Galaxy Graph Project

NED-D distance data: https://ned.ipac.caltech.edu/Archive/Distances/NED30.5.1-D-17.1.2-20200415.csv
RA/DEC data request form: https://ned.ipac.caltech.edu/forms/gmd.html

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```
(* Workspace setup *)
homedir = NotebookDirectory[];
savedir := homedir <> "saves/";
txtdir := homedir <> "textparts/";
retdir := homedir <> "returned/";
nedcsv := homedir <> "ned_d.csv";
txtpfx := txtdir <> "textPart";
csvpfx := retdir <> "part";
tstamp := ToString@UnixTime[];
```

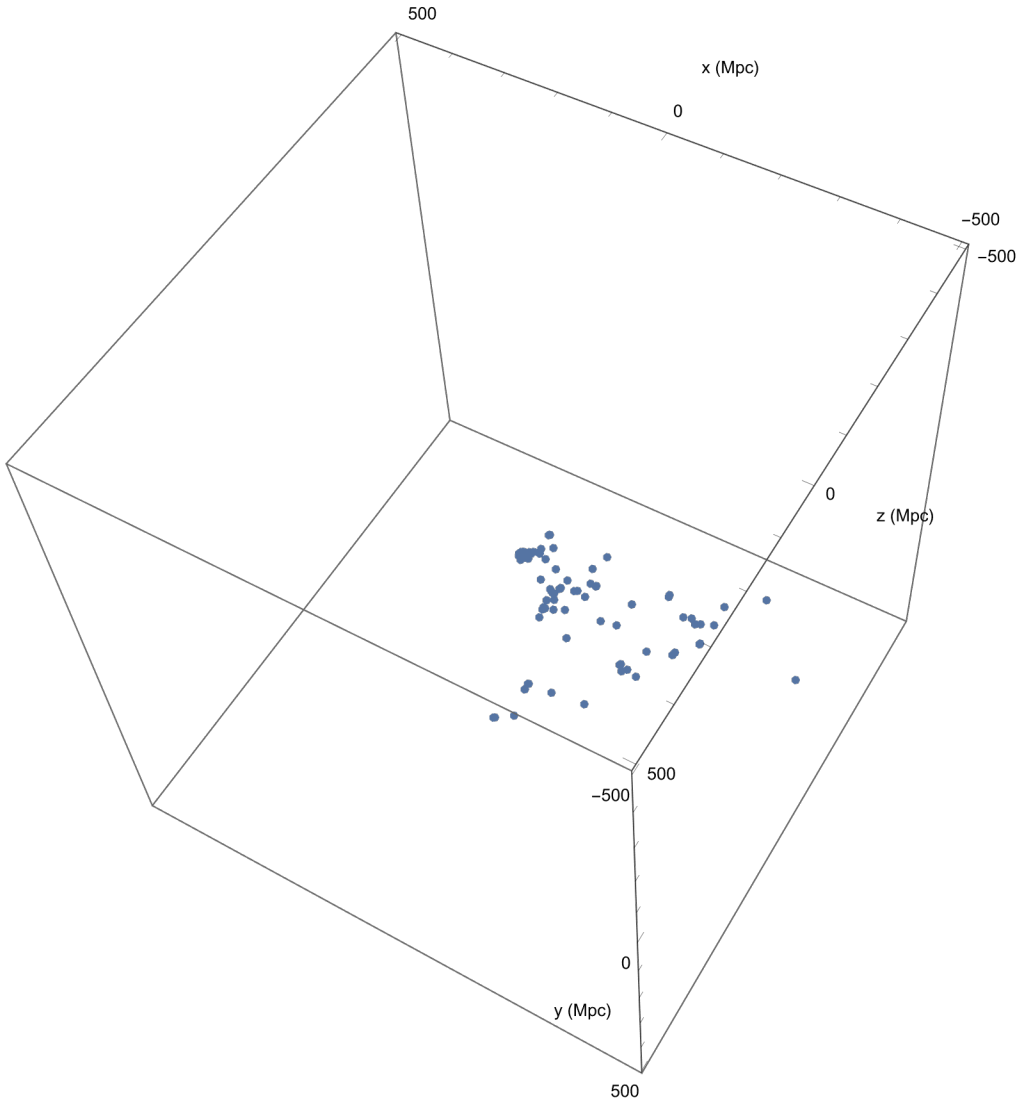
```
(* 1. Import and clean NED-D file with distances to galaxies *)
db = SemanticImport[nedcsv, ExcludedLines → {1 ;; 12}, HeaderLines → 1];(* SLOW *)
origkeys = db[1, Keys] // Normal;
shift = Association[Table[origkeys[[i]] → origkeys[[i - 1]], {i, 2, 15}]];
nedclean = db[All, shift];
Export[savedir <> "nedclean_" <> tstamp <> ".wl", nedclean];
```

