



Determine whether the following Statements are Locally consistent

**WP**  $\{x=2x\} (x < 50)$   
 $\equiv 2x < 50$   
 $\equiv x < 25$   
 $x=20 \Rightarrow x < 25$   
 $\Rightarrow LL$

```

graph TD
    Start(( )) --> Init[x = 20]
    Init --> Loop{x < 50}
    Loop --> Body[x = 2 * x]
    Body --> Loop
    
```

$x=20 \Rightarrow x < 25$   
 $\Rightarrow LL$

**WP**  $\{y=y+2\} (x=y+4)$   
 $\equiv x=y+2+4$   
 $\equiv x=y+6$

```

graph TD
    Start(( )) --> Init[x = y + 2]
    Init --> Loop{x = y + 4}
    Loop --> Body[y = y + 2]
    Body --> Loop
    
```

$x=y+2$   
 $\Rightarrow x=y+6$   
 $\Rightarrow NLL$

**WP**  $\{y=x+2\} (x < 4)$   
 $\equiv y < 4+2$   
 $\equiv y < 6$

```

graph TD
    Start(( )) --> Init[x < 5]
    Init --> Loop{x < 4}
    Loop --> Body[y = x + 2]
    Body --> Loop
    
```

$x < 5 \Rightarrow x < 4$   
 $\Rightarrow NLL$

**WP**  $\{a=a+b\} (a=b(i+1))$   
 $\equiv a+b=b(i+1)$   
 $\equiv a+b=bi+b$   
 $\equiv a=bi$   
 $a=bi \Rightarrow a=bi$   
 $\Rightarrow LL$

```

graph TD
    Start(( )) --> Init[a = b * i]
    Init --> Loop[a = a + b]
    Loop --> Body[a = b(i+1)]
    Body --> Loop
    
```

$a=b(i+1)$   
 $\Rightarrow LL$

**WP**  $\{x=x+1\} (a=6x)$   
 $\equiv a=6(x+1)$   
 $\equiv a=6x+6$

```

graph TD
    Start(( )) --> Init[a = 5 * x]
    Init --> Loop[x = x + 1]
    Loop --> Body[a = 6 * x]
    Body --> Loop
    
```

$a=5x \Rightarrow a=6x+6$   
 $\Rightarrow NLL$



$LC \Leftrightarrow SP[CS](A) \Rightarrow B$   
 $\Leftrightarrow A \Rightarrow WP[CS](B)$

Determine whether the following Statements are Locally consistent

**True Branch**  
 $SP[i \geq n] (a=x^i \wedge i \leq n)$   
 $\equiv a=x^i \wedge i \leq n$

```

graph TD
    Start(( )) --> Init[a = x^i]
    Init --> Loop{i < n}
    Loop --> Body[i >= n]
    Body --> TrueBranch[a = x^n]
    TrueBranch --> Loop
    
```

$a=x^i \wedge i \leq n \Rightarrow a=x^n$   
 $\Rightarrow LL$

**False Branch**  
 $SP[i \geq n] (a=x^i \wedge i \leq n)$   
 $\equiv SP[i \leq n] (a=x^i \wedge i \leq n)$   
 $\equiv a=x^i \wedge i \leq n$   
 $a=x^i \wedge i \leq n \Rightarrow i \leq 2n$   
 $(z.B.: i=-3, n=-2)$   
 $\Rightarrow NLL$

**True Branch**  
 $SP[a < d] (a < d \wedge b < c \wedge c < d)$   
 $\equiv a < d \wedge b < c \wedge c < d$

```

graph TD
    Start(( )) --> Init[a < d]
    Init --> Loop[a < d]
    Loop --> TrueBranch[a < b]
    TrueBranch --> Loop
    
```

