6.s02: EECS II - From A Medical Perspective

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April 7, 2014

1. (a) Average heart rate: 87.7 bpm
   Standard deviation of RR interval: 0.0021

```
function [ times, rrt ] = ecg2rr( ecg, minheight, mindistance )
    t = linspace(0, 30+(5/60), length(ecg));
    [pks, locs] = findpeaks(ecg, 'MINPEAKHEIGHT', minheight, 'MINPEAKDISTANCE',
        mindistance);
    times = diff(t(locs));
    rrt = t(locs(2:end));
end

sum(times.^-1)/length(times) %bpm
std(rrt) %std
```

   (b) K=2
   Centroids: 0.0105, 0.0137
   Heart rates: 95.12, 73.23

```
[IDX, C] = kmeans(times, 2, 'Start', [min(times); max(times)])
C %centroids
C.^-1 %heart rates
```

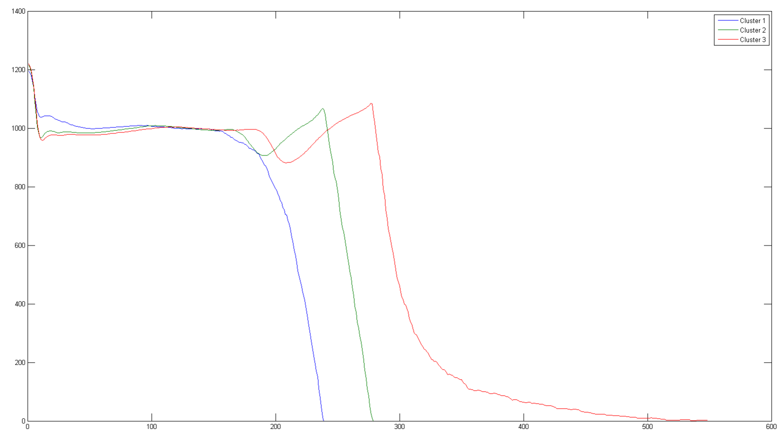
   (c) K=3
   Centroids: 0.0101, 0.0127, 0.0182
   Heart rates: 99.22, 78.81, 54.84
   Clusters: <cluster 1, 1146 pts, 0.44%> <cluster 2, 1307 pts, 50%> <cluster 3, 106 pts, 6%>

```
[IDX, C] = kmeans(times, 3, 'Start', [min(times); mean(times); max(times)])
C %centroids
C.^-1 %heart rates
```

2. (a) Longest beat: 547 elements

```
[pks, locs] = findpeaks(x01, 'MINPEAKHEIGHT', 1100, 'MINPEAKDISTANCE', 140);
intervals = diff(locs);
V = zeros(length(intervals), max(intervals));
for i = 1:length(intervals)
    Bi = x01(locs(i):locs(i+1));
    V(i, 1:length(Bi)) = Bi;
end
```

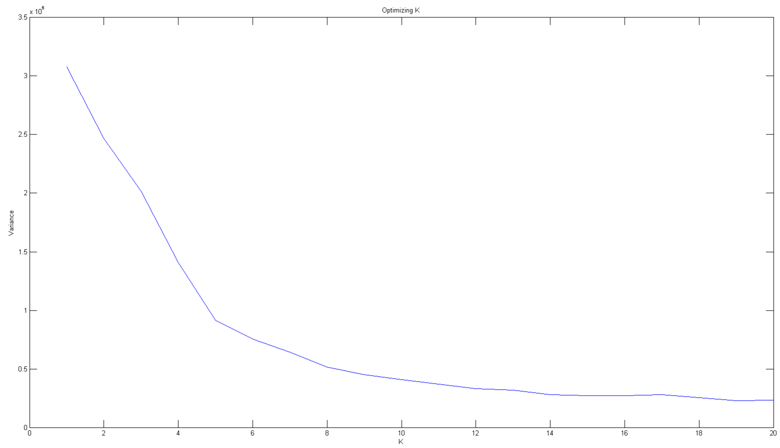
(b) Longest beat: 547 elements




```
[I,C] = kmeans(V, 3);
representatives = zeros(1, 3);
for i = 1:3
    variance = cluster_variance(V(I==i,:), C(i,:));
end

plot(1:size(C,2), C(1,:), 1:size(C,2), C(2,:),1:size(C,2), C(3,:))
```

(c) There is no obvious optimal k value. The answer depends on how willing one is to put in additional computational resources in calculating larger values of k, if more clusters actually would partition appropriately real life distinct classes, and the variance one is willing to tolerate. One reasonable choice is $k = 8$, which is the location on the graph at which the rate of decrease in variance begins to plateau off to a much slower decay.



```
function [ variance ] = cluster_variance( cluster, centroid )
    points_in_cluster = size(cluster, 1);
    L2 = zeros(1, points_in_cluster);
    for i = 1:points_in_cluster
        L2(i) = norm(cluster(i,:) - centroid);
    end
    variance = var(L2);
end

Ks = 1:20;
variances = zeros(1,length(Ks));
for k = min(Ks):max(Ks)
    [I,C] = kmeans(V, k);
    cluster_count = size(C, 1);
    variance = zeros(1, cluster_count);
    for i = 1:cluster_count
        variance(i) = cluster_variance(V(I==i,:), C(i,:));
    end
    variances(k) = mean(variance);
end

plot(Ks, variances);
```

---

3. LF/HF ratio: 5.02
   This is a normal ratio, so we have no reason to expect that the patient is at risk.

```
function [ XRR1, xrr1 ] = rrfc( xrr0, rrt, fs )
    rrt_linspace = linspace(rrt(1), rrt(end), ((rrt(end)-rrt(1))*fs));
    xrr1 = interp1(rrt, xrr0, rrt_linspace);
    X0 = fft(xrr1);
    XRR1 = fftshift(X0);
end

function [ p ] = signal_power( xrr0, rrt, f1, f2, fs )
    [ XRR1, xrr1] = rrfc( xrr0, rrt, fs);
    N = length(xrr1);
    k1 = N * f1 / fs;
    k2 = N * f2 / fs;
    XRR1s = abs(XRR1).^2;
    p = sum(XRR1s(floor(k1+(N-1)/2):floor(k2+(N-1)/2)))*N;
end

total_time = (23+(52/60)) * 60 * 60;
times = linspace(0, total_time, length(x03));
[pks, locs] = findpeaks(x03, 'MINPEAKHEIGHT', 75);
intervals = diff(times(locs));
rrt = times(locs(2:end));

lf = signal_power(intervals, rrt, 0.04, 0.15, x03_sampling_frequency_in_Hz);
hf = signal_power(intervals, rrt, 0.15, 0.4, x03_sampling_frequency_in_Hz);

ratio = lf/hf
```