Alias Analysis

15-411/15-611 Compiler Design

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November 12, 2019

Constant Propagation on Memory

$$l_1 : M[q] \leftarrow 4$$
$$l_2 : M[p] \leftarrow 8128$$
$$l_3 : x \leftarrow M[q]$$

- Can we replace l_3 with **x ← 4**?

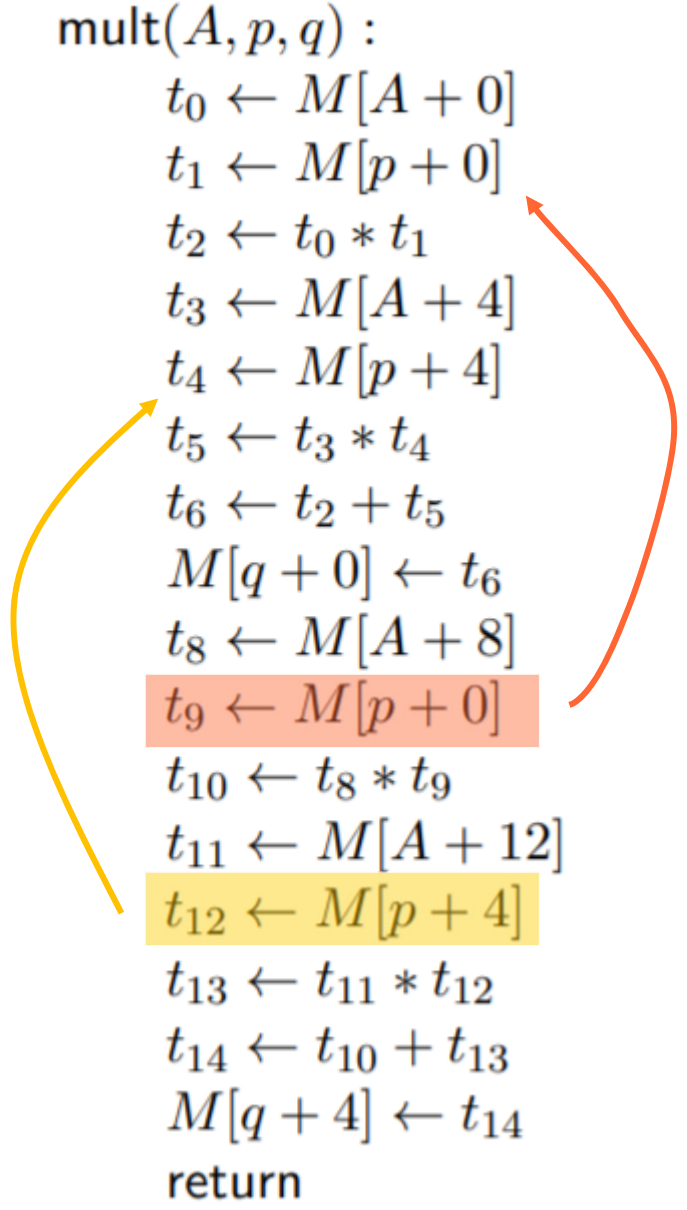
CSE

```
foo() {
        int a,k;
        extern int *q;
        ...
        ... // maybe &a or &k
        ...
        k = a+6;
        f(a,&k);
        *q = 13;
        k = a+6
        ...
}
```

CSE on Memory

```
struct point {
  int x;
  int y;
};
typedef struct point pt;

void mult(int[] A, pt* p, pt* q) {
  q->x = A[0] * p->x + A[1] * p->y;
  q->y = A[2] * p->x + A[3] * p->y;
  return;
}
```



Dependence Information

```
foo(int[] a, int[] b, int n) {
     int i;
     for (i=1; i<n; i++) {
          a[i] = b[i-1]+a[i]
     }
}
```

