

# Exercises

Program Analysis (CO70020)

Sheet 1

**Exercise 1** Give a labelling of the following program and the (intuitive) flow ‘flow’ and the reverse flow ‘flow<sup>R</sup>’.

```
x := 1;
while y>0 do (
  if y<=0
  then   x := x+3
  else   skip
  x := x-1;
  z := z+x;
)
x := 2;
```

What “simplifications” could you think of with regard to the guard  $y > 0$ ?  
What happens if you generalise your approach to any guard/test predicate  $p(y)$   
(and not  $p(y)$ , respectively)?

**Exercise 2** Consider the following **While** program:

```
x:=1;
if (x>0)
then x:=x-1
else y:=y-1
```

Construct the flow formally.

**Exercise 3** Guess the RD solutions for the following three **While** programs:

<pre>x := 4; z := 2; if y &gt; x then   x := 3; else   x := 4; z := x;</pre>	<pre>x := 4; z := 2; if y &gt; x then   x := 3; else   x := 3; z := x;</pre>	<pre>x := 4; y := 2; if y &gt; x then   x := 3; else   x := 5; z := x;</pre>
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What kind of optimisation could you suggest.

**Exercise 4** Construct the RD equations for the following program:

```
x := 4;
z := 2;
if y > x then
  x := 3;
else
  x := 4;
z := x;
```

**Exercise 5** Is there a program such that:

1.  $\{(x, 1), (x, 4), (x, 8)\} \subseteq \text{RD}_{\text{entry}}(9)$ , or a program such that:
2.  $\{(x, 1), (x, 4), (y, 4)\} \subseteq \text{RD}_{\text{entry}}(9)$

Give example(s) or argument(s).