Blink Signal Removal From EEG Using PCA and ICA

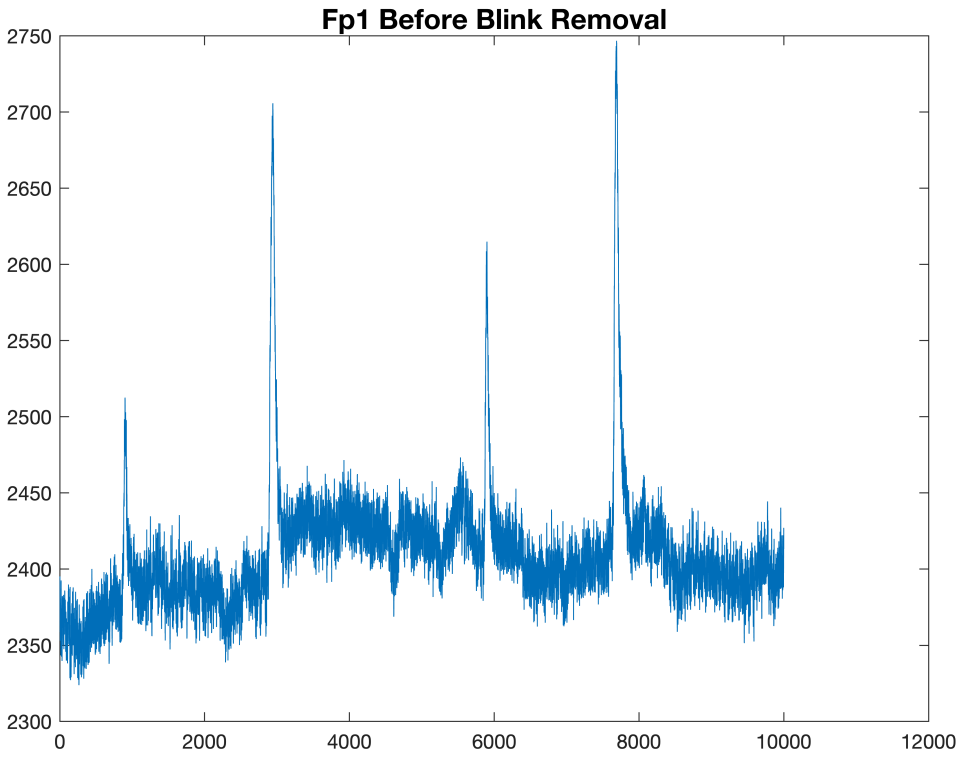
Code Authored By: Shawhin Talebi

```
clear; close all; clc
warning('off')
```

Import Data

```
load('EEG_data')

% plot Fp1 electrode data (sits at front left part of head hear left eye)
% perturbations can be seen visually due to blinks
plot(Data(:,1))
title("Fp1 Before Blink Removal", 'FontSize', 14)
```



PCA

```
% DEFINE NUMBER OF PRINICPLE COMPONENTS TO KEEP
% NOTE: it is typically a good idea to try out different numbers and
% compare their total explained variation
q=21;

% PERFORM PCA
% NOTE: it is important to normalize data! (i.e. substract mean of each
```

```
% column and divide by standard deviation. MATLAB's pca function does this
% automatically :p
[coeff,Data_PCA,latent,tsquared,explained,mu] = pca(Data, 'NumComponents', q);

% compute and display explained variation
disp(strcat("Top ", string(q), " principle components explain ", ...
    string(sum(explained(1:q))), " of variation"))
```

```
Top 21 principle components explain 99.5134 of variation
```

ICA

```
% compute independent components from principle components
% train ICA model
Mdl = rica(Data_PCA, q);

% apply ica
Data_ICA = transform(Mdl, Data_PCA);
```

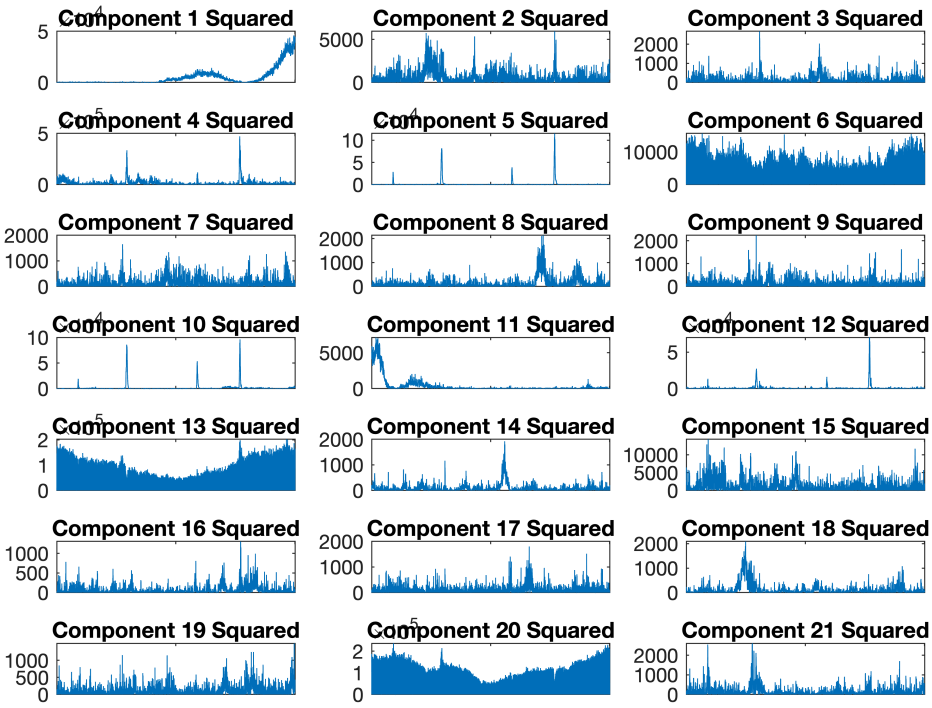
Plot Components

```
% define number of plots per column of figure
plotsPerCol = 7;

% plot components
figure(2)
for i = 1:q

    subplot(plotsPerCol,ceil(q/plotsPerCol),i)
    plot(Data_ICA(:,i).^2)
    title(strcat("Component ", string(i), " Squared"))
    ax = gca;
    ax.XTickLabel = {};

end
```



