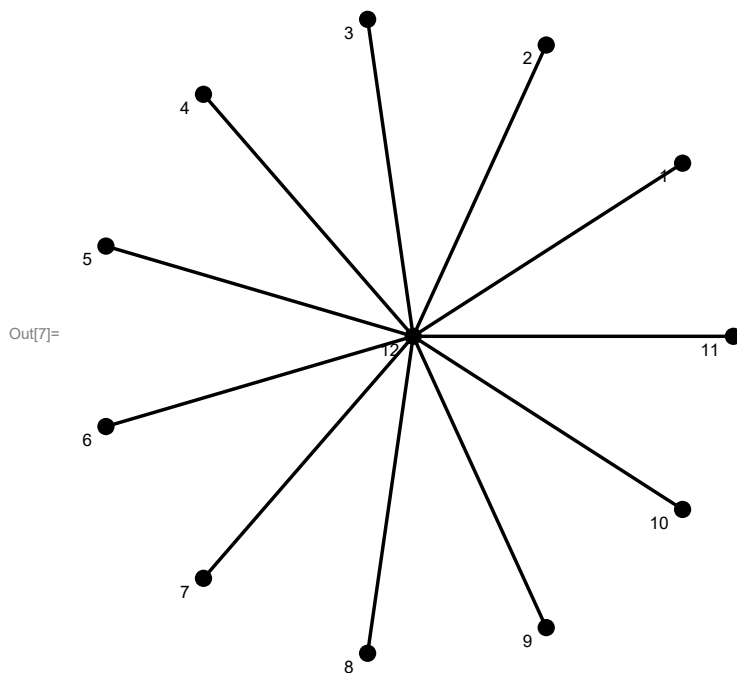


Graphs in Mathematica

Graphs representation

```
In[3]:= << Combinatorica`
```

```
In[7]:= ShowGraph[Star[12], VertexNumber -> True]
```



```
In[8]:= g1 = Star[12]
```

```
Out[8]= - Graph:< 11,12,Undirected >-
```

```
In[9]:= Head[g1]
```

```
Out[9]= Graph
```

g1[[1]] (* the first element of g1 is a list of edges *)

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

```
In[16]:= Edges[g1] (* the correct way of getting the edges is using the function Edges *)
```

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

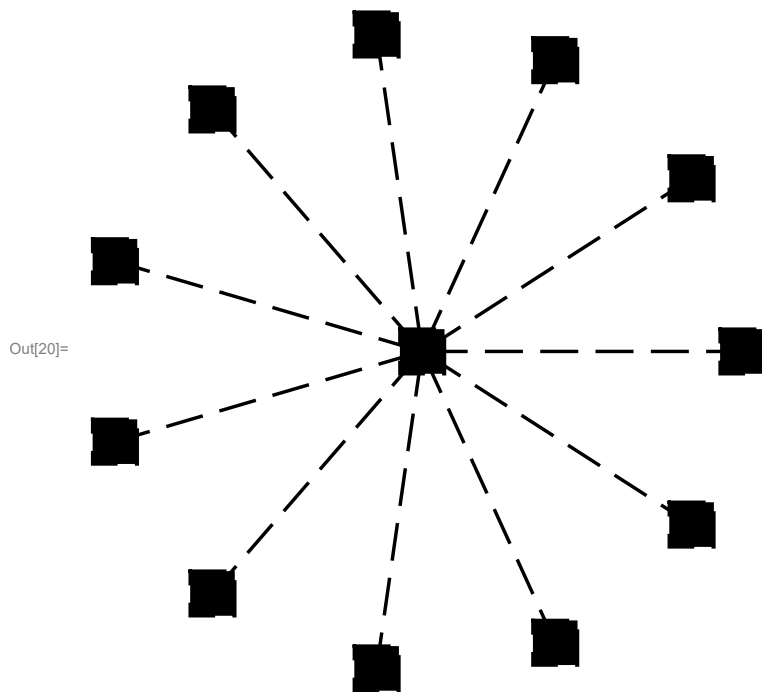
`g1[[2]]` (* the second element of `g1` is a list of vertices containing the position of the point representing the vertex *)

```
Out[15]= {{{0.841254, 0.540641}}, {{0.415415, 0.909632}},
          {{-0.142315, 0.989821}}, {{-0.654861, 0.75575}}, {{-0.959493, 0.281733}},
          {{-0.959493, -0.281733}}, {{-0.654861, -0.75575}}, {{-0.142315, -0.989821}},
          {{0.415415, -0.909632}}, {{0.841254, -0.540641}}, {{1., 0}}, {{0, 0}}}
```

