Analysis of Ad-Hoc Communications Network

You have been asked to help with planning an ad-hoc communications network over a large rectangular region. Each individual tower can monitor a rectangular subsection of a specific width and height. The main problem is that none of the individual towers can provide coverage for the entire region of interest. Communications towers are unreliable and are put up independently and at random. You have no control over where or how big a tower's footprint is placed. Importantly, due to technical issues such as cross-talk, no individual rectangular subsection can have multiple towers providing coverage for it. That is, there can be no overlap between any pair of rectangular subsections provided by the two respective towers. In any case, the desire is to maximize the coverage area of any available communications tower.

The order of when the towers come online is important. Once a tower has acquired its rectangular section, no subsequent tower can overlap that section. You may assume the following for this problem:

- All rectangular sections have integer-based corners.
- All rectangular sections must be contained in the overall rectangular footprint.
- The height and width of each rectangular section is sampled from a uniform distribution.
- Positions of the windows are also determined by uniform random distribution.
- All footprints must be rectangles (not general polygons).
- When a new tower comes online, if its coverage rectangle intersects the pre-existing composite footprint, then that new tower's coverage is trimmed such that its maximum remaining coverage area is retained (see sequential diagram below).

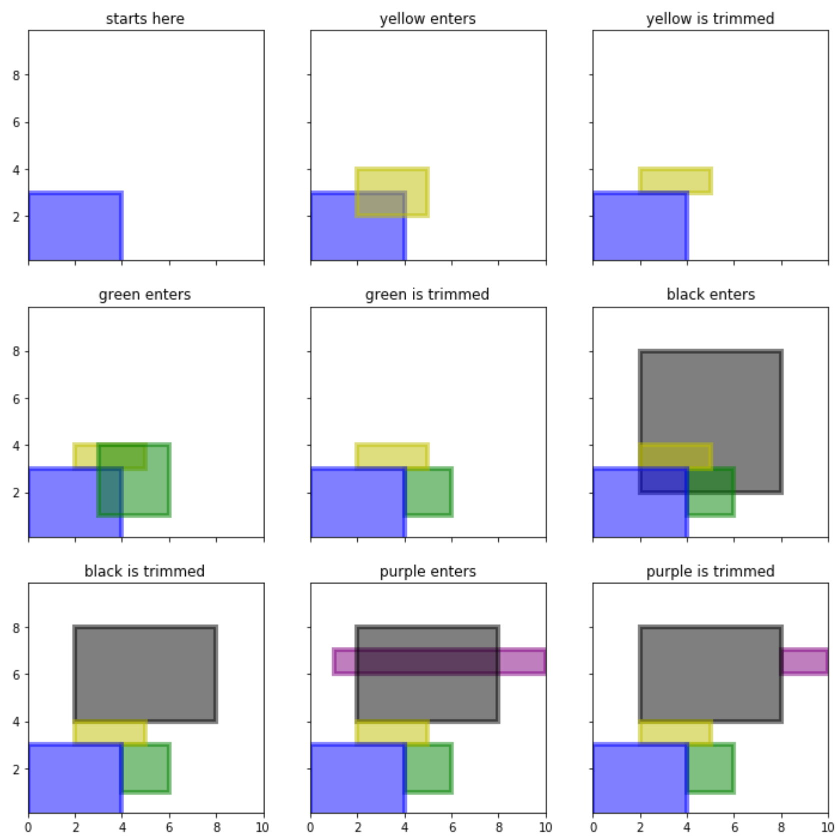
Write a detailed Jupyter notebook that implements a solution to this problem such that the user can supply the following overall size of desired coverage footprint and then determine the following:

- Given an overall desired coverage footprint and a sequence of n communications towers, what is the resulting resolved coverage?
- What is the total area of coverage relative to the desired total coverage area of the original footprint? That is, are there any gaps in coverage?
- On average, how many communications towers are required before full coverage is obtained?

This project is graded according to the following criteria:

Criteria	**Grade(%)**
Code quality (e.g., docstrings, modularization)	20
Effective use of Jupyter notebook for documentation and discussion of problem	20
Thoughtful discussion of problem, trade-offs, limitations details, and analysis.	20
Ability to provide reusable code that answers the three computational requirements above.	20
Effective use of static or dynamic visualizations to illustrate key insights of your solution.	20

The purpose of this project is for you to exercise your Python skills to understand and *think* through a detailed problem on your own. Python provides many tools that are excellent *lenses* for viewing a problem, but the focus of this project is for you to apply your analysis skills based on these views. The objective is **insight**, not code or numbers. The following figure should help.



<u>Submission instructions</u>

1. The deadline for the individual project is 3 weeks from the date of release. It is due on **05/22/2018 at 4 A.M.** This is a hard deadline, no extensions will be given out.
2. Please use a github repository to send in your submissions. Use a git tag to mark your final submission. The latest tagged version before the deadline would be considered as your final submission.
3. Your submission should consist of a one Jupyter notebook that can run out of the box, along with any associated helper files. It should contain all reproducible code, written using all the good practices suggested. You can either use modular or OOPs paradigm.
4. The notebook should be more than just a script. It should contain thoughtful discussions on the problem, trade-offs, limitations details, and analysis. It should also contain good visualizations and some examples of your results.