likelihood = prob. data given model

http://phylogeny.uconn.edu/normalsnap/

After playing with the app...

Can you increase lnL over the "snap-to" value?

Is the average height of the points related to lnL?

Why does it report the natural logarithm of the likelihood (lnL) and not the likelihood?

How confident are you that the true mu and sigma equal the values shown?

Draw a crude plot showing your confidence level for various values of mu

Where does your plot peak? Does it fall off on both sides of the peak? What does height mean in your plot?

Do the same for sigma.

What about a 3D plot with mu on x-axis, sigma on y-axis, and lnL on z-axis?

\[ \mu = -0.3 \quad \sigma = 2.2 \quad \lnL = -109.409 \]
http://phylogeny.uconn.edu/mcmc-robot/ (for other versions, see mcmcrobot.org)

In the MCMC robot app, keep in mind that you are looking down on the surface being explored.

Pretend that the x-axis is \( \mu \) and the y-axis is \( \sigma \) in our normalsnap example.

How does MCMC help us assess uncertainty in model parameters?

What does the height of the surface denote in an MCMC analysis?

How do we get the probability that \( \mu \) is in \((-1,+1)\) and \( \sigma \) is in \((1,3)\) from an MCMC analysis?
MCMC robot’s rules

- Uphill steps are always accepted.
- Slightly downhill steps are usually accepted.
- Drastic “off the cliff” downhill steps are almost never accepted.

With these rules, it is easy to see why the robot tends to stay near the tops of hills.
(Actual) MCMC robot rules

Uphill steps are always accepted because $R > 1$

Slightly downhill steps are usually accepted because $R$ is near 1

Drastic “off the cliff” downhill steps are almost never accepted because $R$ is near 0

The robot takes a step if it draws a Uniform(0,1) random deviate that is less than or equal to $R$
## Likelihood vs. Probability

<table>
<thead>
<tr>
<th>Coin flipped once</th>
<th>Fair coin model</th>
<th>Two-heads model</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>0.5</td>
<td>1</td>
</tr>
<tr>
<td>T</td>
<td>0.5</td>
<td>0</td>
</tr>
</tbody>
</table>

**Probability of the data** implies function of the data (the model is fixed)

**Likelihood** is *always* a function of the model (data is fixed)

Say “likelihood of the *model*” and “probability of the *data*”