Average Precision (AP)

```
% Load data
load C:\Users\Andrea\Desktop\MAGISTRALE\Anno1-sem2\SearchEngines\HWS\seupd2021-goldr\RUN\RUN202

measure_ap = runtotonlymap(1:49,:);
measure_ap = table2array(measure_ap)
```

```
measure_ap = 49×5
    0.6795    0.6795    0.6791    0.6826    0.6940
    0.3077    0.3077    0.3065    0.2759    0.3285
    0.3348    0.3348    0.3347    0.4506    0.4506
    0.3442    0.3288    0.3442    0.2586    0.2547
    0.2412    0.2452    0.2396    0.1159    0.1137
    0.3408    0.3354    0.3408    0.2038    0.1967
    0.2727    0.2774    0.2697    0.2075    0.2178
    0.1035    0.1035    0.1024    0.0233    0.0226
    0.2454    0.2487    0.2454    0.1703    0.1895
    0.2328    0.2286    0.2328    0.1725    0.1908
      ⋮
```

```
% remove the now useless ap matrix
clear runtotonlymap;

% the significance level
alpha = 0.05;

% the mean for each run across the topics
% Note that if the measure is AP (Average Precision),
% this is exactly MAP (Mean Average Precision) for each run
m1 = mean(measure_ap);

% sort in descending order of mean score
[~, idx] = sort(m1, 'descend');

ogmyruns = "";
ogmyruns(1) = "run1";
ogmyruns(2) = "run2";
ogmyruns(3) = "run3";
ogmyruns(4) = "run4";
ogmyruns(5) = "run5";

% re-order runs by descending mean of the measure
measure_ap = measure_ap(:, idx);
myruns = ogmyruns;
myruns = myruns(:, idx);
```

One way ANOVA

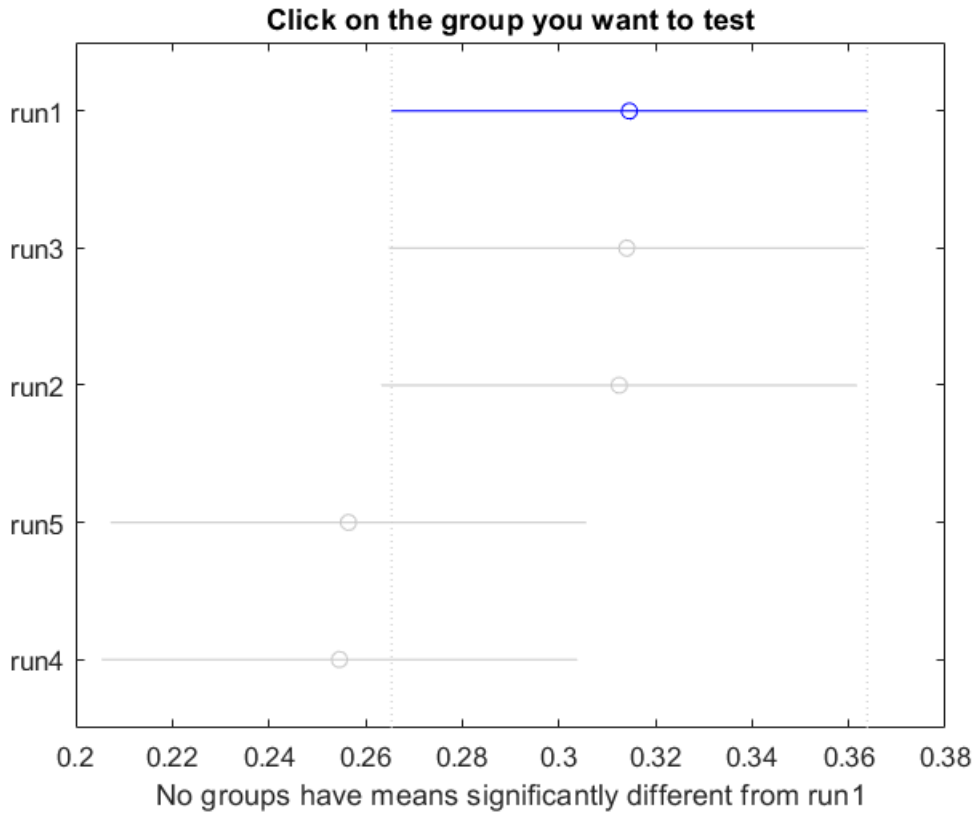
```
% perform the ANOVA
[~, tbl_ap, sts_ap] = anova1(measure_ap, myruns, 'off');
```

```
% display the ANOVA table
tbl_ap
```

tbl_ap = 4×6 cell

	1	2	3	4	5	6
1	'Source'	'SS'	'df'	'MS'	'F'	'Prob>F'
2	'Columns'	0.1994	4	0.0499	1.5630	0.1849
3	'Error'	7.6556	240	0.0319	[ ]	[ ]
4	'Total'	7.8550	244	[ ]	[ ]	[ ]

```
c = multcompare(sts_ap, 'Alpha', alpha, 'Ctype', 'hsd');
```




```
% display the multiple comparisons
c
```

