从临时模块中删除当前模块，将 22 个输出的后 10 个生成电路，将电路粘贴到目标模块中，并对输入输出进行简单的修改，即可完成控制模块的设计，为便于阅读，生成的真值表见附录 1。

二、测试方案

（一）典型测试样例

根据指令的类型，主要构造了九个测试点，如下：

　　#1

　　test_allJ：主要测试四个跳转指令

　　包含的指令：add,addi,addiu,beq,j,jal,jalr,jr,slti,sw

　　#2

　　test_allB：主要测试六个条件跳转指令

包含的指令：addi,beq,bgez,bgtz,blez,bltz,bne,j,slti,sw

#3

test_allRP1：主要测试若干 R 类型的指令，有点多所以分了两个测试点

包含的指令：addi,addu,and,lw,nor,or,sllv,slt,sltu,srav,srlv,subu,sw,xor

#4

test_allRP2：主要测试若干 R 类型的指令，有点多所以分了两个测试点

包含的指令：add,addi,addu,and,lw,nor,or,sllv,slt,sltu,srav,srlv,sub,subu,sw,xor

#5

test_allLW：主要测试八个内存读写指令

包含的指令：addi,beq,j,lb,lbu,lh,lhu,lw,sb,sh,sw

#6

test_allIP1：主要测试若干 I 类型的指令，有点多所以分了两个测试点

包含的指令：addi,addiu,andi,ori,sll,srl,sw

#7

test_allIP2：主要测试若干 I 类型的指令，有点多所以分了两个测试点

包含的指令：addi,lui,slti,sltiu,sra,sw,xori

#8

test_narcissistic：实质是跑水仙花数，找个比较长的有意义的程序跑下试试

包含的指令：add,addi,beq,j,jal,jr,slt,slti,sw

#9

test_quicksort：实质是跑 n=100 的快排，找个有递归的有意义的程序跑下试试

包含的指令：add,addi,addiu,beq,bgez,bgtz,blez,bltz,bne,j,jal,jr,lw,sll,srl,sub,subi,sw

注：

1.考虑到 5 位最多可执行 32 条不同指令，非常不便于测试，因此采用 24 位 IM 地址和 24 为 DM 地址的 CPU 进行测试。

2.考虑到 Mars 得到的程序指令从 0x3000 开始，为便于测试和提交，此 CPU 支持任意指定指令的起始地址，只需要指定 PC 和 IM 中的两个常量即可，我们可以在测试时将其改成 0x3000，在提交时将其改为 0。

3.测试点较长，为方便阅读，将这些测试点的 rom 输入，ram 输入和标准答案按顺序放在附录 2，附录 3，附录 4。

（二）数据构造方法

覆盖所有测试功能正常进行的样例，极端情况的样例，以 R 指令的测试为例，我们对每个 R 指令，测试在两个输入分别为正正，负负，正负，负正，零零，正零，负零，正数负数分别包含如 1、-1、2147483647,、-2147483648 在内的数据和随机数，同时我们会测试 ARB、BRA、ARA、BRB，其它测试点的构造类似，具体见 MIPS 汇编程序，考虑到汇编程序较长，为方便阅读，将这些测试点的汇编代码放在附录 5。

（三）自动测试工具

显然面对上千的输出，肉眼将 RAM 中的结果与标准答案对比是不现实的，又因为 Logisim 导出的数据会存在 a*x 表示 a 个 x，会忽略前导 0，会一行多个输出，考虑用 c 语言将从 RAM 导出的数据进行格式化，从而在 cmd 中使用 fc 进行对比，这是一个平凡的字符串处理和 bat 批处理，代码如下：

```
#include <stdio.h>

char s[1111]; int tot;
unsigned int data[111111];

inline bool judge(char c)
{
    if ('0'<=c && c<='9') return 1;
    if ('a'<=c && c<='f') return 1;
    return 0;
}

inline unsigned int change(char c)
```

```cpp
{
    if ('0'<=c && c<='9') return c-'0';
    if ('a'<=c && c<='f') return c-'a'+10;
    return 0;
}


inline int todigit(int num)
{
    int ans;
    char s[11];
    sprintf(s,"%x",num);
    sscanf(s,"%d",&ans);
    return ans;
}


int main()
{
    freopen("out.txt","w",stdout);
    gets(s);
    while (gets(s))
    {
        int rep=1;
        unsigned int num=0;
        for (int i=0;s[i];i++)
        {
            if (judge(s[i]))
                num=(num<<4)+change(s[i]);
            else if (s[i]=='*')
```

```
                    rep=todigit(num),num=0;
                else if (s[i]==' ')
                {
                    for (int j=0;j<rep;j++)
                        data[tot++]=num;
                    num=0,rep=1;
                }
            }
            for (int j=0;j<rep;j++)
                data[tot++]=num;
        }
        //printf("%d\n",tot);
        for (int i=0;i<tot;i++)
            printf("%08x\n",data[i]);
        return 0;
    }


    @echo off
    fc out.txt ans.txt
    pause
    :end
```

三、思考题

（一）

现在我们的模块中 IM 使用 ROM，DM 使用 RAM，GRF 使用 Register，这种做法合理吗？请给出分析，若有改进意见也请一并给出。

我认为合理，ROM 是只读存储器，考虑到指令存储器只需要输出指令而不需要写入指令，使用 ROM 进行存储是合理的。DM 用来访问内存中的数据，这需要足够的存储空间且

要求支持读写，因此仅 RAM 可以满足此要求。GRF 需要足够快的存储速度，而不需要很大的空间(32*32)，因此采用寄存器搭建 GRF 是合理的。

（二）

事实上，实现 nop 空指令，我们并不需要将它加入控制信号真值表，为什么？

因为 nop 指令的编码实质上是特殊的 sll 指令，即将 0 号寄存器中的值左移 0 位后存入 0 号寄存器，这和什么都没有做没有任何区别，由于此处理器已经完成了对 sll 指令的支持，我们并不需要将 nop 空指令加入控制信号真值表。

（三）

上文提到，MARS 不能导出 PC 与 DM 起始地址均为 0 的机器码。实际上，可以通过为 DM 增添片选信号，来避免手工修改的麻烦，请查阅相关资料进行了解，并阐释为了解决这个问题，你最终采用的方法。

题目可能有误，MARS 中，我们选择了"Compact, Data at Address 0"，因此，"可以通过为 DM 增添片选信号"应为"可以通过为 PC 增添片选信号"，如上文中所述，我对 PC 和 IM 进行了修改，记 PC 初始化值为 A，只要在 IM 的输入信号输入到 ROM 前将其减去 A，就可以起到 PC 的起始地址为 X 的效果，我们可以任意修改 X 来满足不同的测试要求。

（四）

除了编写程序进行测试外，还有一种验证 CPU 设计正确性的办法——形式验证。形式验证的含义是根据某个或某些形式规范或属性，使用数学的方法证明其正确性或非正确性。请搜索"形式验证"了解相关内容后，简要阐述相比于测试，形式验证的优劣之处。

形式验证的优点包括：形式验证是对指定描述的所有可能的情况进行验证，覆盖率达到了 100%；形式验证技术是借用数学上的方法将待验证电路和功能描述或参考设计直接进行比较，不需要开发测试激励；形式验证的验证时间短，可以很快发现和改正电路设计中的错误，可以缩短设计周期。形式验证的不足包括无法分析一些动态的特性，无法有效验证电路性能，如电路的功耗和延迟等等。

附录 1:

upper_six:

```
x x x x x x x x x x x x
x x x x x x x x x x x x
x 0 x x x x x x x x x 0
0 0 x x x x x x x x x 1
x 0 1 0 0 0 1 1 0 0 x 0
x 0 1 0 1 1 0 1 0 0 x 0
x 0 1 0 1 1 1 1 0 0 x 0
x 0 1 0 0 1 0 0 0 0 x 0
0 0 0 0 0 0 1 0 0 1 0 1
0 0 0 0 0 0 1 0 0 1 0 1
0 0 0 0 0 1 1 1 0 1 0 1
0 0 0 0 1 1 1 0 0 1 0 1
0 0 0 0 0 0 0 0 0 1 0 1
0 0 0 0 0 0 0 1 0 1 0 1
0 0 0 0 0 0 1 1 0 1 0 1
0 0 0 1 0 0 0 0 0 1 0 1
x x x x x x x x x x x x
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x x x x x x x x x x x x
x x x x x x x x x x x x
x x x x x x x x x x x x
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x x x x x x x x x x x x
x x x x x x x x x x x x
x x x x x x x x x x x x
1 0 0 0 0 0 1 0 0 1 0 1
1 0 0 0 0 0 1 0 0 1 0 1
x x x x x x x x x x x x
1 0 0 0 0 0 1 0 0 1 0 1
1 0 0 0 0 0 1 0 0 1 0 1
1 0 0 0 0 0 1 0 0 1 0 1
x x x x x x x x x x x x
x x x x x x x x x x x x
```

```
x 1 0 0 0 0 1 0 0 1 x 0
x 1 0 0 0 0 1 0 0 1 x 0
x x x x x x x x x x x x
x 1 0 0 0 0 1 0 0 1 x 0
x x x x x x x x x x x x
x x x x x x x x x x x x
x x x x x x x x x x x x
x x x x x x x x x x x x
x x x x x x x x x x x x
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x x x x x x x x x x x x
```

```
x x x x x x x x x x x
x x x x x x x x x x x
x x x x x 0 1 x x 0
x x x x x 0 1 1 1 0
x x x 0 0 0 0 x x 0
x x x 0 0 0 0 x x 0
x x x 0 0 0 0 x x 0
x x x 0 0 0 0 x x 0
x x x 0 0 0 0 0 0 1
x x x 0 0 0 0 0 0 0
x x x 0 0 0 0 0 0 0
x x x 0 0 0 0 0 0 0
x x x 0 1 0 0 0 0 0
x x x 0 1 0 0 0 0 0
x x x 0 1 0 0 0 0 0
x x x 0 0 0 0 0 0 0
x x x x x x x x x x
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x x x x x x x x x x
1 0 1 0 0 0 0 0 0 0
0 1 1 0 0 0 0 0 0 0
x x x x x x x x x x
0 0 x 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0
0 1 0 0 0 0 0 0 0 0
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1 0 x 0 0 0 0 x x 0
0 1 x 0 0 0 0 x x 0
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0 0 x 0 0 0 0 x x 0
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```
x x x x x x x x x x
x x x x x x x x x x
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x x x x x x x x x x


lower_six:
0 0 0 0 1 0 0 1 1 0 1 1
x x x x x x x x x x x x
0 0 0 0 1 0 1 0 1 0 1 1
0 0 0 0 1 0 1 1 1 0 1 1
0 0 0 0 1 0 0 1 0 0 1 1
x x x x x x x x x x x x
0 0 0 0 1 0 1 0 0 0 0 1 1
0 0 0 0 1 0 1 1 0 0 1 1
x 0 x x x x x x x x x 0
0 0 x x x x x x x x 1 1
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middle_five:

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ae2a0000
22310004
3c01fcdf
3421e5bd
00014820
292a7fff
ae2a0000
22310004
3c01fcdf
3421e5bd
00014820
292a8000
ae2a0000
22310004
3c01fcdf
3421e5bd
00014820
292a3478
ae2a0000
22310004
3c01fcdf
3421e5bd
00014820
292aeb85
```