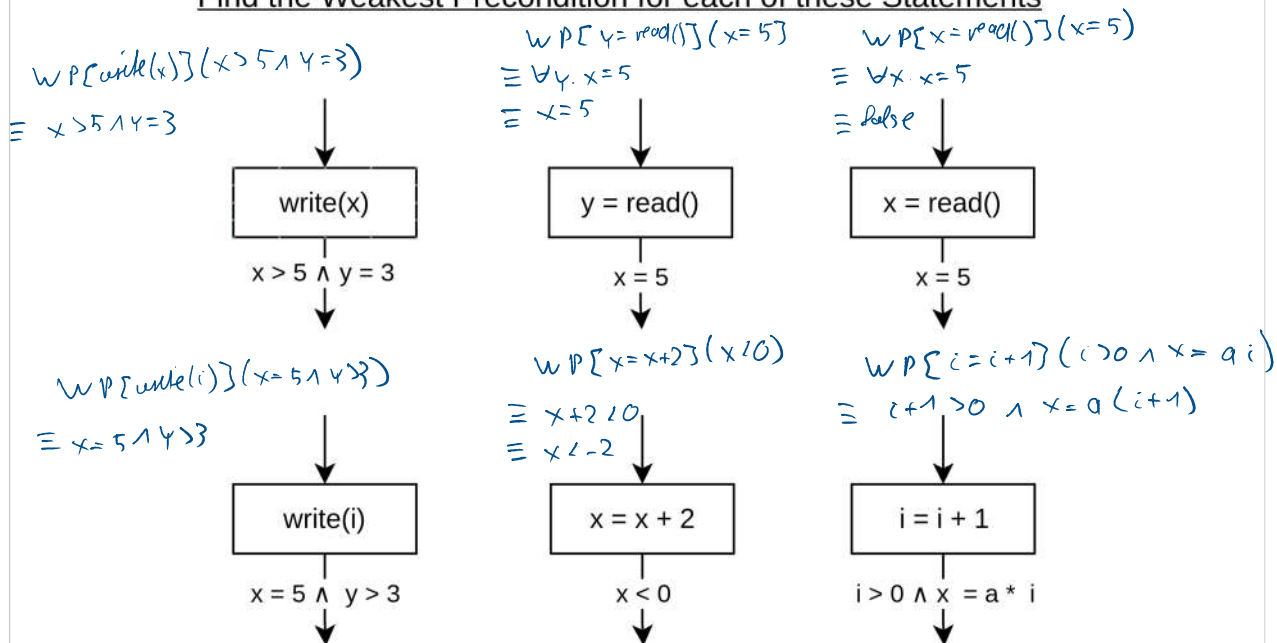
$a < d \wedge b < c \wedge c < d$   
 $\Rightarrow a < b$   
 $\Rightarrow NLL$