c = 10×6

```
    1.0000    2.0000   -0.0979    0.0005    0.0990    1.0000
    1.0000    3.0000   -0.0963    0.0021    0.1005    1.0000
    1.0000    4.0000   -0.0403    0.0582    0.1566    0.4896
    1.0000    5.0000   -0.0384    0.0600    0.1584    0.4569
    2.0000    3.0000   -0.0969    0.0016    0.1000    1.0000
    2.0000    4.0000   -0.0408    0.0576    0.1560    0.4993
    2.0000    5.0000   -0.0390    0.0595    0.1579    0.4664
    3.0000    4.0000   -0.0424    0.0561    0.1545    0.5274
    3.0000    5.0000   -0.0405    0.0579    0.1563    0.4942
    4.0000    5.0000   -0.0966    0.0019    0.1003    1.0000
```

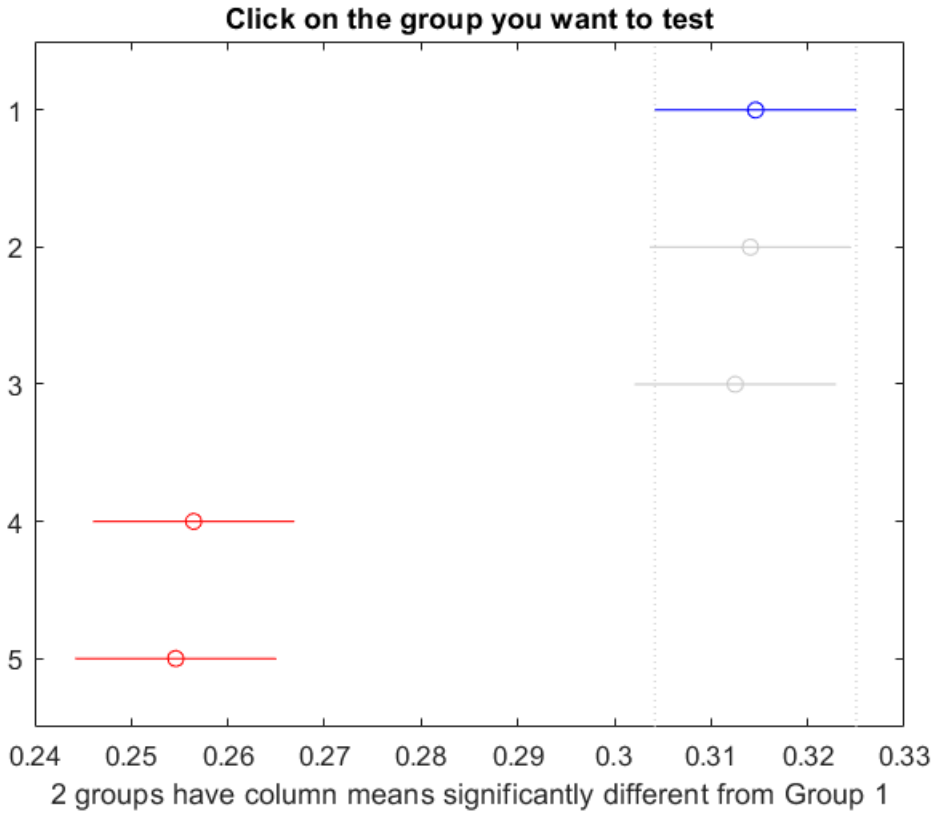
Two way ANOVA

```
% perform the ANOVA
[~, tbl2_ap, sts2_ap] = anova2(measure_ap, 1, 'off');

% display the ANOVA table
tbl2_ap
```

tbl2_ap = 5×6 cell

	1	2	3	4	5	6
1	'Source'	'SS'	'df'	'MS'	'F'	'Prob>F'
2	'Columns'	0.1994	4	0.0499	34.8793	7.0038e-22
3	'Rows'	7.3812	48	0.1538	107.5816	1.6047e-115
4	'Error'	0.2744	192	0.0014	[ ]	[ ]
5	'Total'	7.8550	244	[ ]	[ ]	[ ]

```
c2 = multcompare(sts2_ap, 'Alpha', alpha, 'Ctype', 'hsd', "Estimate","column")
```



c2 = 10×6

```
    1.0000    2.0000   -0.0203    0.0005    0.0214    1.0000
    1.0000    3.0000   -0.0187    0.0021    0.0229    0.9987
    1.0000    4.0000    0.0373    0.0582    0.0790    0.0000
    1.0000    5.0000    0.0392    0.0600    0.0809    0.0000
    2.0000    3.0000   -0.0193    0.0016    0.0224    0.9996
    2.0000    4.0000    0.0368    0.0576    0.0785    0.0000
    2.0000    5.0000    0.0386    0.0595    0.0803    0.0000
    3.0000    4.0000    0.0352    0.0561    0.0769    0.0000
```