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2d2a0000
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22310004
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2d2a0001
ae2a0000
22310004
20090000
2d2affff
ae2a0000
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2d2a7fff
ae2a0000
22310004
20090000
2d2a8000
ae2a0000
22310004
20090000
2d2a3478
ae2a0000
22310004
20090000
2d2aeb85
ae2a0000
22310004
20090001
2d2a0000
ae2a0000
22310004
20090001
2d2a0001
ae2a0000
22310004
20090001
2d2affff
ae2a0000
22310004
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20090001
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ae2a0000
22310004
20090001
2d2a8000
ae2a0000
22310004
20090001
2d2a3478
ae2a0000
22310004
20090001
2d2aeb85
ae2a0000
22310004
2009ffff
2d2a0000
ae2a0000
22310004
2009ffff
2d2a0001
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22310004
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2009ffff
2d2a8000
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22310004
2009ffff
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22310004
2009ffff
2d2aeb85
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00014820
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3c017fff
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00014820
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ae2a0000
22310004
3c017fff
3421ffff
00014820
2d2aeb85
```

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34210000
00014820
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22310004
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34210000
00014820
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00014820
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00014820
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ae2a0000
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3c018000
34210000
00014820
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```

ae2a0000
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34210cb5
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ae2a0000
22310004
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34210cb5
00014820
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ae2a0000
22310004
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34210cb5
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ae2a0000
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34210cb5
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2d2a8000
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34210cb5
00014820
2d2a3478
ae2a0000
22310004
3c010002
34210cb5
00014820
2d2aeb85

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3421e5bd
00014820
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3421e5bd
00014820
2d2aeb85

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22310004
3c010176
3421618c
00014820
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22310004
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00014820
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22310004
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3421618c
00014820
00095043
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22310004
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3421ffff
00014820
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00014820
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22310004
20090000
00095203
ae2a0000
22310004
20090001
00095203
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3421618c
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34210000
00014820
00095203
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22310004
3c0a0001
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22310004
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ae2a0000
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ae2a0000
22310004
3c0a0288
ae2a0000
22310004
3c0a000f
```

```
ae2a0000
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22310004
200a08ae
ae2a0000
22310004
200a0d05
ae2a0000
22310004
200a115c
ae2a0000
22310004

v2.0 raw
08000c2f
21080001
20090000
200a0000
20050000
00b0202a
10800003
01505020
20a50001
08000c05
20050000
00b0202a
10800003
012a4820
20a50001
08000c0b
200a0000
20050000
00b1202a
10800003
01515020
20a50001
08000c12
20050000
00b1202a
10800003
```

```
012a4820
20a50001
08000c18
200a0000
20050000
00b2202a
10800003
01525020
20a50001
08000c1f
20050000
00b2202a
10800003
012a4820
20a50001
08000c25
11090001
03e00008
acc90000
20c60004
03e00008
20100001
21080063
2a04000a
1080000d
20110000
2a24000a
10800008
20120000
2a44000a
10800003
0c000c01
22520001
08000c37
22310001
08000c34
22100001
08000c31

v2.0 raw
241d2ffc
24100064
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24110000
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02019022
0c000c07
08000c86
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0501007c
02329820
00139842
00112080
8c890000
00122080
8c8a0000
012a4022
1d000001
08000c16
00112080
ac8a0000
00122080
ac890000
00132080
8c890000
00122080
8c8a0000
012a4022
1d000001
08000c21
00132080
ac8a0000
00122080
ac890000
00132080
8c890000
00112080
8c8a0000
012a4022
1d000001
08000c2c
00132080
ac8a0000
00112080
ac890000
```

```
00116021
00126821
00112080
8c8e0000
118d0021
000d2080
8c880000
010e4822
05210001
08000c3c
018d4822
05200001
08000c3c
20010001
01a16822
08000c31
000c2080
8c880000
010e4822
19200001
08000c46
018d4822
05200001
08000c46
218c0001
08000c3c
018d4822
05200001
08000c30
000c2080
8c880000
000d2080
8c890000
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ac890000
000d2080
ac880000
08000c30
000c2080
8c880000
00112080
ac880000
```

```
000c2080
ac8e0000
000c9821
000c6821
01914022
05000008
000c2080
8c880000
00132080
8c890000
15090003
20010001
01816022
08000c5a
01b24022
1d000007
000d2080
8c880000
00132080
8c890000
15090002
21ad0001
08000c64
afbf0000
20010004
03a1e822
afad0000
20010004
03a1e822
afb20000
20010004
03a1e822
000c9021
0c000c07
23bd0004
8fb20000
23bd0004
8fad0000
23bd0004
8fbf0000
afbf0000
20010004
```

```
03a1e822
000d8821
0c000c07
23bd0004
8fbf0000
03e00008
24110190
200a08ae
ae2a0000
22310004
200a0d05
ae2a0000
22310004
200a115c
ae2a0000
22310004
```

附录 3：
v2.0 raw

```
v2.0 raw
00000050
fffffff6
fffffff7
fffffff8
fffffff9
fffffffa
fffffffb
fffffffc
fffffffd
fffffffe
ffffffff
00000000
00000001
00000002
00000003
00000004
00000005
00000006
00000007
00000008
00000009
```

```
0000000a

v2.0 raw
00000050
0000006f
000000de
80000000
fffffe44
7fffffff
fffffd66
ffffffff
00000001
00000000
00000000
7fffffff
00000000
00000000

v2.0 raw
00000050
ffffffff
00000000
00000000
00007f34
00000000
ffff2244
0000006f
000000de
fffffeb3
fffffe44
00343fe8
fffa8e64
ffffffff
00000001
00000000
00000000
00000929
00000000

v2.0 raw
00000050
ffffffff6
```

```
fffffff7
fffffff8
fffffff9
fffffffa
fffffffb
fffffffc
fffffffd
fffffffe
ffffffff
00000000
00000001
00000002
00000003
00000004
00000005
00000006
00000007
00000008
00000009
0000000a
7fffffff
80000000
00000000


v2.0 raw


v2.0 raw


v2.0 raw


v2.0 raw
00000032
00000031
00000030
0000002f
0000002e
0000002d
0000002c
0000002b
0000002a
00000029
00000028
```

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00000027
00000026
00000025
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0000001f
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0000000d
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0000000b
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00000009
00000008
00000007
00000006
00000005
00000004
00000003
00000002
00000001
00000064
00000063
00000062
```

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00000061
00000060
0000005f
0000005e
0000005d
0000005c
0000005b
0000005a
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0000003e
0000003d
0000003c
0000003b
0000003a
00000039
00000038
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00000037
00000036
00000035
00000034
00000033
```

附录 4：
```
00000005
00000007
00000012
0000000f
00000002
00000002
00000002
00000002
00000002
00000002
000008ae
00000d05
0000115c
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00000002
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00000003
ffffffff
00000004
ffffffff
00000005
ffffffff
00000006
ffffffff
00000007
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00000008
ffffffff
00000009
00000000
0000000a
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0000000b
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0000000c
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00000020
00000001
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00000021
00000001
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00000027
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00000023
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00000025
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00000027
ffffffff
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ffffffff
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```
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000000ff
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```
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000001bb
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fffffe44
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fffffffe
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00000001
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00000d05
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00007f34
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00000045
00000046
00000047
00000048
00000049
0000004a
0000004b
0000004c
0000004d
0000004e
0000004f
00000050
00000051
00000052
00000053
00000054
00000055
00000056
00000057
00000058
00000059
0000005a
0000005b
0000005c
0000005d
0000005e
0000005f
00000060
00000061
00000062
00000063
00000064
000008ae
00000d05
```

```
0000115c
```