**False Branch**  
 $a > b$   
 $\Rightarrow NLL$

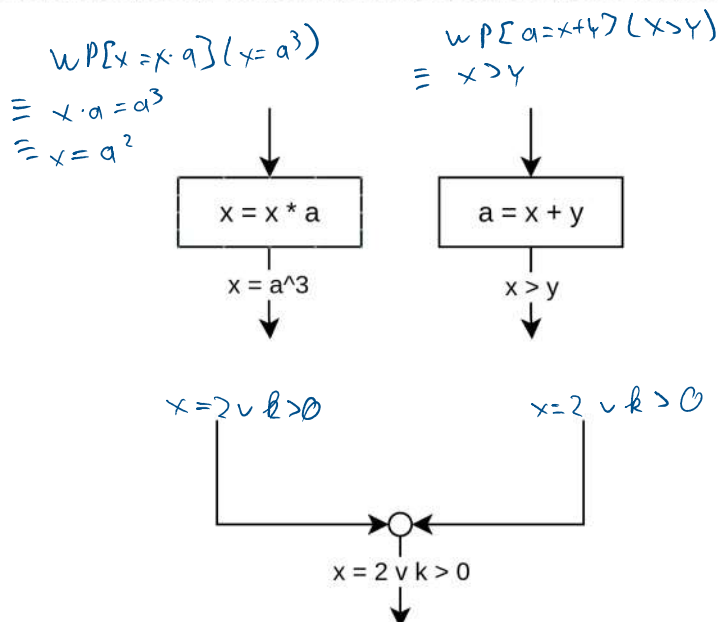


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condition

### Find the Weakest Precondition for each of these Statements

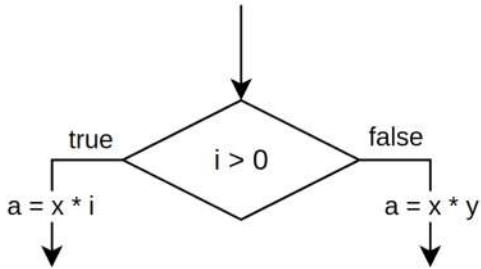


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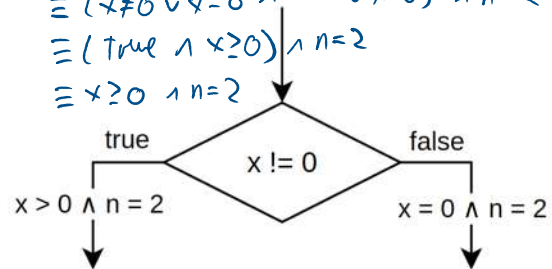


Find the Weakest Precondition for each of these Statements

B false B true  
 $WP[i > 0](a = x \cdot y, a = x \cdot i)$   
 $\equiv (i > 0 \wedge a = x \cdot i) \vee (i \leq 0 \wedge a = x \cdot y)$



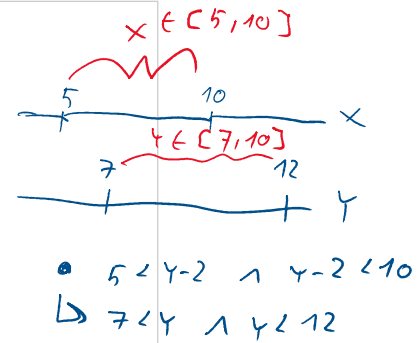
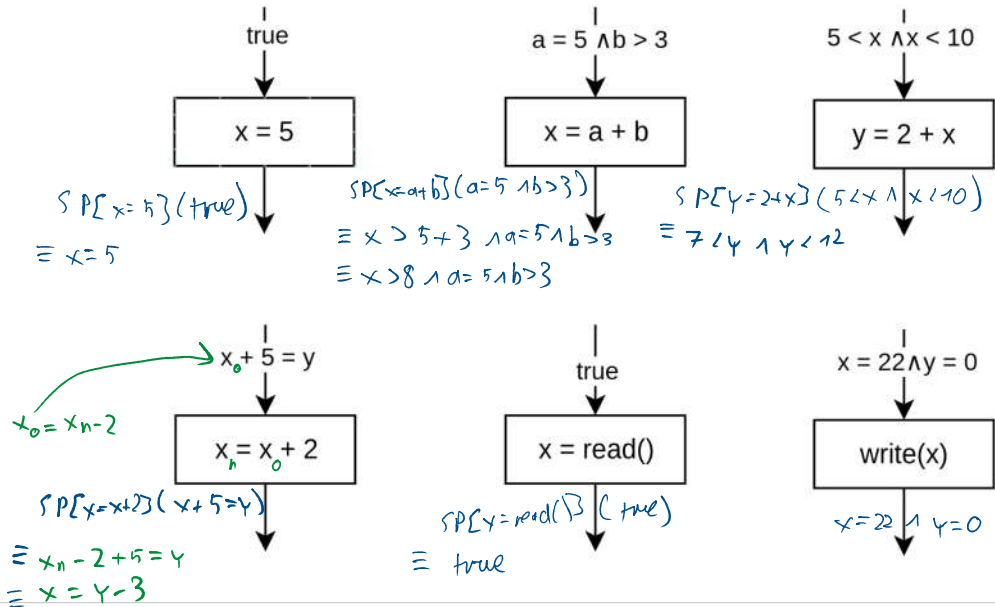
$WP[x \neq 0](x = 0 \wedge n = 2, x > 0 \wedge n = 2)$   
 $\equiv (x \neq 0 \wedge x > 0 \wedge n = 2) \vee (x = 0 \wedge x = 0 \wedge n = 2)$   
 $\equiv ((x \neq 0 \wedge x > 0) \vee x = 0) \wedge n = 2$   
 $\equiv (x \neq 0 \vee x = 0 \wedge x > 0 \vee x = 0) \wedge n = 2$   
 $\equiv (true \wedge x > 0) \wedge n = 2$   
 $\equiv x > 0 \wedge n = 2$



