Project C - random matrix spectra

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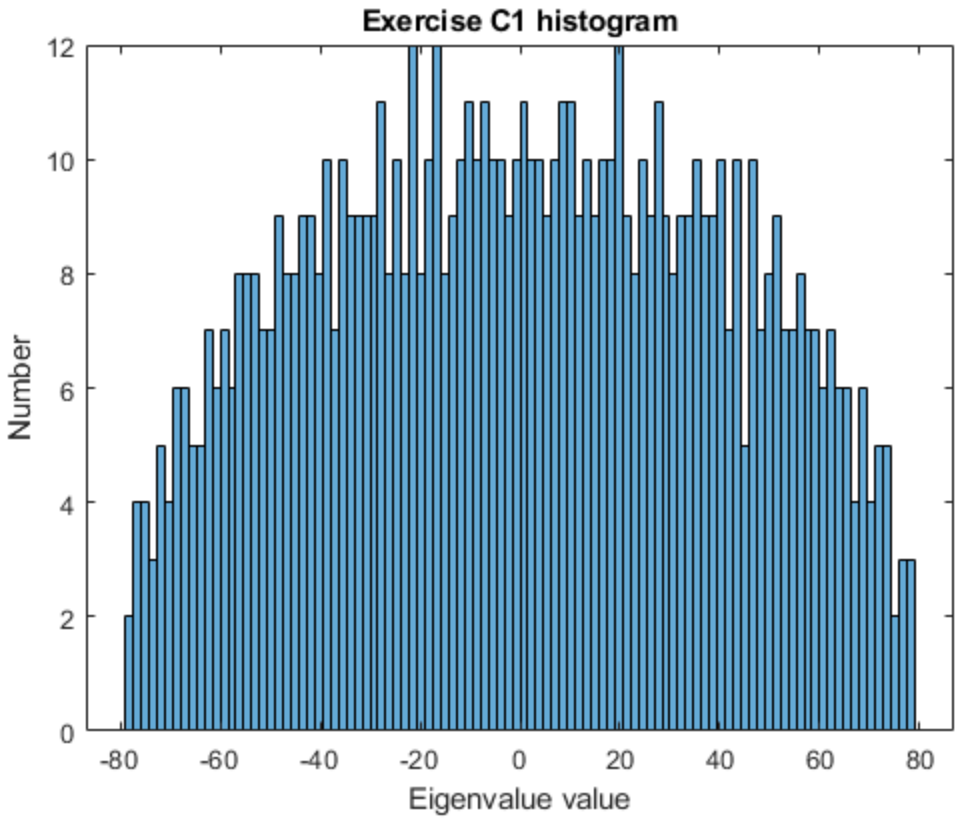
Exercise C1

```
type RandSpec.m
%Obtain Eigenvalues
EigenValues = RandSpec(800);
%Plot them on a histrogram with 100 bins
hold off;
histogram(EigenValues, 100)
%Add axis titles, etc.
title("Exercise C1 histogram")
xlabel("Eigenvalue value")
ylabel("Number")
%This histogram looks fairly close to an ellipse with some noise, or
%perhaps a truncated gaussian distribution.


function e = RandSpec(n)
% Exercise C1
    %Generate M, an nxn matrix of Gaussian variables
    M = randn(n);
    %Symmetrise it to produce S
    S = M + M.';
    %Output the eigenvalues of S
    e = eig(S);
end
```



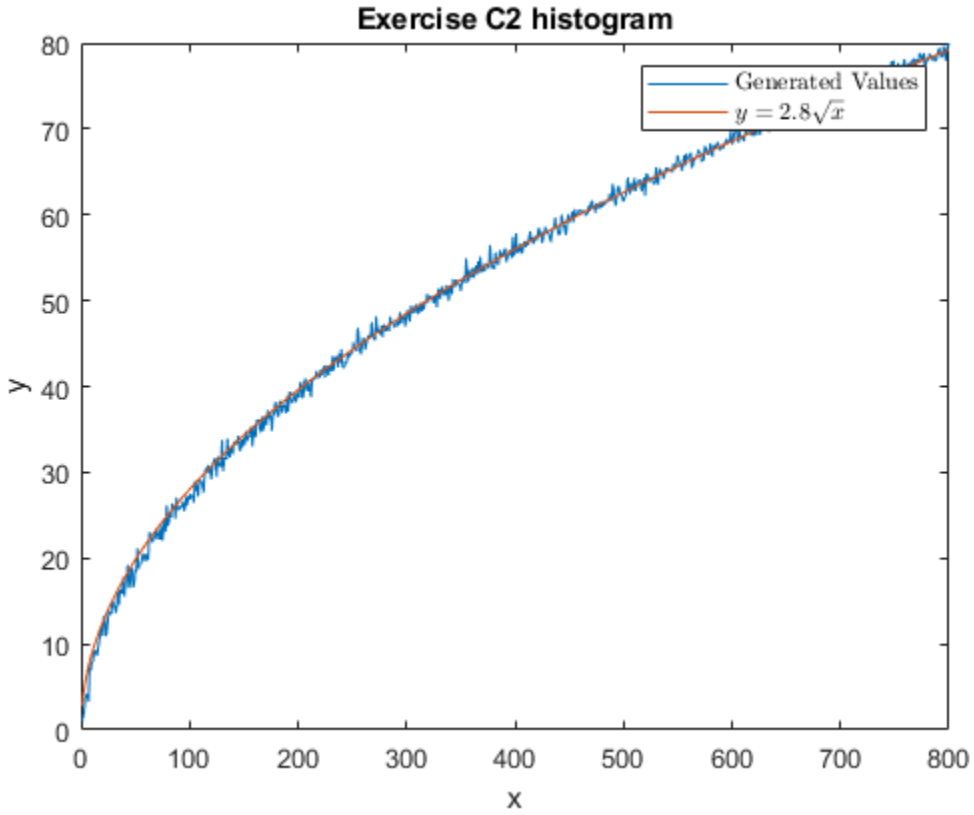
Exercise C2

```
type MaxEval.m
%Define an X range
X = 1:800;
%Obtain values from MaxEval
Y = MaxEval(800);
%Plot the values of Y(i) and the values of 2.8sqrt(i) on the same plot
plot(X,Y)
hold on;
plot(X,2.8.*X.^(.5))

%Add a legend, axis titles, etc.
l = legend("Generated Values","$y=2.8\sqrt{x}$");
title("Exercise C2 histogram")
xlabel("x")
ylabel("y")
%Set legend interpreter to latex
set(l, "interpreter", "latex")
hold off;


function e = MaxEval(n)
% Exercise C2
    %Preallocate e's size for reduced memory usage
    e = zeros(n,1);
```

```
    %Iterate across i in {1,...,n}
    for i = 1:n
        %Generate Eigenvalues from an ixi matrix
        EigenValues = RandSpec(i);
        %Store the maximum element of EigenValues in e(i)
        e(i) = max(EigenValues);
    end
end
```



