Position Independent Code
Position Independent Data

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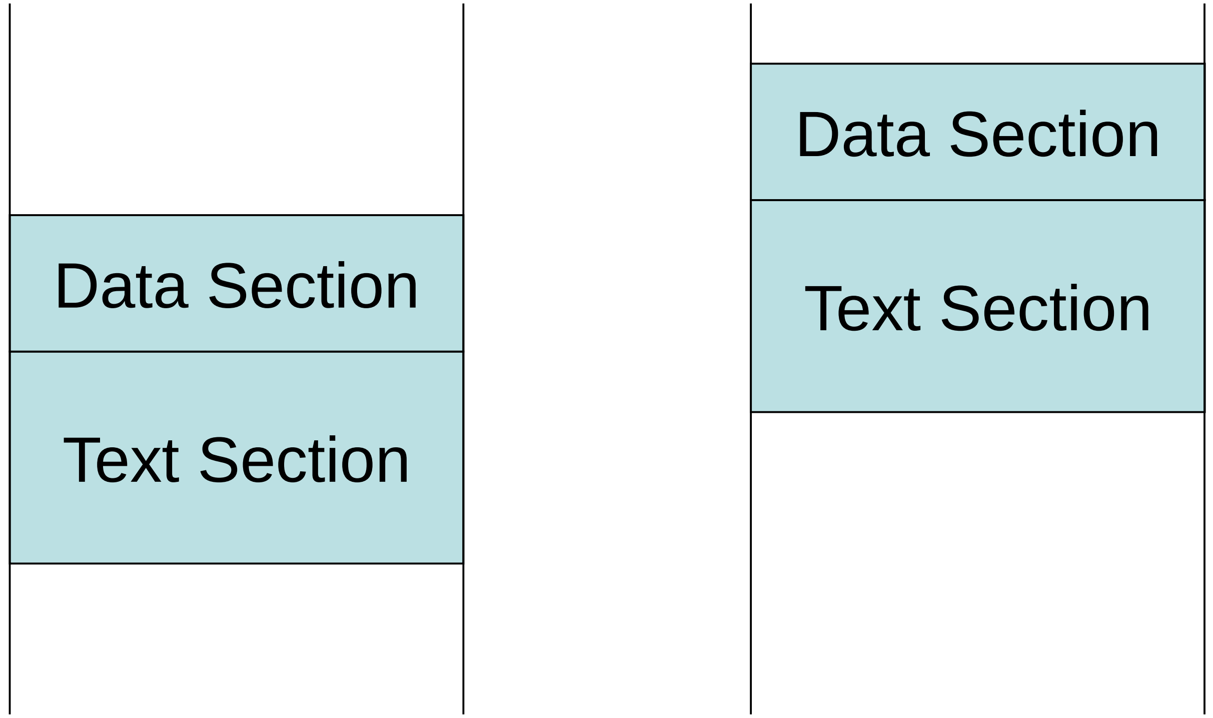
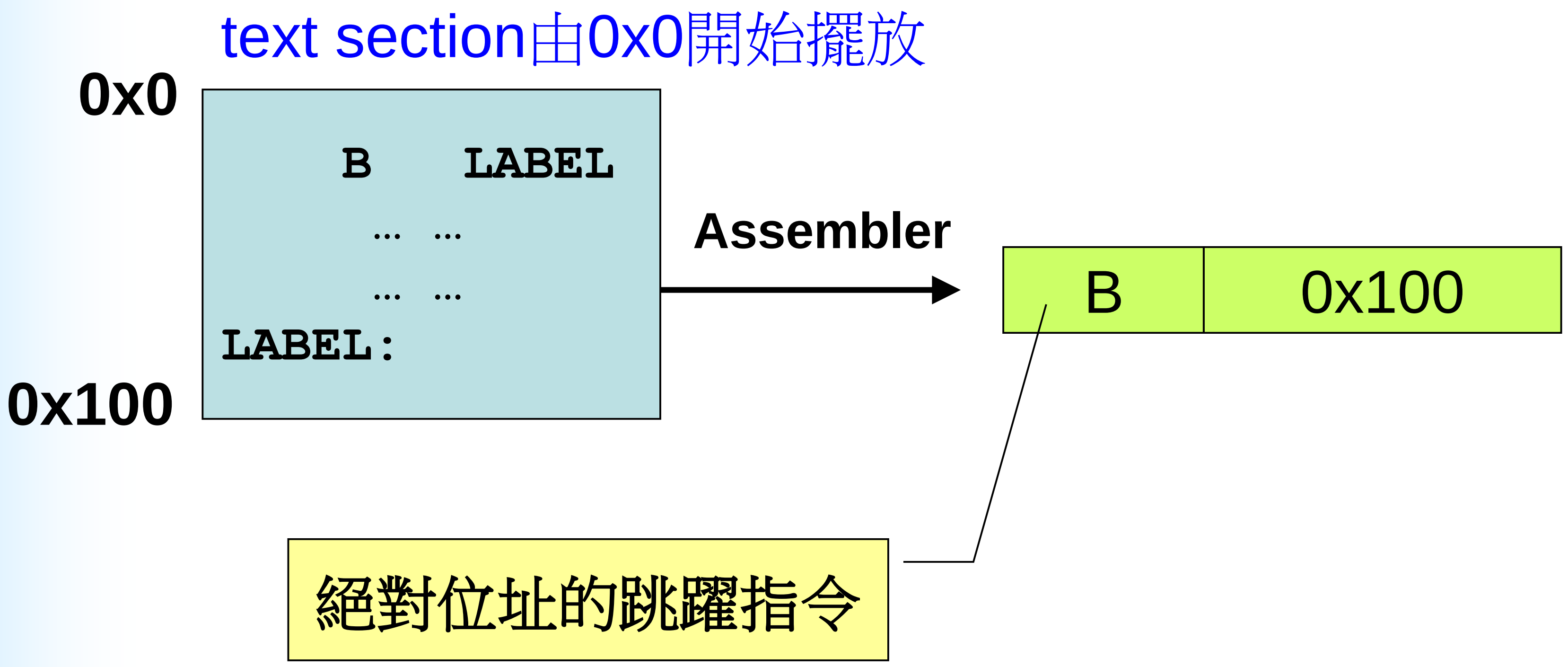
Position Independent Code