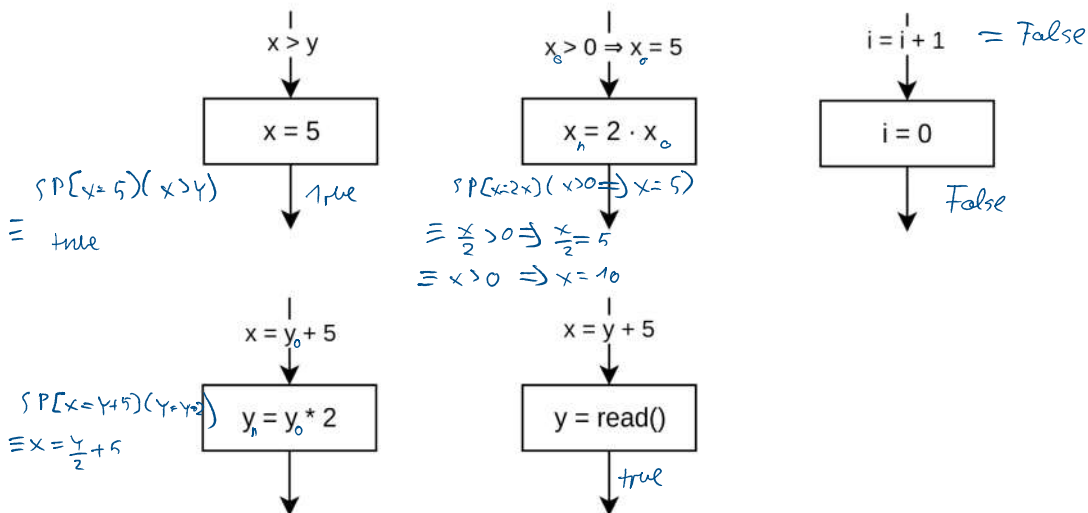


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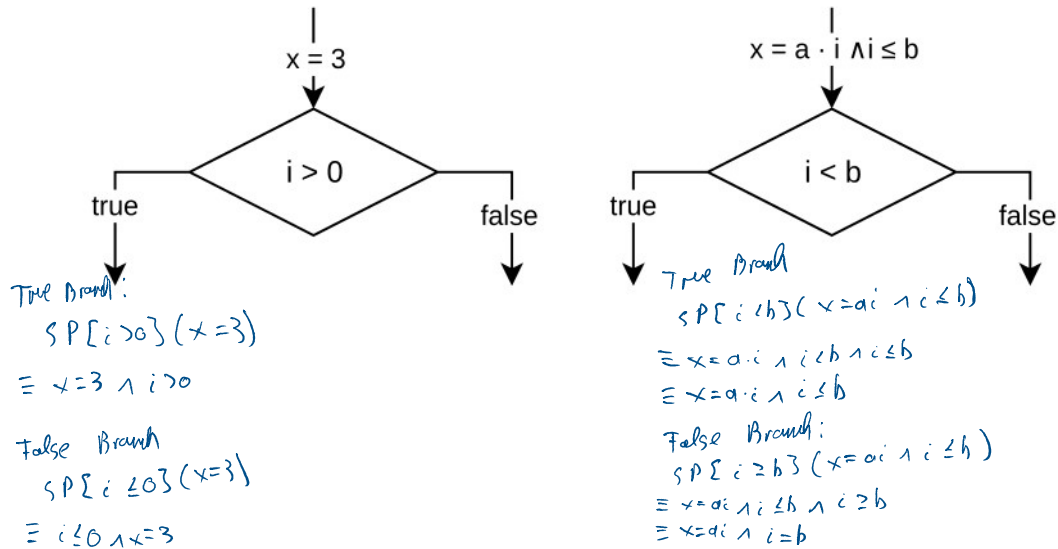
### Find the Strongest Postcondition for each of these Statements



