ToyScan2

This *Mathematica* notebook plots the Markov chains obtained by running ToyScan2. As defined in main.cpp, this scan uses 10 chains and 100k steps to seek out a radius of 3 around the center point (2, 1) with a Gaussian likelihood profile, with uncertainty in the radius 0.3.

Import and parse the chains

In[1]:=
```
SetDirectory[NotebookDirectory[]];

Chains = {};
Module[{i, FileData},
 For[i = 1, i ≤ 10, i++,
  FileData = Import["chains/ToyScan2_chain" <> ToString[i] <> ".dat"];
  AppendTo[Chains, Split[FileData, # ≠ {} &]]
 ]
]
```

In[4]:=
```
Chains[[1, 1 ;; 10]] // MatrixForm
```

Out[4]//MatrixForm=

$$\begin{pmatrix}
\{1.21776, -5.1825\} & \{6.23179, 1.69665\} & \{6.31125\times10^{-26}\} & \{\} \\
\{7.04425, 5.2149\} & \{6.57341, 0.696066\} & \{1.55217\times10^{-31}\} & \{\} \\
\{2.51169, 5.38781\} & \{4.41754, 1.4547\} & \{0.0000141824\} & \{\} \\
\{-2.66476, 0.449229\} & \{4.69716, 3.02407\} & \{1.12312\times10^{-7}\} & \{\} \\
\{-2.66476, 0.449229\} & \{4.69716, 3.02407\} & \{1.12312\times10^{-7}\} & \{\} \\
\{2.81658, 6.12512\} & \{5.18976, 1.4128\} & \{2.69597\times10^{-12}\} & \{\} \\
\{5.87087, 3.13357\} & \{4.41992, 0.503753\} & \{0.0000136601\} & \{\} \\
\{5.87087, 3.13357\} & \{4.41992, 0.503753\} & \{0.0000136601\} & \{\} \\
\{5.89859, -1.19311\} & \{4.47312, 0.512419\} & \{5.80975\times10^{-6}\} & \{\} \\
\{4.92844, -2.3906\} & \{4.48017, 0.858406\} & \{5.17523\times10^{-6}\} & \{\}
\end{pmatrix}$$

