Online Homework System

Assignment Worksheet
6/8/20 - 1:00:41 PM EDT

Name: _____ **Class:**
Class #: _____ **Section #:** _____
Instructor: Nathaniel Stevens **Assignment:** Quiz 4

Question 1: (1 point)

Suppose that $M = 9$ *independent* hypothesis tests are performed, each at significant level $\alpha = 0.02$. Calculate the family-wise error rate in this case. Round your answer to 4 decimals.

_____ $1-(1-\alpha)^M = 1-(1-0.02)^9 = 0.1663$

Question 2: (1 point)

In class we've discussed four methods for dealing with the *multiple comparison problem*. These methods vary in their likelihood of committing Type I Errors. By dragging and dropping the names below, arrange the four methods from *least likely* to commit a Type I Error (left) to *most likely* to commit a Type I Error (right).

null Bonferroni Šidák Holm Benjamini-Hochberg

Question 3: (1 point)

TRUE or FALSE: In order to account for the multiple comparison problem, you will need *fewer* experimental units in each condition than you would have needed otherwise.

(a) True

(b) False

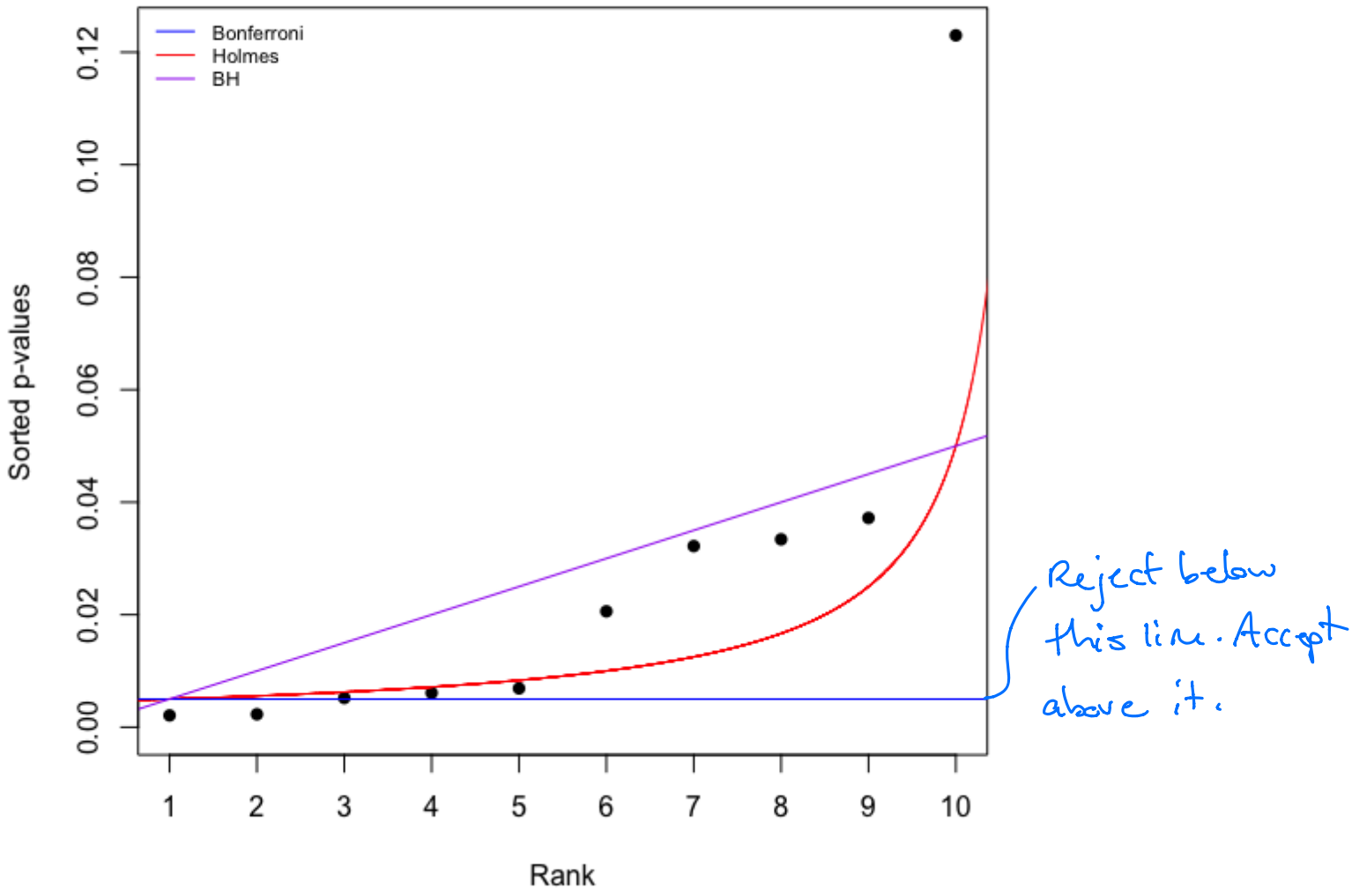
Question 4: (1 point)