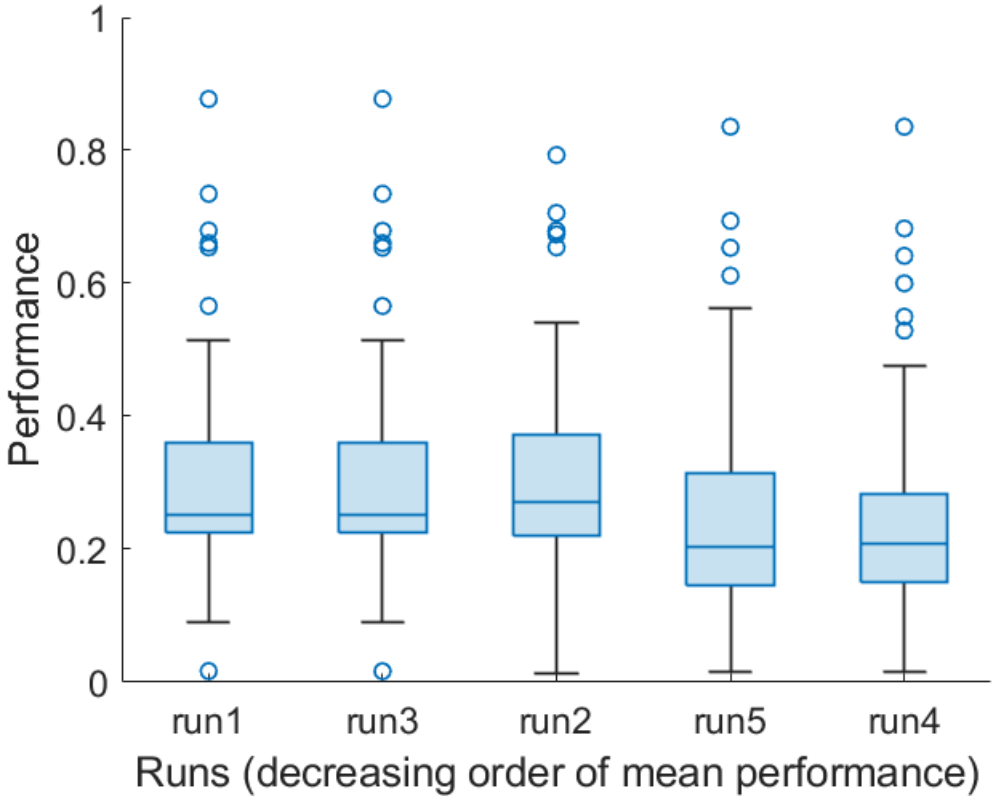
```
    3.0000    5.0000    0.0371    0.0579    0.0787    0.0000
    4.0000    5.0000   -0.0190    0.0019    0.0227    0.9992
```

```
c2
```

```
c2 = 10×6
    1.0000    2.0000   -0.0203    0.0005    0.0214    1.0000
    1.0000    3.0000   -0.0187    0.0021    0.0229    0.9987
    1.0000    4.0000    0.0373    0.0582    0.0790    0.0000
    1.0000    5.0000    0.0392    0.0600    0.0809    0.0000
    2.0000    3.0000   -0.0193    0.0016    0.0224    0.9996
    2.0000    4.0000    0.0368    0.0576    0.0785    0.0000
    2.0000    5.0000    0.0386    0.0595    0.0803    0.0000
    3.0000    4.0000    0.0352    0.0561    0.0769    0.0000
    3.0000    5.0000    0.0371    0.0579    0.0787    0.0000
    4.0000    5.0000   -0.0190    0.0019    0.0227    0.9992
```

BoxPlot

```
% Compute the mean performance of each run across topics
% This is the MAP for each run, if we loaded the AP data
m2 = mean(measure_ap);

% sort in descending order of mean score
[~, idx] = sort(m2, 'descend');

% re-order runs by descending mean of the measure
% needed to have a more nice looking box plot
measure_ap = measure_ap(:, idx);
myruns2 = myruns(:,idx);

figure

% show the box plot
boxchart(measure_ap)

%hold on

% plot the mean on top of the box plot
%plot (m, ':x', "MarkerSize", 10, "LineWidth", 2)

% adjust tick labels on x-axis, y-axis range, and font size
ax = gca;
ax.FontSize = 14;
ax.XTickLabel = myruns2;
xlabel("Runs (decreasing order of mean performance)")
ylabel("Performance")
```




```
TOTALComparisons = (length(myruns) * (length(myruns) - 1)) / 2
```

