1. In a study of the effectiveness of eye exercises in improving near-sightedness, $N$ matched pairs of children are assigned at random to treatment (an hour’s supervised exercise daily) or control (no special exercises). State for what values of $V_s$ you would reject the hypothesis of no treatment effect at the closest attainable significance level to .02 if (i) $N = 10$; (ii) $N = 13$; (iii) $N = 16$. Repeat the above for $\alpha = .05$, but with highest achievable level $\leq \alpha$.

2. In Example 3 in Ch. 3, the results on other sets of 10 rats each were

(i) After 10 days

<table>
<thead>
<tr>
<th>Tape</th>
<th>63</th>
<th>56</th>
<th>32</th>
<th>56</th>
<th>48</th>
<th>45</th>
<th>45</th>
<th>96</th>
<th>56</th>
<th>71</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suture</td>
<td>79</td>
<td>143</td>
<td>37</td>
<td>56</td>
<td>40</td>
<td>135</td>
<td>45</td>
<td>96</td>
<td>87</td>
<td>83</td>
</tr>
</tbody>
</table>

(ii) After 150 days

<table>
<thead>
<tr>
<th>Tape</th>
<th>2334</th>
<th>1228</th>
<th>1596</th>
<th>1798</th>
<th>622</th>
<th>1543</th>
<th>1389</th>
<th>1984</th>
<th>1571</th>
<th>1619</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suture</td>
<td>1862</td>
<td>1330</td>
<td>1596</td>
<td>1234</td>
<td>692</td>
<td>894</td>
<td>1190</td>
<td>1786</td>
<td>833</td>
<td>1167</td>
</tr>
</tbody>
</table>

Test the hypothesis of no difference (a) by a two-sided sign test; (b) by a two-sided Wilcoxon test. Try to understand why you can combine both data sets for a single test of Tape ~ Suture.

To make life easier I give you for cutting and pasting

```r
x1 <- c(63, 56, 32, 56, 48, 45, 45, 96, 56, 71)
y1 <- c(79, 143, 37, 56, 40, 135, 45, 96, 87, 83)
x2 <- c(2334, 1228, 1596, 1798, 622, 1543, 1389, 1984, 1571, 1619)
y2 <- c(1862, 1330, 1596, 1234, 692, 894, 1190, 1786, 833, 1167)
```

Use `wilcoxsign_test` and `SignedRank`, but no need to provide the plot from the latter.

3. Find a constant $c'$ such that the inequalities $V_s \geq c$ and $V_r \leq c'$ are equivalent. Since $V_s$ and $V_r$ have the same null distribution this also implies $P_H(V_s \geq c) = P_H(V_s \leq c')$. Relate $c'$ to $c$ and $N$.

4. Find a constant $c'$ such that $P_H(S_N \geq c) = P_H(S_N \leq c')$. Relate $c'$ to $c$ and $N$.

5. Using `qbinom`, `pbinom`, `qsignrank`, `psignrank` and what you learned from 3. and 4. above, write an R function

```r
critical <- function(N, alpha, alternative="greater", closest=F){…}
```

that for given $N$ and significance level $\alpha = \text{alpha}$ returns the two critical values and the corresponding achieved levels for the sign and the Wilcoxon signed rank tests. Here `alternative` should allow values "greater" and "less" for the two types of one-sided tests, and `closest` can be `T` or `F`. When `T` we want achieved critical values closest to $\alpha$, when `F` we want it closest to $\alpha$ but also $\leq \alpha$. Your output vector should name its components, in fact use
# some footwork to get simple output
# without unnecessary trailing zeros
out <- c(c(SN), c.Vs, round(c(a.SN, a.Vs), 4)) # a.SN, a.Vs = achieved alpha
names(out) <- c("SN.crit", "Vs.crit", "SN.alpha", "Vs.alpha")
out <- t(out)
dimnames(out)[[1]] <- "" # see result when you comment this out
out

Give your code and the results when using N=50, \( \alpha = .01 \) for the 4 combinations of alternative and closest.