- 程式的執行與程式擺放在記憶體的位置無關

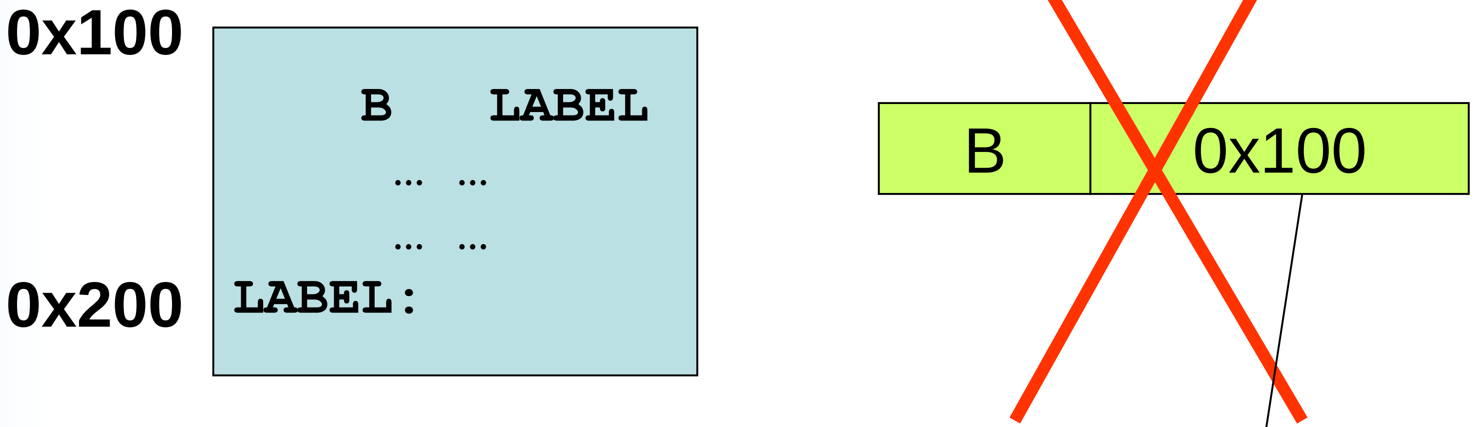


Example (1)


text section由0x0開始擺放
0x0
B LABEL
… …
… …
LABEL:
0x100
Assembler
B
0x100
絕對位址的跳躍指令