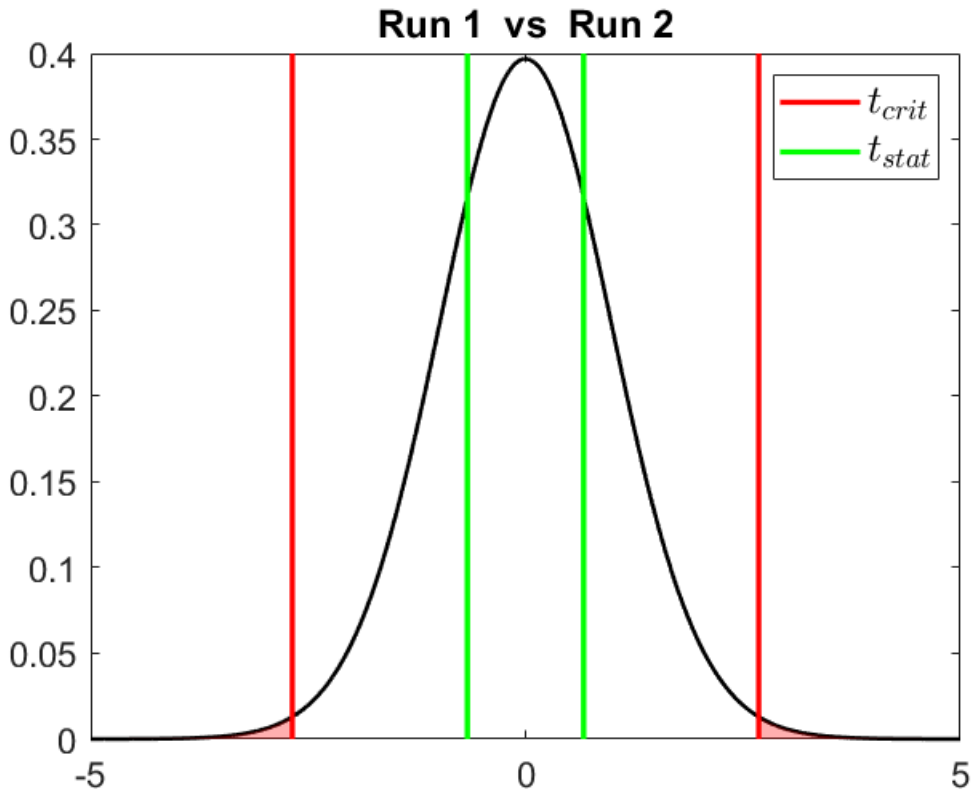
```
TOTALComparisons = 10
```

```
newmeasure = measure_ap(:, [1,3,2,5,4]);
```

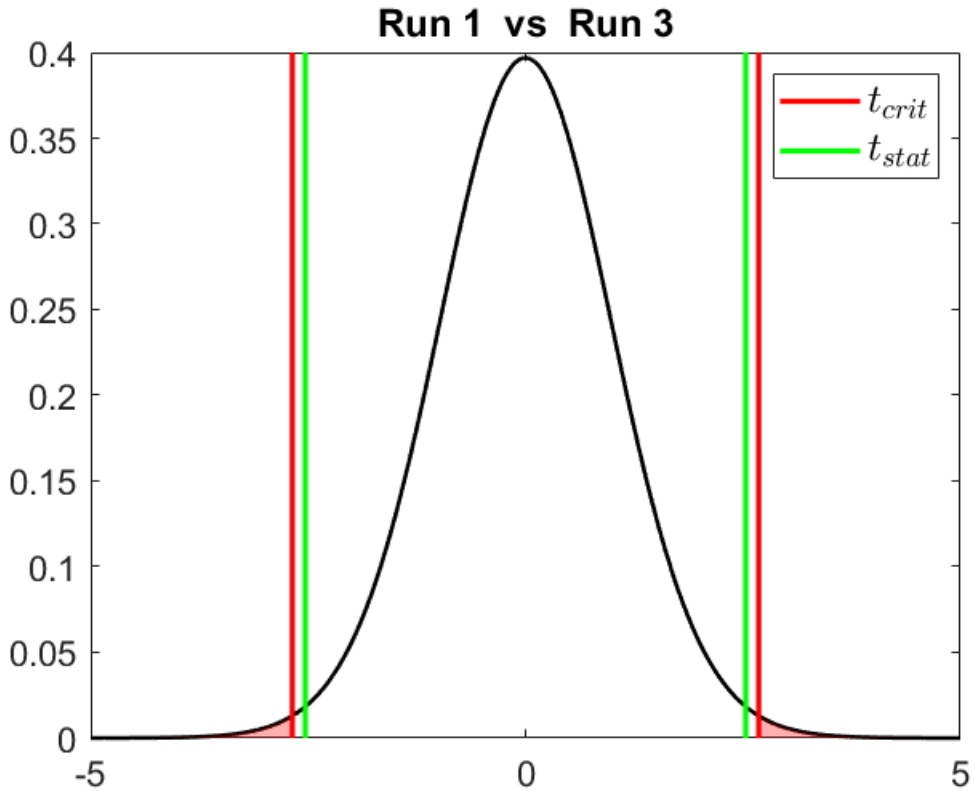
```
for r1 = 1:length(myruns)
    for r2 = 1:length(myruns)
        if r1 < r2
            %tstudnet comparisons
            %rna1 = myruns(r1);
            %rn1 = find(myruns==rna1);
            %rna2 = myruns(r2);
            %rn2 = find(myruns==rna2);

            [~, p] = ttest(newmeasure(:, r1), newmeasure(:, r2));
            fprintf("Run %s vs %s: p-value %f", ogmyruns(r1), ogmyruns(r2), p)
            df = length(newmeasure) - 1;
            tCrit = tinv(1 - 0.01/2, df);
            tRuns = tinv(1 - p/2, df);

            % t distribution
            ar = -5:.01:5;
            ts = tpdf(ar, df);
```

```
            % find where we are above and below tCrit
            idx1 = ar >= tCrit;
            idx2 = ar <= -tCrit;

            figure

            plot(ar, ts, "LineWidth", 1.5, "Color", "k");

            hold on

            % plot two vertical lines corresponding to tCrit
            h(1) = plot([tCrit tCrit], get(gca, "ylim"), "Color", "r", "LineWidth", 2, "LineSty
            plot([-tCrit -tCrit], get(gca, "ylim"), "Color", "r", "LineWidth", 2, "LineStyle",

            % color the area under the t distribution above and below tCrit
            area(ar(idx1), ts(idx1) , "FaceColor", "r", "FaceAlpha", 0.3, "EdgeColor", "none");
            area(ar(idx2), ts(idx2), "FaceColor", "r", "FaceAlpha", 0.3, "EdgeColor", "none");

            h(2) = plot([tRuns tRuns], get(gca, "ylim"), "Color", "g", "LineWidth", 2, "LineSty
            plot([-tRuns -tRuns], get(gca, "ylim"), "Color", "g", "LineWidth", 2, "LineStyle",
            %xline(tRuns, "Color", "g", "LineWidth", 2);

            ax = gca;
            ax.FontSize = 13;
            %ax.YLim = [0 ax.YLim(2) + 0.05];
            %ax.XLim = [-5, 5];
            title(['Run ',num2str(r1),'  vs  Run ',num2str(r2)])

            lgnd = legend([h(1), h(2)], ["$t_{crit}$", "$t_{stat}$"], "Interpreter", "Latex");
            lgnd.FontSize = 15;

            %fprintf("%d - %d \n", r1, r2)
            if r2 == 5
                break
            end
        end
    end
end
```