`Vertices[g1]` (* the correct way of getting the infos of the vertices *)

```
Out[17]= {{0.841254, 0.540641}, {0.415415, 0.909632}, {-0.142315, 0.989821}, {-0.654861, 0.75575},
          {-0.959493, 0.281733}, {-0.959493, -0.281733}, {-0.654861, -0.75575},
          {-0.142315, -0.989821}, {0.415415, -0.909632}, {0.841254, -0.540641}, {1., 0}, {0, 0}}
```

```
In[20]= ShowGraph[
        g2 = SetGraphOptions[Star[12], VertexStyle -> Box[Large], EdgeStyle -> NormalDashed]]
```

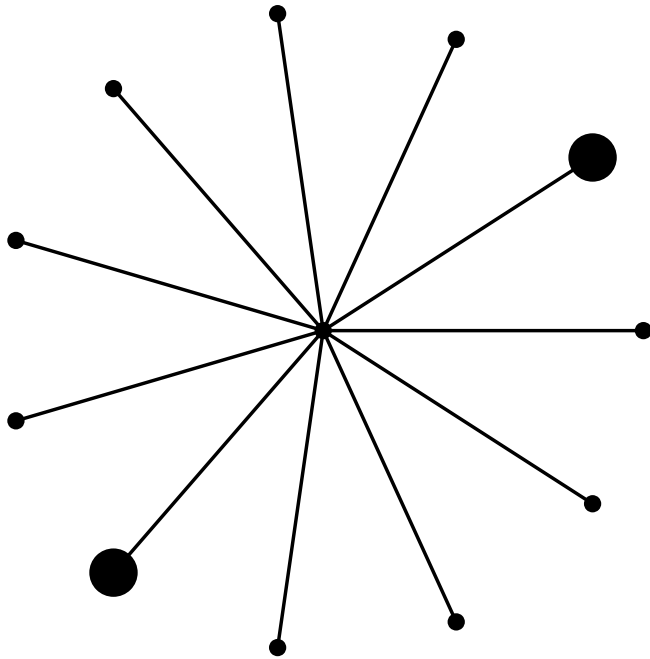


```
In[21]= {g2[[3]], g2[[4]]}
```

```
Out[21]= {VertexStyle -> Box[Large], EdgeStyle -> NormalDashed}
```

In[22]= `ShowGraph[g3 = SetGraphOptions[Star[12], {{1, 7, VertexStyle -> Disk[Large]}]}]`