Example (2)

程式重新執行，
text section由0x100開始擺放



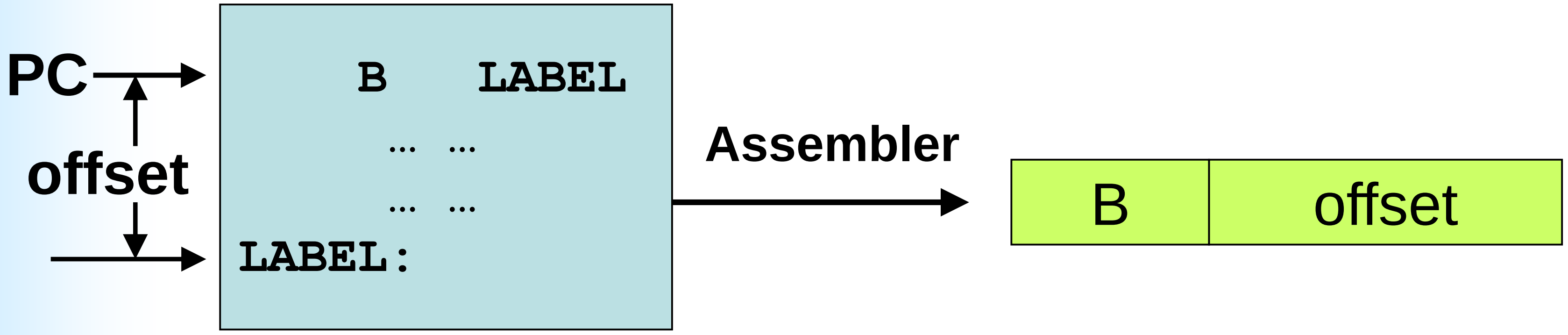
跳躍的位址跟程式由哪裡開始執行有關
=> **position dependent code**

Position Independent Code (1)

- 程式的執行跟程式擺放在記憶體的哪個位置無關
- 有彈性
- Loader或OS可根據目前系統的狀態，將程式載入到記憶體最適當的地方

Position Independent Code (2)

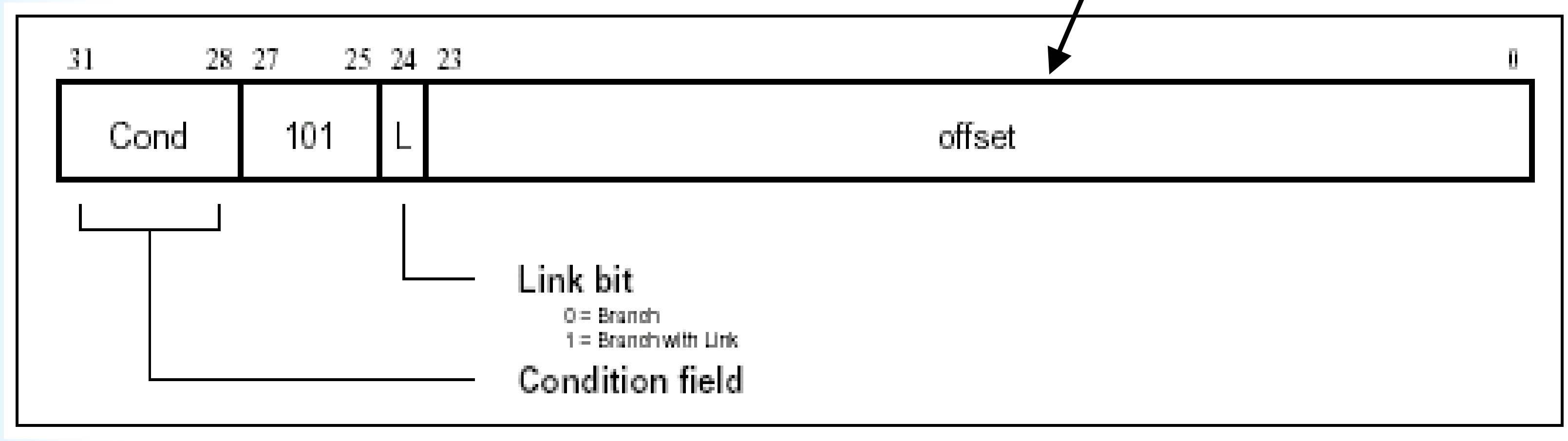
- 使用relative jump instruction
- Ex: PC-relative => 只記錄PC與target位址的差
- Ex: 以某個register為base，紀錄target與該register的差 (offset)