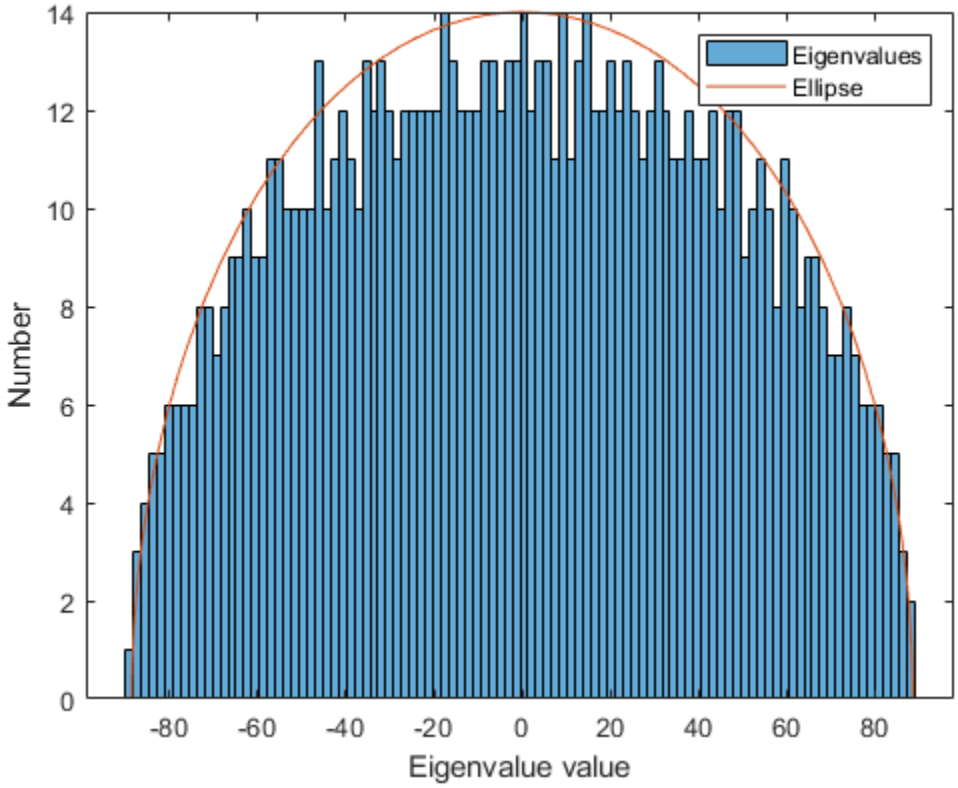
Exercise C3

```
%Generate Eigenvalues of a 1000x1000 matrix
EigenValues = RandSpec(1000);
%Plot it's histogram, as in C1
histogram(EigenValues, 100)

%The highest bar appears to be at 14. Initialize a and b
b = 14;
a = 2.8*1000^.5;
%Plot the upper half of the ellipse (x/a)^2 + (y/b)^2 = 1 on the same
%graph, i.e. plotting y = b*sqrt(1 - (x/a)^2) for x in [-a, a]
hold on;
fplot(@(x) b*(1-(x/a)^2)^.5,[-a,a]);
%Add legend, axis titles, etc.
legend("Eigenvalues", "Ellipse")
xlabel("Eigenvalue value")
```

```
ylabel("Number")
%The graph looks better approximated by b=13 but aside from that it
%the histogram is reasonably bounded by the given ellipse.
```

```
Warning: Function behaves unexpectedly on array inputs. To improve
 performance,
properly vectorize your function to return an output with the same
 size and
shape as the input arguments.
```



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