Out[22]=



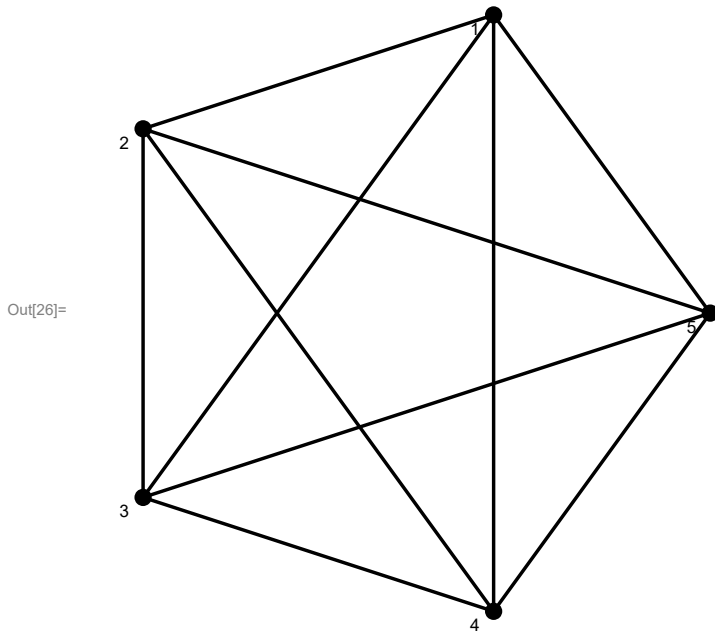
In[23]= `Vertices[g3, All]`

Out[23]= `{{{0.841254, 0.540641}, VertexStyle -> Disk[Large]},
 {{0.415415, 0.909632}}, {{-0.142315, 0.989821}}, {{-0.654861, 0.75575}},
 {{-0.959493, 0.281733}}, {{-0.959493, -0.281733}},
 {{-0.654861, -0.75575}, VertexStyle -> Disk[Large]}, {{-0.142315, -0.989821}},
 {{0.415415, -0.909632}}, {{0.841254, -0.540641}}, {{1., 0}}, {{0, 0}}}`

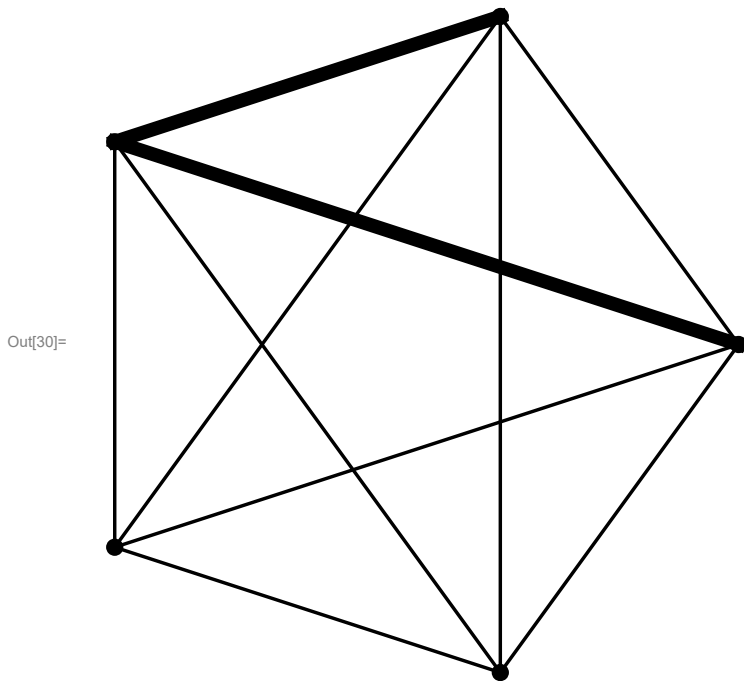
In[46]= `DegreeSequence[g3]`

Out[46]= `{11, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1}`

```
In[26]:= ShowGraph[g4 = CompleteGraph[5], VertexNumber -> True,  
TextStyle -> {FontSize -> 13}, PlotRange -> 0.1]
```



```
In[30]:= ShowGraph[g4 = SetGraphOptions[CompleteGraph[5], {{{1, 2}, {2, 5}, EdgeStyle -> Thick}}]]
```



In[31]= **Edges[g4, All]**

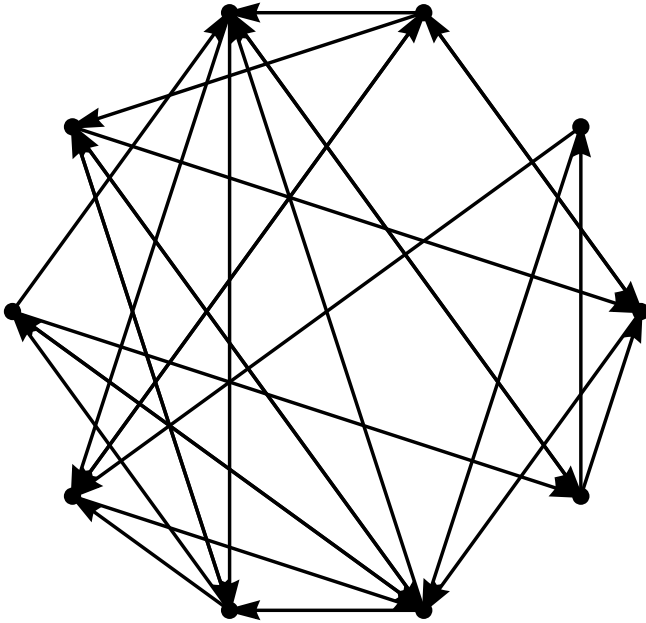
Out[31]= {{{1, 2}, EdgeStyle → Thickness[Large]}, {{1, 3}}, {{1, 4}}, {{1, 5}}, {{2, 3}},
 {{2, 4}}, {{2, 5}, EdgeStyle → Thickness[Large]}, {{3, 4}}, {{3, 5}}, {{4, 5}}}

