Galaxy graph project

Settings

In[◦]:=
```
(* Export options *)
csvOut = False;
pngOut = False;
stlOut = False;
dispHist = True;
disp3D = True;
```

In[◦]:=
```
(* Data selection *)
within = 0.0002; (* Maximum vertex distance from origin in data units *)
coneangle = ArcCos[Sqrt[2 / 3]];
(* field of view on sky pointing at (1,1,1) vector *)
ss = 1; (* Fraction of available points to sample *)
```

In[◦]:=
```

(* Graph parameters *)
minconnp = 3; (* Minimum incident edges per vertex *)
lcscale = 0.0001; (* Light cone radius multiplier *)
{lrp, urp} = {0.005, 0.015};(* min/max vertex radius *)
{amin, amax} = {0.1, 0.3};
sfac = 0.05;
mmsubdivs = {8, 12};
```

Functions

Create graph

```
205 galaxies within 200 mpc covering 35.3°
Connected graph: 396 edges, avg edges/vert: 3.9
Edges/vert: {3, 7}, lengths: {0.00288355, 0.258245}
```

Solve edge style

In[◦]:=
```
edges = EdgeList@gp;
```

In[◦]:=
```
verts = VertexList@gp;
```

In[◦]:=
```
edgelengths = Table[(Norm[#[[1]] - #[[2]]] &)@(edge2vertpair[edge]), {edge, edges}];
```

In[◦]:=
```
edgevpairs = edge2vertpair /@ edges; Dimensions@edgevpairs;
```

```
In[•]:= vertindpairs = Table[{Position[verts, edgevpairs[[n]][[1]]][[1]][[1]],
            Position[verts, edgevpairs[[n]][[2]]][[1]][[1]]}, {n, Range[Length@edgevpairs]}];
        Length@vertindpairs;

In[•]:= epvmm = MinMax@(Length /@ (connedges /@ (verts)));

In[•]:= vertradii = Table[lcrad[vert, epvmm[[1]], epvmm[[2]]], {vert, verts}]; Length@vertradii;

In[•]:= emm = MinMax@edgelengths; emm;

In[•]:= rmm = MinMax@vertradii; rmm;
```

In[•]:= dels = Table[

$$\left(\left(\left(\frac{(emm[[2]] - edgelengths[[n]])}{(emm[[2]] - emm[[1]])} + \left(\frac{(rmm[[2]] - vertradii[[vertindpairs[[n]][[1]]]])}{(rmm[[2]] - rmm[[1]])}\right)\right)^{1/2}\right)^{1/2} \left(\left(\left(1 - \frac{(rmm[[2]] - vertradii[[vertindpairs[[n]][[1]]]])}{(rmm[[2]] - rmm[[1]])}\right) + \left(1 - \frac{(emm[[2]] - edgelengths[[n]])}{(emm[[2]] - emm[[1]])}\right)\right)\right)^{1/2}\right), \{n, Range[Length@edges]\}];$$