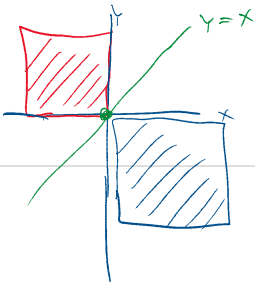
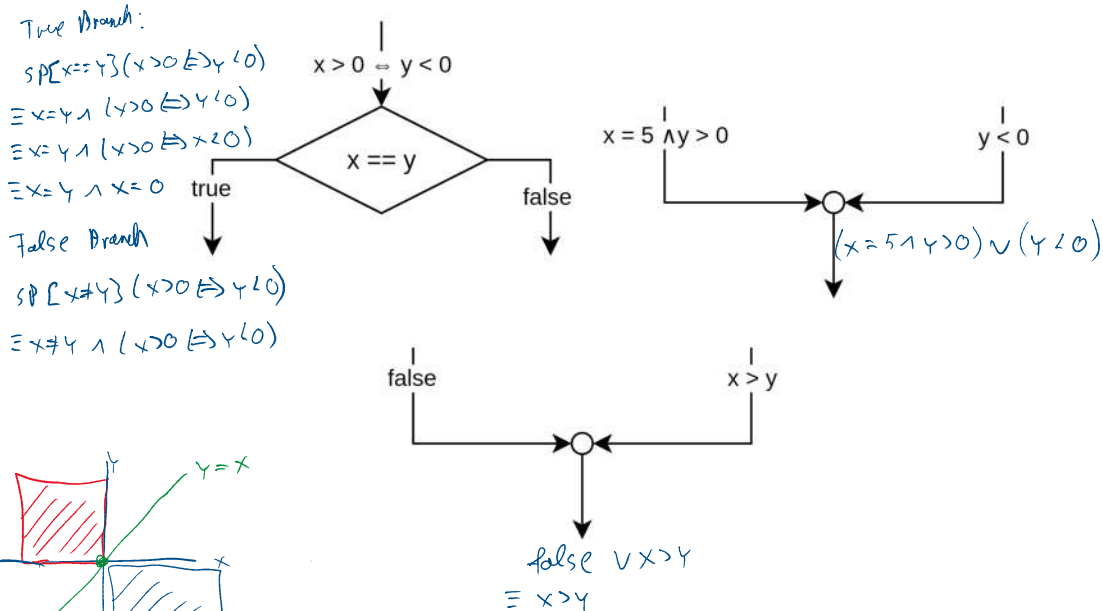
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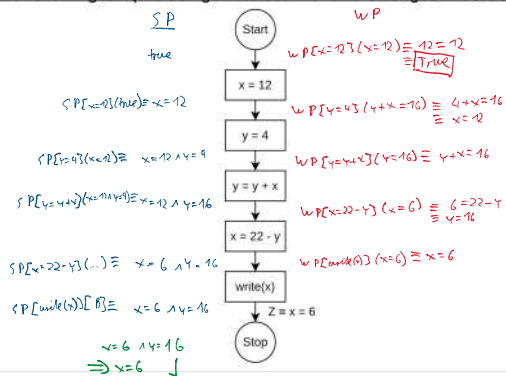


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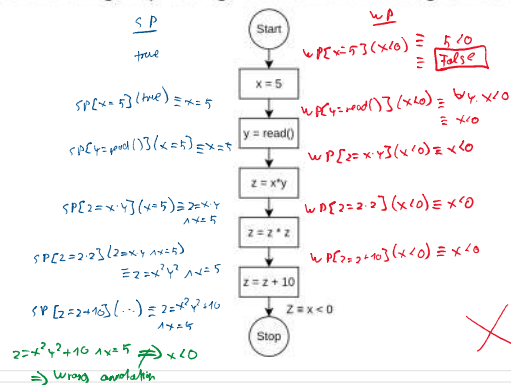




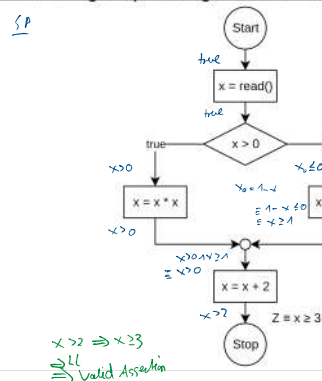
## Prove the following Graphs using Weakest Pre- and Strongest PostCondition



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