

SPIHT examples

First example

Constructing T1

```
In[480]:= T1 = {1, 1, 1, 2, 2, 5};
In[481]:= make1 = maketree[T1, 0]
treetest finished
properedges finished
omega finished
Out[481]:= {{1, 2, 3, 4, 5, 6}, {1}, {3, 4, 6}, {{2, 3}, {4, 5}, {}, {}, {6}, {}},
  {1 ↔ 2, 1 ↔ 3, 2 ↔ 4, 2 ↔ 5, 5 ↔ 6}, {1 → v1, 2 → v2, 3 → v3, 4 → v4, 5 → v5, 6 → v6}}
```

```
In[482]:= vertices1 = make1[[1]]
Out[482]:= {1, 2, 3, 4, 5, 6}
In[483]:= t1 = make1[[5 ;; 6]]
Out[483]:= {{1 ↔ 2, 1 ↔ 3, 2 ↔ 4, 2 ↔ 5, 5 ↔ 6}, {1 → v1, 2 → v2, 3 → v3, 4 → v4, 5 → v5, 6 → v6}}
```

Constructing σ, δ, λ for $(T1, C1)$ and $N=4$

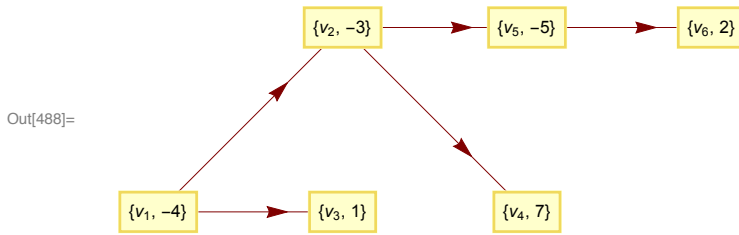
```
In[484]:= C1 = {-4, -3, 1, 7, -5, 2};
In[485]:= sm1 = sigmap[T1, C1, 4, 0][[4 ;; 6]];
treetest finished
properedges finished
omega finished
```

$(T1, C1)$ visualized

```
In[486]:= label1c = Map[# → {v#, C1[[#]]} &, vertices1]
Out[486]:= {1 → {v1, -4}, 2 → {v2, -3}, 3 → {v3, 1}, 4 → {v4, 7}, 5 → {v5, -5}, 6 → {v6, 2}}
```

```
In[487]:= edges1c = Map[#[[1]] → #[[2]] &, t1[[1]]] /. label1c
Out[487]:= {{v1, -4} → {v2, -3}, {v1, -4} → {v3, 1},
  {v2, -3} → {v4, 7}, {v2, -3} → {v5, -5}, {v5, -5} → {v6, 2}}
```

```
In[488]:= LayeredGraphPlot[edges1c, Left, VertexLabeling → True]
```



The σ mapping visualized

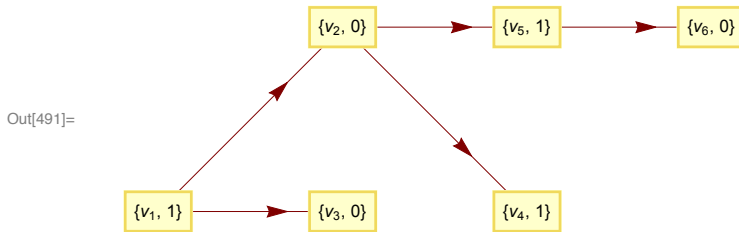
In[489]:= `label1s = Map[# -> {v#, sm1[[1, #]]} &, vertices1]`

Out[489]= `{1 -> {v1, 1}, 2 -> {v2, 0}, 3 -> {v3, 0}, 4 -> {v4, 1}, 5 -> {v5, 1}, 6 -> {v6, 0}}`

In[490]:= `edges1s = Map[#[[1]] -> #[[2]] &, t1[[1]]] /. label1s`

Out[490]= `{{{v1, 1} -> {v2, 0}, {v1, 1} -> {v3, 0},
{v2, 0} -> {v4, 1}, {v2, 0} -> {v5, 1}, {v5, 1} -> {v6, 0}}`

In[491]:= `LayeredGraphPlot[edges1s, Left, VertexLabeling -> True]`



The δ mapping visualized

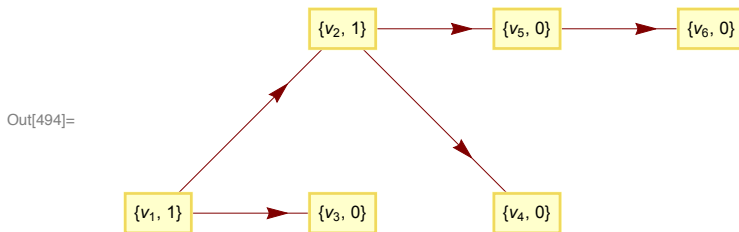
In[492]:= `label1d = Map[# -> {v#, sm1[[2, #]]} &, vertices1]`

Out[492]= `{1 -> {v1, 1}, 2 -> {v2, 1}, 3 -> {v3, 0}, 4 -> {v4, 0}, 5 -> {v5, 0}, 6 -> {v6, 0}}`

In[493]:= `edges1d = Map[#[[1]] -> #[[2]] &, t1[[1]]] /. label1d`

Out[493]= `{{{v1, 1} -> {v2, 1}, {v1, 1} -> {v3, 0},
{v2, 1} -> {v4, 0}, {v2, 1} -> {v5, 0}, {v5, 0} -> {v6, 0}}`