附录 5：
```
addi    $1,$1,23333
addi    $2,$2,23333
addi    $3,$3,23333
addi    $4,$4,23333
addi    $5,$5,23333
addi    $6,$6,23333
addi    $7,$7,23333
addi    $8,$8,23333
addi    $9,$9,23333
addi    $10,$10,23333
addi    $11,$11,23333
addi    $12,$12,23333
addi    $13,$13,23333
addi    $14,$14,23333
addi    $15,$15,23333
addi    $16,$16,23333
addi    $17,$17,23333
addi    $18,$18,23333
addi    $19,$19,23333
addi    $20,$20,23333
addi    $21,$21,23333
addi    $22,$22,23333
addi    $23,$23,23333
addi    $24,$24,23333
addi    $25,$25,23333
addi    $26,$26,23333
addi    $27,$27,23333
addi    $28,$28,23333
addi    $29,$29,23333
addi    $30,$30,23333
addi    $31,$31,23333

addi  $s1,$0,40
addi  $s2,$0,0

la    $a1,TAG5
add     $t2,$0,$a1
jalr  $a0,$t2
sw    $t1,0($s2)
```

```
addi  $s2,$s2,4


la    $a1,TAG7
add      $t2,$0,$a1
jalr  $a0,$t2
sw    $t1,0($s2)
addi  $s2,$s2,4


la    $a1,TAG18
add      $t2,$0,$a1
jalr  $a0,$t2
sw    $t1,0($s2)
addi  $s2,$s2,4


la    $a1,TAG15
add      $t2,$0,$a1
jalr  $a0,$t2
sw    $t1,0($s2)
addi  $s2,$s2,4


la    $a1,TAG2
add      $t2,$0,$a1
jalr  $a0,$t2
sw    $t1,0($s2)
addi  $s2,$s2,4


j     AFTER


TAG1:
addi  $t1,$0,1
jr    $a0
TAG2:
addi  $t1,$0,2
jr    $a0
TAG3:
addi  $t1,$0,3
jr    $a0
TAG4:
addi  $t1,$0,4
jr    $a0
TAG5:
addi  $t1,$0,5
```

```
jr    $a0
TAG6:
addi  $t1,$0,6
jr    $a0
TAG7:
addi  $t1,$0,7
jr    $a0
TAG8:
addi  $t1,$0,8
jr    $a0
TAG9:
addi  $t1,$0,9
jr    $a0
TAG10:
addi  $t1,$0,10
jr    $a0
TAG11:
addi  $t1,$0,11
jr    $a0
TAG12:
addi  $t1,$0,12
jr    $a0
TAG13:
addi  $t1,$0,13
jr    $a0
TAG14:
addi  $t1,$0,14
jr    $a0
TAG15:
addi  $t1,$0,15
jr    $a0
TAG16:
addi  $t1,$0,16
jr    $a0
TAG17:
addi  $t1,$0,17
jr    $a0
TAG18:
addi  $t1,$0,18
jr    $a0
TAG19:
addi  $t1,$0,19
```

```
jr     $a0
TAG20:
addi   $t1,$0,20
jr     $a0


AFTER:

la     $a0,TAG13
add    $t2,$0,$a1
jalr   $a0,$t2
sw     $t1,0($s2)
addi   $s2,$s2,4


la     $a0,TAG9
add    $t2,$0,$a1
jalr   $a0,$t2
sw     $t1,0($s2)
addi   $s2,$s2,4


la     $a0,TAG1
add    $t2,$0,$a1
jalr   $a0,$t2
sw     $t1,0($s2)
addi   $s2,$s2,4


la     $a0,TAG17
add    $t2,$0,$a1
jalr   $a0,$t2
sw     $t1,0($s2)
addi   $s2,$s2,4


la     $a0,TAG10
add    $t2,$0,$a1
jalr   $a0,$t2
sw     $t1,0($s2)
addi   $s2,$s2,4


addi   $s0,$0,0
j      LOOP_BGEIN1


PRINT11:
   addi  $t0,$0,-1
```

```
    sw      $t0,0($s2)
    addi  $s2,$s2,4
    jr      $31
PRINT12:
    addi  $t0,$0,0
    sw      $t0,0($s2)
    addi  $s2,$s2,4
    jr      $31
PRINT13:
    addi  $t0,$0,1
    sw      $t0,0($s2)
    addi  $s2,$s2,4
    jr      $31


LOOP_BGEIN1:
    beq      $s0,$s1,END_LOOP1
    slti  $t0,$s0,30
    beq      $t0,$0,UPPER1
    slti  $t0,$s0,10
    beq      $t0,$0,MID1
    LOWER1:
        jal        PRINT11
        j      OUT1
    MID1:
        jal        PRINT12
        j      OUT1
    UPPER1:
        jal        PRINT13
        j      OUT1
    OUT1:
    sw      $s0,0($s2)
    addi  $s2,$s2,4
    addi  $s0,$s0,1
    j      LOOP_BGEIN1
END_LOOP1:

addi  $s0,$0,0

LOOP_BGEIN2:
    beq      $s0,$s1,END_LOOP2
    slti  $t0,$s0,30
    beq      $t0,$0,UPPER2
```

```
    slti  $t0,$s0,10
    beq     $t0,$0,MID2
    LOWER2:
        jal      PRINT21
        j    OUT2
    MID2:
        jal      PRINT22
        j    OUT2
    UPPER2:
        jal      PRINT23
        j    OUT2
    OUT2:
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    addi  $s0,$s0,1
    j     LOOP_BGEIN2
END_LOOP2:
    j     TEST3


PRINT21:
    addi  $t0,$0,-1
    sw    $t0,0($s2)
    addi  $s2,$s2,4
    jr    $31
PRINT22:
    addi  $t0,$0,0
    sw    $t0,0($s2)
    addi  $s2,$s2,4
    jr    $31
PRINT23:
    addi  $t0,$0,1
    sw    $t0,0($s2)
    addi  $s2,$s2,4
    jr    $31

TEST3:

addi  $s0,$0,0

LOOP_BGEIN3:
    beq     $s0,$s1,END_LOOP3
    slti  $t0,$s0,30
```

```
        j       SKIP1
    PRINT31:
        addi  $t0,$0,-1
        sw    $t0,0($s2)
        addi  $s2,$s2,4
        jr    $31
    SKIP1:
    beq       $t0,$0,UPPER3
    slti  $t0,$s0,10
    beq       $t0,$0,MID3
    LOWER3:
        jal     PRINT31
        j       SKIP3
        PRINT33:
            addi  $t0,$0,1
            sw    $t0,0($s2)
            addi  $s2,$s2,4
            jr    $31
        SKIP3:
        j       OUT3
    MID3:
        jal     PRINT32
        j       OUT3
    UPPER3:
        jal     PRINT33
        j       OUT3
    OUT3:
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     SKIP2
    PRINT32:
        addi  $t0,$0,0
        sw    $t0,0($s2)
        addi  $s2,$s2,4
        jr    $31
    SKIP2:
    addi  $s0,$s0,1
        j     LOOP_BGEIN3
END_LOOP3:

j       LOOP_BGEINN1
```

```
PRINTN11:
    addi  $a0,$31,0
    addi  $t0,$0,-1
    sw    $t0,0($s2)
    addi  $s2,$s2,4
    jr    $a0
PRINTN12:
    addi  $a0,$31,0
    addi  $t0,$0,0
    sw    $t0,0($s2)
    addi  $s2,$s2,4
    jr    $a0
PRINTN13:
    addi  $a0,$31,0
    addi  $t0,$0,1
    sw    $t0,0($s2)
    addi  $s2,$s2,4
    jr    $a0

addi  $s0,$0,0

LOOP_BGEINN1:
    beq     $s0,$s1,END_LOOPN1
    slti  $t0,$s0,30
    beq     $t0,$0,UPPERN1
    slti  $t0,$s0,10
    beq     $t0,$0,MIDN1
    LOWERN1:
        jal     PRINTN11
        j    OUTN1
    MIDN1:
        jal     PRINTN12
        j    OUTN1
    UPPERN1:
        jal     PRINTN13
        j    OUTN1
    OUTN1:
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    addi  $s0,$s0,1
    j     LOOP_BGEINN1
END_LOOPN1:
```

```
addi  $s0,$0,0

LOOP_BGEINN2:
    beq      $s0,$s1,END_LOOPN2
    slti $t0,$s0,30
    beq      $t0,$0,UPPERN2
    slti $t0,$s0,10
    beq      $t0,$0,MIDN2
    LOWERN2:
        jal      PRINTN21
        j    OUTN2
    MIDN2:
        jal      PRINTN22
        j    OUTN2
    UPPERN2:
        jal      PRINTN23
        j    OUTN2
    OUTN2:
    sw    $s0,0($s2)
    addi $s2,$s2,4
    addi $s0,$s0,1
    j    LOOP_BGEINN2
END_LOOPN2:
    j    TESTN3

PRINTN21:
    addi $a0,$31,0
    addi $t0,$0,-1
    sw    $t0,0($s2)
    addi $s2,$s2,4
    jr   $a0
PRINTN22:
    addi $a0,$31,0
    addi $t0,$0,0
    sw    $t0,0($s2)
    addi $s2,$s2,4
    jr   $a0
PRINTN23:
    addi $a0,$31,0
    addi $t0,$0,1
    sw    $t0,0($s2)
```

```
   addi  $s2,$s2,4
   jr    $a0


TESTN3:

addi  $s0,$0,0

LOOP_BGEINN3:
   beq     $s0,$s1,END_LOOPN3
   slti  $t0,$s0,30
   j     SKIPN1
   PRINTN31:
      addi  $a0,$31,0
      addi  $t0,$0,-1
      sw    $t0,0($s2)
      addi  $s2,$s2,4
      jr    $a0
   SKIPN1:
   beq     $t0,$0,UPPERN3
   slti  $t0,$s0,10
   beq     $t0,$0,MIDN3
   LOWERN3:
      jal     PRINTN31
      j     SKIPN3
      PRINTN33:
         addi  $a0,$31,0
         addi  $t0,$0,1
         sw    $t0,0($s2)
         addi  $s2,$s2,4
         jr    $a0
      SKIPN3:
      j     OUTN3
   MIDN3:
      jal     PRINTN32
      j     OUTN3
   UPPERN3:
      jal     PRINTN33
      j     OUTN3
   OUTN3:
   sw    $s0,0($s2)
   addi  $s2,$s2,4
   j     SKIPN2
```

```
    PRINTN32:
        addi  $a0,$31,0
        addi  $t0,$0,0
        sw    $t0,0($s2)
        addi  $s2,$s2,4
        jr    $a0
    SKIPN2:
    addi  $s0,$s0,1
    j     LOOP_BGEINN3
END_LOOPN3:

addi  $t2,$0,2222
sw    $t2,0($s1)
addi  $s1,$s1,4
addi  $t2,$0,3333
sw    $t2,0($s1)
addi  $s1,$s1,4
addi  $t2,$0,4444
sw    $t2,0($s1)
addi  $s1,$s1,4


--------------------------------------------------
li    $t2,80
sw    $t2,0($0)
li    $t2,-10
sw    $t2,4($0)
li    $t2,-9
sw    $t2,8($0)
li    $t2,-8
sw    $t2,12($0)
li    $t2,-7
sw    $t2,16($0)
li    $t2,-6
sw    $t2,20($0)
li    $t2,-5
sw    $t2,24($0)
li    $t2,-4
sw    $t2,28($0)
li    $t2,-3
sw    $t2,32($0)
li    $t2,-2
sw    $t2,36($0)
```

```
li      $t2,-1
sw      $t2,40($0)
li      $t2,0
sw      $t2,44($0)
li      $t2,1
sw      $t2,48($0)
li      $t2,2
sw      $t2,52($0)
li      $t2,3
sw      $t2,56($0)
li      $t2,4
sw      $t2,60($0)
li      $t2,5
sw      $t2,64($0)
li      $t2,6
sw      $t2,68($0)
li      $t2,7
sw      $t2,72($0)
li      $t2,8
sw      $t2,76($0)
li      $t2,9
sw      $t2,80($0)
li      $t2,10
sw      $t2,84($0)


#---------------------------------------------

addi    $1,$1,23333
addi    $2,$2,23333
addi    $3,$3,23333
addi    $4,$4,23333
addi    $5,$5,23333
addi    $6,$6,23333
addi    $7,$7,23333
addi    $8,$8,23333
addi    $9,$9,23333
addi    $10,$10,23333
addi    $11,$11,23333
addi    $12,$12,23333
addi    $13,$13,23333
addi    $14,$14,23333
addi    $15,$15,23333
```

```
addi  $16,$16,23333
addi  $17,$17,23333
addi  $18,$18,23333
addi  $19,$19,23333
addi  $20,$20,23333
addi  $21,$21,23333
addi  $22,$22,23333
addi  $23,$23,23333
addi  $24,$24,23333
addi  $25,$25,23333
addi  $26,$26,23333
addi  $27,$27,23333
addi  $28,$28,23333
addi  $29,$29,23333
addi  $30,$30,23333
addi  $31,$31,23333


addi  $s0,$0,0
addi  $s2,$0,0
addi  $s1,$0,40


LOOP_BGEIN1:
    beq     $s0,$s1,END_LOOP1
    slti  $t0,$s0,30
    beq     $t0,$0,UPPER1
    slti  $t0,$s0,10
    beq     $t0,$0,MID1
    LOWER1:
        addi  $t0,$0,-1
        sw    $t0,0($s2)
        addi  $s2,$s2,4
        j     OUT1
    MID1:
        addi  $t0,$0,0
        sw    $t0,0($s2)
        addi  $s2,$s2,4
        j     OUT1
    UPPER1:
        addi  $t0,$0,1
        sw    $t0,0($s2)
        addi  $s2,$s2,4
    OUT1:
```

```
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    addi  $s0,$s0,1
    j     LOOP_BGEIN1

END_LOOP1:

addi  $s1,$0,40
addi  $s0,$0,0

LOOP_BGEIN2:
    beq      $s0,$s1,END_LOOP2
    slti  $t0,$s0,10
    bne      $t0,$0,LOWER2
    slti  $t0,$s0,30
    bne      $t0,$0,MID2
    UPPER2:
        addi  $t0,$0,1
        sw    $t0,0($s2)
        addi  $s2,$s2,4
        j     OUT2
    MID2:
        addi  $t0,$0,0
        sw    $t0,0($s2)
        addi  $s2,$s2,4
        j     OUT2
    LOWER2:
        addi  $t0,$0,-1
        sw    $t0,0($s2)
        addi  $s2,$s2,4
    OUT2:
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    addi  $s0,$s0,1
    j     LOOP_BGEIN2

END_LOOP2:

addi  $s0,$0,1
addi  $s1,$0,1
beq      $s0,$s1,FLASE1
```

```
FRUE1:
    addi  $s0,$0,1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     NEXT1
FLASE1:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
NEXT1:

addi  $s0,$0,1
addi  $s1,$0,2
beq       $s0,$s1,FLASE2

FRUE2:
    addi  $s0,$0,1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     NEXT2
FLASE2:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
NEXT2:

addi  $s0,$0,-1
addi  $s1,$0,-1
beq       $s0,$s1,FLASE3

FRUE3:
    addi  $s0,$0,1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     NEXT3
FLASE3:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
NEXT3:

addi  $s0,$0,-2
```

```
addi  $s1,$0,-3
beq      $s0,$s1,FLASE4

FRUE4:
   addi  $s0,$0,1
   sw    $s0,0($s2)
   addi  $s2,$s2,4
   j     NEXT4
FLASE4:
   addi  $s0,$0,-1
   sw    $s0,0($s2)
   addi  $s2,$s2,4
NEXT4:

addi  $s0,$0,1
addi  $s1,$0,-1
beq      $s0,$s1,FLASE5

FRUE5:
   addi  $s0,$0,1
   sw    $s0,0($s2)
   addi  $s2,$s2,4
   j     NEXT5
FLASE5:
   addi  $s0,$0,-1
   sw    $s0,0($s2)
   addi  $s2,$s2,4
NEXT5:

addi  $s0,$0,-1
addi  $s1,$0,1
beq      $s0,$s1,FLASE6

FRUE6:
   addi  $s0,$0,1
   sw    $s0,0($s2)
   addi  $s2,$s2,4
   j     NEXT6
FLASE6:
   addi  $s0,$0,-1
   sw    $s0,0($s2)
   addi  $s2,$s2,4
```

```
NEXT6:

addi  $s0,$0,0
addi  $s1,$0,1
beq     $s0,$s1,FLASE7

FRUE7:
   addi  $s0,$0,1
   sw    $s0,0($s2)
   addi  $s2,$s2,4
   j     NEXT7
FLASE7:
   addi  $s0,$0,-1
   sw    $s0,0($s2)
   addi  $s2,$s2,4
NEXT7:

addi  $s0,$0,0
addi  $s1,$0,-1
beq     $s0,$s1,FLASE8

FRUE8:
   addi  $s0,$0,1
   sw    $s0,0($s2)
   addi  $s2,$s2,4
   j     NEXT8
FLASE8:
   addi  $s0,$0,-1
   sw    $s0,0($s2)
   addi  $s2,$s2,4
NEXT8:

addi  $s0,$0,1
addi  $s1,$0,0
beq     $s0,$s1,FLASE9

FRUE9:
   addi  $s0,$0,1
   sw    $s0,0($s2)
   addi  $s2,$s2,4
   j     NEXT9
FLASE9:
```

```
   addi  $s0,$0,-1
   sw    $s0,0($s2)
   addi  $s2,$s2,4
NEXT9:

addi  $s0,$0,-1
addi  $s1,$0,0
beq      $s0,$s1,FLASE10

FRUE10:
   addi  $s0,$0,1
   sw    $s0,0($s2)
   addi  $s2,$s2,4
   j     NEXT10
FLASE10:
   addi  $s0,$0,-1
   sw    $s0,0($s2)
   addi  $s2,$s2,4
NEXT10:

addi  $s0,$0,0
addi  $s1,$0,0
beq      $s0,$s1,FLASE11

FRUE11:
   addi  $s0,$0,1
   sw    $s0,0($s2)
   addi  $s2,$s2,4
   j     NEXT11
FLASE11:
   addi  $s0,$0,-1
   sw    $s0,0($s2)
   addi  $s2,$s2,4
NEXT11:

#------------------------------

addi  $s0,$0,1
addi  $s1,$0,1
bne      $s0,$s1,NFLASE1

NFRUE1:
```

```
    addi  $s0,$0,1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     NNEXT1
NFLASE1:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
NNEXT1:

addi  $s0,$0,1
addi  $s1,$0,2
bne       $s0,$s1,NFLASE2