- What are the dependence distances?

```
struct intlist {
        int val;
        struct intlist* next;
};

struct int foo() {
      struct intlist* p;
      struct intlist* q;
      int a = 1;

      q = alloc(struct intlist);
      q->val = 0;
      q->next NULL;
      p = alloc(struct intlist);
      p->val = 0;
      p->next = q;
      q->val = 5;
      a = p->val;
      return a;
}
```

```
1:  MOVE   t2        <- 0                          p
2:  MOVE   t3        <- 0                          q
3:  MOVE   t4        <- 1                          a
4:  CALL   t5        <- malloc(8)    (t5,4,0)      q <- alloc
5:  PLUS   u1        <- t5,    0
6:  STORE  MEM[u1]   <-  0                         q->val = 0
7:  PLUS   u2        <- t5,    4
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19: LOAD   t4        <- MEM[u6]                    a
20: RET              t4
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```

```
struct intlist* foo() {
      struct intlist* p;
      struct intlist* q;
      int a = 1;

      p = alloc(struct intlist);
      p->val = 0;
      p->next = 0;

      q = alloc(struct intlist);
      q->val = 6;
      q->next = p;

      if (a == 0) p = q;
      p->val = 4;
      return p;
}
```

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1:  CALL   t2       <- malloc(8)              p
2:  PLUS   u1       <- t2,0
3:  STR    MEM[u1] <-  0                     p->val = 0
4:  PLUS   u2       <- t2, 4
5:  STR    MEM[u2] <- 0                      p->next = 0
6:  MOVE   t3       <- t2                     x=p
7:  CALL   t4       <- malloc(8)              q
8:  PLUS   u3       <- t4,0
9:  STR    MEM[u3] <- 6                      q->val = 6
10: PLUS   u4       <- t4,0
11: STR    MEM[u4] <- t3                     q->next = p
12: MOVE   t5       <- t4                     q
13: MOVE   t6       <- 1                      a
14: CJUMP  t6 == 0, ifT0,ifF1                 a == 0 ?
ifT0:
16: MOVE   t3'      <- t5                     x=q
ifF1:
18: PHI    t3''     <- ϕ(t3,t3')
19: PLUS   u5       <- t3'', 0
20: STR    MEM[u5] <- 4
21: RET    t2
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```
1:  CALL   t2       <- malloc(8) (t2,1,0)      p
2:  PLUS   u1       <- t2,0
3:  STR    MEM[u1] <-  0                       p->val = 0
4:  PLUS   u2       <- t2, 4
5:  STR    MEM[u2] <- 0                        p->next = 0
6:  MOVE   t3       <- t2                      x=p
7:  CALL   t4       <- malloc(8)               q
8:  PLUS   u3       <- t4,0
9:  STR    MEM[u3] <- 6                        q->val = 6
10: PLUS   u4       <- t4,0
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2:  PLUS   u1       <- t2,0      (u1,1,0)
3:  STR    MEM[u1]  <-  0                      p->val = 0
4:  PLUS   u2       <- t2, 4     (u2,1,4)
5:  STR    MEM[u2]  <- 0                       p->next = 0
6:  MOVE   t3       <- t2        (t3,1,0)      x=p
7:  CALL   t4       <- malloc(8) (t4,7,0)      q
8:  PLUS   u3       <- t4,0      (u3,7,0)
9:  STR    MEM[u3]  <- 6                       q->val = 6
10: PLUS   u4       <- t4,0      (u4,7,0)
11: STR    MEM[u4]  <- t3                      q->next = p
12: MOVE   t5       <- t4        (t5,7,0)      q
13: MOVE   t6       <- 1                       a
14: CJUMP  t6 == 0, ifT0,ifF1                  a == 0 ?
ifT0:
16: MOVE   t3'      <- t5        (t3',7,0)     x=q
ifF1:
18: PHI    t3''     <- ϕ(t3,t3') (t3'',7,0),(t3'',1,0)
19: PLUS   u5       <- t3'', 0
20: STR    MEM[u5]  <- 4
21: RET    t2
```

```
1:  CALL   t2       <- malloc(8) (t2,1,0)      p
2:  PLUS   u1       <- t2,0      (u1,1,0)
3:  STR    MEM[u1]  <-  0                      p->val = 0
4:  PLUS   u2       <- t2, 4     (u2,1,4)
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19: PLUS   u5       <- t3'', 0   (u5,7,0),(u5,1,0)
20: STR    MEM[u5]  <- 4
21: RET    t2
```

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