In[494]:= `LayeredGraphPlot[edges1d, Left, VertexLabeling -> True]`



The λ mapping visualized

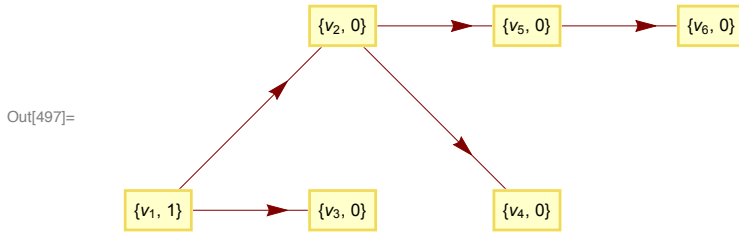
In[495]:= `label1l = Map[# -> {v#, sm1[[3, #]]} &, vertices1]`

Out[495]= `{1 -> {v1, 1}, 2 -> {v2, 0}, 3 -> {v3, 0}, 4 -> {v4, 0}, 5 -> {v5, 0}, 6 -> {v6, 0}}`

In[496]:= `edges1l = Map[#[[1]] -> #[[2]] &, t1[[1]]] /. label1l`

```
Out[496]= {{v1, 1} → {v2, 0}, {v1, 1} → {v3, 0},
           {v2, 0} → {v4, 0}, {v2, 0} → {v5, 0}, {v5, 0} → {v6, 0}}
```

```
In[497]:= LayeredGraphPlot[edges1l, Left, VertexLabeling → True]
```



Applying scantree

```
In[498]:= scantree[T1, C1, 4, {{1, "A"}}, {1}, {}, 1]
```

```

treetest finished
properedges finished
omega finished
vertices: {1, 2, 3, 4, 5, 6}
roots: {1}
leaves: {3, 4, 6}
N: 4
LIS: {{1, A}}
new LIS: {}
LIP: {1}
LSP: {}
out: σ[1] = 1
out: sign[-4]
LSP: {1}
LIP: {1}
LIS: {{1, A}}
out: δ[1] = 1
out: σ[2] = 0
LSP: {1}
LIP: {1, 2}
out: σ[3] = 0
LSP: {1}
LIP: {1, 2, 3}
LIS: {{1, B}}
LIS: {{1, B}}
out: λ[1] = 1
LIS: {{2, A}, {3, A}}
```

```

LIS: {{2, A}, {3, A}}
out:  $\delta[2] = 1$ 
out:  $\sigma[4] = 1$ 
out: sign[7]
LSP: {1, 4}
LIP: {1, 2, 3}
out:  $\sigma[5] = 1$ 
out: sign[-5]
LSP: {1, 4, 5}
LIP: {1, 2, 3}
LIS: {{3, A}, {2, B}}
LIS: {{3, A}, {2, B}}
out:  $\delta[3] = 0$ 
newLIS: {{3, A}}
LIS: {{2, B}}
out:  $\lambda[2] = 0$ 
newLIS: {{3, A}, {2, B}}
new LIS: {{3, A}, {2, B}}
new LIP: {2, 3}
new LSP: {1, 4, 5}
output: {1, sign[-4], 1, 0, 0, 1, 1, 1, sign[7], 1, sign[-5], 0, 0}
Out[498]= {{{3, A}, {2, B}}, {2, 3}, {1, 4, 5},
  {1, sign[-4], 1, 0, 0, 1, 1, 1, sign[7], 1, sign[-5], 0, 0}}

```

Second example

Constructing T2

```
In[499]:= T2 = {1, 1, 1, 1, 2, 2, 2, 2, 3, 3, 3, 3, 4, 4, 4, 4};
```

```
In[500]:= Table[M2L[i, j], {i, 0, 3}, {j, 0, 3}] // MatrixForm
```

```
Out[500]/MatrixForm=
```

$$\begin{pmatrix} 0 & 1 & 4 & 5 \\ 2 & 3 & 6 & 7 \\ 8 & 9 & 12 & 13 \\ 10 & 11 & 14 & 15 \end{pmatrix}$$

```
In[501]:= Table[T2[[M2L[i, j] + 1]], {i, 0, 3}, {j, 0, 3}] // MatrixForm
```

```
Out[501]/MatrixForm=
```

$$\begin{pmatrix} 1 & 1 & 2 & 2 \\ 1 & 1 & 2 & 2 \\ 3 & 3 & 4 & 4 \\ 3 & 3 & 4 & 4 \end{pmatrix}$$

```
In[502]:= make2 = maketree[T2, 0]
```

```
treetest finished
properedges finished
omega finished
```

```
Out[502]= {{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16},
  {1}, {5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16},
  {{2, 3, 4}, {5, 6, 7, 8}, {9, 10, 11, 12}, {13, 14, 15, 16}, {}, {}, {}, {},
  {}, {}, {}, {}, {}, {}, {}, {}, {}, {1 ↔ 2, 1 ↔ 3, 1 ↔ 4, 2 ↔ 5, 2 ↔ 6, 2 ↔ 7,
  2 ↔ 8, 3 ↔ 9, 3 ↔ 10, 3 ↔ 11, 3 ↔ 12, 4 ↔ 13, 4 ↔ 14, 4 ↔ 15, 4 ↔ 16},
  {1 → v1, 2 → v2, 3 → v3, 4 → v4, 5 → v5, 6 → v6, 7 → v7, 8 → v8, 9 → v9,
  10 → v10, 11 → v11, 12 → v12, 13 → v13, 14 → v14, 15 → v15, 16 → v16}}
```

```
In[503]= vertices2 = make2[[1]]
```

```
Out[503]= {1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16}
```

```
In[504]= t2 = make2[[5 ;; 6]]
```

```
Out[504]= {{1 ↔ 2, 1 ↔ 3, 1 ↔ 4, 2 ↔ 5, 2 ↔ 6, 2 ↔ 7, 2 ↔ 8,
  3 ↔ 9, 3 ↔ 10, 3 ↔ 11, 3 ↔ 12, 4 ↔ 13, 4 ↔ 14, 4 ↔ 15, 4 ↔ 16},
  {1 → v1, 2 → v2, 3 → v3, 4 → v4, 5 → v5, 6 → v6, 7 → v7, 8 → v8, 9 → v9,
  10 → v10, 11 → v11, 12 → v12, 13 → v13, 14 → v14, 15 → v15, 16 → v16}}
```

