

Homework 7.

9.1. (a) Loop {2, 5}
Loop {2, 3, 5}
Loop {3, 4}

(b). 只有 a=1 可替换, b=2 没有.

B₂: (3) c = 1 + b
(4) d = c - 1
B₄: (6) d = 1 + b
B₅: (8) b = 1 + b.
(9) e = c - 1

(c). 全局公共子表达式.

Loop: {2, 5} \Rightarrow 有 (3): a + b.
Loop: {2, 3, 5} \Rightarrow (4): c - a.
Loop {3, 4} 没有.

(d). 归纳变量:

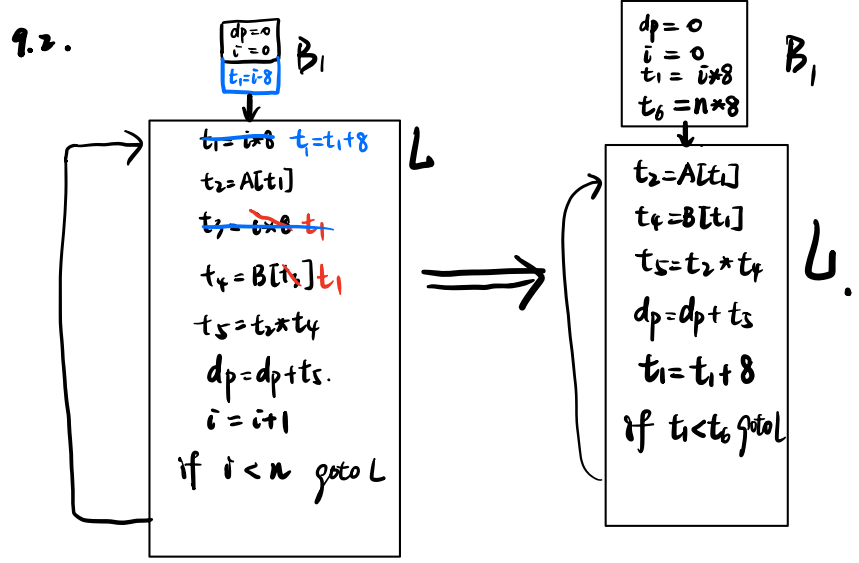
Loop: {3, 4} \Rightarrow (7) e = e + 1

Loop: {2, 5} \Rightarrow (8) b = b + 1
Loop: {2, 3, 5} \Rightarrow (3) c = c + 2 在 B₁ 中定义 c = b - 1

(e) 循环不变量:

Loop: {3, 4}: a + b 是循环不变量.

Loop: {2, 5}, {2, 3, 5} 无循环不变的计算



9.3. (a)

	B_1	B_2	B_3	B_4	B_5	B_6
gen	$\{1, 2\}$	$\{3, 4\}$	$\{5\}$	$\{6, 7\}$	$\{8, 9\}$	$\{10, 11\}$
kill	$\{8, 10, 11\}$	$\{5, 6\}$	$\{4, 6\}$	$\{4, 5, 9\}$	$\{2, 7, 11\}$	$\{1, 2, 9\}$

$\rightarrow U_{pred}$
 第一次: $IN = \emptyset$
 $OUT = \{1, 2\}$
 $\hookrightarrow gen \cup \{In - kill\}$

	\emptyset	$\{1, 2\}$	$\{1, 2, 3, 4\}$	$\{1, 2, 3, 5\}$	$\{1, 2, 3, 4, 5\}$	$\{1, 2, 3, 4, 5, 8, 9\}$
	$\{1, 2\}$	$\{1, 2, 3, 4\}$	$\{1, 2, 3, 5\}$	$\{1, 2, 3, 6, 7\}$	$\{1, 2, 3, 4, 5, 8, 9\}$	$\{3, 4, 5, 4, 10\}$

设 $d_1 d_2 \dots d_n$ 用 $\{0, 1\}$ 形式进行编码.
 $IN(B) = \bigcup_{B.pred.d} ; \quad OUT(B) = gen(B) \cup [IN(B) \cap \overline{kill(B)}]$

进行迭代, 直到 output 不变, 即:

i	gen(B_i)	kill(B_i)	IN(B_i)	OUT(B_i)
1	1100 0000 000	0000 0001 011	0000 0000 000	1100 0000 000
2	0011 0000 000	0000 1100 000	1111 1001 100	1111 0001 100
3	0000 1000 000	0001 0100 000	1111 0111 100	1110 1011 100
4	0000 0110 000	0001 1000 100	1110 1011 100	1110 0111 000
5	0000 0001 100	0100 0010 001	1111 1011 100	1011 1001 100
6	0000 0000 011	1100 0001 000	1011 1001 100	0011 1000 111

(b) 首先全集 $U = \{1, 2, a+b, c-a, b+d, e+1, b*d, a-d\}$

那么由 $IN(B) = \bigcap_{pred.B.out} \quad OUT(B) = e - gen(B) \cup \{IN(B) - e - kill(B)\}$

i	gen-e(B_i)	kill-e(B_i)	IN(B_i)	OUT(B_i)
1	$\{1, 2\}$	$\{a+b, c-a, b+d, b*d, a-d\}$	\emptyset	$\{1, 2\}$
2	$\{a+b, c-a\}$	$\{c-a, b+d, b*d, a-d\}$	$\{1, 2\}$	$\{1, 2, a+b, c-a\}$
3	\emptyset	$\{b+d, b*d, a-d\}$	$\{1, 2, a+b, c-a\}$	$\{1, 2, a+b, c-a\}$
4	$\{a+b\}$	$\{b+d, b*d, a-d, e+1\}$	$\{1, 2, a+b, c-a\}$	$\{1, 2, a+b, c-a\}$
5	$\{c-a\}$	$\{b+d, b*d, e+1, a+b\}$	$\{1, 2, a+b, c-a\}$	$\{1, 2, c-a\}$
6	$\{a-d\}$	$\{a+b, c-a, b+d, b*d\}$	$\{1, 2, c-a\}$	$\{1, 2, a-d\}$

(c) $U = \{a, b, c, d, e\}$

$OUT(B) = \bigcup_{In(B, succ)} \quad IN(B) = use(B) \cup \{OUT(B) - def(B)\}$

use_c : 在引用c之前没被用 def_c : 在定义c前没被引用c.

顺序: $B_6 \rightarrow B_5 \rightarrow B_4 \rightarrow B_3 \rightarrow B_2 \rightarrow B_1$

i	use $_B$	def $_B$	OUT(B)	IN(B)
1	\emptyset	$\{a, b\}$	$\{e\}$	$\{a, b, e\}$
2	$\{a, b\}$	$\{c, d\}$	$\{a, b, e\}$	$\{a, b, c, d, e\}$
3	$\{b, d\}$	\emptyset	$\{a, b, c, d, e\}$	$\{a, b, c, d, e\}$
4	$\{a, b, e\}$	$\{d\}$	$\{a, b, c, d\}$	$\{a, b, c, d, e\}$
5	$\{a, b, c\}$	$\{e\}$	$\{a, b, c, d\}$	$\{a, b, d, e\}$
6	$\{b, d\}$	$\{a\}$	\emptyset	$\{b, d\}$

9.15. (a)

支配结点	支配对象
1	1-6
2	2-6
3	3, 4.
4	4.
5	5, 6.
6	6.

(e).

回边	自然循环.
5 → 2.	{2, 5, 3, 4}
4 → 3.	{3, 4}