
Algorithm 1 SeedSubTrees(Γ)

```
1: for  $comp \in \{Components\}$  do
2:    $level = []$ ; {dynamic array of failed components at subTree level}
3:    $nFailed = (0,0,...,0)$ ; {counts failed components}
4:    $BFHist = \{Array\ of\ linked\ lists\}$ ;
      {breadth first history of subTrees, array is indexed by component,
      stores parent in linked list for each component}
5:
6:   if (NotEmpty( $\Gamma_{comp}$ )) then
7:     append  $comp$  to  $level$ ;
8:      $nFailed[comp] = 1$ ;
9:     append  $|$  to  $BFHist[comp]$ ; {signifies comp has failed}
10:    AddSubTreeLevel( $level, nFailed, BFHist, 1$ );
11:   end if
12: end for
```

Algorithm 2 AddSubTreeLevel(*level*, *nFailed*, *BFHist*, *subTreeRate*, *rootC*)

```

1:  $nextLevelPossibilities = \prod_{i=1}^{|level|} \mathcal{P}(\Gamma_{level[i]});$ 
   {Cartesian Product (Power Sets (Ordered Set))}
2: for oneNextLevelPossibility  $\in nextLevelPossibilities$  do
3:   nextLevel = oneNextLevelPossibility;
4:
5:   for parentC  $\in level$  do
6:     for childC  $\in \Gamma_{parentC}$  do
7:       if childC  $\in nextLevel$  then
8:         if nFailed[childC] == Redundancy(childC) then
9:           goto line 3; {invalid subtree, requires more comps than total}
10:        end if
11:        nFailed[childC] = nFailed[childC] + 1;
12:        append | to BFHist[comp]; {signifies comp has failed}
13:        subTreeRate = subTreeRate *  $\phi_{parentC, childC}$ ;
        {update rate with  $\phi$ }
14:      else
15:        append parentC to BFHist[childC]; {signifies comp has not
        failed}
16:      end if
17:    end for
18:  end for
19:
20:  if Children Added then
21:    AddSubTreeLevel(level, nFailed, BFHist, subTreeRate, rootC);
    {subTree can be grown further}
22:  else
23:    ProcessRates(nFailed, BFHist, subTreeRate, rootC);
    {subTree is stunted}
24:  end if
25: end for

```

Algorithm 3 ProcessRates($nFailed$, $BFHist$, $subTreeRate$, $rootC$)

```
1: for  $x \in Q$  do
2:    $y = x + nFailed$ ;
3:    $env = \text{Environment}(x)$ ;
4:   if  $\text{ValidState}(y)$  then
5:      $n = \text{Redundancy}(rootC) - x[rootC]$ ;
6:      $rootFailureRate = n * \lambda_{rootC, env}$ ;
7:      $complementRate = 1$ ; {complement rate of comps that could have failed}
8:     for  $comp \in \{Components\}$  do
9:        $compsAvailable = \text{Redundancy}(comp) - x[comp]$ ;
10:      for  $parentC \in BFHist[comp]$  do
11:        if  $parentC == |$  then
12:           $compsAvailable = compsAvailable - 1$ ;
13:        else if  $compsAvailable > 0$  then
14:           $complementRate = complementRate * (1 - \phi_{parentC, comp})$ ;
15:        end if
16:      end for
17:    end for
18:  end if
19:   $Q(x, y) = rootFailureRate * subTreeRate * complementRate$ ;
20: end for
```