Constructing σ, δ, λ for $(T_2, C_2, 4)$ and $N=4$

```
In[505]= C2 = {18, 6, 3, -5, 8, -7, 13, 1, 2, 1, 2, -2, -6, 3, 4, -2}
```

```
Out[505]= {18, 6, 3, -5, 8, -7, 13, 1, 2, 1, 2, -2, -6, 3, 4, -2}
```

```
In[506]= sm2 = sigmap[T2, C2, 4, 0][[4 ;; 6]];
```

```
treetest finished
properedges finished
omega finished
```

The σ mapping

```
In[507]= Table[sm2[[1, M2L[i, j] + 1]], {i, 0, 3}, {j, 0, 3}] // MatrixForm
```

```
Out[507]//MatrixForm=
```

$$\begin{pmatrix} 1 & 1 & 1 & 1 \\ 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 \end{pmatrix}$$

The δ mapping

```
In[508]= Table[sm2[[2, M2L[i, j] + 1]], {i, 0, 3}, {j, 0, 3}] // MatrixForm
```

```
Out[508]//MatrixForm=
```

$$\begin{pmatrix} 1 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}$$

The λ mapping

```
In[509]:= Table[sm2[[3, M2L[i, j] + 1]], {i, 0, 3}, {j, 0, 3}] // MatrixForm
Out[509]/MatrixForm=

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}$$

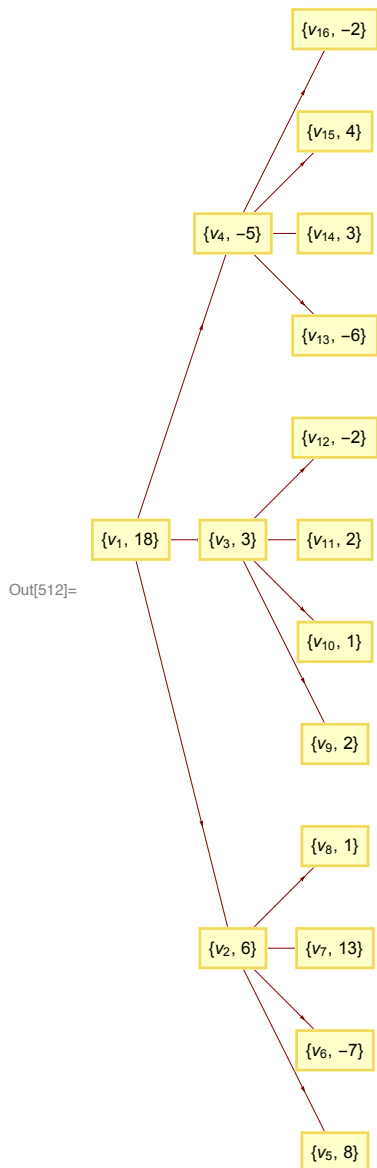
```

Displaying (T2,C2)

```
In[510]:= label2 = Map[# → {v#, C2[[#]]} &, vertices2]
Out[510]= {1 → {v1, 18}, 2 → {v2, 6}, 3 → {v3, 3}, 4 → {v4, -5}, 5 → {v5, 8}, 6 → {v6, -7},
7 → {v7, 13}, 8 → {v8, 1}, 9 → {v9, 2}, 10 → {v10, 1}, 11 → {v11, 2},
12 → {v12, -2}, 13 → {v13, -6}, 14 → {v14, 3}, 15 → {v15, 4}, 16 → {v16, -2}}
```

```
In[511]:= edges2 = Map[#[[1]] → #[[2]] &, t2[[1]]] /. label2
Out[511]= {{v1, 18} → {v2, 6}, {v1, 18} → {v3, 3}, {v1, 18} → {v4, -5}, {v2, 6} → {v5, 8},
{v2, 6} → {v6, -7}, {v2, 6} → {v7, 13}, {v2, 6} → {v8, 1}, {v3, 3} → {v9, 2},
{v3, 3} → {v10, 1}, {v3, 3} → {v11, 2}, {v3, 3} → {v12, -2}, {v4, -5} → {v13, -6},
{v4, -5} → {v14, 3}, {v4, -5} → {v15, 4}, {v4, -5} → {v16, -2}}
```

```
In[512]:= LayeredGraphPlot[edges2, Left, VertexLabeling → True]
```



Executing scantree on (T2,C2) with significance level N=16 (round 1)

```

In[513]:= scantree[T2, C2, 16, {{1, "A"}}, {1}, {}, 1]
treetest finished
properedges finished
omega finished
vertices: {1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16}
roots: {1}
leaves: {5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16}

```

```

N: 16
LIS: {{1, A}}
new LIS: {}
LIP: {1}
LSP: {}
out:  $\sigma[1] = 1$ 
out: sign[18]
LSP: {1}
LIP: {1}
LIS: {{1, A}}
out:  $\delta[1] = 0$ 
newLIS: {{1, A}}
new LIS: {{1, A}}
new LIP: {}
new LSP: {1}
output: {1, sign[18], 0}

```

```
Out[513]= {{{1, A}}, {}, {1}, {1, sign[18], 0}}
```

Executing scantree on (T2, C2) with significance level $N = 8$ (round 2)

```

In[514]= scantree[T2, C2, 8, %[[1]], %[[2]], %[[3]], 1]
treetest finished
properedges finished
omega finished
vertices: {1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16}
roots: {1}
leaves: {5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16}
N: 8
LIS: {{1, A}}
new LIS: {}
LIP: {}
LSP: {1}
LSP: {1}
LIP: {}
LIS: {{1, A}}
out:  $\delta[1] = 1$ 
out:  $\sigma[2] = 0$ 
LSP: {1}
LIP: {2}
out:  $\sigma[3] = 0$ 

