

# HW01

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## 1 Problem 1

1.  $x$  is even  $y == x + 1$  is strongest
2.  $1 \leq x \leq 3$  is strongest
3.  $x > 0 \ \&\& \ y > 0$  is strongest
4.  $x$  is divisible by 50 is strongest
5. None
6.  $\text{abs}(\text{result} * \text{result} - x) < 0.000001$  is strongest

## 2 Problem 2

1. Is Valid
2. Is Valid
3. Not valid, since  $i + j + 1 - 1 = i + j$ , so the post-condition can still be  $i + j! = 0$
4. Not valid, if  $m == y$  then it must be the reverse of if condition:  $y \geq x$  for sure.  
The post condition should be  $(m == x \ \&\& \ x > y) || (m == y \ \&\& \ y \geq x)$

### **3 Problem 3**

1. Valid
2. Possibly invalid

## 4 Problem 4

1. 

```
{ x > 0 }  
  x = 10;  
    { x == 10 }  
  y = 20 - x;  
    { x == 10 && y == 10 }  
  z = y + 4;  
    { x == 10 && y == 10 && z == 14 }  
  y = 0;  
    { x == 10 && y == 10 && y == 0 }
```
2. 

```
{ |x| > 11 }  
  x = -x;  
    { |x| > 11 }  
  x = x * x;  
    { x > 121 }  
  x = x + 1;  
    { x > 122 }
```
3. 

```
{ |x| < 5 }  
  if (x > 0) {  
    { (|x| < 5 && x > 0) = (0 < x < 5) }  
    y = x + 2;  
    { (0 < x < 5) && (2 < y < 7) }  
  } else {  
    { |x| < 5 && x <= 0) = (-5 < x <= 0) }  
    y = x - 1;  
    { (-5 < x <= 0) && (-6 < y <= -1) }  
  }  
  { ((0 < x < 5) && (2 < y < 7)) || ((-5 > x >= 0) && (-6 > y >= -1)) }
```

## 5 Problem 5

1.
 

```

      { wp(x = -5, y > -2 * x) = (y > 10) }
        x = -5;
      { wp(z = 2 * x + y, z > 0) = (2 * x + y > 0) = (y > -2 * x) }
        z = 2 * x + y;
      { z > 0 }
      
```
2.
 

```

      { wp(if (x > 0) x = x + 6; else x = 4 - x;, x > 7)
        = (x > 0 && x > 1) || (x <= 0 && x < -3)
        = (x > 1) || (x < -3) }
      if (x > 0) {
        { wp(x = x + 6 && x > 7) = (x > 1) }
        x = x + 6;
      } else {
        { wp(x = 4 - x && x > 7) = (x < -3) }
        x = 4 - x;
      }
      { x > 7 }
      
```
3.
 

```

      { wp(if (x > 4) x = x - 3; else x > -1;, x > 0)
        = (x > 4 && x > 3) || (x <= 4 && x > 0)
        = (x > 4) || (4 >= x > 0)
        = (x > 0) }
      if (x > 4) {
        { wp(x = x - 3, x > 0) = (x > 3) }
        x = x - 3;
      } else {
        { wp(if (x < -4) x = x + 3; else x = x + 1;, x > 0)
          = (x < -4 && x > -3) || (x >= -4 && x > -1)
          = (x > -1) }
        if (x < -4) {
          { wp(x = x + 3, x > 0) = (x > -3) }
          x = x + 3;
        } else {
          { wp(x = x + 1, x > 0) = (x > -1) }
          x = x + 1;
        }
      }
      { x > 0 }
      
```
4.
 

```

      { wp(x = y + 2, x > 2 * y - 1) = (y + 2 > 2 * y - 1) = (y < 3) }
      x = y + 2;
      { wp(z = x + 1, z > 2 * y) = (x > 2 * y - 1) }
      
```

```

z = x + 1;
{ z > 2 * y }

```

```

5.      { wp(if (x >= 0) z = x; else z = x + 1;, z != 0)
        = (x >= 0 && x != 0) || (x < 0 && x != -1)
        = (x > 0) || (x < -1) }
if (x >= 0)
  { wp(z = x, z != 0) = (x != 0) }
  z = x;
else
  { wp(z = x + 1, z != 0) = (x != -1) }
  z = x + 1;
  { z != 0 }

```

## 6 Problem 6

1.     `{ x < 2 }`  
       `{ wp(z < 0, z = x - 1 ) = (x < 1) }`  
           `z = x - 1;`  
       `{ wp(w > 0, w = -z) = (z < 0) }`  
           `w = -z;`  
       `{ wp(w > 1, w = w + 1) = (w > 0) }`  
           `w = w + 1;`  
       `{ w > 1 }`  
       Sufficient or Insufficient: Insufficient, since  $(x < 1)$  is stronger than  $(x < 2)$
  
2.     `{ (x == y && y > 0) || (y != x) }`  
       `{ wp(if (x == y) x = -1; else x = y - 1;;, x < y)`  
           `= (x == y && y > -1) || (x != y && true)`  
           `= (x == y && y > -1) || (x != y) }`  
           `if (x == y)`  
       `{ wp(x < y, x = -1) = (y > -1)}`  
           `x = -1;`  
       `else`  
       `{ wp(x < y, x = y - 1) = true }`  
           `x = y - 1;`  
       `{ x < y }`  
       Sufficient or Insufficient: Sufficient, since  $(y > -1)$  is weaker than  $(y > 0)$