2022 計算機組織
Computer Organization

Lab 3 Report

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Question List

Q1 : Why the immediate of jal & branch doesn't include imm[0] ?
What's the advantage of this design?
Why we need jalr ?

(a) In RV32I, each instruction occupies 4 bytes, therefore, the offset of jal must be a multiple of 4. However, there are also 16 bits instructions in compressed extension ISA, so there may be some mixture of 32bits and 16bits instructions. Since all instructions are multiple of 2, there's no need of imm[0], since that it will always be 0.

(b) In order to solve the problems of compressed extension ISA.

(c) Because the instruction "jal" can only jump to the instructions within the distance of +/- Mib, we need jalr to jump to the instructions out of this distance.

Q2 : Please explain RISC-V calling convention in your word

There are two critical procedures during function call.

(a) ra and callee save: all function-like instruction blocks, including main, functions, should manually save ra and callee registers before starting the function; after the function itself is finished, the blocks should retrieve ra and callee registers for its caller before return to it.

(b) Caller save: before calling a function, the caller must manually make a copy of its registers' information since the callee won't do it for caller. After the end of the function, the caller should also retrieve the information from stack in order to continue without the loss of data.

Q3 : Why there is no bgt(u) / ble(u) in standard RV32I ?

Because theoretically, it will be sufficient with bge and blt since the function of bgt a, b, offset can be achieved by blt b, a, offset; And the function of ble a, b, offset can be achieved by bge g, a, offset. Since the memory space of the rom on the chip is limited, it would be better to keep as less instructions as possible.

Q4 : We can find that auipc, jal, branch are all PC-relative instructions.
What's the advantage of PC-relative ?

Compared to writing address directly, using pc-relative instruction not only accesses less ram but also faster.

Exercise 1

⑩ 0x01000000 ~ 0x01000078

Address	Word	Byte 0	Byte 1	Byte 2	Byte 3
0x01000078	0x00000000	0x00	0x00	0x00	0x00
0x01000074	0x00000000	0x00	0x00	0x00	0x00
0x01000070	0x00000001	0x01	0x00	0x00	0x00
0x0100006c	0x00000001	0x01	0x00	0x00	0x00
0x01000068	0x00000001	0x01	0x00	0x00	0x00
0x01000064	0x00000001	0x01	0x00	0x00	0x00
0x01000060	0x00000001	0x01	0x00	0x00	0x00
0x0100005c	0x00000000	0x00	0x00	0x00	0x00
0x01000058	0x00000001	0x01	0x00	0x00	0x00
0x01000054	0xffffffff	0xff	0xff	0xff	0xff
0x01000050	0x00000001	0x01	0x00	0x00	0x00
0x0100004c	0x00000000	0x00	0x00	0x00	0x00
0x01000048	0x00000001	0x01	0x00	0x00	0x00
0x01000044	0xfffffffe	0xfe	0xff	0xff	0xff
0x01000040	0x00000001	0x01	0x00	0x00	0x00
0x0100003c	0xfffffffe	0xfe	0xff	0xff	0xff
0x01000038	0x00000001	0x01	0x00	0x00	0x00
0x01000034	0x00000000	0x00	0x00	0x00	0x00
0x01000030	0x00000001	0x01	0x00	0x00	0x00
0x0100002c	0x00000005	0x05	0x00	0x00	0x00
0x01000028	0x00000001	0x01	0x00	0x00	0x00
0x01000024	0x00000002	0x02	0x00	0x00	0x00
0x01000020	0x00000001	0x01	0x00	0x00	0x00
0x0100001c	0x00000001	0x01	0x00	0x00	0x00
0x01000018	0x00000001	0x01	0x00	0x00	0x00
0x01000014	0x00000000	0x00	0x00	0x00	0x00
0x01000010	0x00000001	0x01	0x00	0x00	0x00
0x0100000c	0x00000000	0x00	0x00	0x00	0x00
0x01000008	0x00000001	0x01	0x00	0x00	0x00
0x01000004	0x00000000	0x00	0x00	0x00	0x00
0x01000000	0x00000000	0x00	0x00	0x00	0x00

