

Problems 7: Available expressions

In the following program (in quadruples form), state which expressions are available before and after each quadruple.

	gen	kill
1: $i = 0$	{ }	{exp(i) }
2: $j = i * 4$	{ $i*4$ }	{exp(j) }
3: $t1 = i * 4$	{ $i*4$ }	{exp(t1) }
4: $x = M[t1]$	{ $M[t1]$ }	{exp(x) }
5: $y = M[t1]$	{ $M[t1]$ }	{exp(y) }
6: $t2 = i * 4$	{ $i*4$ }	{exp(t2) }
7: $t3 = x * y$	{ $x*y$ }	{exp(t3) }
8: $i = i + 1$	{ }	{exp(i) }
9: $k = i * 4$	{ $i*4$ }	{exp(k) }
10: $M[t2] = t3$	{ }	{exp(M[]) }
11: if (i < 10) goto 3	{ }	{ }
12: write(k)	{ }	{ }

pred(3) = {2,11}

in		out
	1: $i = 0$	{ }
{ }	2: $j = i * 4$	{ $i*4$ }
{ $i*4$ }	3: $t1 = i * 4$	{ $i*4$ }
{ $i*4$ }	4: $x = M[t1]$	{ $i*4, M[t1]$ }
{ $i*4, M[t1]$ }	5: $y = M[t1]$	{ $i*4, M[t1]$ }
{ $i*4, M[t1]$ }	6: $t2 = i * 4$	{ $i*4, M[t1]$ }
{ $i*4, M[t1]$ }	7: $t3 = x * y$	{ $i*4, M[t1], x*y$ }
{ $i*4, M[t1], x*y$ }	8: $i = i + 1$	{ $M[t1], x*y$ }
{ $M[t1], x*y$ }	9: $k = i * 4$	{ $M[t1], i*4, x*y$ }
{ $M[t1], i*4, x*y$ }	10: $M[t2] = t3$	{ $i*4, x*y$ }
{ $i*4, x*y$ }	11: if (i<10) goto 3	{ $i*4, x*y$ }
{ $i*4, x*y$ }	12: write(k)	

State which common (repeated) subexpressions can be eliminated from the above program, explaining why these can be eliminated and others cannot. Then show the program after these expressions have been eliminated.

$(i*4)$ appears in 2, 3, 6, and 9. Can be eliminated in 3 and 6 because it is available at the beginning of 3 and 6.

$M[t1]$ appears in 4 and 5. Can be eliminated in 5 because it is available at the beginning of 5.

```
1:      i = 0
2:      w1 = i * 4
2':     j = w1
3:      t1 = w1
4:      w2 = M[t1]
4':     x = w2
5:      y = w2
6:      t2 = w1
7:      t3 = x * y
8:      i = i + 1
9:      w1 = i * 4
9':     k = w1
10:     M[t2] = t3
11:     if (i < 10) goto 3
12:     write(k)
```