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Teaching With Jupyter In-Class Activities: Lessons Learned and Next Steps

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What is Jupyter Notebook?

- Interactive browser-based document that enables mixing *rich text* with *mathematical equations*, live *data visualizations*, and interactive *execution of code*.
- Popular with students and professionals alike from fields as diverse as Data Science, Sociology, Political Science, Physics, and Journalism.
- Supports more than 40 programming languages:

- The benefits of using notebooks include:
  - ✓ Interactivity.
  - ✓ Analytical reproducibility.
  - ✓ Collaboration.
  - ✓ Ease of access to computing resources.
- Used by dozens of major companies and part of curriculum at many universities.

Active Learning using Jupyter Notebook

In-Class Activities

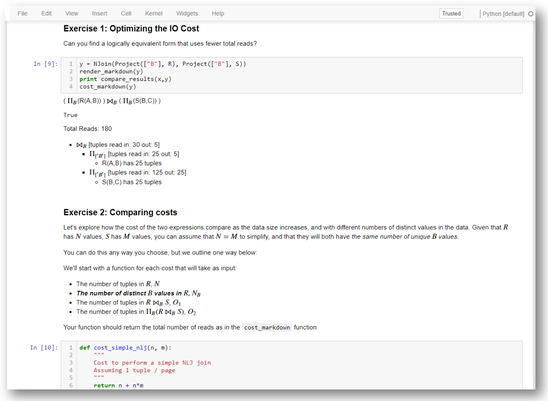
- Designed to aid presentation of theoretical concepts, helping students learn through practice.
- Plan to include 1-2 Activities per class.
- Beginning of notebook introduces topic and ties in with lecture.
- Description of concepts is intermingled with demonstrations and short practical exercises.
- Students work in groups and are given 5-10 minutes to complete exercises.
- Each exercise is followed with in-class discussion analyzing proposed solutions by students in the class.

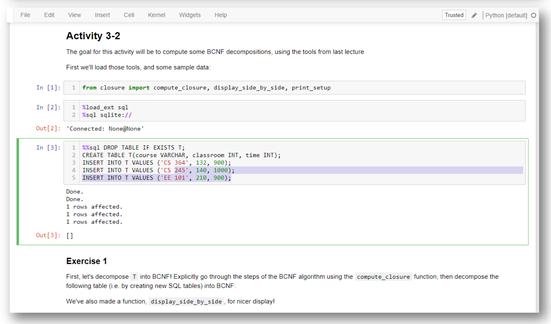
Take-Home Activities

- Some notebooks are assigned as homework assignments and provide additional opportunity for practice.
- Activities are not graded on correctness. Students are encouraged to work through activity problems.