Setting up accessor functions

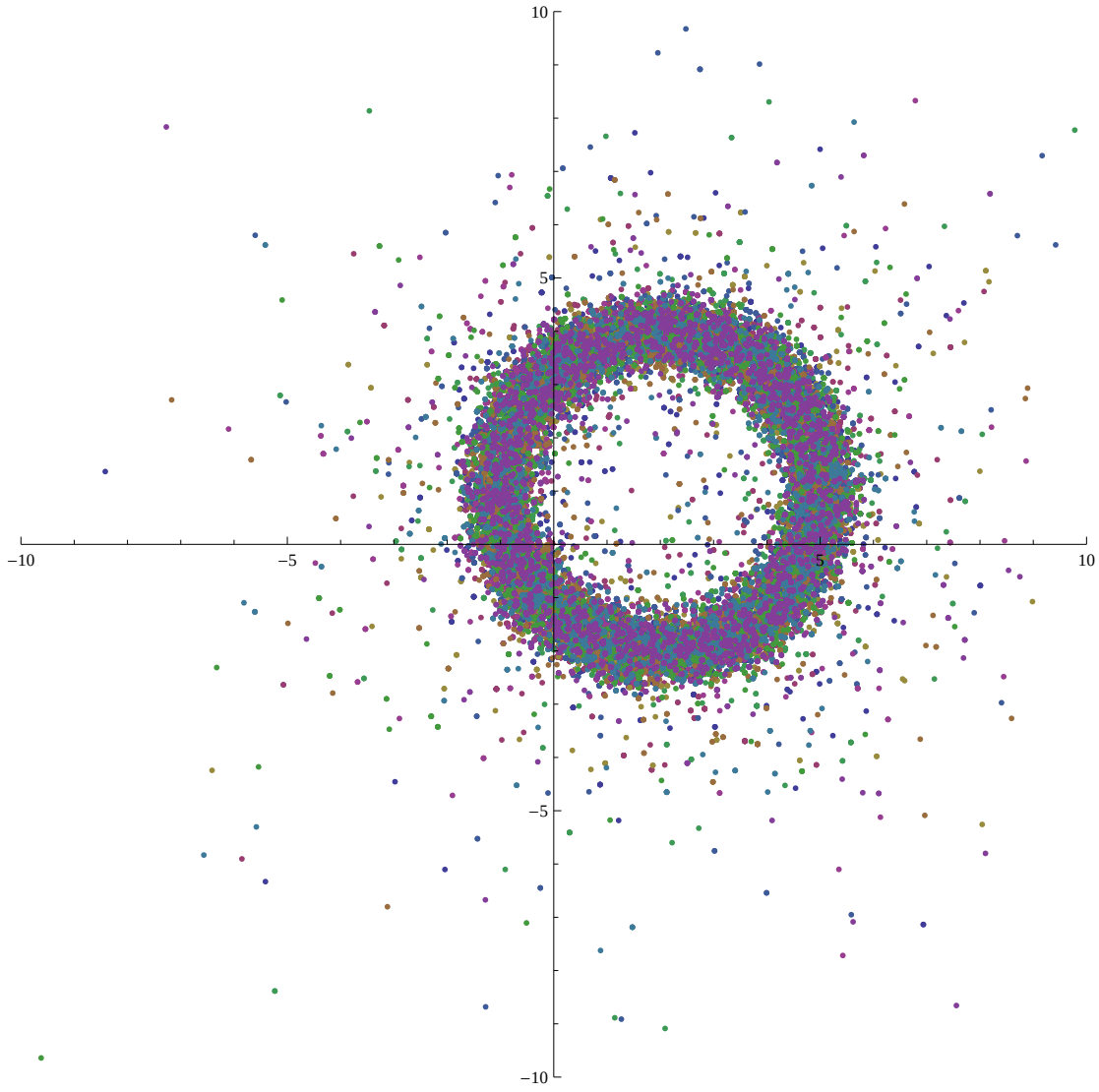
In[5]:=
```
ChainLength[iChain_] := Length[Chains[[iChain]]];

Parameters[iChain_, iPoint_] := Chains[[iChain, iPoint, 1]];
r[iChain_, iPoint_] := Chains[[iChain, iPoint, 2, 1]];
θ[iChain_, iPoint_] := Chains[[iChain, iPoint, 2, 2]];
NegativeLogLikelihood[iChain_, iPoint_] :=
  -Log[10, Chains[[iChain, iPoint, 3, 1]]];
```

Plotting the chains

Here I plot the full chains, from beginning to end, without burning the initial fraction. The different colors correspond to different chains.

In[10]:=
```
ListPlot[Parameters[All, All],
 PlotRange → {{-10, 10}, {-10, 10}}, AspectRatio → 1, ImageSize → Large]
```

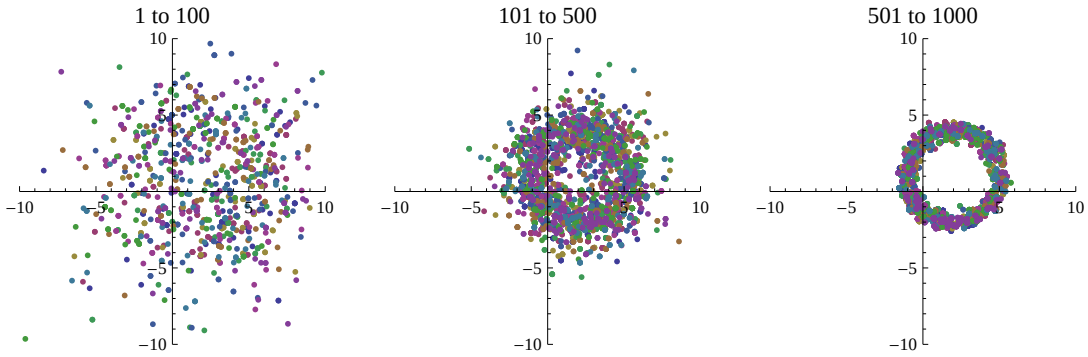
Out[10]=



Here is what the different sections of the chains look like, as they progress toward the posterior probability distribution.