NFRUE2:
    addi  $s0,$0,1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     NNEXT2
NFLASE2:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
NNEXT2:

addi  $s0,$0,-1
addi  $s1,$0,-1
bne       $s0,$s1,NFLASE3

NFRUE3:
    addi  $s0,$0,1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     NNEXT3
NFLASE3:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
NNEXT3:

addi  $s0,$0,-2
addi  $s1,$0,-3
```

```
bne       $s0,$s1,NFLASE4

NFRUE4:
   addi  $s0,$0,1
   sw    $s0,0($s2)
   addi  $s2,$s2,4
   j     NNEXT4
NFLASE4:
   addi  $s0,$0,-1
   sw    $s0,0($s2)
   addi  $s2,$s2,4
NNEXT4:

addi  $s0,$0,1
addi  $s1,$0,-1
bne       $s0,$s1,NFLASE5

NFRUE5:
   addi  $s0,$0,1
   sw    $s0,0($s2)
   addi  $s2,$s2,4
   j     NNEXT5
NFLASE5:
   addi  $s0,$0,-1
   sw    $s0,0($s2)
   addi  $s2,$s2,4
NNEXT5:

addi  $s0,$0,-1
addi  $s1,$0,1
bne       $s0,$s1,NFLASE6

NFRUE6:
   addi  $s0,$0,1
   sw    $s0,0($s2)
   addi  $s2,$s2,4
   j     NNEXT6
NFLASE6:
   addi  $s0,$0,-1
   sw    $s0,0($s2)
   addi  $s2,$s2,4
NNEXT6:
```

```
addi  $s0,$0,0
addi  $s1,$0,1
bne      $s0,$s1,NFLASE7

NFRUE7:
    addi  $s0,$0,1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     NNEXT7
NFLASE7:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
NNEXT7:

addi  $s0,$0,0
addi  $s1,$0,-1
bne      $s0,$s1,NFLASE8

NFRUE8:
    addi  $s0,$0,1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     NNEXT8
NFLASE8:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
NNEXT8:

addi  $s0,$0,1
addi  $s1,$0,0
bne      $s0,$s1,NFLASE9

NFRUE9:
    addi  $s0,$0,1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     NNEXT9
NFLASE9:
    addi  $s0,$0,-1
```

```
    sw    $s0,0($s2)
    addi  $s2,$s2,4
NNEXT9:

addi  $s0,$0,-1
addi  $s1,$0,0
bne       $s0,$s1,NFLASE10

NFRUE10:
    addi  $s0,$0,1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     NNEXT10
NFLASE10:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
NNEXT10:

addi  $s0,$0,0
addi  $s1,$0,0
bne       $s0,$s1,NFLASE11

NFRUE11:
    addi  $s0,$0,1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     NNEXT11
NFLASE11:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
NNEXT11:

#-----------------------------

addi  $s0,$0,1
bgtz  $s0,GTFLASE1

GTFRUE1:
    addi  $s0,$0,1
    sw    $s0,0($s2)
```

```
       addi  $s2,$s2,4
       j     GTNEXT1
GTFLASE1:
       addi  $s0,$0,-1
       sw    $s0,0($s2)
       addi  $s2,$s2,4
GTNEXT1:

addi  $s0,$0,-1
bgtz  $s0,GTFLASE2

GTFRUE2:
       addi  $s0,$0,1
       sw    $s0,0($s2)
       addi  $s2,$s2,4
       j     GTNEXT2
GTFLASE2:
       addi  $s0,$0,-1
       sw    $s0,0($s2)
       addi  $s2,$s2,4
GTNEXT2:

addi  $s0,$0,32767
bgtz  $s0,GTFLASE3

GTFRUE3:
       addi  $s0,$0,-32768
       sw    $s0,0($s2)
       addi  $s2,$s2,4
       j     GTNEXT3
GTFLASE3:
       addi  $s0,$0,-1
       sw    $s0,0($s2)
       addi  $s2,$s2,4
GTNEXT3:

addi  $s0,$0,2315
bgtz  $s0,GTFLASE4

GTFRUE4:
       addi  $s0,$0,-4523
       sw    $s0,0($s2)
```

```
    addi  $s2,$s2,4
    j     GTNEXT4
GTFLASE4:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
GTNEXT4:

addi  $s0,$0,0
bgtz  $s0,GTFLASE5

GTFRUE5:
    addi  $s0,$0,1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     GTNEXT5
GTFLASE5:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
GTNEXT5:

#------------------------------

addi  $s0,$0,1
bgez  $s0,GEFLASE1

GEFRUE1:
    addi  $s0,$0,1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     GENEXT1
GEFLASE1:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
GENEXT1:

addi  $s0,$0,-1
bgez  $s0,GEFLASE2

GEFRUE2:
```

```
    addi  $s0,$0,1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     GENEXT2
GEFLASE2:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
GENEXT2:

addi  $s0,$0,32767
bgez  $s0,GEFLASE3

GEFRUE3:
    addi  $s0,$0,-32768
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     GENEXT3
GEFLASE3:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
GENEXT3:

addi  $s0,$0,2315
bgez  $s0,GEFLASE4

GEFRUE4:
    addi  $s0,$0,-4523
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     GENEXT4
GEFLASE4:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
GENEXT4:

addi  $s0,$0,0
bgez  $s0,GEFLASE5

GEFRUE5:
```

```
    addi  $s0,$0,1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     GENEXT5
GEFLASE5:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
GENEXT5:

#-----------------------------

addi  $s0,$0,1
bltz  $s0,LTFLASE1

LTFRUE1:
    addi  $s0,$0,1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     LTNEXT1
LTFLASE1:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
LTNEXT1:

addi  $s0,$0,-1
bltz  $s0,LTFLASE2

LTFRUE2:
    addi  $s0,$0,1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     LTNEXT2
LTFLASE2:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
LTNEXT2:

addi  $s0,$0,32767
bltz  $s0,LTFLASE3
```

```
LTFRUE3:
    addi  $s0,$0,-32768
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     LTNEXT3
LTFLASE3:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
LTNEXT3:

addi  $s0,$0,2315
bltz  $s0,LTFLASE4

LTFRUE4:
    addi  $s0,$0,-4523
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     LTNEXT4
LTFLASE4:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
LTNEXT4:

addi  $s0,$0,0
bltz  $s0,LTFLASE5

LTFRUE5:
    addi  $s0,$0,1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     LTNEXT5
LTFLASE5:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
LTNEXT5:

#-------------------------------
```

```
addi  $s0,$0,1
blez  $s0,LEFLASE1


LEFRUE1:
    addi  $s0,$0,1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     LENEXT1
LEFLASE1:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
LENEXT1:


addi  $s0,$0,-1
blez  $s0,LEFLASE2


LEFRUE2:
    addi  $s0,$0,1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     LENEXT2
LEFLASE2:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
LENEXT2:


addi  $s0,$0,32767
blez  $s0,LEFLASE3


LEFRUE3:
    addi  $s0,$0,-32768
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     LENEXT3
LEFLASE3:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
LENEXT3:
```

```
addi  $s0,$0,2315
blez  $s0,LEFLASE4

LEFRUE4:
    addi  $s0,$0,-4523
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     LENEXT4
LEFLASE4:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
LENEXT4:

addi  $s0,$0,0
blez  $s0,LEFLASE5

LEFRUE5:
    addi  $s0,$0,1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
    j     LENEXT5
LEFLASE5:
    addi  $s0,$0,-1
    sw    $s0,0($s2)
    addi  $s2,$s2,4
LENEXT5:

addi  $t2,$0,2222
sw    $t2,0($s2)
addi  $s2,$s2,4
addi  $t2,$0,3333
sw    $t2,0($s2)
addi  $s2,$s2,4
addi  $t2,$0,4444
sw    $t2,0($s2)
addi  $s2,$s2,4


----------------------------------------------------
li    $t2,80
sw    $t2,0($0)
li    $t2,111
```

```
sw    $t2,4($0)
li    $t2,222
sw    $t2,8($0)
li    $t2,-2147483648
sw    $t2,12($0)
li    $t2,-444
sw    $t2,16($0)
li    $t2,2147483647
sw    $t2,20($0)
li    $t2,-666
sw    $t2,24($0)
li    $t2,-1
sw    $t2,28($0)
li    $t2,1
sw    $t2,32($0)
li    $t2,0
sw    $t2,36($0)
li    $t2,0
sw    $t2,40($0)
li    $t2,2147483647
sw    $t2,44($0)
li    $t2,0
sw    $t2,48($0)

#-------------------------------------

addi  $1,$1,23333
addi  $2,$2,23333
addi  $3,$3,23333
addi  $4,$4,23333
addi  $5,$5,23333
addi  $6,$6,23333
addi  $7,$7,23333
addi  $8,$8,23333
addi  $9,$9,23333
addi  $10,$10,23333
addi  $11,$11,23333
addi  $12,$12,23333
addi  $13,$13,23333
addi  $14,$14,23333
addi  $15,$15,23333
addi  $16,$16,23333
```

```
addi   $17,$17,23333
addi   $18,$18,23333
addi   $19,$19,23333
addi   $20,$20,23333
addi   $21,$21,23333
addi   $22,$22,23333
addi   $23,$23,23333
addi   $24,$24,23333
addi   $25,$25,23333
addi   $26,$26,23333
addi   $27,$27,23333
addi   $28,$28,23333
addi   $29,$29,23333
addi   $30,$30,23333
addi   $31,$31,23333


addi  $s0,$0,0
lw    $s1,0($s0)
addi  $s0,$s0,4


#---------------------------------------
lw    $t0,0($s0)
addi  $s0,$s0,4
lw    $t1,0($s0)
addi  $s0,$s0,4


addu  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
addu  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
addu  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
addu  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4


subu  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
```

```
subu  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
subu  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
subu  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

and     $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
and     $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
and     $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
and     $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

or    $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
or    $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
or    $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
or    $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

slt     $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
slt     $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
```

```
slt     $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
slt     $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

xor     $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
xor     $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
xor     $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
xor     $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

nor     $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
nor     $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
nor     $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
nor     $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

sllv  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
sllv  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sllv  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
```

```
sllv   $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

srlv   $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
srlv   $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
srlv   $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
srlv   $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

srav   $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
srav   $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
srav   $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
srav   $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

sltu   $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
sltu   $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
sltu   $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
sltu   $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
```

```
#----------------------------------
lw      $t0,0($s0)
addi    $s0,$s0,4
lw      $t1,0($s0)
addi    $s0,$s0,4

addu    $t2,$t0,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4
addu    $t2,$t1,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
addu    $t2,$t0,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
addu    $t2,$t1,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4

subu    $t2,$t0,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4
subu    $t2,$t1,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
subu    $t2,$t0,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
subu    $t2,$t1,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4

and     $t2,$t0,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4
and     $t2,$t1,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
and     $t2,$t0,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
```

```
and     $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

or    $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
or    $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
or    $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
or    $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

slt     $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
slt     $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
slt     $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
slt     $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

xor     $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
xor     $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
xor     $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
xor     $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
```