```
(* 2. Only process entries in NED-
 D within given distance and confidence limits *)

maxerr = 0.05; maxd = 500; (* Distance in Mpc *)

derr[d_, δμ_] := 0.461 d δμ;(* Distance modulus to pc
 conversion: https://en.wikipedia.org/wiki/Distance_modulus *)

withblankcode = Query[Select[MemberQ[{""}, #"Exclusion Code"] &]]@nedclean;

gids =
  DeleteDuplicates@(Query[Select[derr[#"D (Mpc)", #"err"] < maxerr #"D (Mpc)" &&
          #"D (Mpc)" < maxd &]]@withblankcode)[All, "G"] // Normal;

selected = Query[Select[MemberQ[gids, #"G"] &]]@withblankcode;(* SLOW *)

Export[savedir <> "selected_" <> tstamp <> ".wl", selected];

(* (* 3. Export several text files of galaxy IDs
 ready to paste into NED web form for RA/DEC data *) *)

(*splitsize=300;*)

(*prefnames=selected[[All,"Galaxy ID"]]//Normal;*)

(*plist=DeleteDuplicates@*Flatten@prefnames;*)

(*breaks=Union[Append[Range[1,Length[plist],splitsize-1],Length[plist]]];*)

(*MapIndexed[Export[txtpfx<>ToString[#2[[1]]]<>".txt",Take[plist,#1],"Text"]&,
  Partition[breaks,2,1]];*)

(* 4. Import and clean RA/DEC results from NED form
 queries (saved manually by copy-paste into several txt files) *)

allfiles = FileNames["*.csv", retdir];

radecdata = Append[Import[csvpfx <> ToString[Length@allfiles] <> ".csv",
      "Table", "FieldSeparators" → "|"] // Normal]@
   Table[Drop[#, -1] &@Import[csvpfx <> ToString[j] <> ".csv", "Table",
       "FieldSeparators" → "|"] // Normal, {j, Length@allfiles - 1}];

radecdb = Flatten[radecdata, 1] // Dataset;

radecdbfull = Select[radecdb, ! Or @@ StringMatchQ[{#[[2]], #[[3]]}, Whitespace] &];

rdconv[ds_, ch_] := ds[Apply[Association], #[ch] → KeyDrop[#, ch] &];

namedradecdb =
  rdconv[radecdbfull[All, <|"GalName" → 1, "RA" → 2, "DEC" → 3|>], "GalName"];
```

```
In[•]:= uniquegnums = DeleteDuplicates@(selected[All, "G"] // Normal);

        gnames[gnum_] :=
          DeleteDuplicates@((Select[#"G" == gnum &]@selected)[All, "Galaxy ID"] // Normal);

In[•]:= galaxytbl = Table[selected[Select[#"G" == gid &], All][Mean, "D (Mpc)"],
            {gid, uniquegnums}];(* SLOW *)

In[•]:= galaxies = Dataset@
            AssociationThread[uniquegnums, AssociationThread[{"r"}, #] & /@ galaxytbl];

In[•]:= Export[savedir <> "galaxies_" <> tstamp <> ".wl", galaxies];

---

In[•]:= (* 5. Coordinate transformation functions *)

        getradec[gnum_] :=
          (SelectFirst[StringTrim@#"GalName" == gidnames[Key[gnum]] &]@namedradecdb)[[
            {"RA", "DEC"}]] // Values // Normal;

In[•]:= hms2deg[hmsstr_] :=
          {1, 1/60, 1/3600}.ToExpression@StringSplit[hmsstr, {"h", "m", "s"}];

        radec2sph[arr_] := {π/2 - (Pi/180 FromDMS@arr[[2]]), (Pi/180 hms2deg@arr[[1]]) - π};

        (* DEC→Theta, RA→Phi *)

In[•]:= (*thphi[gnum_]:=AssociationThread[{"θ","ϕ"}→radec2sph[getradec[gnum]]];*)
```

```
(* 6. Compute coordinates and plot *)

testsize = 1000;

SeedRandom[4321];
sampgids = Sort@RandomSample[gids, testsize];
gtest = galaxies[[Table[Key[i], {i, sampgids}]]];

gidnamesasc = AssociationThread[
    (Keys[gtest] // Normal) → ((gnames /@ sampgids) // Normal)] // Dataset;

gidnames = AssociationMap[gidnamesasc[Key[#]][[1]] &, sampgids] // Dataset;

Export[savedir <> "gtest_" <> tstamp <> ".wl", gtest];

appendangs[obj_] := Join[Normal[obj], AssociationMap[
    AssociationThread[{"θ", "ϕ"} → radec2sph[getradec[#]]] &, sampgids], 2];

galcoords = (appendangs@gtest) // Dataset; (* SLOW *)

sphpts = Table[galcoords[[i, All]] // Values // Normal, {i, Length[galcoords]}];