ARM ISA: Branch and Branch with Link

When the processor executes a branch instruction, the offset is added to the PC, and the machine begins fetching instructions from this new address.

Range: +/- 32 Mbytes



Assembler syntax: B {L} {cond} <expression>

Position Independent Code (3)

- ARM: PC-relative
- 若硬體沒有PC-relative jump的指令
  - 自己動手做

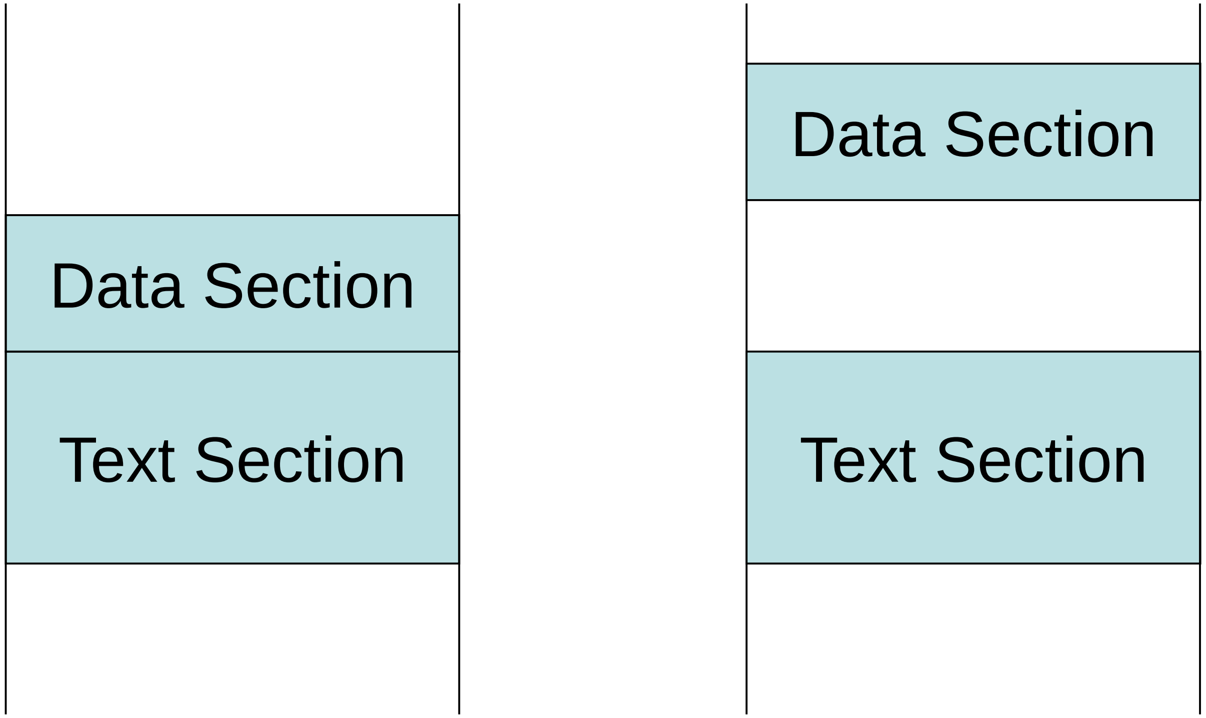
Pseudo code

```
             mov r0, #(LABEL - Here)
             B   (pc, r0)
Here:        ???
             …  …
             …  …
LABEL:
```