Remove Embedded Blink Information

```
% use heuristic to pick component corresponding to blink
Components_blink = pickBlinkComponents(Data_ICA);
disp("Blink component(s):")
```

```
Blink component(s):
```

```
disp(Components_blink)
```

```
    10    12
```

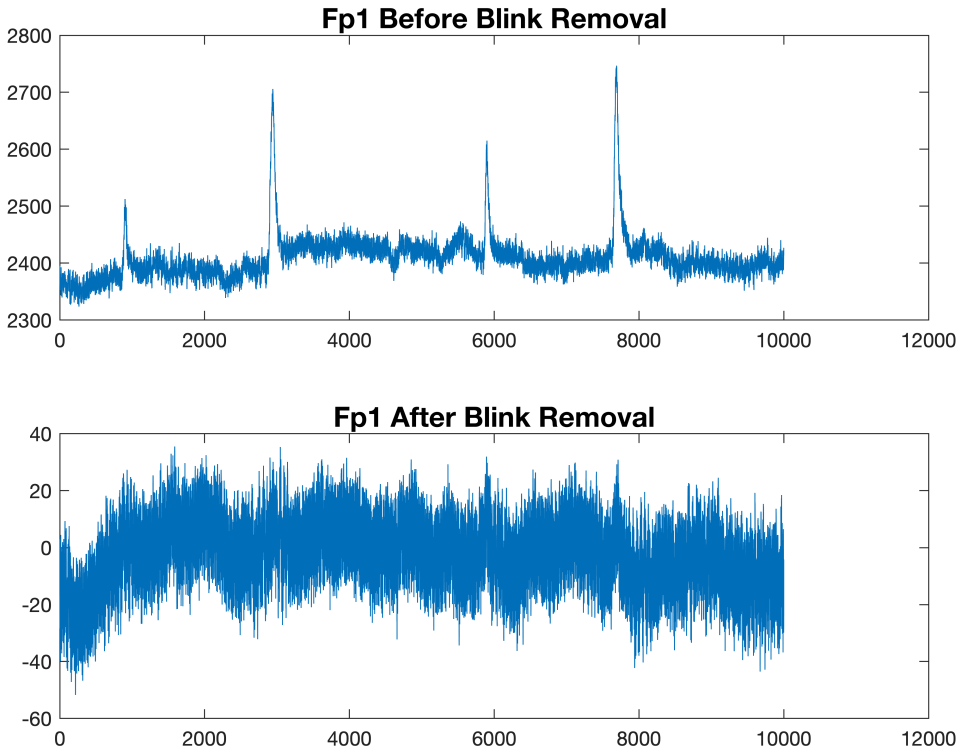
```
% zero all columns corresponsing to blink components
Data_ICA_noBlinks = Data_ICA;
Data_ICA_noBlinks(:,Components_blink) = ...
    zeros(length(Data_ICA), length(Components_blink));

% perform inverse ica transform
Data_PCA_noBlinks = Data_ICA_noBlinks*Mdl.TransformWeights;

% perform inverse pca transform
Data_noBlinks = Data_PCA_noBlinks*coeff';

% plot Fp1 electrode before and after
figure(3)
subplot(2,1,1)
```

```
plot(Data(:,1))
title("Fp1 Before Blink Removal", 'FontSize', 14)
subplot(2,1,2)
plot(Data_noBlinks(:,1))
title("Fp1 After Blink Removal", 'FontSize', 14)
```



Funtion Definitions

```
function Components_blink = pickBlinkComponents(Data_ICA)

    % get total number of components from input array
    [~, q] = size(Data_ICA);

    % initialize counter and output array
    i = 1;
    Components_blink = [];

    while i<q

        % find peaks of ith component
        % MinPeakDistance informed by average blink rate of 22 blinks/min
        % and 500 Hz sampling rate
        % MinPeakProminence defined by trial and error
        pks = findpeaks(Data_ICA(:,i), ...
            'MinPeakDistance', 1500, ...
            'MinPeakProminence', 100);
```

```
        % if four peaks exist choose as blink component
        if length(pks)==4
            Components_blink = [Components_blink i];
        end

        % increment counter
        i = i + 1;

    end

end
```