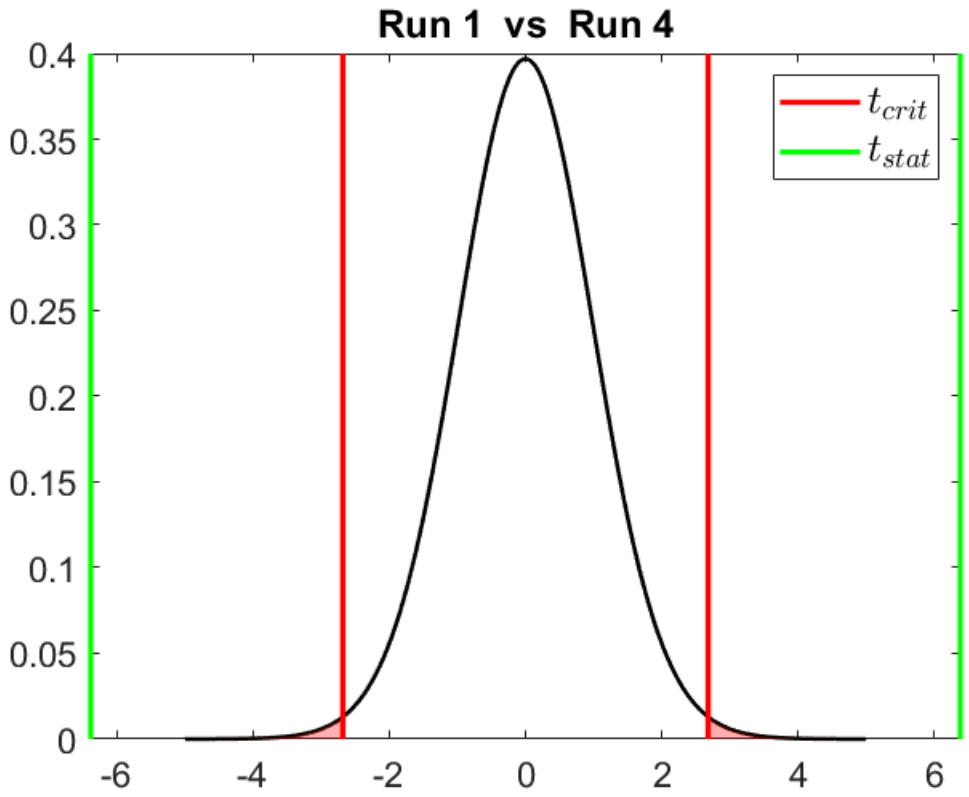
```
Run run1 vs run2: p-value 0.506734
```