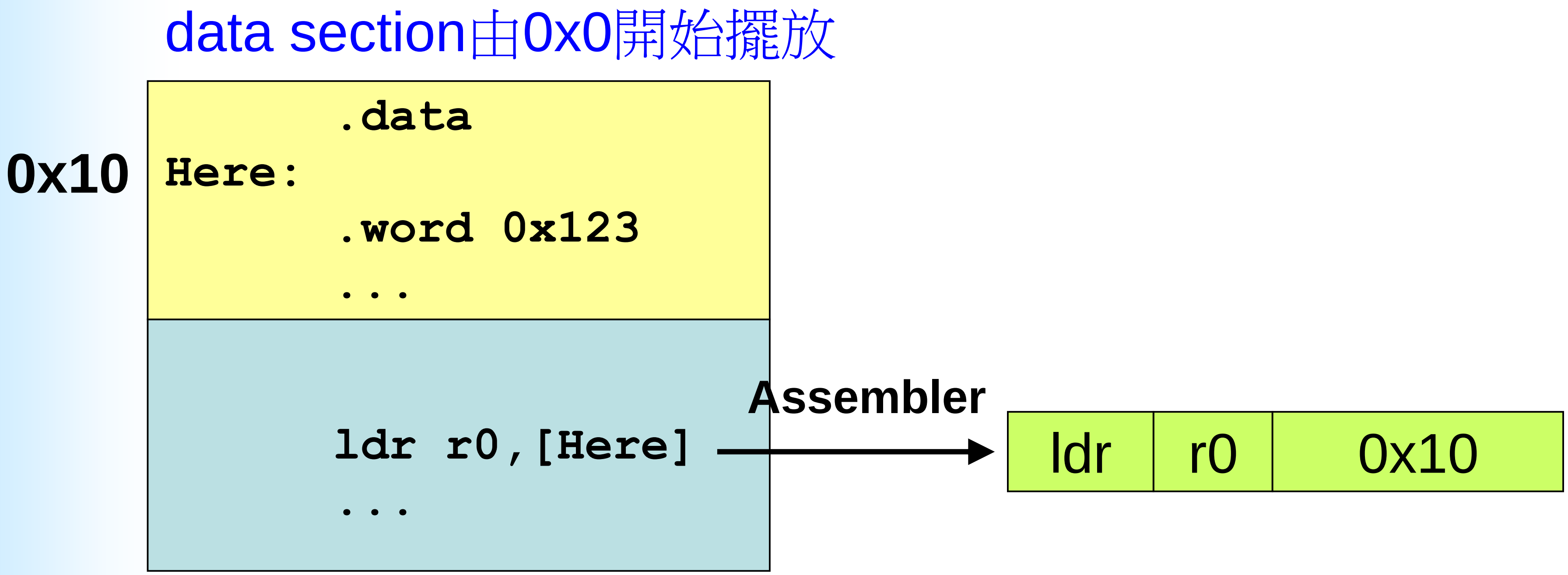
branch to the address of (pc + r0)

Position Independent Data (1)