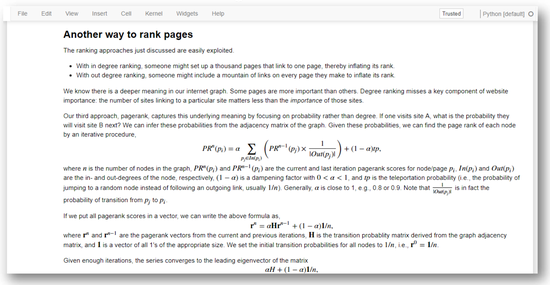
Example Jupyter Notebook Activities

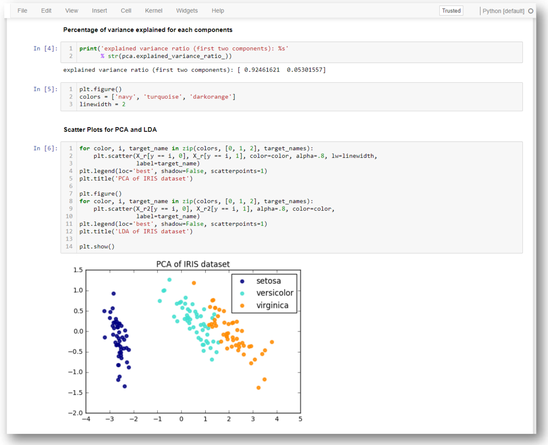
CMPE 139: Database Systems I





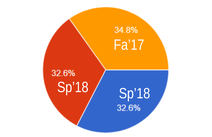
CMPE 255: Data Mining

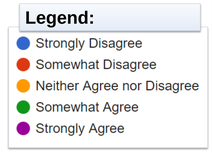


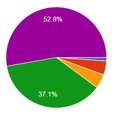


Lessons Learned from Student Feedback

- End of semester survey given to students in 3 sections of CMPE 255 (Data Mining), over 2 semesters.
- Likert-scale survey with 10 categorical and 4 open answer questions.
- Avoids response style bias by testing both positive and negative responses.
- Positive questions coded 1-5 and negative ones 5-1.
- 89 responses, evenly distributed between sections.

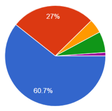


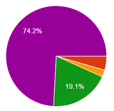




I understood material taught in class better because of the Jupyter Notebook activities

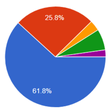
The Jupyter Notebook activities did not help clarify concepts in the lectures.

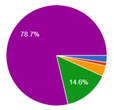




It was helpful to have rich text descriptions of problems and concepts in the same page I was coding in.

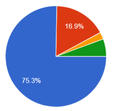
I found the ability to intersperse textual information with executable code in Jupyter Notebooks odd and useless.

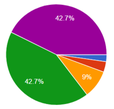




Once installed, I found the Jupyter notebooks easy to use and intuitive.

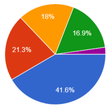
I found it difficult to execute programs in the Jupyter Notebook environment.





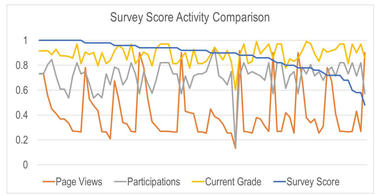
Activities had a good degree of difficulty that kept me engaged.

The activities were too difficult and I could not finish them even if I spent the whole class time on them.



- Results primarily positive: 94% over 3.5 and 78% over 4.0.
- Results not found to be correlated with student in-class activity (measured by Canvas page views and interactions) or current grade.

$$r_{views} = -0.069$$
$$r_{part} = -0.133$$
$$r_{grade} = -0.171$$



Open Answer Questions and Example Answers

What were the most useful features of the Jupyter Notebook activities? Why?

- *It helped us learn concepts better. Was a very good learning tool and very easy to use.*
- *[Executing] pieces of programs in real time [helps] break down complex material into understandable chunks.*
- *Concept followed by activity. Faster learning.*
- *It helped me understand the methods and algorithms mentioned in the slides in a practical way.*

What were the downsides of programming in Jupyter Notebooks? Why?

- *I can not recall any downside.*
- *Syntax highlighting or syntax help like in other editors.*

How, if at all, did you approach solving homework assignments for the class (or even other classes) in a different way after being exposed to Jupyter Notebook?

- *Running step by step programs to make sure each part works well.*
- *[Getting] into the habit of writing descriptions along with the program.*
- *I would dissect the problems into a set of small problems, implement each of them instead of trying to solve the big problem as a whole.*

What is one thing that could be improved in the use of Jupyter Notebook and/or in-class activities for this class?

- *Should be more in-class with a little more time.*
- *Have a complete solution posted after the in-class activities are due.*

Next Steps: Jupyter Hub, HPC, and JupyterLab

- Alleviate initial setup troubles + ensure identical setup.

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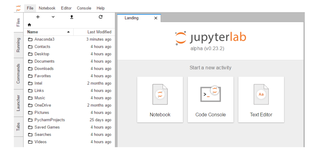

- *JupyterLab* will soon replace Jupyter Notebook.
- Continue to add and improve activities.

Acknowledgements and Links

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[1] Project Jupyter: https://jupyter.org
[2] Jupyter Lab: https://github.com/jupyterlab/jupyterlab
[3] Teaching with Jupyter (Google Group): https://groups.google.com/d/forum/jupyter-education
[4] JupyterHub for Teaching: http://jupyterhub-deploy-teaching.readthedocs.io