```



```

LSP: {1}
LIP: {2, 3}
out:  $\sigma[4] = 0$ 
LSP: {1}
LIP: {2, 3, 4}
LIS: {{1, B}}
LIS: {{1, B}}
out:  $\lambda[1] = 1$ 
LIS: {{2, A}, {3, A}, {4, A}}
LIS: {{2, A}, {3, A}, {4, A}}
out:  $\delta[2] = 1$ 
out:  $\sigma[5] = 1$ 
out: sign[8]
LSP: {1, 5}
LIP: {2, 3, 4}
out:  $\sigma[6] = 0$ 
LSP: {1, 5}
LIP: {2, 3, 4, 6}
out:  $\sigma[7] = 1$ 
out: sign[13]
LSP: {1, 5, 7}
LIP: {2, 3, 4, 6}
out:  $\sigma[8] = 0$ 
LSP: {1, 5, 7}
LIP: {2, 3, 4, 6, 8}
LIS: {{3, A}, {4, A}}
out:  $\delta[3] = 0$ 
newLIS: {{3, A}}
LIS: {{4, A}}
out:  $\delta[4] = 0$ 
newLIS: {{3, A}, {4, A}}
new LIS: {{3, A}, {4, A}}
new LIP: {2, 3, 4, 6, 8}
new LSP: {1, 5, 7}
output: {1, 0, 0, 0, 1, 1, 1, sign[8], 0, 1, sign[13], 0, 0, 0}
Out[514]= {{{3, A}, {4, A}}, {2, 3, 4, 6, 8}, {1, 5, 7},
  {1, 0, 0, 0, 1, 1, 1, sign[8], 0, 1, sign[13], 0, 0, 0}}

```

Executing scantree on (T2, C2) with significance level $N = 4$ (round 3)

```

In[515]:= scantree[T2, C2, 4, %[[1]], %[[2]], %[[3]], 1]
treetest finished
properedges finished
omega finished
vertices: {1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16}
roots: {1}
leaves: {5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16}
N: 4
LIS: {{3, A}, {4, A}}
new LIS: {}
LIP: {2, 3, 4, 6, 8}
LSP: {1, 5, 7}
out:  $\sigma[2] = 1$ 
out: sign[6]
out:  $\sigma[3] = 0$ 
out:  $\sigma[4] = 1$ 
out: sign[-5]
out:  $\sigma[6] = 1$ 
out: sign[-7]
out:  $\sigma[8] = 0$ 
LSP: {1, 5, 7, 2, 4, 6}
LIP: {2, 3, 4, 6, 8, 3, 8}
LIS: {{3, A}, {4, A}}
out:  $\delta[3] = 0$ 
newLIS: {{3, A}}
LIS: {{4, A}}
out:  $\delta[4] = 1$ 
out:  $\sigma[13] = 1$ 
out: sign[-6]
LSP: {1, 5, 7, 2, 4, 6, 13}
LIP: {2, 3, 4, 6, 8, 3, 8}
out:  $\sigma[14] = 0$ 
LSP: {1, 5, 7, 2, 4, 6, 13}
LIP: {2, 3, 4, 6, 8, 3, 8, 14}
out:  $\sigma[15] = 1$ 
out: sign[4]
LSP: {1, 5, 7, 2, 4, 6, 13, 15}
LIP: {2, 3, 4, 6, 8, 3, 8, 14}
out:  $\sigma[16] = 0$ 

```

```

LSP: {1, 5, 7, 2, 4, 6, 13, 15}
LIP: {2, 3, 4, 6, 8, 3, 8, 14, 16}
new LIS: {{3, A}}
new LIP: {3, 8, 14, 16}
new LSP: {1, 5, 7, 2, 4, 6, 13, 15}
output: {1, sign[6], 0, 1, sign[-5], 1, sign[-7], 0, 0, 1, 1, sign[-6], 0, 1, sign[4], 0}
Out[515]= {{{3, A}}, {3, 8, 14, 16}, {1, 5, 7, 2, 4, 6, 13, 15},
          {1, sign[6], 0, 1, sign[-5], 1, sign[-7], 0, 0, 1, 1, sign[-6], 0, 1, sign[4], 0}}

```

Executing scantree on (T2, C2) with significance level N = 2 (round 4)

```

In[516]= scantree[T2, C2, 2, %[[1]], %[[2]], %[[3]], 0]
treetest finished
properedges finished
omega finished
Out[516]= {{}, {8, 10}, {1, 5, 7, 2, 4, 6, 13, 15, 3, 14, 16, 9, 11, 12},
          {1, sign[3], 0, 1, sign[3], 1, sign[-2], 1, 1, sign[2], 0, 1, sign[2], 1, sign[-2]}}

```

Executing scantree on (T2, C2) with significance level N = 1 (round 5)

```

In[517]= scantree[T2, C2, 1, %[[1]], %[[2]], %[[3]], 1]
treetest finished
properedges finished
omega finished
vertices: {1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16}
roots: {1}
leaves: {5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16}
N: 1
LIS: {}
new LIS: {}
LIP: {8, 10}
LSP: {1, 5, 7, 2, 4, 6, 13, 15, 3, 14, 16, 9, 11, 12}
out:  $\sigma[8] = 1$ 
out: sign[1]
out:  $\sigma[10] = 1$ 
out: sign[1]
LSP: {1, 5, 7, 2, 4, 6, 13, 15, 3, 14, 16, 9, 11, 12, 8, 10}
LIP: {8, 10}
new LIS: {}
new LIP: {}
new LSP: {1, 5, 7, 2, 4, 6, 13, 15, 3, 14, 16, 9, 11, 12, 8, 10}

```

```
output: {1, sign[1], 1, sign[1]}
```

```
Out[517]= {{}, {}, {1, 5, 7, 2, 4, 6, 13, 15, 3, 14, 16, 9, 11, 12, 8, 10},
           {1, sign[1], 1, sign[1]}}
```