Exercise 2

⑩ 0x01000000 ~ 0x01000090

0x01000090	0x00000000	0x00	0x00	0x00	0x00
0x0100008c	0x00000000	0x00	0x00	0x00	0x00
0x01000088	0x00000001	0x01	0x00	0x00	0x00
0x01000084	0x000002d9	0xd9	0x02	0x00	0x00
0x01000080	0x00000001	0x01	0x00	0x00	0x00
0x0100007c	0xffffff0d	0x0d	0xff	0xff	0xff
0x01000078	0x00000001	0x01	0x00	0x00	0x00
0x01000074	0x00000000	0x00	0x00	0x00	0x00
0x01000070	0x00000001	0x01	0x00	0x00	0x00
0x0100006c	0x00000008	0x08	0x00	0x00	0x00
0x01000068	0x00000001	0x01	0x00	0x00	0x00
0x01000064	0x00000001	0x01	0x00	0x00	0x00
0x01000060	0x00000001	0x01	0x00	0x00	0x00
0x0100005c	0xffffffff	0xff	0xff	0xff	0xff
0x01000058	0x00000001	0x01	0x00	0x00	0x00
0x01000054	0x00000001	0x01	0x00	0x00	0x00
0x01000050	0x00000001	0x01	0x00	0x00	0x00
0x0100004c	0x00000001	0x01	0x00	0x00	0x00
0x01000048	0x00000001	0x01	0x00	0x00	0x00

0x01000048	0x00000001	0x01	0x00	0x00	0x00
0x01000044	0xffffffff	0xff	0xff	0xff	0xff
0x01000040	0x00000001	0x01	0x00	0x00	0x00
0x0100003c	0x00000001	0x01	0x00	0x00	0x00
0x01000038	0x00000001	0x01	0x00	0x00	0x00
0x01000034	0x00000001	0x01	0x00	0x00	0x00
0x01000030	0x00000001	0x01	0x00	0x00	0x00
0x0100002c	0x00000001	0x01	0x00	0x00	0x00
0x01000028	0x00000001	0x01	0x00	0x00	0x00
0x01000024	0x00000001	0x01	0x00	0x00	0x00
0x01000020	0x00000001	0x01	0x00	0x00	0x00
0x0100001c	0x00000001	0x01	0x00	0x00	0x00
0x01000018	0x00000001	0x01	0x00	0x00	0x00
0x01000014	0x00000000	0x00	0x00	0x00	0x00
0x01000010	0x00000001	0x01	0x00	0x00	0x00
0x0100000c	0x00000000	0x00	0x00	0x00	0x00
0x01000008	0x00000000	0x00	0x00	0x00	0x00
0x01000004	0x00000000	0x00	0x00	0x00	0x00
0x01000000	0x00000000	0x00	0x00	0x00	0x00

Exercise 3

❿ 0x01000000 ~ 0x01000014

0x01000014	0x00000000	0x00	0x00	0x00	0x00
0x01000010	0x00375f00	0x00	0x5f	0x37	0x00
0x0100000c	0x00000078	0x78	0x00	0x00	0x00
0x01000008	0x00000001	0x01	0x00	0x00	0x00
0x01000004	0x00000001	0x01	0x00	0x00	0x00
0x01000000	0xffffffff	0xff	0xff	0xff	0xff

Exercise 4

❿ 0x01000000 ~ 0x01000088

0x01000088	0xffffffce	0xce	0xff	0xff	0xff
0x01000084	0x00000031	0x31	0x00	0x00	0x00
0x01000080	0x0000002f	0x2f	0x00	0x00	0x00
0x0100007c	0x0000002e	0x2e	0x00	0x00	0x00
0x01000078	0x0000002d	0x2d	0x00	0x00	0x00
0x01000074	0x0000002d	0x2d	0x00	0x00	0x00
0x01000070	0x0000002b	0x2b	0x00	0x00	0x00
0x0100006c	0x00000029	0x29	0x00	0x00	0x00
0x01000068	0x00000028	0x28	0x00	0x00	0x00
0x01000064	0x00000028	0x28	0x00	0x00	0x00
0x01000060	0x00000027	0x27	0x00	0x00	0x00
0x0100005c	0x00000026	0x26	0x00	0x00	0x00
0x01000058	0x00000025	0x25	0x00	0x00	0x00
0x01000054	0x00000025	0x25	0x00	0x00	0x00
0x01000050	0x0000001e	0x1e	0x00	0x00	0x00
0x0100004c	0x0000001b	0x1b	0x00	0x00	0x00
0x01000048	0x00000018	0x18	0x00	0x00	0x00
0x01000044	0x00000017	0x17	0x00	0x00	0x00