2020.11.9计算机组成原理   19373354 陈昊

```
nor     $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
nor     $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
nor     $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
nor     $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

sllv  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
sllv  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sllv  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sllv  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

srlv  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
srlv  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
srlv  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
srlv  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

srav  $t2,$t0,$t1
sw    $t2,0($s1)
```

```
addi  $s1,$s1,4
srav  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
srav  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
srav  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

sltu  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
sltu  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sltu  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sltu  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

#-------------------------------------
lw    $t0,0($s0)
addi  $s0,$s0,4
lw    $t1,0($s0)
addi  $s0,$s0,4

addu  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
addu  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
addu  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
addu  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
```

```
subu    $t2,$t0,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4
subu    $t2,$t1,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
subu    $t2,$t0,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
subu    $t2,$t1,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4

and     $t2,$t0,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4
and     $t2,$t1,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
and     $t2,$t0,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
and     $t2,$t1,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4

or      $t2,$t0,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4
or      $t2,$t1,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
or      $t2,$t0,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
or      $t2,$t1,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4

slt     $t2,$t0,$t1
sw      $t2,0($s1)
```

```
addi  $s1,$s1,4
slt     $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
slt     $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
slt     $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

xor     $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
xor     $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
xor     $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
xor     $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

nor     $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
nor     $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
nor     $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
nor     $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

sllv  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
sllv  $t2,$t1,$t0
sw    $t2,0($s1)
```

```
addi  $s1,$s1,4
sllv  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sllv  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

srlv  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
srlv  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
srlv  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
srlv  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

srav  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
srav  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
srav  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
srav  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

sltu  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
sltu  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sltu  $t2,$t0,$t0
sw    $t2,0($s1)
```

```
addi  $s1,$s1,4
sltu  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4


#-------------------------------------
lw    $t0,0($s0)
addi  $s0,$s0,4
lw    $t1,0($s0)
addi  $s0,$s0,4


addu  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
addu  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
addu  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
addu  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4


subu  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
subu  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
subu  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
subu  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4


and      $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
and      $t2,$t1,$t0
sw    $t2,0($s1)
```

```
addi    $s1,$s1,4
and        $t2,$t0,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
and        $t2,$t1,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4

or      $t2,$t0,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4
or      $t2,$t1,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
or      $t2,$t0,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
or      $t2,$t1,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4

slt        $t2,$t0,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4
slt        $t2,$t1,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
slt        $t2,$t0,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
slt        $t2,$t1,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4

xor        $t2,$t0,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4
xor        $t2,$t1,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
xor        $t2,$t0,$t0
sw      $t2,0($s1)
```

```
addi  $s1,$s1,4
xor      $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

nor      $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
nor      $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
nor      $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
nor      $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

sllv  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
sllv  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sllv  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sllv  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

srlv  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
srlv  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
srlv  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
srlv  $t2,$t1,$t1
sw    $t2,0($s1)
```

```
addi   $s1,$s1,4

srav   $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
srav   $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
srav   $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
srav   $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

sltu   $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
sltu   $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
sltu   $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
sltu   $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

#--------------------------------------
lw     $t0,0($s0)
addi   $s0,$s0,4
lw     $t1,0($s0)
addi   $s0,$s0,4

addu   $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
addu   $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
addu   $t2,$t0,$t0
sw     $t2,0($s1)
```

```
addi  $s1,$s1,4
addu  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

subu  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
subu  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
subu  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
subu  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

and       $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
and       $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
and       $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
and       $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

or    $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
or    $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
or    $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
or    $t2,$t1,$t1
sw    $t2,0($s1)
```

```
addi  $s1,$s1,4


slt      $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
slt      $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
slt      $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
slt      $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4


xor      $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
xor      $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
xor      $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
xor      $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4


nor      $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
nor      $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
nor      $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
nor      $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4


sllv  $t2,$t0,$t1
```

```
sw     $t2,0($s1)
addi   $s1,$s1,4
sllv   $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
sllv   $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
sllv   $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

srlv   $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
srlv   $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
srlv   $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
srlv   $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

srav   $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
srav   $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
srav   $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
srav   $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

sltu   $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
sltu   $t2,$t1,$t0
```

```
sw    $t2,0($s1)
addi  $s1,$s1,4
sltu  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sltu  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4


#------------------------------------
lw    $t0,0($s0)
addi  $s0,$s0,4
lw    $t1,0($s0)
addi  $s0,$s0,4


addu  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
addu  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
addu  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
addu  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4


subu  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
subu  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
subu  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
subu  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4


and     $t2,$t0,$t1
```

```
sw      $t2,0($s1)
addi    $s1,$s1,4
and     $t2,$t1,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
and     $t2,$t0,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
and     $t2,$t1,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4

or      $t2,$t0,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4
or      $t2,$t1,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
or      $t2,$t0,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
or      $t2,$t1,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4

slt     $t2,$t0,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4
slt     $t2,$t1,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
slt     $t2,$t0,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
slt     $t2,$t1,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4

xor     $t2,$t0,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4
xor     $t2,$t1,$t0
```

```
sw      $t2,0($s1)
addi    $s1,$s1,4
xor     $t2,$t0,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
xor     $t2,$t1,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4

nor     $t2,$t0,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4
nor     $t2,$t1,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
nor     $t2,$t0,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
nor     $t2,$t1,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4

sllv    $t2,$t0,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4
sllv    $t2,$t1,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
sllv    $t2,$t0,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
sllv    $t2,$t1,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4

srlv    $t2,$t0,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4
srlv    $t2,$t1,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
srlv    $t2,$t0,$t0
```

```
sw    $t2,0($s1)
addi  $s1,$s1,4
srlv  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

srav  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
srav  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
srav  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
srav  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

sltu  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
sltu  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sltu  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sltu  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t2,$0,2222
sw    $t2,0($s1)
addi  $s1,$s1,4
addi  $t2,$0,3333
sw    $t2,0($s1)
addi  $s1,$s1,4
addi  $t2,$0,4444
sw    $t2,0($s1)
addi  $s1,$s1,4
```

```
-------------------------------------------------
li     $t2,80
sw     $t2,0($0)
li     $t2,-1
sw     $t2,4($0)
li     $t2,0
sw     $t2,8($0)
li     $t2,0
sw     $t2,12($0)
li     $t2,32564
sw     $t2,16($0)
li     $t2,0
sw     $t2,20($0)
li     $t2,-56764
sw     $t2,24($0)
li     $t2,111
sw     $t2,28($0)
li     $t2,222
sw     $t2,32($0)
li     $t2,-333
sw     $t2,36($0)
li     $t2,-444
sw     $t2,40($0)
li     $t2,3424232
sw     $t2,44($0)
li     $t2,-356764
sw     $t2,48($0)
li     $t2,-1
sw     $t2,52($0)
li     $t2,1
sw     $t2,56($0)
li     $t2,0
sw     $t2,60($0)
li     $t2,0
sw     $t2,64($0)
li     $t2,2345
sw     $t2,68($0)
li     $t2,0
sw     $t2,72($0)


#-------------------------------------
```

```
addi  $1,$1,23333
addi  $2,$2,23333
addi  $3,$3,23333
addi  $4,$4,23333
addi  $5,$5,23333
addi  $6,$6,23333
addi  $7,$7,23333
addi  $8,$8,23333
addi  $9,$9,23333
addi  $10,$10,23333
addi  $11,$11,23333
addi  $12,$12,23333
addi  $13,$13,23333
addi  $14,$14,23333
addi  $15,$15,23333
addi  $16,$16,23333
addi  $17,$17,23333
addi  $18,$18,23333
addi  $19,$19,23333
addi  $20,$20,23333
addi  $21,$21,23333
addi  $22,$22,23333
addi  $23,$23,23333
addi  $24,$24,23333
addi  $25,$25,23333
addi  $26,$26,23333
addi  $27,$27,23333
addi  $28,$28,23333
addi  $29,$29,23333
addi  $30,$30,23333
addi  $31,$31,23333

addi  $s0,$0,0
lw    $s1,0($s0)
addi  $s0,$s0,4


#------------------------------------
lw    $t0,0($s0)
addi  $s0,$s0,4
lw    $t1,0($s0)
addi  $s0,$s0,4
```

```
add     $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
add     $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
add     $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
add     $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

addu   $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
addu   $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
addu   $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
addu   $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

sub     $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
sub     $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
sub     $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
sub     $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

subu   $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
```

```
subu  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
subu  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
subu  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

and    $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
and    $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
and    $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
and    $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

or    $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
or    $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
or    $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
or    $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

slt    $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
slt    $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
```

```
slt      $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
slt      $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

xor      $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
xor      $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
xor      $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
xor      $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

nor      $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
nor      $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
nor      $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
nor      $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

sllv $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
sllv $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
sllv $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
```

```
sllv  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

srlv  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
srlv  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
srlv  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
srlv  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

srav  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
srav  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
srav  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
srav  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

sltu  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
sltu  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sltu  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sltu  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
```

```
#-------------------------------------
lw      $t0,0($s0)
addi    $s0,$s0,4
lw      $t1,0($s0)
addi    $s0,$s0,4

add     $t2,$t0,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4