In[11]:=
```
GraphicsRow[{
  ListPlot[Parameters[All, 1 ;; 100], PlotRange → {{-10, 10}, {-10, 10}},
   PlotLabel → "1 to 100", AspectRatio → 1, ImageSize → Small],
  ListPlot[Parameters[All, 101 ;; 500], PlotRange → {{-10, 10}, {-10, 10}},
   PlotLabel → "101 to 500", AspectRatio → 1, ImageSize → Small],
  ListPlot[Parameters[All, 501 ;; 1000], PlotRange → {{-10, 10}, {-10, 10}},
   PlotLabel → "501 to 1000", AspectRatio → 1, ImageSize → Small]
 }]
```

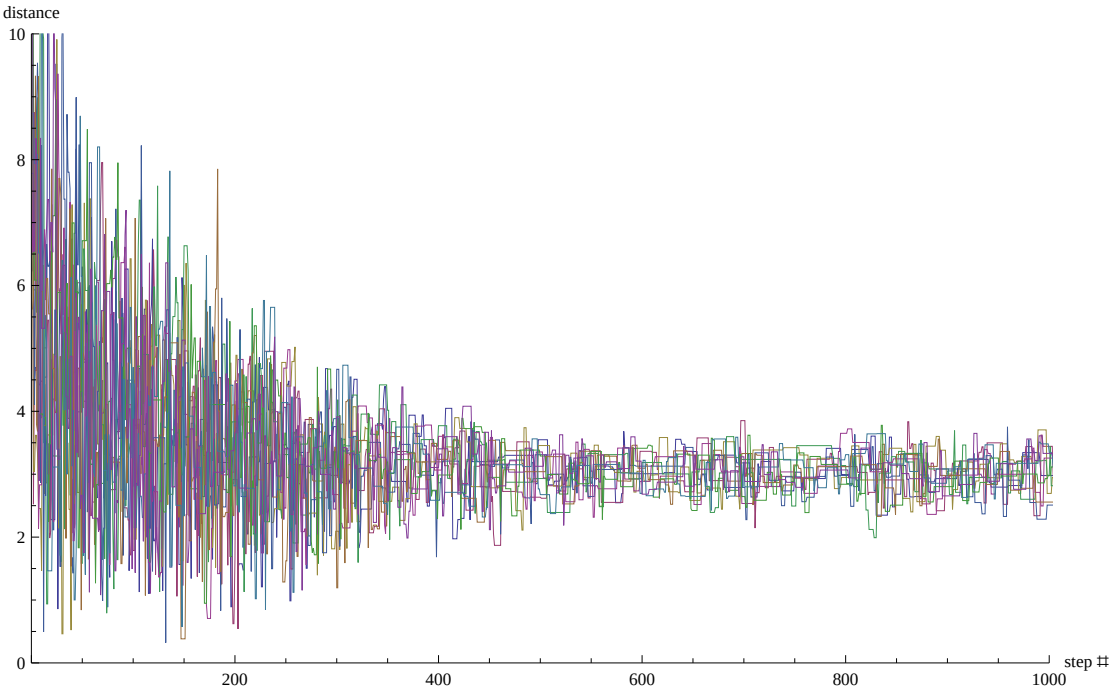
Out[11]=



Plotting distance from the center point

In[12]:=
```
ListPlot[r[All, All], Joined → True, PlotRange → {{0, 1000}, {0, 10}},
 AxesLabel → {"step #", "distance"}, ImageSize → Large]
```

Out[12]=



Plotting likelihood

This plots the negative log-likelihood of the points in the chains. It shows how many orders of magni-

tude below likelihood == 1.0 (which indicates perfect agreement with the constraint) the likelihood is at. As the chains' likelihood increases, the negative log-likelihood approaches zero.

In[13]:=
```
ListPlot[NegativeLogLikelihood[All, All],
 Joined → True, PlotRange → {{0, 1000}, {0, 100}},
 AxesLabel → {"step #", "-log10L"}, ImageSize → Large]
```

Out[13]=