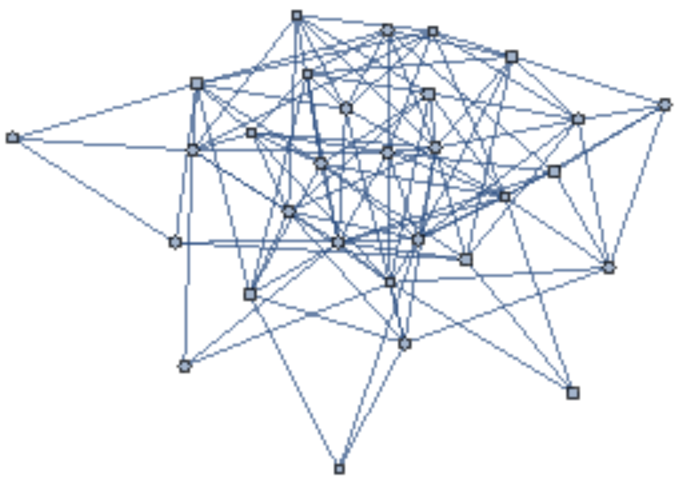
In[23]:=
```
npop = 30;  (*number of nodes*)
ρ = 0.24;  (*prob of connection*)
```

In[24]:=
```
adj = Table[If[i <= j, 0, RandomVariate[BinomialDistribution[1, ρ]]],
    {i, 1, npop}, {j, 1, npop}];
Table[If[i < j,  adj[[i, j]] = adj[[j, i]]], {i, 1, npop}, {j, 1, npop}];
```

In[26]:=
```
links = Table[Flatten[Position[adj[[i]], 1]], {i, 1, npop}] ;
(*Get the list of outgoing links for each node*)
```

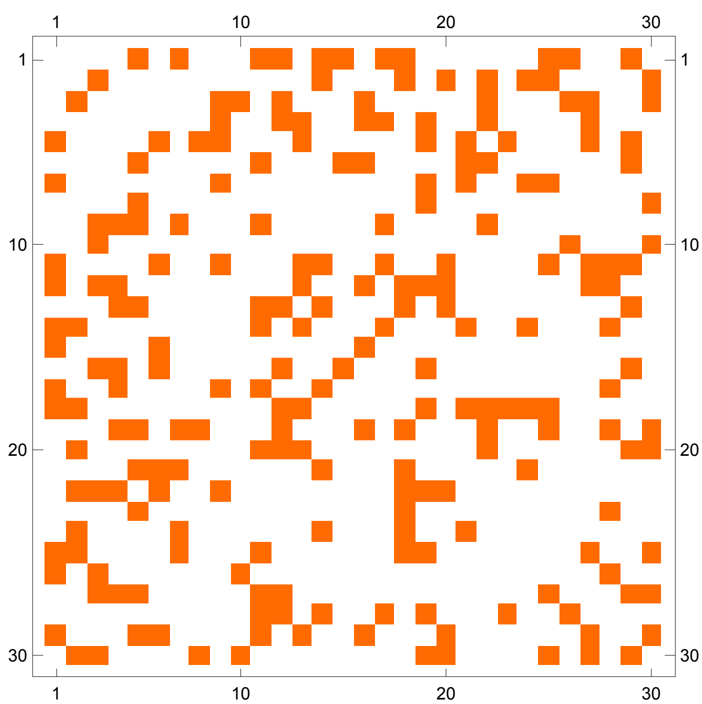
In[27]:=
```
AdjacencyGraph[adj]
```

Out[27]=



In[28]:=
```
MatrixPlot[adj]
```

Out[28]=



In[29]:=
```
αstep := α * δ;
βstep := β * δ;
δ = 0.5;
k = 40; α = 0.2; β = 0.1;
```

In[53]:=
```
UpdatePop[n_] := (
  newbirths =
   RandomVariate[BinomialDistribution[n, Max[{0, (αstep * (1 - n / k))}]]];
  newdeaths = RandomVariate[BinomialDistribution[n, βstep]];
  n + newbirths - newdeaths)
```

In[146]:=
```
d = 0.05 (*probability of dispersal *);
e = 0.051 (*patch extinction probability *);
```

In[227]:=
```
metapopup[popsvar_] := (
  pops = popsvar;
  (*we need to be able to write to our pops variable,
  so copy from the input argument*)
  emmigrants = Table[RandomVariate[BinomialDistribution[pops[[i]], d]],
    {i, 1, npop}];
  (*Choose how many emmigrants to send out*)
  pops = pops - emmigrants;
  (*Remove the emmigrants from their natal populations*)
  extinct = Sort[RandomSample[Table[i, {i, 1, npop}], RandomVariate[
      BinomialDistribution[npop, e]]]]; (*choose pops to go extinct*)
  Do[pops[[extinct[[i]]]] = 0, {i, 1, Length[extinct]}];
  (*delete extinct pops*)
  pops = migratepops[pops, emmigrants];
  Do[pops[[i]] = UpdatePop[pops[[i]]], {i, 1, npop}];
  pops)
```