add     $t2,$t1,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
add     $t2,$t0,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
add     $t2,$t1,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4

addu    $t2,$t0,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4
addu    $t2,$t1,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
addu    $t2,$t0,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
addu    $t2,$t1,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4

sub     $t2,$t0,$t1
sw      $t2,0($s1)
addi    $s1,$s1,4
sub     $t2,$t1,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
sub     $t2,$t0,$t0
sw      $t2,0($s1)
addi    $s1,$s1,4
```

```
sub      $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

subu   $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
subu   $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
subu   $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
subu   $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

and      $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
and      $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
and      $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
and      $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

or     $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
or     $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
or     $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
or     $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
```

```
slt     $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
slt     $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
slt     $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
slt     $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

xor     $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
xor     $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
xor     $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
xor     $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

nor     $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
nor     $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
nor     $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
nor     $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

sllv $t2,$t0,$t1
sw     $t2,0($s1)
```

```
addi   $s1,$s1,4
sllv   $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
sllv   $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
sllv   $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

srlv   $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
srlv   $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
srlv   $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
srlv   $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

srav   $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
srav   $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
srav   $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
srav   $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

sltu   $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
sltu   $t2,$t1,$t0
sw     $t2,0($s1)
```

```
addi  $s1,$s1,4
sltu  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sltu  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4


#--------------------------------------
lw    $t0,0($s0)
addi  $s0,$s0,4
lw    $t1,0($s0)
addi  $s0,$s0,4


add      $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
add      $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
add      $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
add      $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4


addu  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
addu  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
addu  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
addu  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4


sub      $t2,$t0,$t1
sw    $t2,0($s1)
```

```
addi  $s1,$s1,4
sub     $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sub     $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sub     $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

subu  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
subu  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
subu  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
subu  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

and     $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
and     $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
and     $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
and     $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

or    $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
or    $t2,$t1,$t0
sw    $t2,0($s1)
```

```
addi  $s1,$s1,4
or    $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
or    $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

slt     $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
slt     $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
slt     $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
slt     $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

xor     $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
xor     $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
xor     $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
xor     $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

nor     $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
nor     $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
nor     $t2,$t0,$t0
sw    $t2,0($s1)
```

```
addi   $s1,$s1,4
nor     $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

sllv   $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
sllv   $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
sllv   $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
sllv   $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

srlv   $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
srlv   $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
srlv   $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
srlv   $t2,$t1,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4

srav   $t2,$t0,$t1
sw     $t2,0($s1)
addi   $s1,$s1,4
srav   $t2,$t1,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
srav   $t2,$t0,$t0
sw     $t2,0($s1)
addi   $s1,$s1,4
srav   $t2,$t1,$t1
sw     $t2,0($s1)
```

```
addi  $s1,$s1,4

sltu  $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
sltu  $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sltu  $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sltu  $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

#------------------------------------
lw    $t0,0($s0)
addi  $s0,$s0,4
lw    $t1,0($s0)
addi  $s0,$s0,4

add     $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
add     $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
add     $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
add     $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

sub     $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
sub     $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sub     $t2,$t0,$t0
sw    $t2,0($s1)
```

```
addi  $s1,$s1,4
sub      $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4


#-----------------------------------
lw    $t0,0($s0)
addi  $s0,$s0,4
lw    $t1,0($s0)
addi  $s0,$s0,4


add      $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
add      $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
add      $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
add      $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4


sub      $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
sub      $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sub      $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sub      $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4


#-----------------------------------
lw    $t0,0($s0)
addi  $s0,$s0,4
lw    $t1,0($s0)
addi  $s0,$s0,4
```

```
add     $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
add     $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
add     $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
add     $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4


sub     $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
sub     $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sub     $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sub     $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4


#-------------------------------------
lw    $t0,0($s0)
addi  $s0,$s0,4
lw    $t1,0($s0)
addi  $s0,$s0,4


add     $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
add     $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
add     $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
```

```
add      $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

sub      $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
sub      $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sub      $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sub      $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

#-------------------------------------
lw    $t0,0($s0)
addi  $s0,$s0,4
lw    $t1,0($s0)
addi  $s0,$s0,4

add      $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
add      $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
add      $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
add      $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4

sub      $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
sub      $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
```

```
sub      $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sub      $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4


#-------------------------------------
lw    $t0,0($s0)
addi  $s0,$s0,4
lw    $t1,0($s0)
addi  $s0,$s0,4


add      $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
add      $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
add      $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
add      $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4


sub      $t2,$t0,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4
sub      $t2,$t1,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sub      $t2,$t0,$t0
sw    $t2,0($s1)
addi  $s1,$s1,4
sub      $t2,$t1,$t1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t2,$0,2222
sw    $t2,0($s1)
addi  $s1,$s1,4
```

```
addi  $t2,$0,3333
sw    $t2,0($s1)
addi  $s1,$s1,4
addi  $t2,$0,4444
sw    $t2,0($s1)
addi  $s1,$s1,4


------------------------------------------------
li    $t2,80
sw    $t2,0($0)
li    $t2,-10
sw    $t2,4($0)
li    $t2,-9
sw    $t2,8($0)
li    $t2,-8
sw    $t2,12($0)
li    $t2,-7
sw    $t2,16($0)
li    $t2,-6
sw    $t2,20($0)
li    $t2,-5
sw    $t2,24($0)
li    $t2,-4
sw    $t2,28($0)
li    $t2,-3
sw    $t2,32($0)
li    $t2,-2
sw    $t2,36($0)
li    $t2,-1
sw    $t2,40($0)
li    $t2,0
sw    $t2,44($0)
li    $t2,1
sw    $t2,48($0)
li    $t2,2
sw    $t2,52($0)
li    $t2,3
sw    $t2,56($0)
li    $t2,4
sw    $t2,60($0)
li    $t2,5
sw    $t2,64($0)
```

```
li      $t2,6
sw      $t2,68($0)
li      $t2,7
sw      $t2,72($0)
li      $t2,8
sw      $t2,76($0)
li      $t2,9
sw      $t2,80($0)
li      $t2,10
sw      $t2,84($0)
li      $t2,2147483647
sw      $t2,88($0)
li      $t2,-2147483648
sw      $t2,92($0)


#-------------------------------------

addi    $1,$1,23333
addi    $2,$2,23333
addi    $3,$3,23333
addi    $4,$4,23333
addi    $5,$5,23333
addi    $6,$6,23333
addi    $7,$7,23333
addi    $8,$8,23333
addi    $9,$9,23333
addi    $10,$10,23333
addi    $11,$11,23333
addi    $12,$12,23333
addi    $13,$13,23333
addi    $14,$14,23333
addi    $15,$15,23333
addi    $16,$16,23333
addi    $17,$17,23333
addi    $18,$18,23333
addi    $19,$19,23333
addi    $20,$20,23333
addi    $21,$21,23333
addi    $22,$22,23333
addi    $23,$23,23333
addi    $24,$24,23333
addi    $25,$25,23333
```

```
addi  $26,$26,23333
addi  $27,$27,23333
addi  $28,$28,23333
addi  $29,$29,23333
addi  $30,$30,23333
addi  $31,$31,23333


addi  $s0,$0,100
addi  $s2,$0,0
addi  $s1,$0,96


LOOP_BEGIN1:
    beq   $s2,$s1,END_LOOP1
    lw    $t0,0($s2)
    sw    $t0,0($s0)
    addi  $s0,$s0,4
    addi  $s2,$s2,4
    j     LOOP_BEGIN1
END_LOOP1:

addi  $s2,$0,0
addi  $s1,$0,96


LOOP_BEGIN2:
    beq   $s2,$s1,END_LOOP2
    lh    $t0,0($s2)
    sw    $t0,0($s0)
    addi  $s0,$s0,4
    addi  $s2,$s2,2
    j     LOOP_BEGIN2
END_LOOP2:

addi  $s2,$0,0
addi  $s1,$0,96


LOOP_BEGIN3:
    beq   $s2,$s1,END_LOOP3
    lhu     $t0,0($s2)
    sw    $t0,0($s0)
    addi  $s0,$s0,4
    addi  $s2,$s2,2
    j     LOOP_BEGIN3
```

```
END_LOOP3:

addi  $s2,$0,0
addi  $s1,$0,96


LOOP_BEGIN4:
    beq  $s2,$s1,END_LOOP4
    lb   $t0,0($s2)
    sw   $t0,0($s0)
    addi $s0,$s0,4
    addi $s2,$s2,1
    j      LOOP_BEGIN4
END_LOOP4:

addi  $s2,$0,0
addi  $s1,$0,96


LOOP_BEGIN5:
    beq  $s2,$s1,END_LOOP5
    lbu      $t0,0($s2)
    sw   $t0,0($s0)
    addi $s0,$s0,4
    addi $s2,$s2,1
    j      LOOP_BEGIN5
END_LOOP5:

addi  $s2,$0,4
addi  $s1,$0,96


LOOP_BEGINA1:
    beq  $s2,$s1,END_LOOPA1
    lw   $t0,-4($s2)
    sw   $t0,0($s0)
    addi $s0,$s0,4
    addi $s2,$s2,4
    j      LOOP_BEGINA1
END_LOOPA1:

addi  $s2,$0,6
addi  $s1,$0,96


LOOP_BEGINA2:
```

```
    beq    $s2,$s1,END_LOOPA2
    lh     $t0,-6($s2)
    sw     $t0,0($s0)
    addi   $s0,$s0,4
    addi   $s2,$s2,2
    j      LOOP_BEGINA2
END_LOOPA2:

addi  $s2,$0,2
addi  $s1,$0,96

LOOP_BEGINA3:
    beq    $s2,$s1,END_LOOPA3
    lhu      $t0,-2($s2)
    sw     $t0,0($s0)
    addi   $s0,$s0,4
    addi   $s2,$s2,2
    j      LOOP_BEGINA3
END_LOOPA3:

addi  $s2,$0,5
addi  $s1,$0,96

LOOP_BEGINA4:
    beq    $s2,$s1,END_LOOPA4
    lb     $t0,-5($s2)
    sw     $t0,0($s0)
    addi   $s0,$s0,4
    addi   $s2,$s2,1
    j      LOOP_BEGINA4
END_LOOPA4:

addi  $s2,$0,3
addi  $s1,$0,96

LOOP_BEGINA5:
    beq    $s2,$s1,END_LOOPA5
    lbu      $t0,-3($s2)
    sw     $t0,0($s0)
    addi   $s0,$s0,4
    addi   $s2,$s2,1
    j      LOOP_BEGINA5
```

```
END_LOOPA5:

addi  $s2,$0,-4
addi  $s1,$0,96

LOOP_BEGINS1:
    beq   $s2,$s1,END_LOOPS1
    lw    $t0,4($s2)
    sw    $t0,0($s0)
    addi  $s0,$s0,4
    addi  $s2,$s2,4
    j     LOOP_BEGINS1
END_LOOPS1:

addi  $s2,$0,-6
addi  $s1,$0,96

LOOP_BEGINS2:
    beq   $s2,$s1,END_LOOPS2
    lh    $t0,6($s2)
    sw    $t0,0($s0)
    addi  $s0,$s0,4
    addi  $s2,$s2,2
    j     LOOP_BEGINS2
END_LOOPS2:

addi  $s2,$0,-2
addi  $s1,$0,96

LOOP_BEGINS3:
    beq   $s2,$s1,END_LOOPS3
    lhu    $t0,2($s2)
    sw    $t0,0($s0)
    addi  $s0,$s0,4
    addi  $s2,$s2,2
    j     LOOP_BEGINS3
END_LOOPS3:

addi  $s2,$0,-5
addi  $s1,$0,96

LOOP_BEGINS4:
```

```
    beq   $s2,$s1,END_LOOPS4
    lb    $t0,5($s2)
    sw    $t0,0($s0)
    addi  $s0,$s0,4
    addi  $s2,$s2,1
    j     LOOP_BEGINS4
END_LOOPS4:

addi  $s2,$0,-3
addi  $s1,$0,96

LOOP_BEGINS5:
    beq   $s2,$s1,END_LOOPS5
    lbu     $t0,3($s2)
    sw    $t0,0($s0)
    addi  $s0,$s0,4
    addi  $s2,$s2,1
    j     LOOP_BEGINS5
END_LOOPS5:

#-----------------------------------------

addi  $s2,$0,0
addi  $s1,$0,96
addi  $s0,$s0,8

LOOP_BEGIN6:
    beq   $s2,$s1,END_LOOP6
    lw    $t0,0($s2)
    sw    $t0,-4($s0)
    addi  $s0,$s0,4
    sw    $t0,0($s0)
    addi  $s0,$s0,4
    sw    $t0,4($s0)
    addi  $s0,$s0,4
    addi  $s2,$s2,4
    j     LOOP_BEGIN6
END_LOOP6:

addi  $s2,$0,0
addi  $s1,$0,96
addi  $s0,$s0,8
```

```
LOOP_BEGIN7:
    beq    $s2,$s1,END_LOOP7
    lw     $t0,0($s2)
    sh     $t0,-6($s0)
    addi   $s0,$s0,4
    sh     $t0,-4($s0)
    addi   $s0,$s0,4
    sh     $t0,-2($s0)
    addi   $s0,$s0,4
    sh     $t0,0($s0)
    addi   $s0,$s0,4
    sh     $t0,2($s0)
    addi   $s0,$s0,4
    sh     $t0,4($s0)
    addi   $s0,$s0,4
    sh     $t0,6($s0)
    addi   $s0,$s0,4
    addi   $s2,$s2,4
    j      LOOP_BEGIN7
END_LOOP7:

addi  $s2,$0,0
addi  $s1,$0,96
addi  $s0,$s0,8

LOOP_BEGIN8:
    beq    $s2,$s1,END_LOOP8
    lw     $t0,0($s2)
    sb     $t0,-5($s0)
    addi   $s0,$s0,4
    sb     $t0,-4($s0)
    addi   $s0,$s0,4
    sb     $t0,-3($s0)
    addi   $s0,$s0,4
    sb     $t0,-2($s0)
    addi   $s0,$s0,4
    sb     $t0,-1($s0)
    addi   $s0,$s0,4
    sb     $t0,0($s0)
    addi   $s0,$s0,4
    sb     $t0,1($s0)
```

```
    addi  $s0,$s0,4
    sb    $t0,2($s0)
    addi  $s0,$s0,4
    sb    $t0,3($s0)
    addi  $s0,$s0,4
    sb    $t0,4($s0)
    addi  $s0,$s0,4
    sb    $t0,5($s0)
    addi  $s0,$s0,4
    addi  $s2,$s2,4
    j     LOOP_BEGIN8
END_LOOP8:

addi  $t2,$0,2222
sw    $t2,0($s0)
addi  $s0,$s0,4
addi  $t2,$0,3333
sw    $t2,0($s0)
addi  $s0,$s0,4
addi  $t2,$0,4444
sw    $t2,0($s0)
addi  $s0,$s0,4


--------------------------------------------------
addi  $1,$1,23333
addi  $2,$2,23333
addi  $3,$3,23333
addi  $4,$4,23333
addi  $5,$5,23333
addi  $6,$6,23333
addi  $7,$7,23333
addi  $8,$8,23333
addi  $9,$9,23333
addi  $10,$10,23333
addi  $11,$11,23333
addi  $12,$12,23333
addi  $13,$13,23333
addi  $14,$14,23333
addi  $15,$15,23333
addi  $16,$16,23333
addi  $17,$17,23333
addi  $18,$18,23333
```

```
addi   $19,$19,23333
addi   $20,$20,23333
addi   $21,$21,23333
addi   $22,$22,23333
addi   $23,$23,23333
addi   $24,$24,23333
addi   $25,$25,23333
addi   $26,$26,23333
addi   $27,$27,23333
addi   $28,$28,23333
addi   $29,$29,23333
addi   $30,$30,23333
addi   $31,$31,23333


addi  $s1,$0,0


addi  $t1,$0,0
andi  $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,0
andi  $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,0
andi  $t2,$t1,-1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,0
andi  $t2,$t1,2147483647
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,0
andi  $t2,$t1,-2147483648
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,0
```

```
andi    $t2,$t1,134325
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,0
andi    $t2,$t1,-52435523
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,1
andi    $t2,$t1,0
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,1
andi    $t2,$t1,1
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,1
andi    $t2,$t1,-1
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,1
andi    $t2,$t1,2147483647
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,1
