Neuron Showdown: 2-sample hypothesis testing

*See MATLAB code in **CellBodyAreaAnalysis.m** for a solution to this problem.*

We are interested in morphological differences between two different types of pyramidal neurons in the cerebral cortex. One type is called "feedback" (FB) and the other is called "feedforward." We have used a genetically modified rabies virus to label the two populations, filling each labeled neuron completely. This allows us to reconstruct each neuron and make a number of measurements, summarized in the tables below. We have data from 10 neurons of each cell type:

Table 1: V2 to V1 (Feedback) Cell Body Analysis							
Soma			Dendrite			Apical Dendrite	
Cell	Perimeter(µm)	Area(µm²)	Nodes	Length(µm)	Mean Length	Nodes	Length(µm)
90.1	59.3	235.535	34	3269.2	817.3	32	4376.7
90.2	55.9	152.75	60	5131	733	40	4781.3
89.1	59.7	222.525	26	3465	866.2	34	4310.2
106.1	59.7	218.719	38	4219.4	1054.9	24	2749.8
107.2	65.7	308.505	49	5986.3	855.2	49	6021.7
94.1	64.8	216.59	50	4724.4	944.9	28	2368.5
109.1	61.9	243.867	53	6078.1	607.8	64	6047.9
109.2	84.3	283.662	45	4110.1	456.7	34	3479.7
111.1	50.7	180.066	45	5207.4	1041.5	47	5286.9
114.1	77.8	253.645	51	5507.1	688.4	46	5157.5
Average	63.98	231.59	45.1	4769.8	806.59	39.8	4458.02

Table 2: V2 to MT (Feedforward) Cell Body Analysis							
Soma			Dendrite			Apical Dendrite	
Cell	Perimeter(µm)	Area(µm²)	Nodes	Length(µm)	Mean Length(µm)	Nodes	Length(µm)
316.1	49.5	151.228	36	4534.3	503.8	30	3711.2
256.1	49.6	162.565	73	8100	1350	33	4602.7
265.1	38.8	88.9867	36	4449.4	1112.3	25	3235.3
256.2	46.1	123.797	44	4759.7	951.9	36	4289.5
250.1	59.5	215.728	66	5684.9	631.7	56	5533.6
246.1	55.5	168.144	56	6335.1	905	40	4455.4
245.1	77.7	306.364	38	3593.5	598.9	36	3763.9
238.1	55.1	193.736	46	4842	968.4	35	4202.2
224.1	78.2	400.143	56	7435.7	929.5	27	4132.7
190.1	48	147.524	24	3636.6	519.5	17	2463
Average	55.8	195.82	47.5	5337.12	847.1	33.5	4038.95

Load in the file called 'cellBodyArea.mat'. This file contains two variables, FF and FB, each of which contains ten values consisting of the measurements of the cell body area for Feedback (FB) and FeedForward (FF) neurons.

Your goal is to test the hypothesis that the cell bodies of FB neurons are *larger* in area than those of the FF neurons. The catch is that you cannot use a parametric test—you need to design a test and convince yourself (and the TAs) that it is reasonable. Design your test so that it gives you the probability that the difference in the medians (FB – FF) we actually obtained is larger than what you would expect "by chance."

What do we mean by "by chance"?

Plot a histogram:

What is the actual difference in median values of the two populations?

How likely is it that we got a difference this big by chance? What is the null hypothesis (H0)?

Questions for further study:
1. How would you make this a 2-tailed test?
2. What standard statistical test is our test most similar to?
3. How would you convert this to a t-test?
4. Plot the H0 distribution. Why does it look funny?

Revisions:
RTB wrote it, 24 April 2013 as "CellBodyAreaAnalysis.m"