0x01000040	0x00000017	0x17	0x00	0x00	0x00
0x0100003c	0x00000017	0x17	0x00	0x00	0x00
0x01000038	0x00000012	0x12	0x00	0x00	0x00
0x01000034	0x00000012	0x12	0x00	0x00	0x00
0x01000030	0x00000010	0x10	0x00	0x00	0x00
0x0100002c	0x0000000f	0x0f	0x00	0x00	0x00
0x01000028	0x0000000c	0x0c	0x00	0x00	0x00
0x01000024	0x0000000b	0x0b	0x00	0x00	0x00
0x01000020	0x0000000a	0x0a	0x00	0x00	0x00
0x0100001c	0x0000000a	0x0a	0x00	0x00	0x00
0x01000018	0x00000008	0x08	0x00	0x00	0x00
0x01000014	0x00000006	0x06	0x00	0x00	0x00
0x01000010	0x00000003	0x03	0x00	0x00	0x00
0x0100000c	0x00000003	0x03	0x00	0x00	0x00
0x01000008	0x00000001	0x01	0x00	0x00	0x00
0x01000004	0x00000001	0x01	0x00	0x00	0x00
0x01000000	0x00000000	0x00	0x00	0x00	0x00

❿ 0x01000088 ~ 0x010000d4

0x010000d0	0x00000000	0x00	0x00	0x00	0x00
0x010000cc	0xffffffff	0xff	0xff	0xff	0xff
0x010000c8	0xfffffffe	0xfe	0xff	0xff	0xff
0x010000c4	0xfffffffd	0xfd	0xff	0xff	0xff
0x010000c0	0xfffffffa	0xfa	0xff	0xff	0xff
0x010000bc	0xfffffffa	0xfa	0xff	0xff	0xff
0x010000b8	0xfffffff7	0xf7	0xff	0xff	0xff
0x010000b4	0xfffffff3	0xf3	0xff	0xff	0xff
0x010000b0	0xffffffef	0xef	0xff	0xff	0xff
0x010000ac	0xffffffed	0xed	0xff	0xff	0xff
0x010000a8	0xffffffeb	0xeb	0xff	0xff	0xff
0x010000a4	0xffffffea	0xea	0xff	0xff	0xff
0x010000a0	0xffffffe9	0xe9	0xff	0xff	0xff
0x0100009c	0xffffffe2	0xe2	0xff	0xff	0xff
0x01000098	0xffffffd2	0xd2	0xff	0xff	0xff
0x01000094	0xffffffd1	0xd1	0xff	0xff	0xff
0x01000090	0xffffffd1	0xd1	0xff	0xff	0xff
0x0100008c	0xffffffce	0xce	0xff	0xff	0xff
0x01000088	0xffffffce	0xce	0xff	0xff	0xff

❿ 0x010000d4 ~ 0x01000148

0x01000144	0x0000002e	0x2e	0x00	0x00	0x00
0x01000140	0x00000023	0x23	0x00	0x00	0x00
0x0100013c	0x00000017	0x17	0x00	0x00	0x00
0x01000138	0x00000017	0x17	0x00	0x00	0x00
0x01000134	0x00000016	0x16	0x00	0x00	0x00
0x01000130	0x00000013	0x13	0x00	0x00	0x00
0x0100012c	0x0000000f	0x0f	0x00	0x00	0x00
0x01000128	0x00000009	0x09	0x00	0x00	0x00
0x01000124	0x00000003	0x03	0x00	0x00	0x00
0x01000120	0x00000000	0x00	0x00	0x00	0x00
0x0100011c	0x00000000	0x00	0x00	0x00	0x00
0x01000118	0x00000000	0x00	0x00	0x00	0x00
0x01000114	0xfffffffe	0xfe	0xff	0xff	0xff
0x01000110	0xfffffff0	0xf0	0xff	0xff	0xff
0x0100010c	0xffffffef	0xef	0xff	0xff	0xff
0x01000108	0xffffffee	0xee	0xff	0xff	0xff
0x01000104	0xffffffee	0xee	0xff	0xff	0xff
0x01000100	0xffffffee	0xee	0xff	0xff	0xff
0x010000fc	0xffffffe9	0xe9	0xff	0xff	0xff
0x010000f8	0xffffffe8	0xe8	0xff	0xff	0xff
0x010000f4	0xffffffe3	0xe3	0xff	0xff	0xff
0x010000f0	0xffffffe3	0xe3	0xff	0xff	0xff
0x010000ec	0xffffffdb	0xdb	0xff	0xff	0xff
0x010000e8	0xffffffd6	0xd6	0xff	0xff	0xff
0x010000e4	0xffffffd5	0xd5	0xff	0xff	0xff
0x010000e0	0xffffffd4	0xd4	0xff	0xff	0xff
0x010000dc	0xffffffd2	0xd2	0xff	0xff	0xff
0x010000d8	0xffffffd2	0xd2	0xff	0xff	0xff
0x010000d4	0xffffffcf	0xcf	0xff	0xff	0xff