In class we've discussed four methods for dealing with the *multiple comparison problem*. These methods vary in their likelihood of committing Type II Errors. By dragging and dropping the names below, arrange the four methods from *least powerful* (left) to *most powerful* (right). Note that *powerful* here refers to "power" in the hypothesis testing sense of the word.

null Bonferroni Šidák Holm Benjamini-Hochberg

Question 5: (1 point)

$M = 10$ hypothesis tests have been performed and their sorted p-values are plotted below. The blue, red and purple curves respectively depict the Bonferroni, Holm, and Benjamini-Hochberg thresholds associated with $\alpha^* = 0.05$.

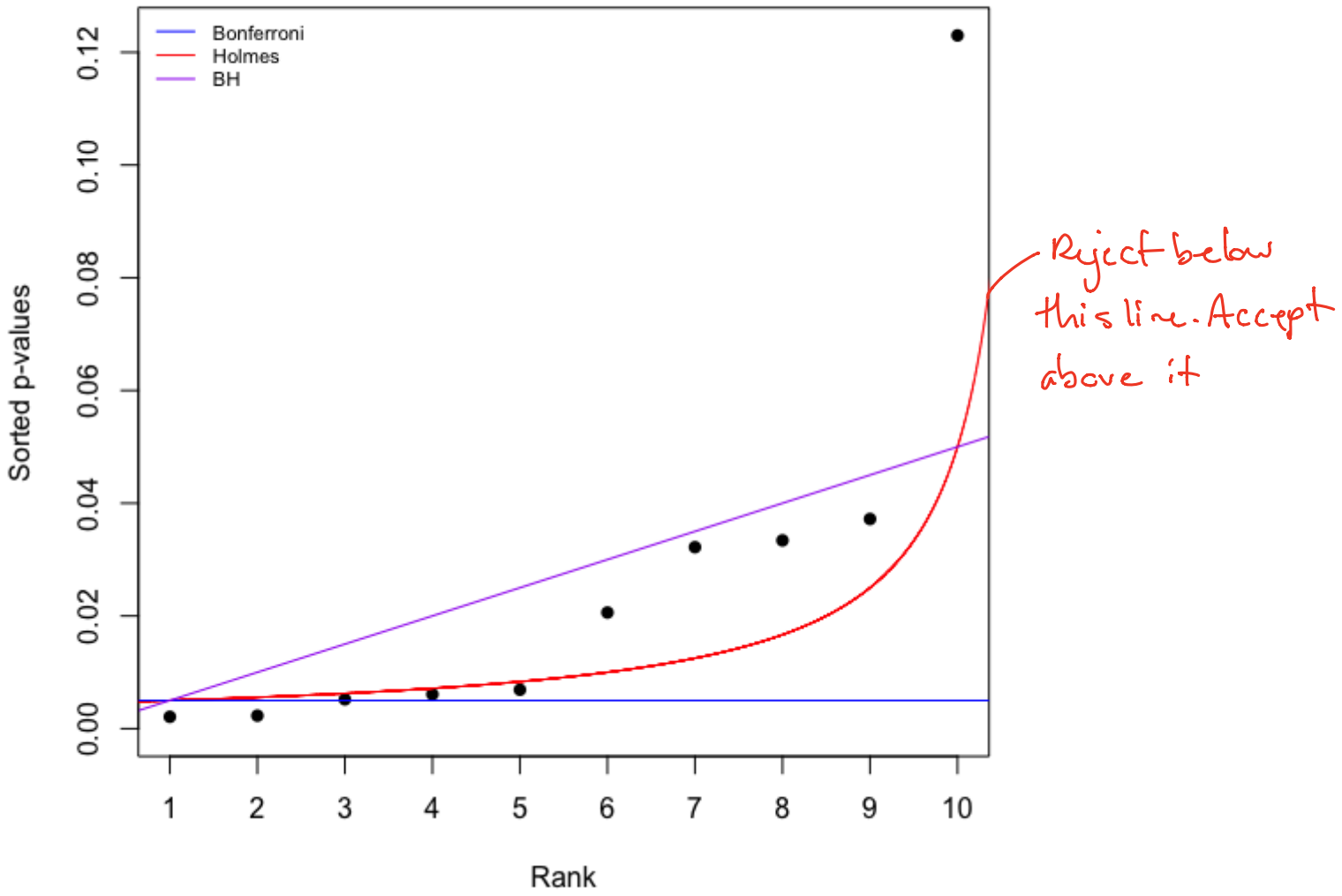


Based on the plot above, indicate whether you REJECT or ACCEPT each of the null hypotheses below, on the basis of the *Bonferroni Correction.*