Third example

The data (T3,C3)

```
In[518]= T3 = Flatten[Join[{1, 2, 3, 4}, Table[Table[a, {4}], {a, 2, 16}]]];
```

```
In[519]= Table[T3[[M2L[i, j] + 1]], {i, 0, 7}, {j, 0, 7}] // MatrixForm
```

```
Out[519]//MatrixForm=
```

$$\begin{pmatrix} 1 & 2 & 2 & 2 & 5 & 5 & 6 & 6 \\ 3 & 4 & 2 & 2 & 5 & 5 & 6 & 6 \\ 3 & 3 & 4 & 4 & 7 & 7 & 8 & 8 \\ 3 & 3 & 4 & 4 & 7 & 7 & 8 & 8 \\ 9 & 9 & 10 & 10 & 13 & 13 & 14 & 14 \\ 9 & 9 & 10 & 10 & 13 & 13 & 14 & 14 \\ 11 & 11 & 12 & 12 & 15 & 15 & 16 & 16 \\ 11 & 11 & 12 & 12 & 15 & 15 & 16 & 16 \end{pmatrix}$$

```
In[520]= C3 = {62, 34, -31, 24, 18, 17, -15, 14, 42, 29, -12, 15, -35, 10, -9, 15, -4, 1, -11,
              0, -2, 6, 4, -1, 29, 10, -1, 9, 6, 9, 5, 13, 4, 45, 3, 0, 13, -1, -2, 21, 0,
              13, -1, 7, 4, 5, -11, 3, 26, -21, -1, 0, 3, 1, 7, 9, 4, 5, 0, 8, 6, 0, 2, 7};
```

```
In[521]= Table[C3[[M2L[i, j] + 1]], {i, 0, 7}, {j, 0, 7}] // MatrixForm
```

```
Out[521]//MatrixForm=
```

$$\begin{pmatrix} 62 & 34 & 18 & 17 & -4 & 1 & -2 & 6 \\ -31 & 24 & -15 & 14 & -11 & 0 & 4 & -1 \\ 42 & 29 & -35 & 10 & 29 & 10 & 6 & 9 \\ -12 & 15 & -9 & 15 & -1 & 9 & 5 & 13 \\ 4 & 45 & 13 & -1 & 26 & -21 & 3 & 1 \\ 3 & 0 & -2 & 21 & -1 & 0 & 7 & 9 \\ 0 & 13 & 4 & 5 & 4 & 5 & 6 & 0 \\ -1 & 7 & -11 & 3 & 0 & 8 & 2 & 7 \end{pmatrix}$$

Executing scantree on (T3, C3) with significance level N = 32 (round 1)

```
In[522]= scantree[T3, C3, 32, {{2, "A"}, {3, "A"}, {4, "A"}}, {1, 2, 3, 4}, {}, 1]
```

```
treetest finished
```

```
properedges finished
```

```
omega finished
```

```
vertices: {1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22,
           23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43,
           44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64}
```

```
roots: {1, 2, 3, 4}
```

```
leaves: {1, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28,
         29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46,
         47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64}
```

```
N: 32
```

```
LIS: {{2, A}, {3, A}, {4, A}}
```

```

new LIS: {}
LIP: {1, 2, 3, 4}
LSP: {}
out:  $\sigma[1] = 1$ 
out: sign[62]
out:  $\sigma[2] = 1$ 
out: sign[34]
out:  $\sigma[3] = 0$ 
out:  $\sigma[4] = 0$ 
LSP: {1, 2}
LIP: {1, 2, 3, 4, 3, 4}
LIS: {{2, A}, {3, A}, {4, A}}
out:  $\delta[2] = 0$ 
newLIS: {{2, A}}
LIS: {{3, A}, {4, A}}
out:  $\delta[3] = 1$ 
out:  $\sigma[9] = 1$ 
out: sign[42]
LSP: {1, 2, 9}
LIP: {1, 2, 3, 4, 3, 4}
out:  $\sigma[10] = 0$ 
LSP: {1, 2, 9}
LIP: {1, 2, 3, 4, 3, 4, 10}
out:  $\sigma[11] = 0$ 
LSP: {1, 2, 9}
LIP: {1, 2, 3, 4, 3, 4, 10, 11}
out:  $\sigma[12] = 0$ 
LSP: {1, 2, 9}
LIP: {1, 2, 3, 4, 3, 4, 10, 11, 12}
LIS: {{4, A}, {3, B}}
LIS: {{4, A}, {3, B}}
out:  $\delta[4] = 1$ 
out:  $\sigma[13] = 1$ 
out: sign[-35]
LSP: {1, 2, 9, 13}
LIP: {1, 2, 3, 4, 3, 4, 10, 11, 12}
out:  $\sigma[14] = 0$ 
LSP: {1, 2, 9, 13}
LIP: {1, 2, 3, 4, 3, 4, 10, 11, 12, 14}