In[32]= **Edges[g4, EdgeWeight]**

Out[32]= {{{1, 2}, 1}, {{1, 3}, 1}, {{1, 4}, 1}, {{1, 5}, 1}, {{2, 3}, 1},
 {{2, 4}, 1}, {{2, 5}, 1}, {{3, 4}, 1}, {{3, 5}, 1}, {{4, 5}, 1}}

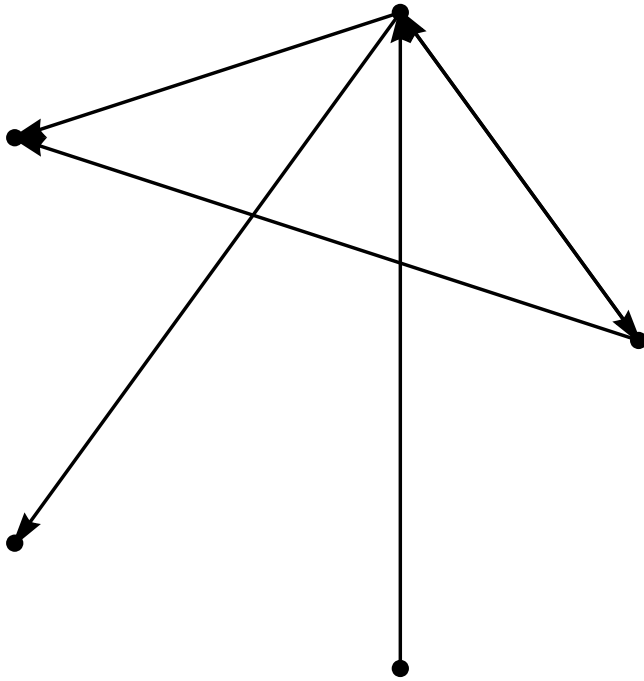
In[67]= **ShowGraph[RandomGraph[10, .3, Type → Directed]]**

Out[67]=



```
In[75]:= ShowGraph[RandomGraph[5, .3, Type -> Directed]]
```

```
Out[75]=
```



Adjacency Lists, Adjacency matrix

```
In[33]:= ToAdjacencyLists[CompleteGraph[4]]
```

```
Out[33]= {{2, 3, 4}, {1, 3, 4}, {1, 2, 4}, {1, 2, 3}}
```

```
In[37]:= ToAdjacencyLists[g4] // ColumnForm
```

```
Out[37]= {2, 3, 4, 5}
          {1, 3, 4, 5}
          {1, 2, 4, 5}
          {1, 2, 3, 5}
          {1, 2, 3, 4}
```

```
In[40]:= ToAdjacencyMatrix[g4] // TableForm
```

```
Out[40]/TableForm=
```

0	1	1	1	1
1	0	1	1	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	0

In[42]:= **ToAdjacencyMatrix[g4] // MatrixForm**

Out[42]//MatrixForm=

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

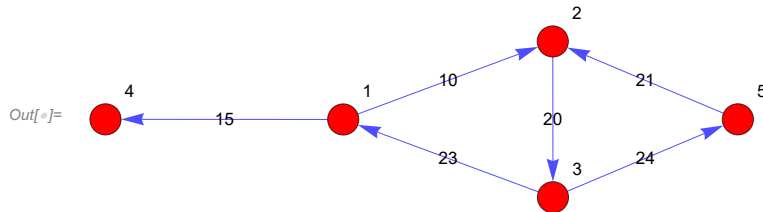
In[44]:= **IncidenceMatrix[g4] // MatrixForm**

Out[44]//MatrixForm=

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

Generating Directed Graphs

**G1 = Graph[{Labeled[1 → 2, 10], Labeled[1 → 4, 15],
Labeled[2 → 3, 20], Labeled[3 → 1, 23], Labeled[5 → 2, 21], Labeled[3 → 5, 24]},
VertexStyle → Red, VertexLabels → "Name", VertexSize → Medium, EdgeStyle → Blue]**