$H_{0,(1)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(2)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(3)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(4)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(5)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(6)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(7)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(8)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(9)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(10)}$	REJECT [ ] ACCEPT [ ]

Question 6: (1 point)

$M = 10$ hypothesis tests have been performed and their sorted p-values are plotted below. The blue, red and purple curves respectively depict the Bonferroni, Holm, and Benjamini-Hochberg thresholds associated with $\alpha^* = 0.05$.



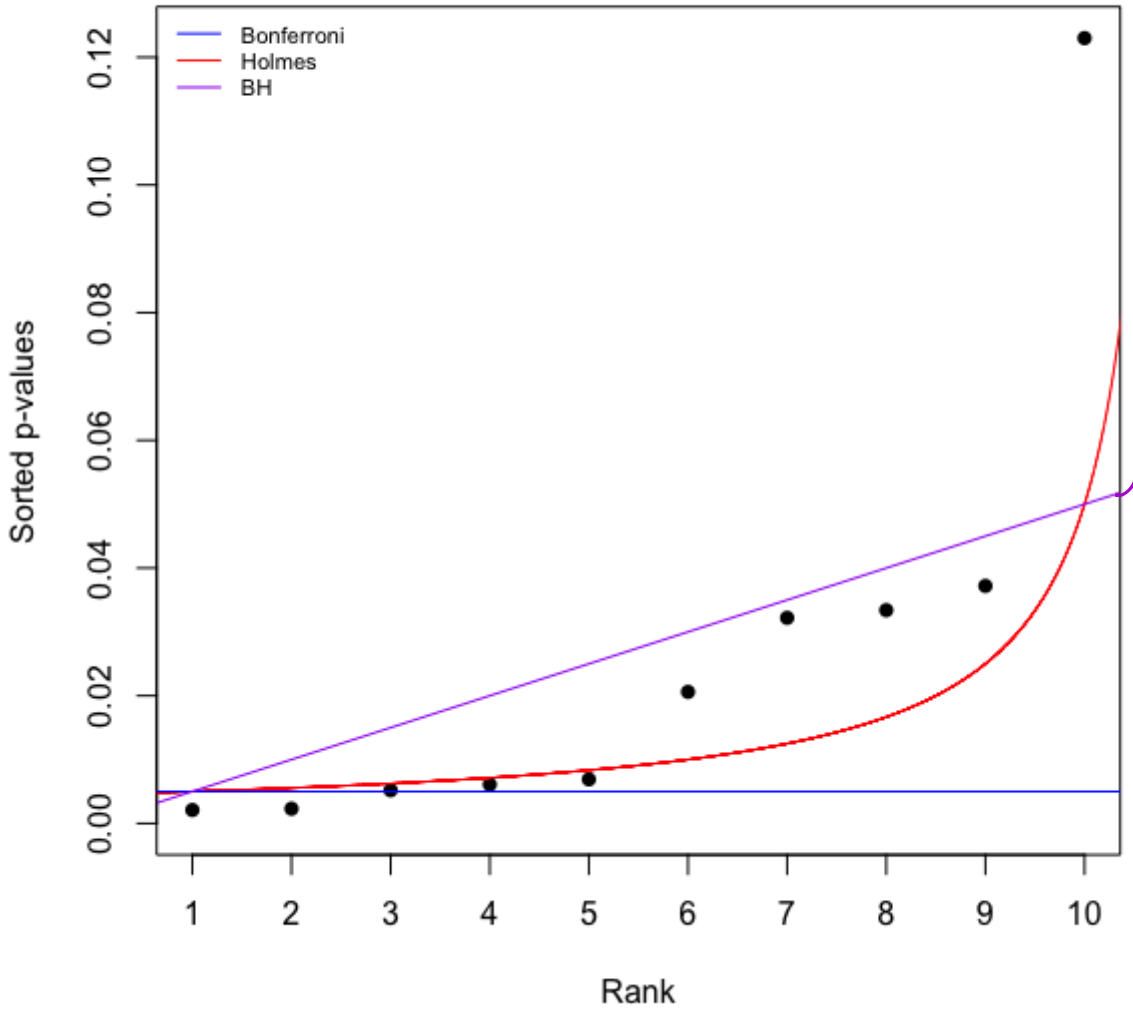
Based on the plot above, indicate whether you REJECT or ACCEPT each of the null hypotheses below, on the basis of *Holm's Procedure.*

