1. Conduct the quadrat test for complete spatial randomness on the cells data set. Carry out the analysis using a 2×2 grid, a 3×3 grid, and a 4×4 grid. Is there evidence of regularity or clustering on one scale but not on the others? Use $\alpha = 0.05$, and carry out just 2-sided tests.

   Please summarize your results, including a table of counts for each of the grid sizes and data sets.

   The cells data set is included in the `spatstat` package:

   ```
   library(spatstat)
   data(cells)
   ```

   Sample code, which you'll need to modify:

   ```
   tmp <- quadratcount(cells, nx=2, ny=2 )
   tmp
   plot(tmp)
   quadrat.test(cells, nx=2, ny=2, alternative="two.sided")
   ```

2. Repeat problem 1 for the redwood seedlings / saplings data set.

   This data set is included in `spatstat`:

   ```
   library(spatstat)
   data(redwood)
   ```

3. Repeat problem 1 for the black pine seedlings data set.

   This data set is posted on Canvas as the file `black_pine_saplings.txt`.

4. Carry out a quadrat test for spatial randomness for each of the three data sets above, using a hexagonal grid with an appropriate grid size. Note the recommendations on page 172 of the lecture notes: At least 6 cells (or so) and an average of at least 5 events per cell. Use 2-sided tests and $\alpha = 0.05$. Summarize your results including a table of counts for each data set.

   You should exclude partial cells, which means you'll have to do some of the calculations yourself.

   Sample code, which you'll need to modify:

   ```
   plot(redwood)
   H <- hextess(redwood, s=2) # s = side length of hexagons
   plot(H)
   plot(quadratcount(redwood, tess=H))
   ```

5. How are the p-values related for the three alternatives of the quadrat test, `two.sided`, `regular` and `clustered`? Answer this question by carrying out tests with each of the alternatives for the cells data, using a 3×3 grid. Also, explain what the results of these three tests tell us about the cells data; when we look at the data, they look regular – is this reflected in the test results? If not, why not?

6. Project proposal.

   There are three basic possibilities for the type of project you select: An analysis of an existing spatial data set of your choosing, a study based on a peer-reviewed paper about a method for analyzing spatial data, or a simulation study.

   If you decide to work with an existing data set, then your project proposal should describe the primary research question (or questions) you are trying to answer, the data you'll be using to answer this question, and the statistical methodologies you expect to use to answer the question. You should also include an appropriate plot or plots of your data.

   If you decide to do a simulation study, for example trying to determine or explore the properties and characteristics of some novel procedure (or possibly an existing procedure for which we simply have a general description), you'll need to sketch an outline for your study and show me the data you'll use – or possibly a good description of how you'll simulate some appropriate data.

   If you decide to base your project on a published paper about a method for analyzing spatial data, you will need to apply the method to a data set; your project will need to go beyond a book-report.

   Your project proposal should be fairly brief, perhaps one page long (typeset), but it should also contain enough detail so that I can determine whether you're proposing to work on a suitable problem (not too simple, not too difficult).