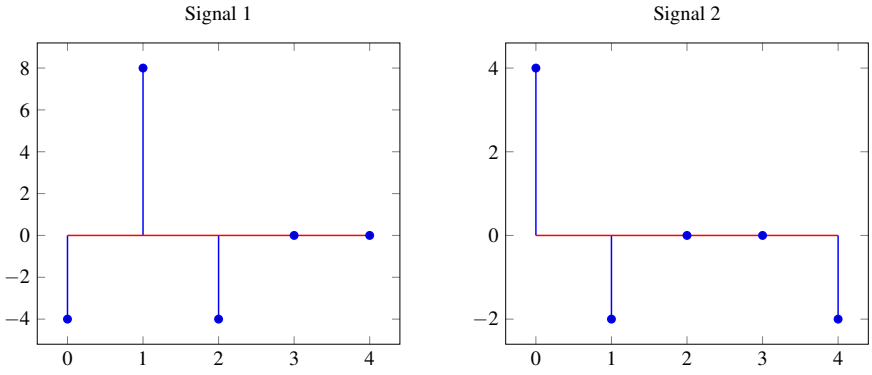
EECS 16A Fall 2017 — Designing Information Devices and Systems I — Discussion 11B

1. Correlation

You are given the following two signals:



Assume that both signals are periodic with period 5, that is, each plot shows one full period of a periodic signal.

(a) Sketch the autocorrelation (correlation with itself) of signal 1.

(b) Sketch the autocorrelation of signal 2.

(c) Sketch the cross-correlation of signal 1 with signal 2. Suppose we know that signal 2 is a delayed (and attenuated) version of signal 1. What does the cross-correlation tell us about the delay?

2. Autocorrelation Peak

Let $\rho_{xx}[m]$ be the autocorrelation of an N-periodic signal $x[n]$. Prove that $\rho_{xx}[0] \geq |\rho_{xx}[m]| \; \forall m$. In other words, the autocorrelation peak (maximum value of autocorrelation) of any periodic signal always occurs at lag $m = 0$.

3. Search and Rescue Dogs

Berkeley's Puppy Pound needs your help! While Mr. Muffin was being walked, the volunteer let go of his leash and he is now running wild in the streets of Berkeley (which are quite dangerous)! Thankfully, all of the puppies at the pound have a collar that sends a bluetooth signal to receiver towers, which are spread throughout the streets (pictured below). If the puppy/collar is within range of the receiver tower, the collar will send the tower a message: the distance of the collar to the tower. Each cell tower has a range of 3 city blocks. Can you help the pound locate their lost puppy?

Note: A city block is defined as the middle of an intersection to the middle of an adjacent intersection (scale provided on map.) Mr. Muffin is constrained to running wild in the streets, meaning he won't be found in any buildings. If your TA asks 'Where is Mr. Muffin?' it is sufficient to answer with his intersection or 'between these two intersections.'

 [1]

(a) You check the logs of the cell towers, and they have received the following messages:

Sensor	Distance
N	1.3
W	3
E	1.5
S	3

On the map provided, identify where Mr. Muffin is!

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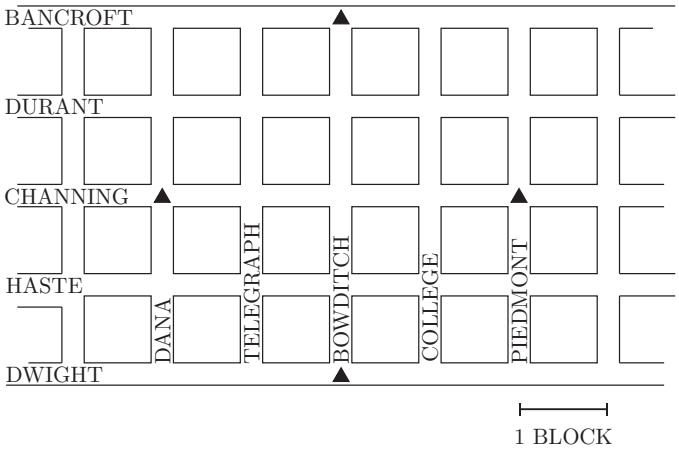

SOUTH OF DWIGHT

(b) Can you set this up as a system of equations? Is it linear? If it's not linear, can you think of a way to make it linear? Now, how do you set this up in matrix form?