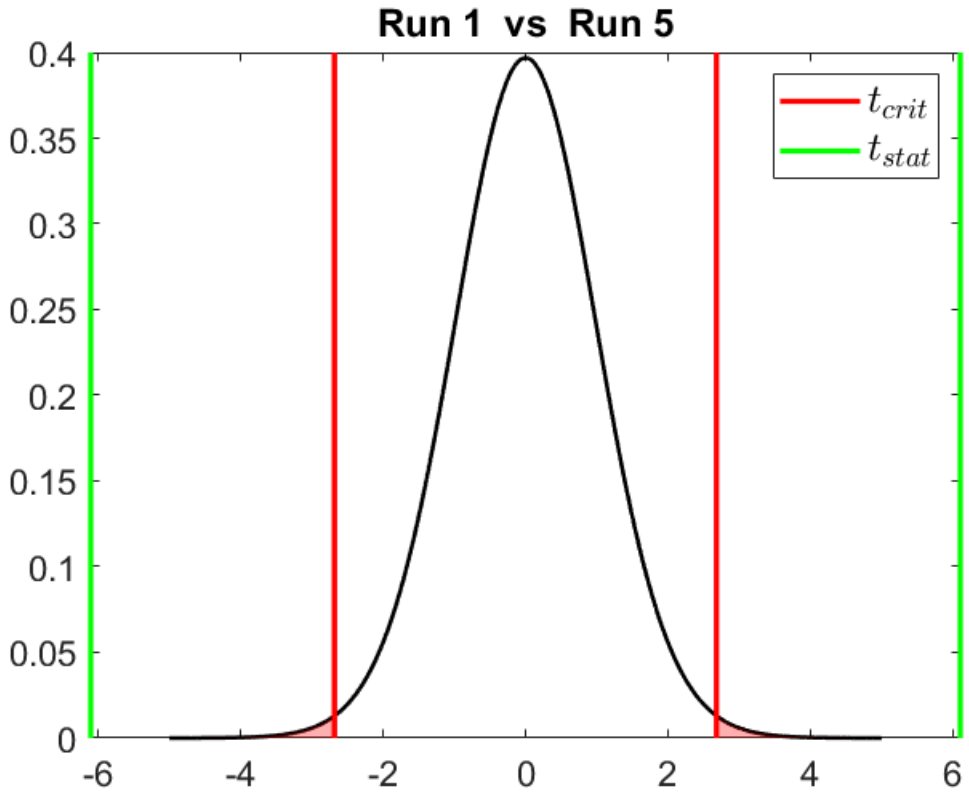

```
Run run1 vs run3: p-value 0.014658
```



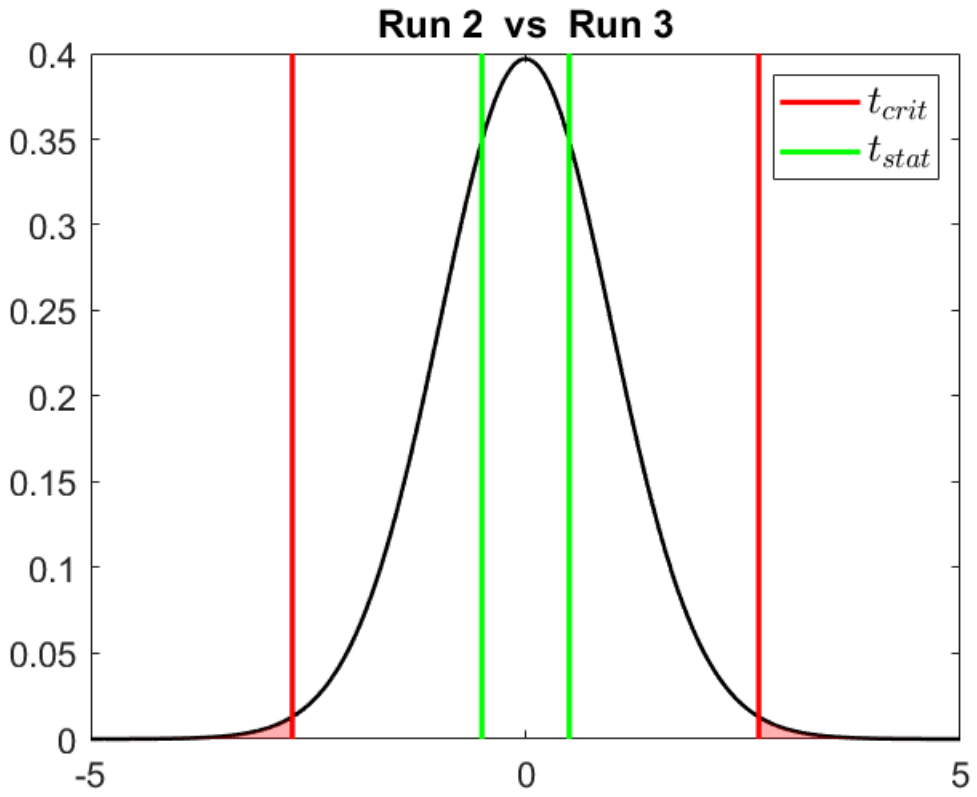

```
Run run1 vs run4: p-value 0.000000
```