- 程式中資料的存取與資料擺放的位置無關

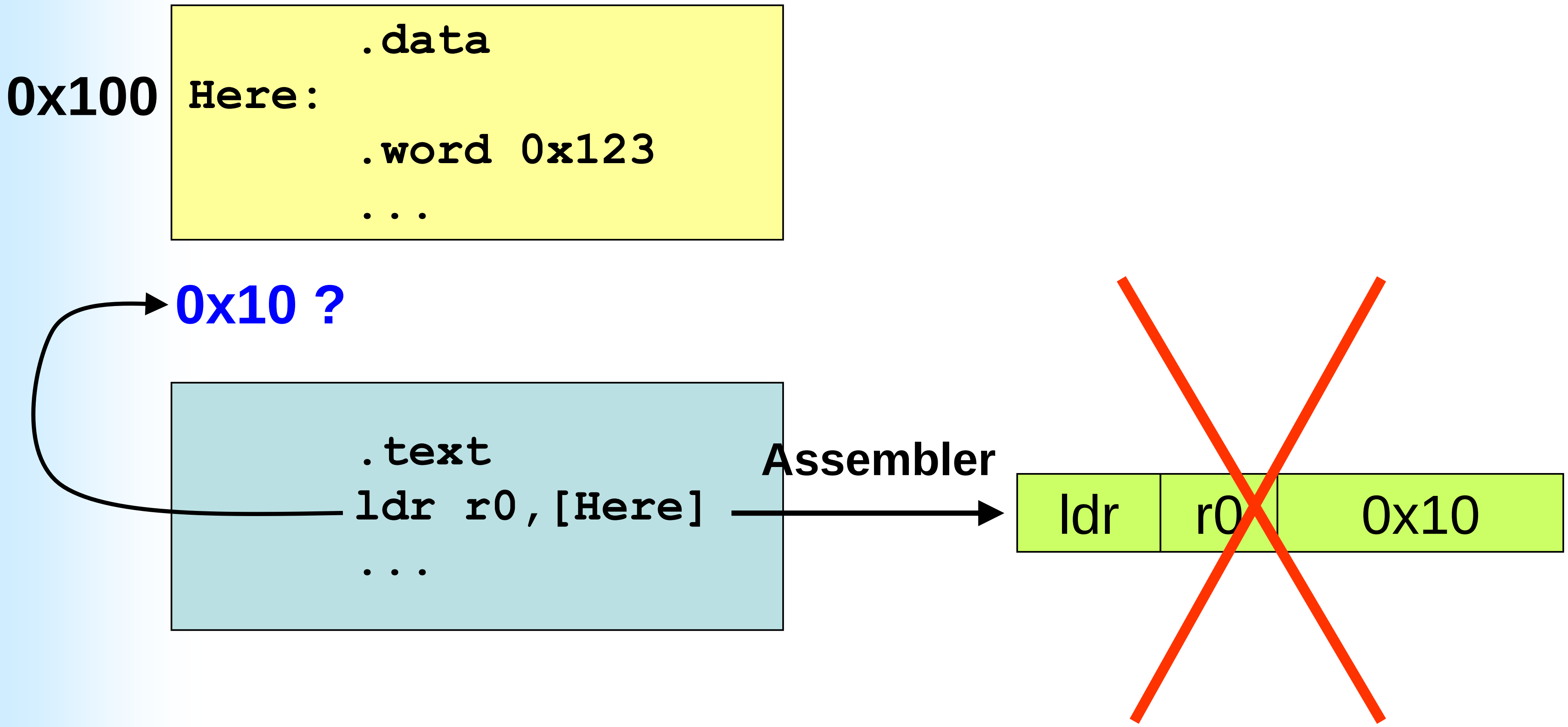


Position Independent Data (2)



Position Independent Data (3)

data section由0x90開始擺放

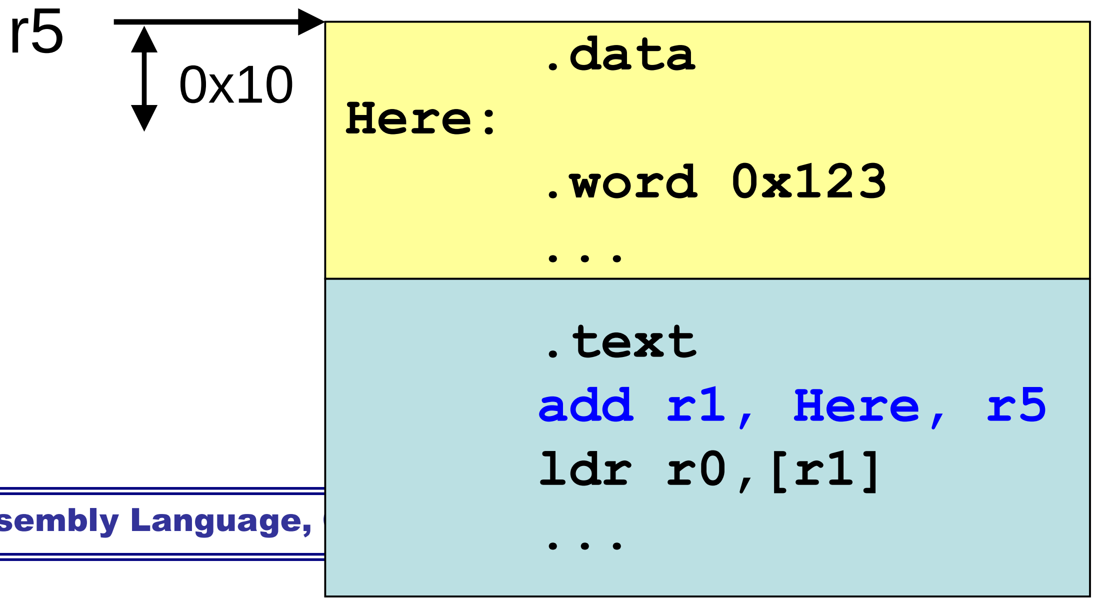


```
        .data
Here:
        .word 0x123
        ...
```

```
        .text
        ldr r0,[Here]
        ...
```