andi    $t2,$t1,-2147483648
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,1
andi    $t2,$t1,134325
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,1
andi    $t2,$t1,-52435523
sw      $t2,0($s1)
```

```
addi  $s1,$s1,4

addi  $t1,$0,-1
andi  $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-1
andi  $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-1
andi  $t2,$t1,-1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-1
andi  $t2,$t1,2147483647
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-1
andi  $t2,$t1,-2147483648
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-1
andi  $t2,$t1,134325
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-1
andi  $t2,$t1,-52435523
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,2147483647
andi  $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4
```

```
addi   $t1,$0,2147483647
andi   $t2,$t1,1
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,2147483647
andi   $t2,$t1,-1
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,2147483647
andi   $t2,$t1,2147483647
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,2147483647
andi   $t2,$t1,-2147483648
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,2147483647
andi   $t2,$t1,134325
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,2147483647
andi   $t2,$t1,-52435523
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,-2147483648
andi   $t2,$t1,0
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,-2147483648
andi   $t2,$t1,1
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,-2147483648
andi   $t2,$t1,-1
```

```
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,-2147483648
andi    $t2,$t1,2147483647
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,-2147483648
andi    $t2,$t1,-2147483648
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,-2147483648
andi    $t2,$t1,134325
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,-2147483648
andi    $t2,$t1,-52435523
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,134325
andi    $t2,$t1,0
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,134325
andi    $t2,$t1,1
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,134325
andi    $t2,$t1,-1
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,134325
andi    $t2,$t1,2147483647
sw      $t2,0($s1)
addi    $s1,$s1,4
```

```
addi   $t1,$0,134325
andi   $t2,$t1,-2147483648
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,134325
andi   $t2,$t1,134325
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,134325
andi   $t2,$t1,-52435523
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,-52435523
andi   $t2,$t1,0
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,-52435523
andi   $t2,$t1,1
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,-52435523
andi   $t2,$t1,-1
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,-52435523
andi   $t2,$t1,2147483647
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,-52435523
andi   $t2,$t1,-2147483648
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,-52435523
```

```
andi  $t2,$t1,134325
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-52435523
andi  $t2,$t1,-52435523
sw    $t2,0($s1)
addi  $s1,$s1,4


#-------------------------------------

addi  $t1,$0,0
ori      $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,0
ori      $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,0
ori      $t2,$t1,-1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,0
ori      $t2,$t1,2147483647
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,0
ori      $t2,$t1,-2147483648
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,0
ori      $t2,$t1,134325
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,0
```

```
ori     $t2,$t1,-52435523
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
ori     $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
ori     $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
ori     $t2,$t1,-1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
ori     $t2,$t1,2147483647
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
ori     $t2,$t1,-2147483648
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
ori     $t2,$t1,134325
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
ori     $t2,$t1,-52435523
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-1
ori     $t2,$t1,0
sw    $t2,0($s1)
```

```
addi  $s1,$s1,4


addi  $t1,$0,-1
ori       $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-1
ori       $t2,$t1,-1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-1
ori       $t2,$t1,2147483647
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-1
ori       $t2,$t1,-2147483648
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-1
ori       $t2,$t1,134325
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-1
ori       $t2,$t1,-52435523
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
ori       $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
ori       $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4
```

```
addi   $t1,$0,2147483647
ori        $t2,$t1,-1
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,2147483647
ori        $t2,$t1,2147483647
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,2147483647
ori        $t2,$t1,-2147483648
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,2147483647
ori        $t2,$t1,134325
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,2147483647
ori        $t2,$t1,-52435523
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,-2147483648
ori        $t2,$t1,0
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,-2147483648
ori        $t2,$t1,1
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,-2147483648
ori        $t2,$t1,-1
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,-2147483648
ori        $t2,$t1,2147483647
```

```
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,-2147483648
ori       $t2,$t1,-2147483648
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,-2147483648
ori       $t2,$t1,134325
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,-2147483648
ori       $t2,$t1,-52435523
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,134325
ori       $t2,$t1,0
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,134325
ori       $t2,$t1,1
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,134325
ori       $t2,$t1,-1
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,134325
ori       $t2,$t1,2147483647
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,134325
ori       $t2,$t1,-2147483648
sw      $t2,0($s1)
addi    $s1,$s1,4
```

```
addi   $t1,$0,134325
ori       $t2,$t1,134325
sw    $t2,0($s1)
addi  $s1,$s1,4


addi   $t1,$0,134325
ori       $t2,$t1,-52435523
sw    $t2,0($s1)
addi  $s1,$s1,4


addi   $t1,$0,-52435523
ori       $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4


addi   $t1,$0,-52435523
ori       $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi   $t1,$0,-52435523
ori       $t2,$t1,-1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi   $t1,$0,-52435523
ori       $t2,$t1,2147483647
sw    $t2,0($s1)
addi  $s1,$s1,4


addi   $t1,$0,-52435523
ori       $t2,$t1,-2147483648
sw    $t2,0($s1)
addi  $s1,$s1,4


addi   $t1,$0,-52435523
ori       $t2,$t1,134325
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-52435523
```

```
ori     $t2,$t1,-52435523
sw    $t2,0($s1)
addi  $s1,$s1,4


#----------------------------------------

addi  $t1,$0,-1
addiu $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,0
addiu $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
addiu $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-32453245
addiu $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,24535436
addiu $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,2147483647
addiu $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-2147483648
addiu $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-1
```

```
addiu $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,0
addiu $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
addiu $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-32453245
addiu $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,24535436
addiu $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,2147483647
addiu $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-2147483648
addiu $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-1
addiu $t2,$t1,8
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,0
addiu $t2,$t1,8
sw    $t2,0($s1)
```

```
addi  $s1,$s1,4

addi  $t1,$0,1
addiu $t2,$t1,8
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-32453245
addiu $t2,$t1,8
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,24535436
addiu $t2,$t1,8
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,2147483647
addiu $t2,$t1,8
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-2147483648
addiu $t2,$t1,8
sw    $t2,0($s1)
addi  $s1,$s1,4

#-----------------------------------------

addi  $t1,$0,-1
sll     $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,0
sll     $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
sll     $t2,$t1,0
sw    $t2,0($s1)
```

```
addi  $s1,$s1,4


addi  $t1,$0,-32453245
sll     $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,24535436
sll     $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
sll     $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-2147483648
sll     $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-1
sll     $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,0
sll     $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,1
sll     $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-32453245
sll     $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4
```

```
addi  $t1,$0,24535436
sll     $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
sll     $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-2147483648
sll     $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-1
sll     $t2,$t1,8
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,0
sll     $t2,$t1,8
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,1
sll     $t2,$t1,8
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-32453245
sll     $t2,$t1,8
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,24535436
sll     $t2,$t1,8
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
sll     $t2,$t1,8
```

```
sw      $t2,0($s1)
addi    $s1,$s1,4


addi    $t1,$0,-2147483648
sll     $t2,$t1,8
sw      $t2,0($s1)
addi    $s1,$s1,4


#-----------------------------------------

addi    $t1,$0,-1
srl     $t2,$t1,0
sw      $t2,0($s1)
addi    $s1,$s1,4


addi    $t1,$0,0
srl     $t2,$t1,0
sw      $t2,0($s1)
addi    $s1,$s1,4


addi    $t1,$0,1
srl     $t2,$t1,0
sw      $t2,0($s1)
addi    $s1,$s1,4


addi    $t1,$0,-32453245
srl     $t2,$t1,0
sw      $t2,0($s1)
addi    $s1,$s1,4


addi    $t1,$0,24535436
srl     $t2,$t1,0
sw      $t2,0($s1)
addi    $s1,$s1,4


addi    $t1,$0,2147483647
srl     $t2,$t1,0
sw      $t2,0($s1)
addi    $s1,$s1,4


addi    $t1,$0,-2147483648
srl     $t2,$t1,0
```

```
sw     $t2,0($s1)
addi   $s1,$s1,4

addi   $t1,$0,-1
srl     $t2,$t1,1
sw     $t2,0($s1)
addi   $s1,$s1,4

addi   $t1,$0,0
srl     $t2,$t1,1
sw     $t2,0($s1)
addi   $s1,$s1,4

addi   $t1,$0,1
srl     $t2,$t1,1
sw     $t2,0($s1)
addi   $s1,$s1,4

addi   $t1,$0,-32453245
srl     $t2,$t1,1
sw     $t2,0($s1)
addi   $s1,$s1,4

addi   $t1,$0,24535436
srl     $t2,$t1,1
sw     $t2,0($s1)
addi   $s1,$s1,4

addi   $t1,$0,2147483647
srl     $t2,$t1,1
sw     $t2,0($s1)
addi   $s1,$s1,4

addi   $t1,$0,-2147483648
srl     $t2,$t1,1
sw     $t2,0($s1)
addi   $s1,$s1,4

addi   $t1,$0,-1
srl     $t2,$t1,8
sw     $t2,0($s1)
addi   $s1,$s1,4
```

```
addi  $t1,$0,0
srl     $t2,$t1,8
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,1
srl     $t2,$t1,8
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-32453245
srl     $t2,$t1,8
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,24535436
srl     $t2,$t1,8
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
srl     $t2,$t1,8
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-2147483648
srl     $t2,$t1,8
sw    $t2,0($s1)
addi  $s1,$s1,4


#----------------------------------------

addi  $t2,$0,2222
sw    $t2,0($s1)
addi  $s1,$s1,4
addi  $t2,$0,3333
sw    $t2,0($s1)
addi  $s1,$s1,4
addi  $t2,$0,4444
sw    $t2,0($s1)
addi  $s1,$s1,4
```

```
---------------------------------------------
addi   $1,$1,23333
addi   $2,$2,23333
addi   $3,$3,23333
addi   $4,$4,23333
addi   $5,$5,23333
addi   $6,$6,23333
addi   $7,$7,23333
addi   $8,$8,23333
addi   $9,$9,23333
addi   $10,$10,23333
addi   $11,$11,23333
addi   $12,$12,23333
addi   $13,$13,23333
addi   $14,$14,23333
addi   $15,$15,23333
addi   $16,$16,23333
addi   $17,$17,23333
addi   $18,$18,23333
addi   $19,$19,23333
addi   $20,$20,23333
addi   $21,$21,23333
addi   $22,$22,23333
addi   $23,$23,23333
addi   $24,$24,23333
addi   $25,$25,23333
addi   $26,$26,23333
addi   $27,$27,23333
addi   $28,$28,23333
addi   $29,$29,23333
addi   $30,$30,23333
addi   $31,$31,23333

addi   $s1,$0,0

addi   $t1,$0,0
xori   $t2,$t1,0
sw     $t2,0($s1)
addi   $s1,$s1,4

addi   $t1,$0,0
```

```
xori  $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,0
xori  $t2,$t1,-1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,0
xori  $t2,$t1,2147483647
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,0
xori  $t2,$t1,-2147483648
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,0
xori  $t2,$t1,134325
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,0
xori  $t2,$t1,-52435523
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
xori  $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
xori  $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
xori  $t2,$t1,-1
sw    $t2,0($s1)
```

```
addi   $s1,$s1,4

addi   $t1,$0,1
xori   $t2,$t1,2147483647
sw     $t2,0($s1)
addi   $s1,$s1,4

addi   $t1,$0,1
xori   $t2,$t1,-2147483648
sw     $t2,0($s1)
addi   $s1,$s1,4

addi   $t1,$0,1
xori   $t2,$t1,134325
sw     $t2,0($s1)
addi   $s1,$s1,4

addi   $t1,$0,1
xori   $t2,$t1,-52435523
sw     $t2,0($s1)
addi   $s1,$s1,4

addi   $t1,$0,-1
xori   $t2,$t1,0
sw     $t2,0($s1)
addi   $s1,$s1,4

addi   $t1,$0,-1
xori   $t2,$t1,1
sw     $t2,0($s1)
addi   $s1,$s1,4

addi   $t1,$0,-1
xori   $t2,$t1,-1
sw     $t2,0($s1)
addi   $s1,$s1,4

addi   $t1,$0,-1
xori   $t2,$t1,2147483647
sw     $t2,0($s1)
addi   $s1,$s1,4
```

```
addi  $t1,$0,-1
xori  $t2,$t1,-2147483648
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-1
xori  $t2,$t1,134325
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-1
xori  $t2,$t1,-52435523
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
xori  $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
xori  $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
xori  $t2,$t1,-1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
xori  $t2,$t1,2147483647
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
xori  $t2,$t1,-2147483648
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
xori  $t2,$t1,134325
```

```
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,2147483647
xori    $t2,$t1,-52435523
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,-2147483648
xori    $t2,$t1,0
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,-2147483648
xori    $t2,$t1,1
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,-2147483648
xori    $t2,$t1,-1
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,-2147483648
xori    $t2,$t1,2147483647
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,-2147483648
xori    $t2,$t1,-2147483648
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,-2147483648
xori    $t2,$t1,134325
sw      $t2,0($s1)
addi    $s1,$s1,4

addi    $t1,$0,-2147483648
xori    $t2,$t1,-52435523
sw      $t2,0($s1)
addi    $s1,$s1,4
```

```
addi   $t1,$0,134325
xori   $t2,$t1,0
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,134325
xori   $t2,$t1,1
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,134325
xori   $t2,$t1,-1
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,134325
xori   $t2,$t1,2147483647
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,134325
xori   $t2,$t1,-2147483648
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,134325
xori   $t2,$t1,134325
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,134325
xori   $t2,$t1,-52435523
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,-52435523
xori   $t2,$t1,0
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,-52435523
```

```
xori  $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-52435523
xori  $t2,$t1,-1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-52435523
xori  $t2,$t1,2147483647
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-52435523
xori  $t2,$t1,-2147483648
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-52435523
xori  $t2,$t1,134325
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-52435523
xori  $t2,$t1,-52435523
sw    $t2,0($s1)
addi  $s1,$s1,4

#----------------------------------------

addi  $t1,$0,0
slti  $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,0
slti  $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,0
```

```
slti  $t2,$t1,-1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,0
slti  $t2,$t1,32767
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,0
slti  $t2,$t1,-32768
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,0
slti  $t2,$t1,13432
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,0
slti  $t2,$t1,-5243
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
slti  $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
slti  $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
slti  $t2,$t1,-1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
slti  $t2,$t1,32767
sw    $t2,0($s1)
```

```
addi  $s1,$s1,4


addi  $t1,$0,1
slti  $t2,$t1,-32768
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,1
slti  $t2,$t1,13432
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,1
slti  $t2,$t1,-5243
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-1
slti  $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-1
slti  $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-1