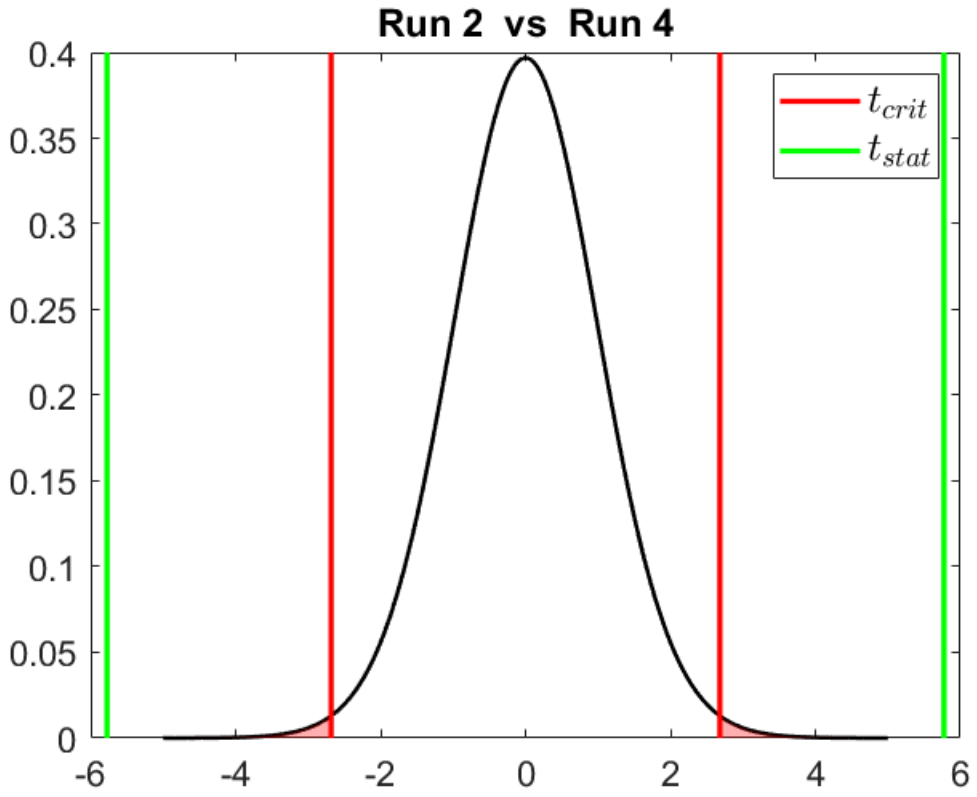

```
Run run1 vs run5: p-value 0.000000
```



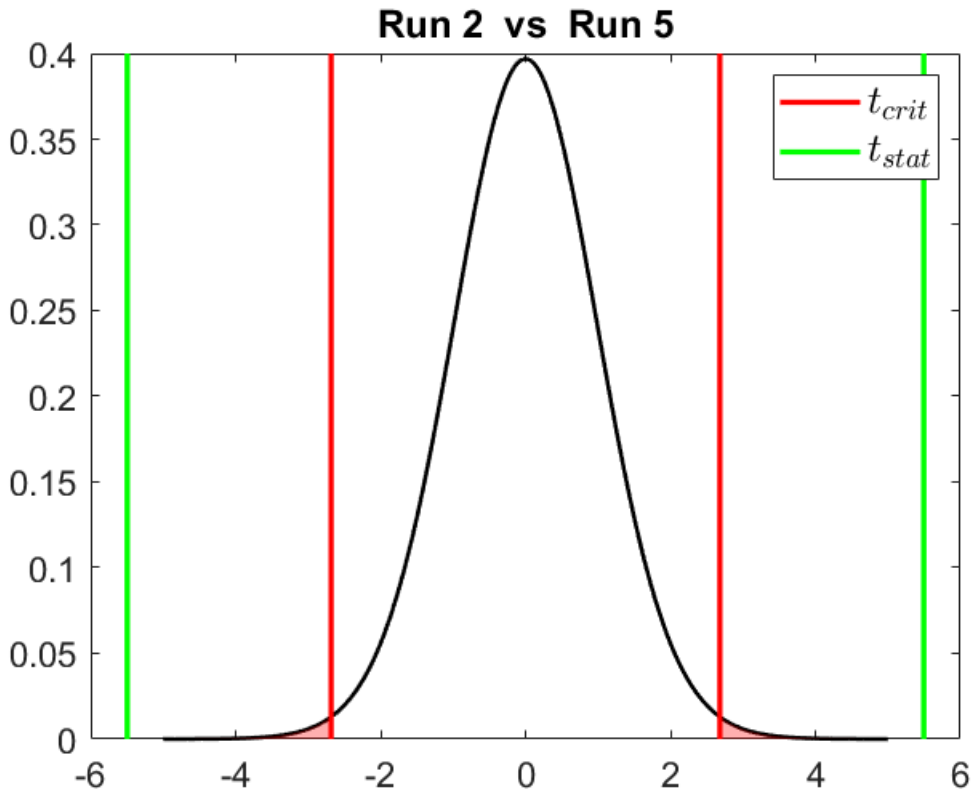

```
Run run2 vs run3: p-value 0.618248
```



