Scale problems

Untangling a large diagram is difficult

1. Layout methods take a long time for large graphs, even on a Pentium VIII 3650 MHz with 256 GB memory
2. Anyway, there is too much information to fit on a screen, even if it is 29”

Faster spring methods

It is feasible to use a spring method followed by a geometric clustering method to obtain a good graph clustering.

Barnes&Hutt proposed a method of computing forces between stars.

An octree (quadtree) is a simple kind of cluster tree that represents the stars at their current positions.

Force directed methods (Aaron Quigley)

Problem: the usual spring algorithm is quite slow.

1. \( p_u = \) some initial position for each node \( u \).
2. Repeat
   2.1 \( F_u := 0 \) for each node \( u \);
   2.2 Foreach pair \( u,v \) of nodes
      2.2.1 calculate the force \( f_{uv} \) between \( u \) and \( v \);
      2.2.2 \( F_u += f_{uv} \);
      2.2.3 \( F_v += f_{uv} \);
   2.3 Foreach node \( u \), \( p_u += \varepsilon F_u \).
   Until \( p_u \) converges for all \( u \).
Faster spring methods

The contents of a subtree of can be approximated by a mass at the centroid.

The force that the subtree s exerts on the star x can approximate the sum of the forces that the nodes in s exert on x.

Faster spring methods

To compute the force on star x, we proceed from the root toward the leaves.

ComputeForce(star x; treenode t)
If the approximation is good then return the approximation;
else return \( \Sigma_s \text{ComputeForce}(x, s) \), where the sum is over all children s of t.

A simple method can be used to determine whether the approximation is good; it depends on the mass of nodes and the distance between x and s.

Faster spring methods

The Barnes-Hutt method is faster than the usual spring algorithm.

1. \( p_x \) = some initial position for each star x;
2. Repeat
   2.1 Build the octree;
   2.2 Foreach star x
      ComputeForce(x, root);
   2.3 Foreach star x, \( p_x += F_x \);
   Until \( p_x \) converges for all x;

In practice, computing all the forces takes \( O(n \log n) \) time.

Faster spring methods

The Barnes-Hutt method provides a synergy between clustering and layout.

1. \( p_u \) = some initial position for each node u;
2. Repeat
   2.1 Build the octree;
   2.2 Foreach node u
      ComputeForce(u, root);
   2.3 Foreach node u, \( p_u += F_u \);
   Until \( p_u \) converges for all u;
Visual abstraction

Abstract view of a 51,000 node graph