```

```

out:  $\sigma[15] = 0$ 
LSP: {1, 2, 9, 13}
LIP: {1, 2, 3, 4, 3, 4, 10, 11, 12, 14, 15}
out:  $\sigma[16] = 0$ 
LSP: {1, 2, 9, 13}
LIP: {1, 2, 3, 4, 3, 4, 10, 11, 12, 14, 15, 16}
LIS: {{3, B}, {4, B}}
LIS: {{3, B}, {4, B}}
out:  $\lambda[3] = 1$ 
LIS: {{4, B}, {9, A}, {10, A}, {11, A}, {12, A}}
LIS: {{4, B}, {9, A}, {10, A}, {11, A}, {12, A}}
out:  $\lambda[4] = 0$ 
newLIS: {{2, A}, {4, B}}
LIS: {{9, A}, {10, A}, {11, A}, {12, A}}
out:  $\delta[9] = 1$ 
out:  $\sigma[33] = 0$ 
LSP: {1, 2, 9, 13}
LIP: {1, 2, 3, 4, 3, 4, 10, 11, 12, 14, 15, 16, 33}
out:  $\sigma[34] = 1$ 
out: sign[45]
LSP: {1, 2, 9, 13, 34}
LIP: {1, 2, 3, 4, 3, 4, 10, 11, 12, 14, 15, 16, 33}
out:  $\sigma[35] = 0$ 
LSP: {1, 2, 9, 13, 34}
LIP: {1, 2, 3, 4, 3, 4, 10, 11, 12, 14, 15, 16, 33, 35}
out:  $\sigma[36] = 0$ 
LSP: {1, 2, 9, 13, 34}
LIP: {1, 2, 3, 4, 3, 4, 10, 11, 12, 14, 15, 16, 33, 35, 36}
LIS: {{10, A}, {11, A}, {12, A}}
out:  $\delta[10] = 0$ 
newLIS: {{2, A}, {4, B}, {10, A}}
LIS: {{11, A}, {12, A}}
out:  $\delta[11] = 0$ 
newLIS: {{2, A}, {4, B}, {10, A}, {11, A}}
LIS: {{12, A}}
out:  $\delta[12] = 0$ 
newLIS: {{2, A}, {4, B}, {10, A}, {11, A}, {12, A}}
new LIS: {{2, A}, {4, B}, {10, A}, {11, A}, {12, A}}
new LIP: {3, 4, 10, 11, 12, 14, 15, 16, 33, 35, 36}

```

```
new LSP: {1, 2, 9, 13, 34}
```

```
output: {1, sign[62], 1, sign[34], 0, 0, 0, 1, 1, sign[42],
         0, 0, 0, 1, 1, sign[-35], 0, 0, 0, 1, 0, 1, 0, 1, sign[45], 0, 0, 0, 0, 0}
```

```
Out[522]= {{{2, A}, {4, B}, {10, A}, {11, A}, {12, A}},
          {3, 4, 10, 11, 12, 14, 15, 16, 33, 35, 36}, {1, 2, 9, 13, 34},
          {1, sign[62], 1, sign[34], 0, 0, 0, 1, 1, sign[42], 0, 0, 0,
           1, 1, sign[-35], 0, 0, 0, 1, 0, 1, 0, 1, sign[45], 0, 0, 0, 0, 0}}
```

Executing scantree on (T3, C3) with significance level N = 16 (round 2)

```
In[523]= scantree[T3, C3, 16, %[[1]], %[[2]], %[[3]], 0]
```

```
treetest finished
```

```
properedges finished
```

```
omega finished
```

```
Out[523]= {{{11, A}, {12, A}, {14, A}, {15, A}, {16, A}, {5, A}, {6, A}, {8, A}},
          {11, 12, 14, 15, 16, 33, 35, 36, 7, 8, 37, 38, 39, 51, 52, 26, 27, 28},
          {1, 2, 9, 13, 34, 3, 4, 10, 5, 6, 40, 49, 50, 25},
          {1, sign[-31], 1, sign[24], 1, sign[29], 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
           sign[18], 1, sign[17], 0, 0, 1, 1, 0, 0, 0, 1, sign[21], 0, 0, 1, 1, 1,
           sign[26], 1, sign[-21], 0, 0, 0, 0, 0, 0, 0, 1, 1, sign[29], 0, 0, 0, 0}}
```

Executing scantree on (T3, C3) with significance level N = 8 (round 3)

```
In[524]= scantree[T3, C3, 8, %[[1]], %[[2]], %[[3]], 0]
```

```
treetest finished
```

```
properedges finished
```

```
omega finished
```

```
Out[524]= {{{16, A}, {6, A}}, {33, 35, 36, 38, 39, 51, 52, 27, 41,
          43, 44, 45, 46, 48, 53, 54, 55, 57, 58, 59, 17, 18, 20, 29, 31},
          {1, 2, 9, 13, 34, 3, 4, 10, 5, 6, 40, 49, 50, 25, 11, 12, 14,
           15, 16, 7, 8, 37, 26, 28, 42, 47, 56, 60, 19, 30, 32},
          {1, sign[-12], 1, sign[15], 1, sign[10], 1, sign[-9], 1, sign[15], 0, 0, 0, 1,
           sign[-15], 1, sign[14], 1, sign[13], 0, 0, 0, 0, 1, sign[10], 0, 1, sign[9], 1,
           0, 1, sign[13], 0, 0, 1, 0, 0, 1, sign[-11], 0, 1, 0, 0, 0, 1, sign[9], 1, 0, 0,
           0, 1, sign[8], 0, 1, 0, 0, 1, sign[-11], 0, 0, 1, 0, 1, sign[9], 0, 1, sign[13]}}
```

Executing scantree on (T3, C3) with significance level N = 4 (round 4)

```
In[525]= scantree[T3, C3, 4, %[[1]], %[[2]], %[[3]], 0]
```

```
treetest finished
```

```
properedges finished
```

```
omega finished
```

```
Out[525]= {{}, {35, 36, 38, 39, 51, 52, 27, 41, 43, 48, 53, 54, 59, 18, 20, 62, 63, 21, 24},
  {1, 2, 9, 13, 34, 3, 4, 10, 5, 6, 40, 49, 50, 25, 11, 12, 14, 15, 16, 7, 8, 37, 26, 28,
  42, 47, 56, 60, 19, 30, 32, 33, 44, 45, 46, 55, 57, 58, 17, 29, 31, 61, 64, 22, 23},
  {1, sign[4], 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, sign[7], 1, sign[4], 1, sign[5], 0,
  0, 0, 1, sign[7], 1, sign[4], 1, sign[5], 0, 1, sign[-4], 0, 0, 1, sign[6],
  1, sign[5], 1, 1, sign[6], 0, 0, 1, sign[7], 1, 0, 1, sign[6], 1, sign[4], 0}}
```