In[37]:=
```
migratepops[popsvar_, emmvar_] := (
  pops = popsvar;
  Table[
   If[emmvar[[i]] > 0,
     disperseto = RandomVariate[MultinomialDistribution[
        emmvar[[i]], Table[1 / Length[links[[i]]], {Length[links[[i]]]}]]];
     Do[pops[[links[[i, j]]]] += disperseto[[j]], {j, 1, Length[links[[i]]]}];,
   {i, 1, npop}] ;
  pops)
```

Do the sim

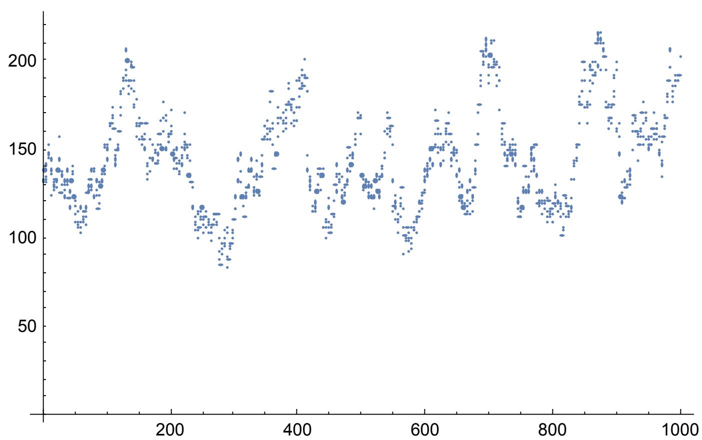
In[228]:=
```
e = 0.03;
```

In[229]:=
```
pops = Table[RandomVariate[BinomialDistribution[60, .5]], {i, 1, npop}];
```

In[233]:=
```
tmax = 1000;
popstab = {};
out = {};
t = 0;
While[(Total[pops] > 0) && ( t < tmax), pops = metapopup[pops];
 AppendTo[out, Total[pops]];
 AppendTo[popstab, pops];
 t++]
```

In[236]:=
```
ListPlot[out]
```

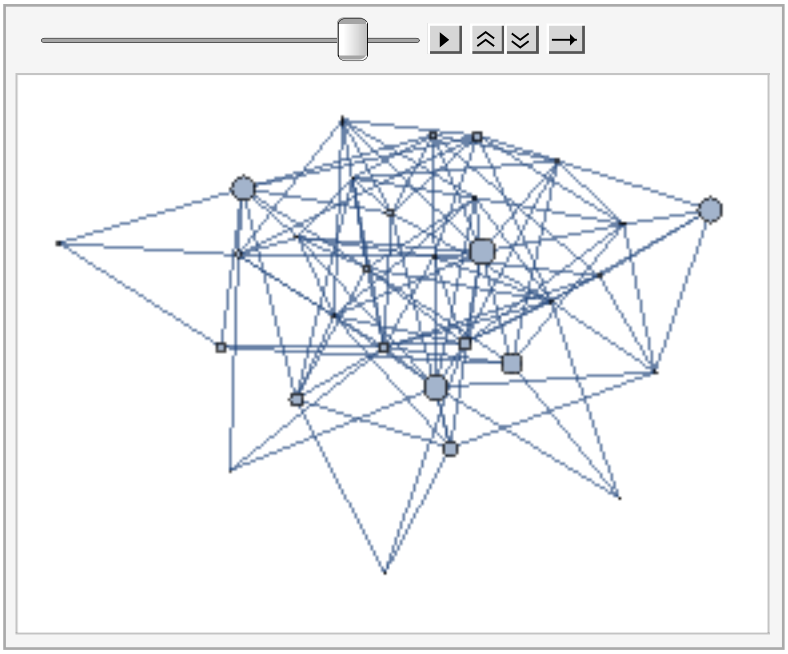
Out[236]=



In[237]:=
```
daplots = Table[AdjacencyGraph[adj,
    VertexSize → Table[i → popstab[[t, i]] / 30, {i, 1, npop}]], {t, 1, 1000}];
```

In[238]:=
```
ListAnimate[daplots]
```

Out[238]=



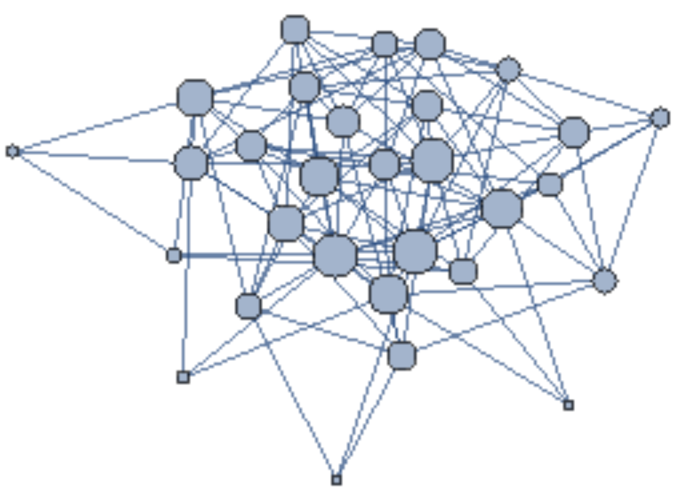
In[183]:=
```
degrees = DegreeCentrality[AdjacencyGraph[adj]] / 11;
```

