**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:
  - Python
  - Julia
  - MATLAB
  - R
  - LaTeX
  - Bash
  - SQL
  - JavaScript
  - MATLAB
  - Spat
  - SQL
  - Bash
  - Python
  - R
  - LaTeX
  - JavaScript
- 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.

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**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.

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**Example Jupyter Notebook Activities**

**CMPE 139: Database Systems I**
- Activity 4-2

**CMPE 255: Data Mining**
- Activity 3-2

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**Lessons Learned from Student Feedback**
- **CMPE 255: Data Mining**
  - 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.

- **CMPE 139: Database Systems I**
  - 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 it difficult to execute programs in the Jupyter Notebook environment.
  - The activities were too difficult and I could not finish them even if I spent the whole class time on them.

- **Results**
  - 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.

- **Legend:**
  - Strongly Agree
  - Somewhat Agree
  - Neither Agree nor Disagree
  - Somewhat Disagree
  - Strongly Disagree

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**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 smaller 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.**

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**Next Steps: Jupyter Hub, HPC, and JupyterLab**

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

**Acknowledgements and Links**

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