Executing scantree on (T3, C3) with significance level N = 2 (round 5)

```
In[526]= scantree[T3, C3, 2, %[[1]], %[[2]], %[[3]], 0]
```

```
treetest finished
properedges finished
omega finished
```

```
Out[526]= {{}, {36, 38, 51, 52, 27, 41, 43, 54, 59, 18, 20, 62, 24},
  {1, 2, 9, 13, 34, 3, 4, 10, 5, 6, 40, 49, 50, 25, 11, 12, 14, 15,
  16, 7, 8, 37, 26, 28, 42, 47, 56, 60, 19, 30, 32, 33, 44, 45, 46,
  55, 57, 58, 17, 29, 31, 61, 64, 22, 23, 35, 39, 48, 53, 63, 21},
  {1, sign[3], 0, 0, 1, sign[-2], 0, 0, 0, 0, 0, 1, sign[3], 1,
  sign[3], 0, 0, 0, 0, 0, 1, sign[2], 1, sign[-2], 0}}
```

Executing scantree on (T3, C3) with significance level N = 1 (round 6)

```
In[527]= scantree[T3, C3, 1, %[[1]], %[[2]], %[[3]], 0]
```

```
treetest finished
properedges finished
omega finished
```

```
Out[527]= {{}, {36, 52, 41, 59, 20, 62},
  {1, 2, 9, 13, 34, 3, 4, 10, 5, 6, 40, 49, 50, 25, 11, 12, 14, 15, 16, 7, 8,
  37, 26, 28, 42, 47, 56, 60, 19, 30, 32, 33, 44, 45, 46, 55, 57, 58, 17, 29,
  31, 61, 64, 22, 23, 35, 39, 48, 53, 63, 21, 38, 51, 27, 43, 54, 18, 24},
  {0, 1, sign[-1], 1, sign[-1], 0, 1, sign[-1], 0, 1, sign[-1],
  1, sign[1], 0, 1, sign[1], 0, 0, 1, sign[-1]}}
```

Example (T3,C3) with the SPIHT-algorithm

```
In[528]= spiht[T3, C3, 6, 0]
```

```
treetest finished
properedges finished
omega finished
treetest finished
properedges finished
omega finished
round: 1 NN: 32
```



```
refinement: {bit[62, 0], bit[34, 0], bit[42, 0], bit[35, 0], bit[45, 0], bit[45, 0],
  bit[31, 0], bit[24, 0], bit[18, 0], bit[17, 0], bit[29, 0], bit[29, 0], bit[21, 0],
  bit[26, 0], bit[21, 0], bit[29, 0], bit[21, 0], bit[26, 0], bit[21, 0], bit[15, 0],
  bit[14, 0], bit[12, 0], bit[15, 0], bit[10, 0], bit[9, 0], bit[15, 0], bit[11, 0],
  bit[10, 0], bit[9, 0], bit[9, 0], bit[13, 0], bit[13, 0], bit[13, 0], bit[11, 0],
  bit[9, 0], bit[8, 0], bit[10, 0], bit[9, 0], bit[13, 0], bit[11, 0], bit[9, 0],
  bit[13, 0], bit[13, 0], bit[11, 0], bit[9, 0], bit[8, 0], bit[4, 0], bit[6, 0],
  bit[4, 0], bit[6, 0], bit[5, 0], bit[4, 0], bit[7, 0], bit[4, 0], bit[5, 0], bit[7, 0],
  bit[4, 0], bit[5, 0], bit[6, 0], bit[7, 0], bit[4, 0], bit[4, 0], bit[6, 0], bit[5, 0],
  bit[7, 0], bit[4, 0], bit[5, 0], bit[7, 0], bit[4, 0], bit[5, 0], bit[6, 0], bit[4, 0],
  bit[6, 0], bit[7, 0], bit[2, 0], bit[3, 0], bit[2, 0], bit[3, 0], bit[3, 0],
  bit[2, 0], bit[3, 0], bit[2, 0], bit[3, 0], bit[3, 0], bit[2, 0], bit[2, 0]}
```

```
Out[528]= {{134, 0}, {146, 6}, {168, 19}, {144, 46}, {98, 74}, {88, 86}}
```

Example (T3,C3) with the 2D-SPIHT-algorithm

```
In[529]= M3 = Table[C3[[M2L[i, j] + 1]], {i, 0, 7}, {j, 0, 7}]; M3 // MatrixForm
```

```
Out[529]//MatrixForm=
```

$$\begin{pmatrix} 62 & 34 & 18 & 17 & -4 & 1 & -2 & 6 \\ -31 & 24 & -15 & 14 & -11 & 0 & 4 & -1 \\ 42 & 29 & -35 & 10 & 29 & 10 & 6 & 9 \\ -12 & 15 & -9 & 15 & -1 & 9 & 5 & 13 \\ 4 & 45 & 13 & -1 & 26 & -21 & 3 & 1 \\ 3 & 0 & -2 & 21 & -1 & 0 & 7 & 9 \\ 0 & 13 & 4 & 5 & 4 & 5 & 6 & 0 \\ -1 & 7 & -11 & 3 & 0 & 8 & 2 & 7 \end{pmatrix}$$

```
In[530]= spiht2D[M3, 2, 6, 0]
```

round: 1 NN: 32

sorting: {1, sign[62], 1, sign[34], 0, 0, 0, 1, 1, sign[42],
0, 0, 0, 1, 1, sign[-35], 0, 0, 0, 1, 0, 1, 0, 1, sign[45], 0, 0, 0, 0, 0}