In[184]:=
```
closenesses = ClosenessCentrality[AdjacencyGraph[adj]];
```

In[222]:=
```
eigenesses = EigenvectorCentrality[AdjacencyGraph[adj]];
```

In[186]:=
```
AdjacencyGraph[adj, VertexSize → Table[i → degrees[[i]], {i, 1, npop}]]
```

Out[186]=



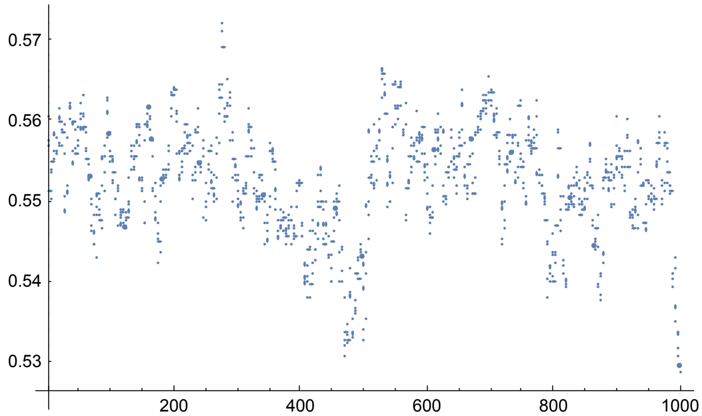
In[193]:=
```
curclose[pops_] := Sum[pops[[i]] * closenesses[[i]], {i, 1, npop}] / Total[pops]
```

In[202]:=
```
curdeg[pops_] := Sum[pops[[i]] * degrees[[i]], {i, 1, npop}] / Total[pops]
```

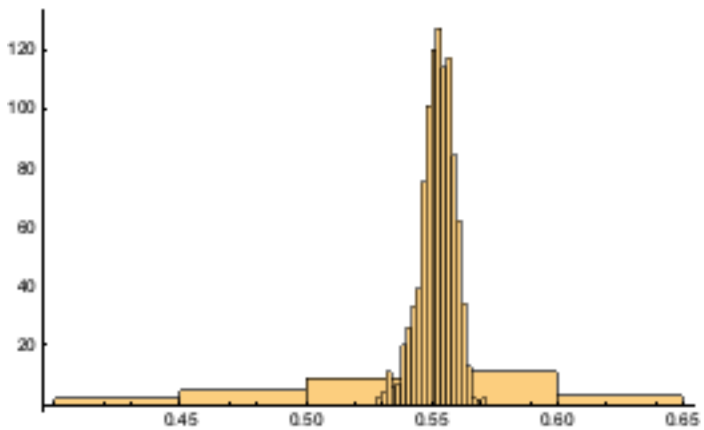
In[207]:=
```
cureig[pops_] := Sum[pops[[i]] * eigenesses[[i]], {i, 1, npop}] / Total[pops]
```

In[204]:=
```
{Mean[closenesses], Mean[degrees]} // N
```
Out[204]=
```
{0.539496, 0.666667}
```

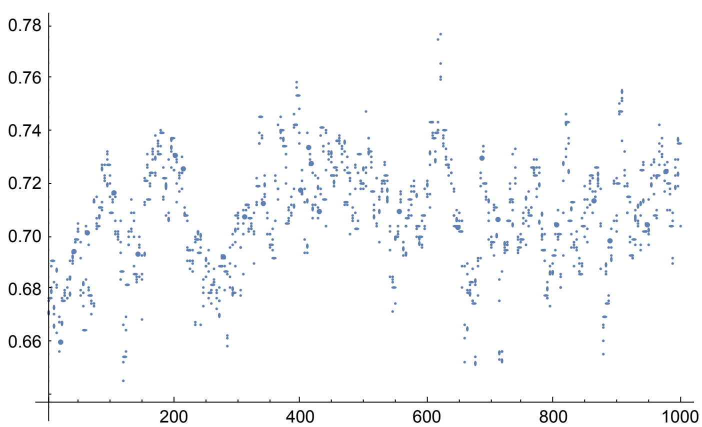
In[246]:=
```
ListPlot[Table[tmp = popstab[[t]]; curclose[tmp], {t, 1, 1000}]]
```
Out[246]=



In[244]:=
```
Show[Histogram[closenesses], Histogram[Table[tmp = popstab[[t]];
    curclose[tmp], {t, 1, 1000}]]]
```
Out[244]=



In[219]:=
```
ListPlot[Table[tmp = popstab[[t]]; curdeg[tmp], {t, 1, 1000}]]
```
Out[219]=



In[223]:=
```
ListPlot[Table[tmp = popstab[[t]]; cureig[tmp], {t, 1, 1000}]]
```

Out[223]=