Hint: Set $(0,0)$ to be Channing and Bowditch.

Hint 2: distance $= \sqrt{(x_1-x_2)^2+(y_1-y_2)^2}$

Hint 3: You don't need all 4 equations. You have two unknowns, x and y. You know from lecture that you need three circles to uniquely find a point. How can you use the third circle/equation to get two equations and two unknowns?

[1] http://www.pupsmile.com/wp-content/uploads/2012/11/running_happy_dog-1024x684.jpeg

(c) Suppose Mr. Muffin is moving fast, and by the time you get to destination in part (a) he's already run off! You check the logs of the cell towers again, and see the following updated messages:

Sensor	Distance
N	2.2
W	Out of Range
E	1.1
S	Out of Range

Can you find Mr. Muffin?

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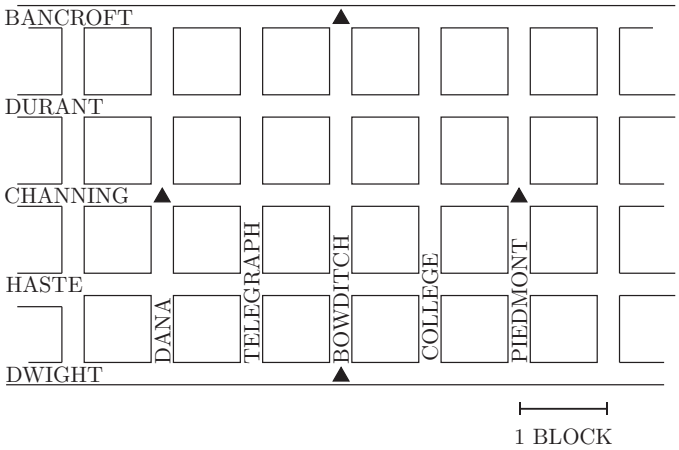

SOUTH OF DWIGHT

(d) Mr. Muffin is a very mischievous puppy, and while playing and running around he damaged his collar. The transmitter on his collar will still send a signal to the receiver towers, but the distance sensor has noise. You check the logs of the cell towers, and they have received the following messages:

Sensor	Distance
N	1.7 ± 0.5
W	2.1 ± 0.2
E	Out of Range
S	Out of Range

On the map provided, identify where Mr. Muffin is! Can you find exactly where he is?

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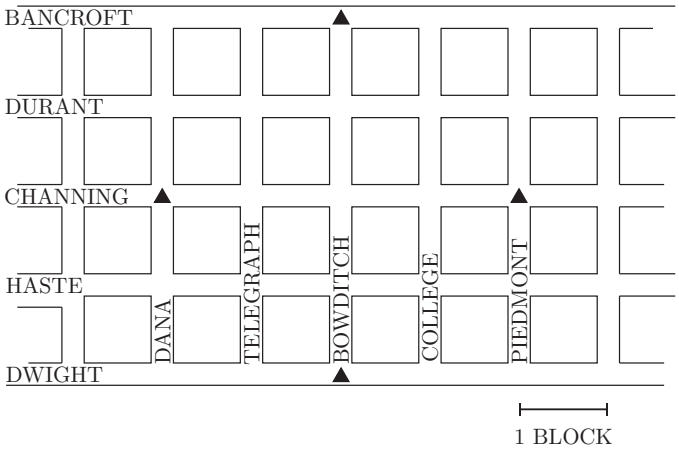

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