gams = Table[

$$\left(\left(\left(\frac{(emm[[2]] - edgelengths[[n]])}{(emm[[2]] - emm[[1]])} + \left(\frac{(rmm[[2]] - vertradii[[vertindpairs[[n]][[2]]]])}{(rmm[[2]] - rmm[[1]])}\right)\right)^{1/2}\right)^{1/2} \left(\left(\left(1 - \frac{(rmm[[2]] - vertradii[[vertindpairs[[n]][[2]]]])}{(rmm[[2]] - rmm[[1]])}\right) + \left(1 - \frac{(emm[[2]] - edgelengths[[n]])}{(emm[[2]] - emm[[1]])}\right)\right)\right)^{1/2}\right), \{n, Range[Length@edges]\}];$$

```
In[•]:= dmax = Max@dels; gmax = Max@gams;(*Print[dmax,", ",gmax]*)

In[•]:= dels = dels / (2 dmax); gams = gams / (2 gmax);

In[•]:= anytoobig =
          Count[Flatten@(Table[Table[vertradii[[vertindpairs[[n]][[i]]]] > 0.5 edgelengths[[n]],
                {i, {1, 2}}], {n, Range[Length@edges]}]), True];
```

```
In[*]:= sols = Table[{xL, xR, a, ϵ0, ϵ1, ϵ2} /. solvn[
          vertradii[[vertindpairs[[n]][[1]]]],
          vertradii[[vertindpairs[[n]][[2]]]],
          edgelengths[[n]],
          dels[[n]], (* Param for vertex 1 [0,0.5] where 0 means prefer meets
           closer to vertex centers (i.e. further out on each side)  *)
          gams[[n]], (* Param for vertex 2 [0,0.5] where 0 means prefer meets
           closer to vertex centers (i.e. further out on each side)  *)
          sfac, (* Small fraction of the vertex radius to restrict meets
           (prevent meets very close to vertex center or vertex radius )  *)
          emm,
          rmm], {n, Range[Length@edges]}] // Quiet;

In[*]:= amm = MinMax@(sols[[All, 3]]);

In[*]:= edgedirs = Table[Normalize[edge[[2]] - edge[[1]]], {edge, edges}];

In[*]:= edgesubdivs = Table[
       Ceiling[linmapp[edgelengths[[n]], emm[[1]], emm[[2]], mmsubdivs[[1]], mmsubdivs[[2]]]],
       {n, Range[Length@edges]}];

In[*]:= edgeinterps = Table[(lerpp[edges[[n]][[1]] + edgedirs[[n]] × sols[[n, 1]], edges[[n]][[1]] +
          edgedirs[[n]] × sols[[n, 2]], edgesubdivs[[n]]]), {n, Range[Length@edges]}];

In[*]:= tubeparams =
      Table[lerpp[sols[[n, 1]], sols[[n, 2]], edgesubdivs[[n]]], {n, Range[Length@edges]}];

In[*]:= edgeradii = Table[Table[normcat[t, sols[[n, 1]], sols[[n, 2]] - sols[[n, 1]],
         sols[[n, 3]], Sqrt[(vertradii[[vertindpairs[[n]][[1]]]])^2 - (sols[[n, 1]])^2],
         Sqrt[(vertradii[[vertindpairs[[n]][[2]]]])^2 - (edgelengths[[n]] - sols[[n, 2]])^2]],
        {t, tubeparams[[n]]}], {n, Range[Length@edges]}];

In[*]:= anyerrs = Table[(Length@edgeinterps[[n]] ≠ Length@edgeradii[[n]]) ||
        (Count[edgeradii[[n]], u_ /; u ≤ 0] > 0), {n, Range[Length@edges]}];

In[*]:= Print["Errors: ", Length@Select[anyerrs, True]];

        Errors: 0
```

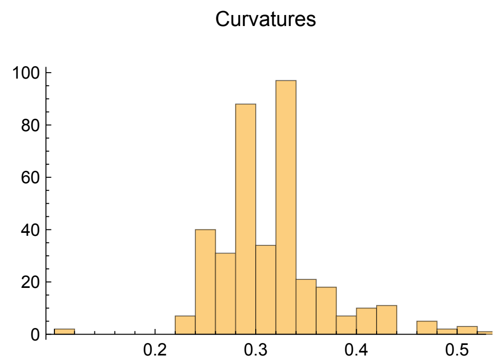
Export graphics

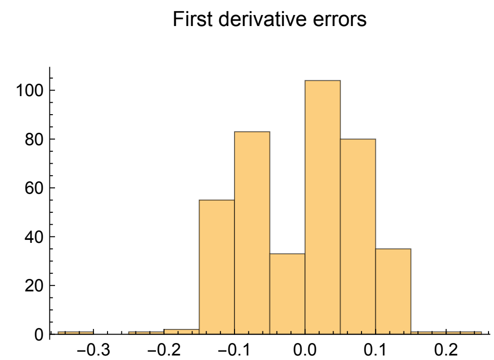
```
Report 1630500945

Size bounds
Dist scale: 200 mpc = 1.05855 box sides
Vertex radii: {0.004, 0.006}
Edge length: {0.00288355, 0.258245}
Curvature: {0.1, 10.}

Error bounds
Function: {-2.8574 × 10^-12, 1.95184 × 10^-11}
Deriv 1: {-0.321863, 0.219407}
Deriv 2: {-0.0069241, 0.334772}
```

Out[ ]=





Out[ ]=