(adjancencymatrix = AdjacencyMatrix[G1] // Normal) // MatrixForm

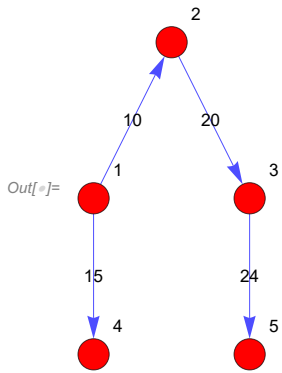
Out[*]//MatrixForm=

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

In[*]:= **(am = AdjacencyList[G1])**

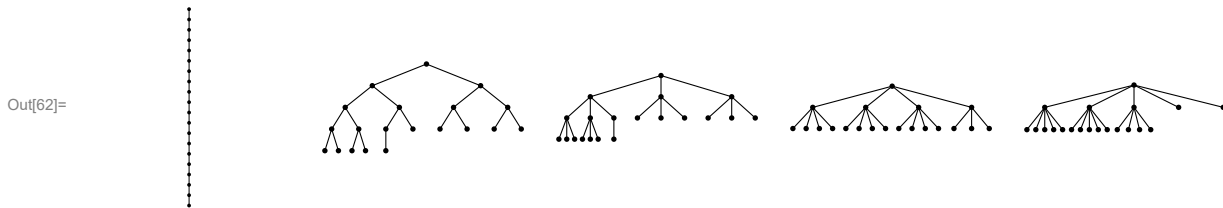
Out[*]= {{2, 4, 3}, {1, 3, 5}, {1}, {1, 2, 5}, {2, 3}}

In[6]:= **FindSpanningTree**[G1]

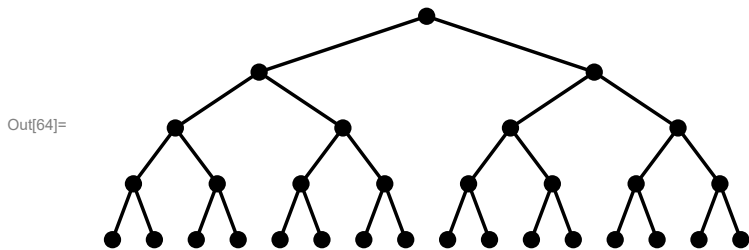


Trees

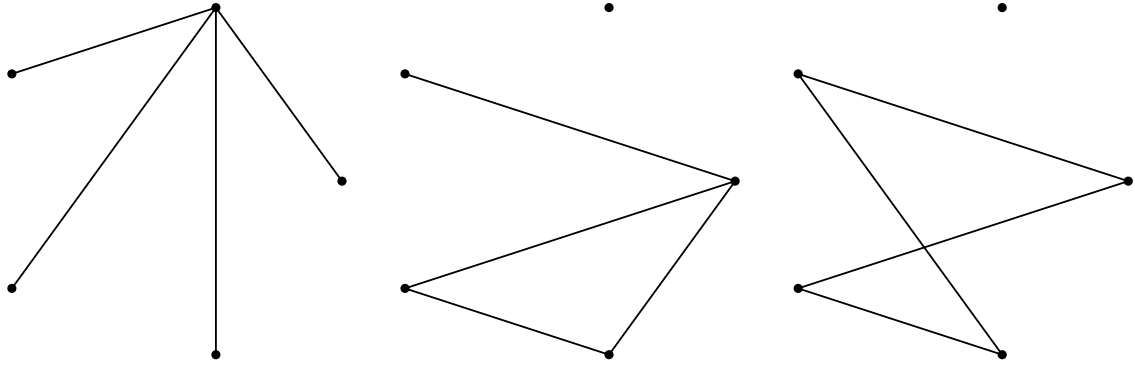
In[62]:= **ShowGraphArray**[Table[**CompleteKaryTree**[20, i], {i, 5}]]



In[64]:= **ShowGraph**[**CompleteBinaryTree**[31]]



In[66]:= ShowGraphArray[Partition[ListGraphs[5, 4], 3]]



Out[66]=