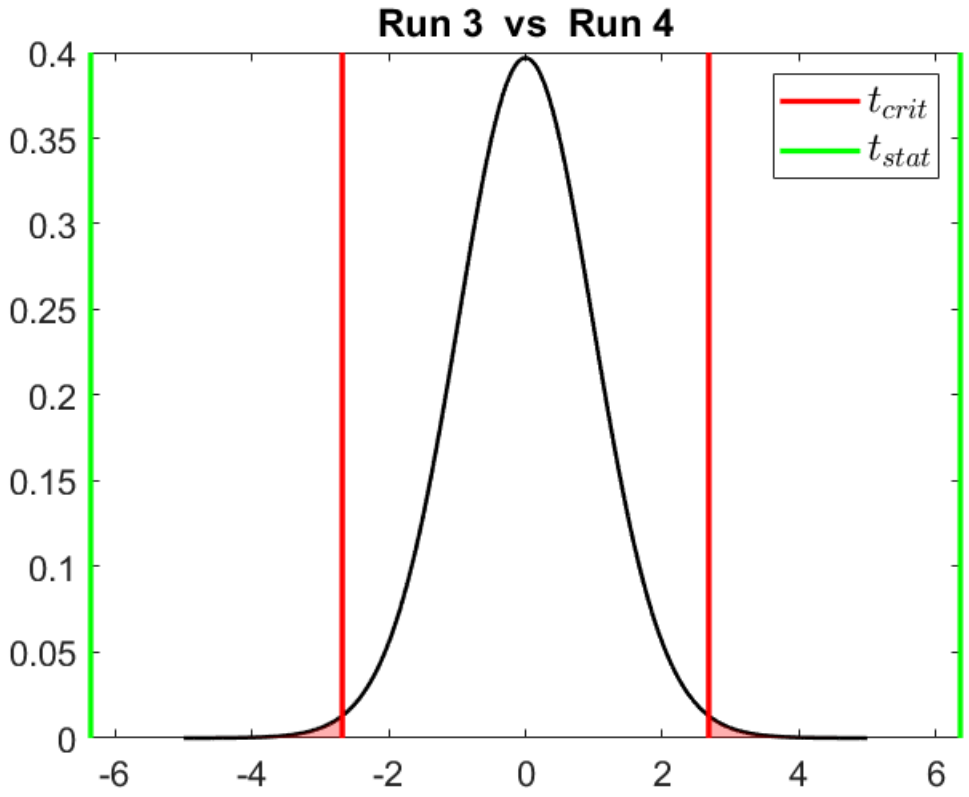
Run run2 vs run4: p-value 0.000001



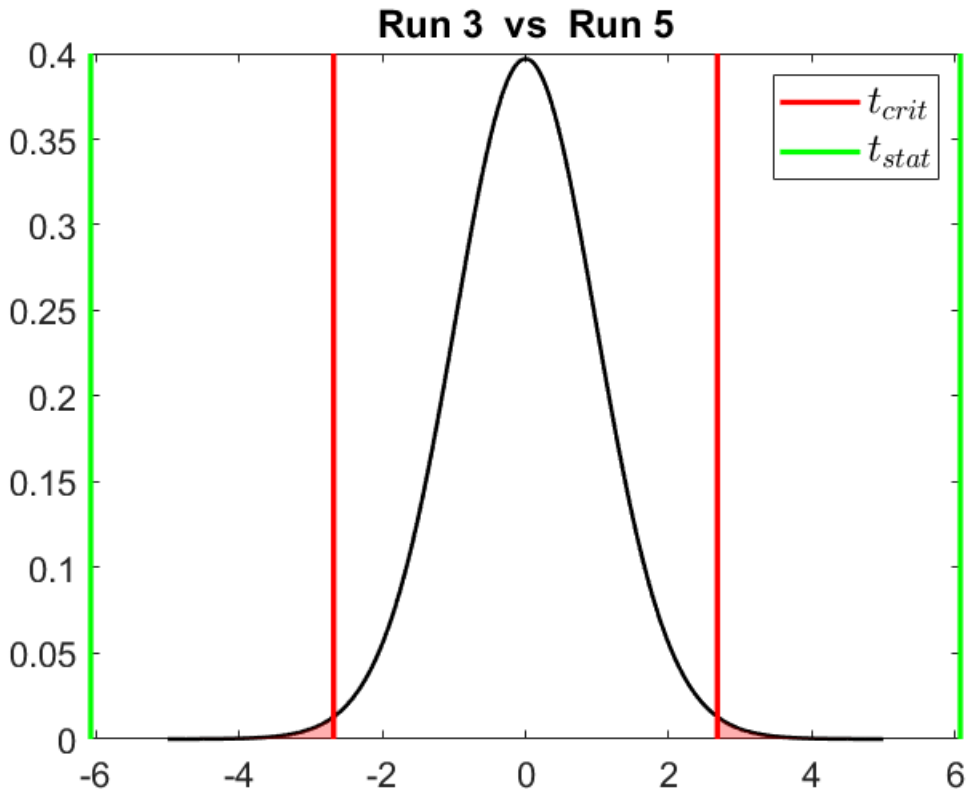
Run run2 vs run5: p-value 0.000001




```
Run run3 vs run4: p-value 0.000000
```




```
Run run3 vs run5: p-value 0.000000
```




```
Run run4 vs run5: p-value 0.269019
```