$H_{0,(1)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(2)}$	REJECT [ ] ACCEPT [ ]

$H_{0,(3)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(4)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(5)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(6)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(7)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(8)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(9)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(10)}$	REJECT [ ] ACCEPT [ ]

Question 7: (1 point)

$M = 10$ hypothesis tests have been performed and their sorted p-values are plotted below. The blue, red and purple curves respectively depict the Bonferroni, Holm, and Benjamini-Hochberg thresholds associated with $\alpha^* = 0.05$.



Reject below this line. Accept above it.

Based on the plot above, indicate whether you REJECT or ACCEPT each of the null hypotheses below, on the basis of the *Benjamini-Hochberg Procedure.*

$H_{0,(1)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(2)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(3)}$	REJECT [ ] ACCEPT [ ]

$H_{0,(4)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(5)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(6)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(7)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(8)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(9)}$	REJECT [ ] ACCEPT [ ]
$H_{0,(10)}$	REJECT [ ] ACCEPT [ ]

Question 8: (4 points)

$M = 4$ hypothesis tests were performed and the following p-values were observed:
$p_1 = 0.0662,\ p_2 = 0.0497,\ p_3 = 0.0412,\ p_4 = 0.0035.$

Listed below are four versions of p_3^*, the adjusted p-value for hypothesis test 3. Using the drop-downs, indicate which correction method gave rise to each adjusted p-value.

_____

Bonferroni: $p_k^* = M p_k$

$p_1^* = 0.2648$ $p_2^* = 0.1988$ $p_3^* = 0.1648$ $p_4^* = 0.0140$

Šidák: $p_k^* = 1 - (1-p_k)^M$

$p_1^* = 0.2396$ $p_2^* = 0.1845$ $p_3^* = 0.1549$ $p_4^* = 0.0139$

Holm's: $p_{(k)}^* = \max_{j \le k} \{ p_{(j)}(M-j+1) \}$

$p_{(1)} = p_4 = 0.0035$, $p_{(2)} = p_3 = 0.0412$, $p_{(3)} = p_2 = 0.0497$, $p_{(4)} = p_1 = 0.0662$

k	$p_{(k)}$	$M-k+1$	$p_{(k)} \times (M-k+1)$	$p_{(k)}^*$
1	0.0035	4	0.014	0.014 ← $\max\{0.014\}$
2	0.0412	3	0.1236	0.1236
3	0.0497	2	0.0994	0.1236
4	0.0662	1	0.0662	0.1236

$\max\{0.014, 0.1236\}$

$\max\{0.014, 0.1236, 0.0994\}$

$\max\{0.014, 0.1236, 0.0994\}$

$\therefore$ $p_3^* = p_{(2)}^* = 0.1236$

Benjamini-Hochberg : $p^*_{(k)} = \min_{j \geq k} \left\{ \frac{M p_{(j)}}{j} \right\}$

$p_{(1)} = p_4 = 0.0035$, $p_{(2)} = p_3 = 0.0412$, $p_{(3)} = p_2 = 0.0497$, $p_{(4)} = p_1 = 0.0662$

k	$p_{(k)}$	$M p_{(k)} / k$	$p^*_{(k)}$	
1	0.0035	0.014	0.014	$\leftarrow \min\{0.014, 0.0824, 0.0663, 0.0662\}$
2	0.0412	0.0824	0.0662	$\leftarrow \min\{0.0824, 0.0663, 0.0662\}$
3	0.0497	0.0663	0.0662	$\leftarrow \min\{0.0663, 0.0662\}$
4	0.0662	0.0662	0.0662	$\leftarrow \min\{0.0662\}$

$\therefore p^*_3 = p^*_{(2)} = 0.0662$