

# Software Testing Assignment 4

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## 1: Book Exercise

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## 2: Random data generator

```
genSetMax = 100
genSetMaxEntries = 10

genSet :: IO (Set Int)
genSet = do
  n <- getRandomInt genSetMaxEntries
  ns <- genSet' genSetMax n
  return ns

genSet' :: (Eq a, Num a) => Int -> a -> IO (Set Int)
genSet' _ 0 = return (Set [])
genSet' d c = do
  n <- getRandomInt d
  ns <- genSet' d (c-1)
  return (insertSet n ns)
```

Time spent: 10 minutes

## Set intersection, union, difference

### Haskell Program

```
intersectSet :: (Ord a) => Set a -> Set a -> Set a
intersectSet (Set []) set2 = (Set [])
intersectSet (Set (x:xs)) set2 | inSet x set2 = insertSet x (intersectSet (Set xs) set2)
                                | otherwise = (intersectSet (Set xs) set2)

-- Pre: no duplicates, it is sorted
-- Post: no duplicates, it is sorted
differenceSet :: (Ord a) => Set a -> Set a -> Set a
differenceSet (Set []) set2 = (Set [])
differenceSet (Set (x:xs)) set2 | inSet x set2 = (differenceSet (Set xs) set2)
                                | otherwise = insertSet x (differenceSet (Set xs) set2)

--Union is already implemented in SetOrd.hs
```

### Intersection Test

```
-- A set I is an intersection of A and B if I is an subset of A and B
testIntersect :: (Ord a) => Set a -> Set a -> Set a -> Bool
testIntersect a b i = subSet i a && subSet i b

automatedI :: IO Bool
automatedI = do
  a <- genSet
  b <- genSet
```

```

    return $ testIntersect a b (intersectSet a b)

automatedI' :: Int -> IO [Bool]
automatedI' 0 = return []
automatedI' c = do
    d <- automatedI
    ds <- automatedI' (c-1)
    return (d:ds)

generateIntersectionTest :: Int -> IO String
generateIntersectionTest c = do
    ps <- automatedI' c
    return ("All Checks Valid: " ++ (show (all (\x -> x) ps)))

```

## Difference Test

```

-- Property: An set D is the difference of A and B if it is an subset
-- of A and has no elements in common with B
testDifference :: (Ord a) => Set a -> Set a -> Set a -> Bool
testDifference a b d = subSet d a && noElement d b

noElement :: (Ord a) => Set a -> Set a -> Bool
noElement (Set[]) _ = True
noElement (Set(x:xs)) set | inSet x set = False
                        | otherwise = noElement (Set xs) set

automatedD :: IO Bool
automatedD = do
    a <- genSet
    b <- genSet
    return $ testDifference a b (differenceSet a b)

automatedD' :: Int -> IO [Bool]
automatedD' 0 = return []
automatedD' c = do
    d <- automatedD
    ds <- automatedD' (c-1)
    return (d:ds)

generateDifferenceTest :: Int -> IO String
generateDifferenceTest c = do
    ps <- automatedD' c
    return ("All Checks Valid: " ++ (show (all (\x -> x) ps)))

```

## Union Test

```

--PROPERTY : Every element in either of the sets should be an element of the union
testUnion :: Int -> IO [Bool]
testUnion 0 = return []
testUnion a = do
    n <- testUnion1
    ns <- testUnion (a-1)
    return(n : ns)

testUnion1 :: IO Bool
testUnion1 = do
    n <- randomIntSet
    m <- randomIntSet
    return(isElementOf n m (unionSet n m))

isElementOf :: (Ord a) => Set a -> Set a -> Set a -> Bool
isElementOf (Set a) (Set b) (Set c) = all (\x -> elem x c) (a++b)

```

```

Lab4> generateDifferenceTest 10
All Checks Valid: True"
Lab4> generateIntersectionTest 10
All Checks Valid: True"
Lab4> generateDifferenceTest 10
All Checks Valid: True"
Lab4> testUnion 10
True,True,True,True,True,True,True,True,True,True]
Lab4>

```

Time spent: 75 minutes

## Transitive Closure

```
trClos :: (Ord a) => Rel a -> Rel a
trClos x = trClos2 x []

-- If the closure n+1 is a subset of n than all closures are found
-- because no new elements were found
trClos2 :: (Ord a) => Rel a -> Rel a -> Rel a
trClos2 = fix (\ f x y ->
    if subSet (list2set x) (list2set y) then (nub x)
    else f ((x @@ x)++x) x)
```

Time spent: 1.5 hours

## Testing Closure

```
testTrClos :: (Ord a) => Rel a -> Rel a -> Bool
testTrClos [] _ = True
testTrClos (x:xs) z = (all (\y -> elem y z) ([x] @@ z)) && (testTrClos xs z)

--RANDOM TESTING
randomTestsTrClos :: Int -> IO [Bool]
randomTestsTrClos 0 = return []
randomTestsTrClos a = do
    n <- randomTestTrClos
    m <- randomTestsTrClos (a-1)
    return (n:m)

randomTestTrClos :: IO Bool
randomTestTrClos = do
    n <- randomRelation maxSize
    return( testTrClos (trClos n) (trClos n))

randomRelation :: (Eq a, Num a) => a -> IO [(Int,Int)]
randomRelation 0 = return []
randomRelation a = do
    n <- getRandomInt range
    m <- getRandomInt range
    l <- randomRelation (a-1)
    return((n,m):l)
```

```
Lab4> randomTestsTrClos 10
True,True,True,True,True,True,True,True,True
Lab4>
```

Time spent: 2 hours