round: 2 NN: 16

sorting: {1, sign[-31], 1, sign[24], 1, sign[29], 0, 0, 0, 0, 0, 0, 0,
0, 1, 1, sign[18], 1, sign[17], 0, 0, 1, 1, 0, 0, 0, 1, sign[21], 0, 0, 1, 1,
1, sign[26], 1, sign[-21], 0, 0, 0, 0, 0, 0, 0, 1, 1, sign[29], 0, 0, 0, 0}

refinement: {bit[62, 4], bit[34, 4], bit[42, 4], bit[35, 4], bit[45, 4]}

round: 3 NN: 8

sorting: {1, sign[-12], 1, sign[15], 1, sign[10], 1, sign[-9], 1, sign[15], 0, 0, 0, 1,
sign[-15], 1, sign[14], 1, sign[13], 0, 0, 0, 0, 1, sign[10], 0, 1, sign[9], 1,
0, 1, sign[13], 0, 0, 1, 0, 0, 1, sign[-11], 0, 1, 0, 0, 0, 1, sign[9], 1, 0, 0,
0, 1, sign[8], 0, 1, 0, 0, 1, sign[-11], 0, 0, 1, 0, 1, sign[9], 0, 1, sign[13]}

refinement:

{bit[62, 3], bit[34, 3], bit[42, 3], bit[35, 3], bit[45, 3], bit[31, 3], bit[24, 3],
bit[29, 3], bit[18, 3], bit[17, 3], bit[21, 3], bit[26, 3], bit[21, 3], bit[29, 3]}

round: 4 NN: 4

sorting: {1, sign[4], 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, sign[7], 1, sign[4], 1, sign[5],
0, 0, 0, 1, sign[7], 1, sign[4], 1, sign[5], 0, 1, sign[-4], 0, 0, 1, sign[6],
1, sign[5], 1, 1, sign[6], 0, 0, 1, sign[7], 1, 0, 1, sign[6], 1, sign[4], 0}

refinement: {bit[62, 2], bit[34, 2], bit[42, 2], bit[35, 2], bit[45, 2],
bit[31, 2], bit[24, 2], bit[29, 2], bit[18, 2], bit[17, 2], bit[21, 2],
bit[26, 2], bit[21, 2], bit[29, 2], bit[12, 2], bit[15, 2], bit[10, 2],
bit[9, 2], bit[15, 2], bit[15, 2], bit[14, 2], bit[13, 2], bit[10, 2], bit[9, 2],
bit[13, 2], bit[11, 2], bit[9, 2], bit[8, 2], bit[11, 2], bit[9, 2], bit[13, 2]}

round: 5 NN: 2

sorting: {1, sign[3], 0, 0, 1, sign[-2], 0, 0, 0, 0, 0,
1, sign[3], 1, sign[3], 0, 0, 0, 0, 0, 1, sign[2], 1, sign[-2], 0}

refinement: {bit[62, 1], bit[34, 1], bit[42, 1], bit[35, 1], bit[45, 1],
bit[31, 1], bit[24, 1], bit[29, 1], bit[18, 1], bit[17, 1], bit[21, 1],
bit[26, 1], bit[21, 1], bit[29, 1], bit[12, 1], bit[15, 1], bit[10, 1],
bit[9, 1], bit[15, 1], bit[15, 1], bit[14, 1], bit[13, 1], bit[10, 1], bit[9, 1],
bit[13, 1], bit[11, 1], bit[9, 1], bit[8, 1], bit[11, 1], bit[9, 1], bit[13, 1],
bit[4, 1], bit[7, 1], bit[4, 1], bit[5, 1], bit[7, 1], bit[4, 1], bit[5, 1],
bit[4, 1], bit[6, 1], bit[5, 1], bit[6, 1], bit[7, 1], bit[6, 1], bit[4, 1]}

round: 6 NN: 1

sorting: {0, 1, sign[-1], 1, sign[-1], 0, 1, sign[-1],
0, 1, sign[-1], 1, sign[1], 0, 1, sign[1], 0, 0, 1, sign[-1]}

refinement: {bit[62, 0], bit[34, 0], bit[42, 0], bit[35, 0], bit[45, 0], bit[31, 0],
bit[24, 0], bit[29, 0], bit[18, 0], bit[17, 0], bit[21, 0], bit[26, 0], bit[21, 0],
bit[29, 0], bit[12, 0], bit[15, 0], bit[10, 0], bit[9, 0], bit[15, 0], bit[15, 0],
bit[14, 0], bit[13, 0], bit[10, 0], bit[9, 0], bit[13, 0], bit[11, 0], bit[9, 0],
bit[8, 0], bit[11, 0], bit[9, 0], bit[13, 0], bit[4, 0], bit[7, 0], bit[4, 0], bit[5, 0],
bit[7, 0], bit[4, 0], bit[5, 0], bit[4, 0], bit[6, 0], bit[5, 0], bit[6, 0], bit[7, 0],
bit[6, 0], bit[4, 0], bit[3, 0], bit[2, 0], bit[3, 0], bit[3, 0], bit[2, 0], bit[2, 0]}

```
Out[530]= {{30, 0}, {50, 5}, {67, 14}, {49, 31}, {25, 45}, {20, 51}}
```

```
In[641]:= spiht2Dshort[M3, 2, 6, 0]
```

```
round: 1 NN: 32
sorting bits: 30
round: 2 NN: 16
sorting bits: 50
refinement bits: 5
round: 3 NN: 8
sorting bits: 67
refinement bits: 14
round: 4 NN: 4
sorting bits: 49
refinement bits: 31
round: 5 NN: 2
sorting bits: 25
refinement bits: 45
round: 6 NN: 1
sorting bits: 20
refinement bits: 51
```

```
Out[641]/TableForm=
```

round	sortbits	refinebits	total
1	30	0	30
2	50	5	85
3	67	14	166
4	49	31	246
5	25	45	316
6	20	51	387

```
In[636]:= ? spiht2Dshort
```

Same as spiht2D, but only bit consumption is recorded and given as output
Original file: spiht-2D.nb