Export[savedir <> "sphpts_" <> tstamp <> ".wl", sphpts];

cartpts = FromSphericalCoordinates /@
   (Table[galcoords[[i, All]] // Values // Normal, {i, Length[galcoords]}]);

bounds = Table[Max[Abs /@ Flatten[#]] {-1, 1}, 3] &;

ListPointPlot3D[cartpts, SphericalRegion → True, BoxRatios → {1, 1, 1},
 PlotStyle → PointSize[Medium], PlotRange → bounds@cartpts,
 AxesLabel → {"x (Mpc)", "y (Mpc)", "z (Mpc)"}, ImageSize → Large]
```

Out[ ]=



In[ ]:= `Table[galcoords[i, "θ"] 180/π, {i, {Min, Max}}]`

Out[ ]=

{25.9471, 162.829}

In[ ]:= `Table[galcoords[i, "ϕ"] 180/π, {i, {Min, Max}}]`

Out[ ]=

{−179.313, −156.415}

In[ ]:= `namedradecdb[Key[gidnames[Key[125]]]]`

Out[ ]=

Failure[⚠ Message: Part Key [WLM] is not applicable to expressions of the form {__Association }.
Tag: Dataset]

In[ ]:=
```
gidnames[Key[125]]
```

Out[ ]=

WLM

In[ ]:=
```
gidnames[Key[125]]
```

Out[ ]=

WLM

"WLM"

In[ ]:=
```
namedradecdb
```

Out[ ]=

GalName	RA
SDSS–II SN 01127	00h01m35.54s
WLM	00h01m58.16s
Andromeda XVIII	00h02m14.50s
2MASX J00024910+0045055	00h02m49.07s
SN 2005ed	00h02m49.37s
SDSS J000306.66+005449.6	00h03m06.66s
SDSS–II SN 15320	00h03m06.66s
NGC 7814	00h03m14.89s
UGC 00014	00h03m35.02s
SN 2006sr	00h03m35.02s
SDSS–II SN 20530	00h03m40.22s
SDSS J000348.32+002134.5	00h03m48.33s
SDSS–II SN 18709	00h03m48.36s
SDSS J000502.85+010847.0	00h05m02.85s
SDSS–II SN 04019	00h05m02.80s
ESO 409–IG 015	00h05m31.85s
UGC 00040	00h05m48.41s
SN 2003it	00h05m48.47s
SDSS–II SN 02552	00h06m14.36s
AGC 748778	00h06m34.30s

rows 1–20 of **9336**

In[ ]:=
```
radecdbfull
```

Out[ ]=

SDSS–II SN 01127	00h01m35.54s
WLM	00h01m58.16s
Andromeda XVIII	00h02m14.50s
2MASX J00024910+0045055	00h02m49.07s
SN 2005ed	00h02m49.37s
SDSS J000306.66+005449.6	00h03m06.66s
SDSS–II SN 15320	00h03m06.66s
NGC 7814	00h03m14.89s
UGC 00014	00h03m35.02s
SN 2006sr	00h03m35.02s
SDSS–II SN 20530	00h03m40.22s
SDSS J000348.32+002134.5	00h03m48.33s
SDSS–II SN 18709	00h03m48.36s
SDSS J000502.85+010847.0	00h05m02.85s
SDSS–II SN 04019	00h05m02.80s
ESO 409–IG 015	00h05m31.85s
UGC 00040	00h05m48.41s
SN 2003it	00h05m48.47s
SDSS–II SN 02552	00h06m14.36s
AGC 748778	00h06m34.30s

rows 1–20 of **9336**

In[ ]:=
```
namedradecdb[Keys, 1]
```

Out[ ]=

```
Failure[ ⚠ Message: Cannot take part 1 of expression of form PatternForm [Atom [String ]].
         Tag: Dataset ]
```

In[ ]:=
```
Keys[namedradecdb] // Normal // Short
```

Out[ ]//Short=

```
{SDSS-II SN 01127              , WLM                          ,
 <<9333>> , SN 2005gx                        }
```

In[ ]:= `namedradecdb // Normal`

Out[ ]=

```
⟨| SDSS-II SN 01127                → ⟨| RA → 00h01m35.54s, DEC → -00d23m37.8s |⟩,
 WLM                               → ⟨| RA → 00h01m58.16s, DEC → -15d27m39.3s |⟩,
 Andromeda XVIII                   → ⟨| RA → 00h02m14.50s, DEC → +45d05m20.0s |⟩,
 ··· 9331 ···,
 SDSS J235932.23+004412.6          → ⟨| RA → 23h59m32.23s, DEC → +00d44m12.6s |⟩,
 SN 2005gx                         → ⟨| RA → 23h59m32.26s, DEC → +00d44m13.8s |⟩ |⟩
```

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