Position Independent Data (4)

- ARM: *adr* is PC-relative
- 自己動手做
  - Data section總是假設從0x0開始擺放
  - 程式執行時再由OS自由擺放，開始擺放的位址存放在某個register (ex: r5)



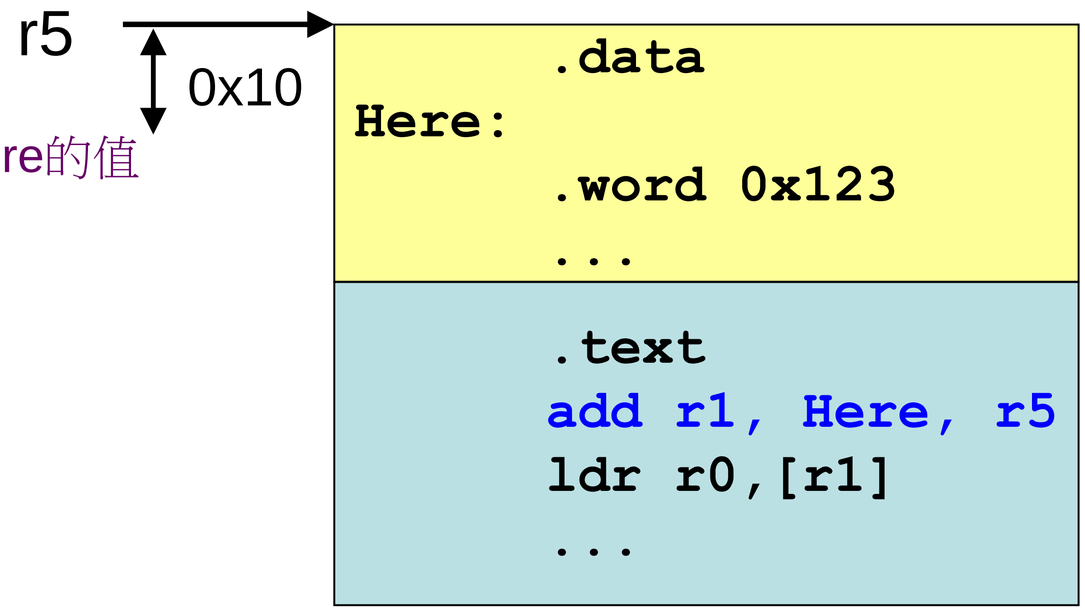
```
        .data
Here:
        .word 0x123
        ...
        .text
        add r1, Here, r5
        ldr r0,[r1]
        ...
```

Position Independent Data (5)

- OS將data section擺在0x0
  - OS會將0x0指定給r5
  - 程式執行時抓到正確的Here的值

    0x10 + 0x0 = 0x10
- OS將data section擺在0x90
  - OS會將0x90指定給r5
  - 程式執行時抓到正確的Here的值

    0x10 + 0x90 = 0x100



```
        .data
Here:
        .word 0x123
        ...

        .text
        add r1, Here, r5
        ldr r0,[r1]
        ...
```

Backup

Position Independent Code (3)

- ARM: PC-relative
- 若硬體沒有PC-relative jump的指令
  - 自己動手做

```
          mov r0, #(LABEL – Here)
          add r0, r0, 4
          add r0, r0, pc
          B   r0
Here:     ???
          …  …
          …  …
LABEL:
```