slti  $t2,$t1,-1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-1
slti  $t2,$t1,32767
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-1
slti  $t2,$t1,-32768
sw    $t2,0($s1)
addi  $s1,$s1,4
```

```
addi  $t1,$0,-1
slti  $t2,$t1,13432
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-1
slti  $t2,$t1,-5243
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
slti  $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
slti  $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
slti  $t2,$t1,-1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
slti  $t2,$t1,32767
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
slti  $t2,$t1,-32768
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
slti  $t2,$t1,13432
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
slti  $t2,$t1,-5243
```

```
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-2147483648
slti  $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-2147483648
slti  $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-2147483648
slti  $t2,$t1,-1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-2147483648
slti  $t2,$t1,32767
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-2147483648
slti  $t2,$t1,-32768
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-2147483648
slti  $t2,$t1,13432
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-2147483648
slti  $t2,$t1,-5243
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,134325
slti  $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4
```

```
addi   $t1,$0,134325
slti   $t2,$t1,1
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,134325
slti   $t2,$t1,-1
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,134325
slti   $t2,$t1,32767
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,134325
slti   $t2,$t1,-32768
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,134325
slti   $t2,$t1,13432
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,134325
slti   $t2,$t1,-5243
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,-52435523
slti   $t2,$t1,0
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,-52435523
slti   $t2,$t1,1
sw     $t2,0($s1)
addi   $s1,$s1,4


addi   $t1,$0,-52435523
```

```
slti  $t2,$t1,-1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-52435523
slti  $t2,$t1,32767
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-52435523
slti  $t2,$t1,-32768
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-52435523
slti  $t2,$t1,13432
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-52435523
slti  $t2,$t1,-5243
sw    $t2,0($s1)
addi  $s1,$s1,4


#----------------------------------------

addi  $t1,$0,0
sltiu $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,0
sltiu $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,0
sltiu $t2,$t1,-1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,0
```

```
sltiu $t2,$t1,32767
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,0
sltiu $t2,$t1,-32768
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,0
sltiu $t2,$t1,13432
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,0
sltiu $t2,$t1,-5243
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
sltiu $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
sltiu $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
sltiu $t2,$t1,-1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
sltiu $t2,$t1,32767
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
sltiu $t2,$t1,-32768
sw    $t2,0($s1)
```

```
addi  $s1,$s1,4

addi  $t1,$0,1
sltiu $t2,$t1,13432
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
sltiu $t2,$t1,-5243
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-1
sltiu $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-1
sltiu $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-1
sltiu $t2,$t1,-1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-1
sltiu $t2,$t1,32767
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-1
sltiu $t2,$t1,-32768
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-1
sltiu $t2,$t1,13432
sw    $t2,0($s1)
addi  $s1,$s1,4
```

```
addi  $t1,$0,-1
sltiu $t2,$t1,-5243
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
sltiu $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
sltiu $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
sltiu $t2,$t1,-1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
sltiu $t2,$t1,32767
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
sltiu $t2,$t1,-32768
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
sltiu $t2,$t1,13432
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,2147483647
sltiu $t2,$t1,-5243
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-2147483648
sltiu $t2,$t1,0
```

```
sw      $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-2147483648
sltiu $t2,$t1,1
sw      $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-2147483648
sltiu $t2,$t1,-1
sw      $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-2147483648
sltiu $t2,$t1,32767
sw      $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-2147483648
sltiu $t2,$t1,-32768
sw      $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-2147483648
sltiu $t2,$t1,13432
sw      $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-2147483648
sltiu $t2,$t1,-5243
sw      $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,134325
sltiu $t2,$t1,0
sw      $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,134325
sltiu $t2,$t1,1
sw      $t2,0($s1)
addi  $s1,$s1,4
```

```
addi  $t1,$0,134325
sltiu $t2,$t1,-1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,134325
sltiu $t2,$t1,32767
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,134325
sltiu $t2,$t1,-32768
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,134325
sltiu $t2,$t1,13432
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,134325
sltiu $t2,$t1,-5243
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-52435523
sltiu $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-52435523
sltiu $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-52435523
sltiu $t2,$t1,-1
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-52435523
```

```
sltiu $t2,$t1,32767
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-52435523
sltiu $t2,$t1,-32768
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-52435523
sltiu $t2,$t1,13432
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-52435523
sltiu $t2,$t1,-5243
sw    $t2,0($s1)
addi  $s1,$s1,4


#-----------------------------------------

addi  $t1,$0,-1
sra      $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,0
sra      $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,1
sra      $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,-32453245
sra      $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4


addi  $t1,$0,24535436
```

```
sra     $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,2147483647
sra     $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-2147483648
sra     $t2,$t1,0
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-1
sra     $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,0
sra     $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
sra     $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-32453245
sra     $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,24535436
sra     $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,2147483647
sra     $t2,$t1,1
sw    $t2,0($s1)
```

```
addi  $s1,$s1,4

addi  $t1,$0,-2147483648
sra      $t2,$t1,1
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-1
sra      $t2,$t1,8
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,0
sra      $t2,$t1,8
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,1
sra      $t2,$t1,8
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-32453245
sra      $t2,$t1,8
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,24535436
sra      $t2,$t1,8
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,2147483647
sra      $t2,$t1,8
sw    $t2,0($s1)
addi  $s1,$s1,4

addi  $t1,$0,-2147483648
sra      $t2,$t1,8
sw    $t2,0($s1)
addi  $s1,$s1,4
```

```
#-----------------------------------------

lui     $t2,0
sw    $t2,0($s1)
addi  $s1,$s1,4

lui     $t2,1
sw    $t2,0($s1)
addi  $s1,$s1,4

lui     $t2,4365
sw    $t2,0($s1)
addi  $s1,$s1,4

lui     $t2,3647
sw    $t2,0($s1)
addi  $s1,$s1,4

lui     $t2,648
sw    $t2,0($s1)
addi  $s1,$s1,4

lui     $t2,15
sw    $t2,0($s1)
addi  $s1,$s1,4

lui     $t2,1243
sw    $t2,0($s1)
addi  $s1,$s1,4

#-----------------------------------------

addi  $t2,$0,2222
sw    $t2,0($s1)
addi  $s1,$s1,4
addi  $t2,$0,3333
sw    $t2,0($s1)
addi  $s1,$s1,4
addi  $t2,$0,4444
sw    $t2,0($s1)
addi  $s1,$s1,4
```

```
--------------------------------------------------
j     MAIN

SOLVE:
    addi  $t0,$t0,1
    addi  $t1,$0,0

    addi  $t2,$0,0
    addi  $a1,$0,0
    LOOPSI0_BEGIN:
        slt       $a0,$a1,$s0
        beq       $a0,$0,END_LOOPSI0
        add       $t2,$t2,$s0
        addi  $a1,$a1,1
        j         LOOPSI0_BEGIN
    END_LOOPSI0:
    addi  $a1,$0,0
    LOOPSI1_BEGIN:
        slt       $a0,$a1,$s0
        beq       $a0,$0,END_LOOPSI1
        add       $t1,$t1,$t2
        addi  $a1,$a1,1
        j         LOOPSI1_BEGIN
    END_LOOPSI1:

    addi  $t2,$0,0
    addi  $a1,$0,0
    LOOPSJ0_BEGIN:
        slt       $a0,$a1,$s1
        beq       $a0,$0,END_LOOPSJ0
        add       $t2,$t2,$s1
        addi  $a1,$a1,1
        j         LOOPSJ0_BEGIN
    END_LOOPSJ0:
    addi  $a1,$0,0
    LOOPSJ1_BEGIN:
        slt       $a0,$a1,$s1
        beq       $a0,$0,END_LOOPSJ1
        add       $t1,$t1,$t2
        addi  $a1,$a1,1
        j         LOOPSJ1_BEGIN
    END_LOOPSJ1:
```

```
addi  $t2,$0,0
addi  $a1,$0,0
LOOPSK0_BEGIN:
    slt      $a0,$a1,$s2
    beq      $a0,$0,END_LOOPSK0
    add      $t2,$t2,$s2
    addi  $a1,$a1,1
    j       LOOPSK0_BEGIN
END_LOOPSK0:
addi  $a1,$0,0
LOOPSK1_BEGIN:
    slt      $a0,$a1,$s2
    beq      $a0,$0,END_LOOPSK1
    add      $t1,$t1,$t2
    addi  $a1,$a1,1
    j       LOOPSK1_BEGIN
END_LOOPSK1:

beq      $t0,$t1,PRINT
jr    $31
PRINT:
    sw    $t1,0($a2)
    addi  $a2,$a2,4
    jr    $31

MAIN:
addi  $s0,$0,1
addi  $t0,$t0,99
LOOPI_BEGIN:
    slti  $a0,$s0,10
    beq      $a0,$0,END_LOOPI
    addi  $s1,$0,0
    LOOPJ_BEGIN:
        slti  $a0,$s1,10
        beq      $a0,$0,END_LOOPJ
        addi  $s2,$0,0
        LOOPK_BEGIN:
            slti  $a0,$s2,10
            beq      $a0,$0,END_LOOPK
            jal       SOLVE
            addi  $s2,$s2,1
```

```
        j       LOOPK_BEGIN
    END_LOOPK:
    addi  $s1,$s1,1
        j       LOOPJ_BEGIN
  END_LOOPJ:
  addi  $s0,$s0,1
    j       LOOPI_BEGIN
END_LOOPI:

-------------------------------------------------
.data
  array:   .space 440

.text
  li     $t2,50
  sw     $t2,0($0)
  li     $t2,49
  sw     $t2,4($0)
  li     $t2,48
  sw     $t2,8($0)
  li     $t2,47
  sw     $t2,12($0)
  li     $t2,46
  sw     $t2,16($0)
  li     $t2,45
  sw     $t2,20($0)
  li     $t2,44
  sw     $t2,24($0)
  li     $t2,43
  sw     $t2,28($0)
  li     $t2,42
  sw     $t2,32($0)
  li     $t2,41
  sw     $t2,36($0)
  li     $t2,40
  sw     $t2,40($0)
  li     $t2,39
  sw     $t2,44($0)
  li     $t2,38
  sw     $t2,48($0)
  li     $t2,37
  sw     $t2,52($0)
```

```
li    $t2,36
sw    $t2,56($0)
li    $t2,35
sw    $t2,60($0)
li    $t2,34
sw    $t2,64($0)
li    $t2,33
sw    $t2,68($0)
li    $t2,32
sw    $t2,72($0)
li    $t2,31
sw    $t2,76($0)
li    $t2,30
sw    $t2,80($0)
li    $t2,29
sw    $t2,84($0)
li    $t2,28
sw    $t2,88($0)
li    $t2,27
sw    $t2,92($0)
li    $t2,26
sw    $t2,96($0)
li    $t2,25
sw    $t2,100($0)
li    $t2,24
sw    $t2,104($0)
li    $t2,23
sw    $t2,108($0)
li    $t2,22
sw    $t2,112($0)
li    $t2,21
sw    $t2,116($0)
li    $t2,20
sw    $t2,120($0)
li    $t2,19
sw    $t2,124($0)
li    $t2,18
sw    $t2,128($0)
li    $t2,17
sw    $t2,132($0)
li    $t2,16
sw    $t2,136($0)
```

```
li      $t2,15
sw      $t2,140($0)
li      $t2,14
sw      $t2,144($0)
li      $t2,13
sw      $t2,148($0)
li      $t2,12
sw      $t2,152($0)
li      $t2,11
sw      $t2,156($0)
li      $t2,10
sw      $t2,160($0)
li      $t2,9
sw      $t2,164($0)
li      $t2,8
sw      $t2,168($0)
li      $t2,7
sw      $t2,172($0)
li      $t2,6
sw      $t2,176($0)
li      $t2,5
sw      $t2,180($0)
li      $t2,4
sw      $t2,184($0)
li      $t2,3
sw      $t2,188($0)
li      $t2,2
sw      $t2,192($0)
li      $t2,1
sw      $t2,196($0)
li      $t2,100
sw      $t2,200($0)
li      $t2,99
sw      $t2,204($0)
li      $t2,98
sw      $t2,208($0)
li      $t2,97
sw      $t2,212($0)
li      $t2,96
sw      $t2,216($0)
li      $t2,95
sw      $t2,220($0)
```

```
li      $t2,94
sw      $t2,224($0)
li      $t2,93
sw      $t2,228($0)
li      $t2,92
sw      $t2,232($0)
li      $t2,91
sw      $t2,236($0)
li      $t2,90
sw      $t2,240($0)
li      $t2,89
sw      $t2,244($0)
li      $t2,88
sw      $t2,248($0)
li      $t2,87
sw      $t2,252($0)
li      $t2,86
sw      $t2,256($0)
li      $t2,85
sw      $t2,260($0)
li      $t2,84
sw      $t2,264($0)
li      $t2,83
sw      $t2,268($0)
li      $t2,82
sw      $t2,272($0)
li      $t2,81
sw      $t2,276($0)
li      $t2,80
sw      $t2,280($0)
li      $t2,79
sw      $t2,284($0)
li      $t2,78
sw      $t2,288($0)
li      $t2,77
sw      $t2,292($0)
li      $t2,76
sw      $t2,296($0)
li      $t2,75
sw      $t2,300($0)
li      $t2,74
sw      $t2,304($0)
```

```
li    $t2,73
sw    $t2,308($0)
li    $t2,72
sw    $t2,312($0)
li    $t2,71
sw    $t2,316($0)
li    $t2,70
sw    $t2,320($0)
li    $t2,69
sw    $t2,324($0)
li    $t2,68
sw    $t2,328($0)
li    $t2,67
sw    $t2,332($0)
li    $t2,66
sw    $t2,336($0)
li    $t2,65
sw    $t2,340($0)
li    $t2,64
sw    $t2,344($0)
li    $t2,63
sw    $t2,348($0)
li    $t2,62
sw    $t2,352($0)
li    $t2,61
sw    $t2,356($0)
li    $t2,60
sw    $t2,360($0)
li    $t2,59
sw    $t2,364($0)
li    $t2,58
sw    $t2,368($0)
li    $t2,57
sw    $t2,372($0)
li    $t2,56
sw    $t2,376($0)
li    $t2,55
sw    $t2,380($0)
li    $t2,54
sw    $t2,384($0)
li    $t2,53
sw    $t2,388($0)
```

```
    li     $t2,52
    sw     $t2,392($0)
    li     $t2,51
    sw     $t2,396($0)
    #----------------------
    li     $29,12284
    li     $s0,100
    li     $s1,0
    subi   $s2,$s0,1
    jal      QSORT
    j      ENDED

QSORT:
    sub      $t0,$s1,$s2
    bgez   $t0,BACK
    add      $s3,$s1,$s2
    srl      $s3,$s3,1
    #----------------------------
    sll      $a0,$s1,2
    lw     $t1,array($a0)
    sll      $a0,$s2,2
    lw     $t2,array($a0)
    sub      $t0,$t1,$t2
    bgtz   $t0,SWAPLR
    j      AFTERSWAPLR
    SWAPLR:
        sll      $a0,$s1,2
        sw     $t2,array($a0)
        sll      $a0,$s2,2
        sw     $t1,array($a0)
    AFTERSWAPLR:
    #----------------------------
    sll      $a0,$s3,2
    lw     $t1,array($a0)
    sll      $a0,$s2,2
    lw     $t2,array($a0)
    sub      $t0,$t1,$t2
    bgtz   $t0,SWAPRMID
    j      AFTERSWAPRMID
    SWAPRMID:
        sll      $a0,$s3,2
        sw     $t2,array($a0)
```

```
    sll     $a0,$s2,2
    sw   $t1,array($a0)
AFTERSWAPRMID:
#-----------------------------
sll     $a0,$s3,2
lw   $t1,array($a0)
sll     $a0,$s1,2
lw   $t2,array($a0)
sub     $t0,$t1,$t2
bgtz  $t0,SWAPLMID
j     AFTERSWAPLMID
SWAPLMID:
    sll     $a0,$s3,2
    sw   $t2,array($a0)
    sll     $a0,$s1,2
    sw   $t1,array($a0)
AFTERSWAPLMID:
#-----------------------------
move    $t4,$s1
move    $t5,$s2
sll     $a0,$s1,2
lw      $t6,array($a0)
#-----------------------------
OUT_WHILE_BEGIN:
    beq     $t4,$t5,OUT_WHILE_END
    WHILE_J_BEGIN:
        sll     $a0,$t5,2
        lw   $t0,array($a0)
        sub     $t1,$t0,$t6
        bgez  $t1,JMAY_RIGHT
        j     WHILE_J_END
        JMAY_RIGHT:
        sub     $t1,$t4,$t5
        bltz  $t1,JIS_RIGHT
        j     WHILE_J_END
        JIS_RIGHT:
        subi  $t5,$t5,1
        j     WHILE_J_BEGIN
    WHILE_J_END:
    #-------------------------------
    WHILE_I_BEGIN:
        sll     $a0,$t4,2
```

```
        lw      $t0,array($a0)
        sub     $t1,$t0,$t6
        blez    $t1,IMAY_RIGHT
        j       WHILE_I_END
        IMAY_RIGHT:
        sub     $t1,$t4,$t5
        bltz    $t1,IIS_RIGHT
        j       WHILE_I_END
        IIS_RIGHT:
        addi    $t4,$t4,1
        j       WHILE_I_BEGIN
    WHILE_I_END:
    #--------------------------------
    sub     $t1,$t4,$t5
    bltz    $t1,TO_SWAP
    j       OUT_WHILE_BEGIN
    TO_SWAP:
        sll     $a0,$t4,2
        lw      $t0,array($a0)
        sll     $a0,$t5,2
        lw      $t1,array($a0)
        sll     $a0,$t4,2
        sw      $t1,array($a0)
        sll     $a0,$t5,2
        sw      $t0,array($a0)
    j       OUT_WHILE_BEGIN
  OUT_WHILE_END:
  sll     $a0,$t4,2
  lw      $t0,array($a0)
  sll     $a0,$s1,2
  sw      $t0,array($a0)
  sll     $a0,$t4,2
  sw      $t6,array($a0)
  move    $s3,$t4
  move    $t5,$t4
  #------------------------------
  WHILE_SUBI_BEGIN:
      sub     $t0,$t4,$s1
      bltz    $t0,WHILE_SUBI_END
      sll     $a0,$t4,2
      lw      $t0,array($a0)
      sll     $a0,$s3,2
```

```
    lw    $t1,array($a0)
    bne      $t0,$t1,WHILE_SUBI_END
    subi  $t4,$t4,1
    j       WHILE_SUBI_BEGIN
WHILE_SUBI_END:
WHILE_ADDJ_BEGIN:
    sub      $t0,$t5,$s2
    bgtz  $t0,WHILE_ADDJ_END
    sll      $a0,$t5,2
    lw    $t0,array($a0)
    sll      $a0,$s3,2
    lw    $t1,array($a0)
    bne      $t0,$t1,WHILE_ADDJ_END
    addi  $t5,$t5,1
    j       WHILE_ADDJ_BEGIN
WHILE_ADDJ_END:
    #------------------------------
    sw    $31,0($sp)
    subi  $sp,$sp,4
    sw    $t5,0($sp)
    subi  $sp,$sp,4
    sw    $s2,0($sp)
    subi  $sp,$sp,4
    move  $s2,$t4
    jal      QSORT
    addi  $sp,$sp,4
    lw    $s2,0($sp)
    addi  $sp,$sp,4
    lw    $t5,0($sp)
    addi  $sp,$sp,4
    lw    $31,0($sp)
    #------------------------------
    sw    $31,0($sp)
    subi  $sp,$sp,4
    move  $s1,$t5
    jal      QSORT
    addi  $sp,$sp,4
    lw    $31,0($sp)
BACK:
    jr    $31


ENDED:
```

```
li     $s1,400
addi   $t2,$0,2222
sw     $t2,0($s1)
addi   $s1,$s1,4
addi   $t2,$0,3333
sw     $t2,0($s1)
addi   $s1,$s1,4
addi   $t2,$0,4444
sw     $t2,0($s1)
addi   $s1,$s1,4
```

```
li     $s1,400
addi   $t2,$0,2222
```