

Integrating Interactive Computing Experiences into Materials Science and Engineering Curricula Using Open-source Jupyter Authoring Tools

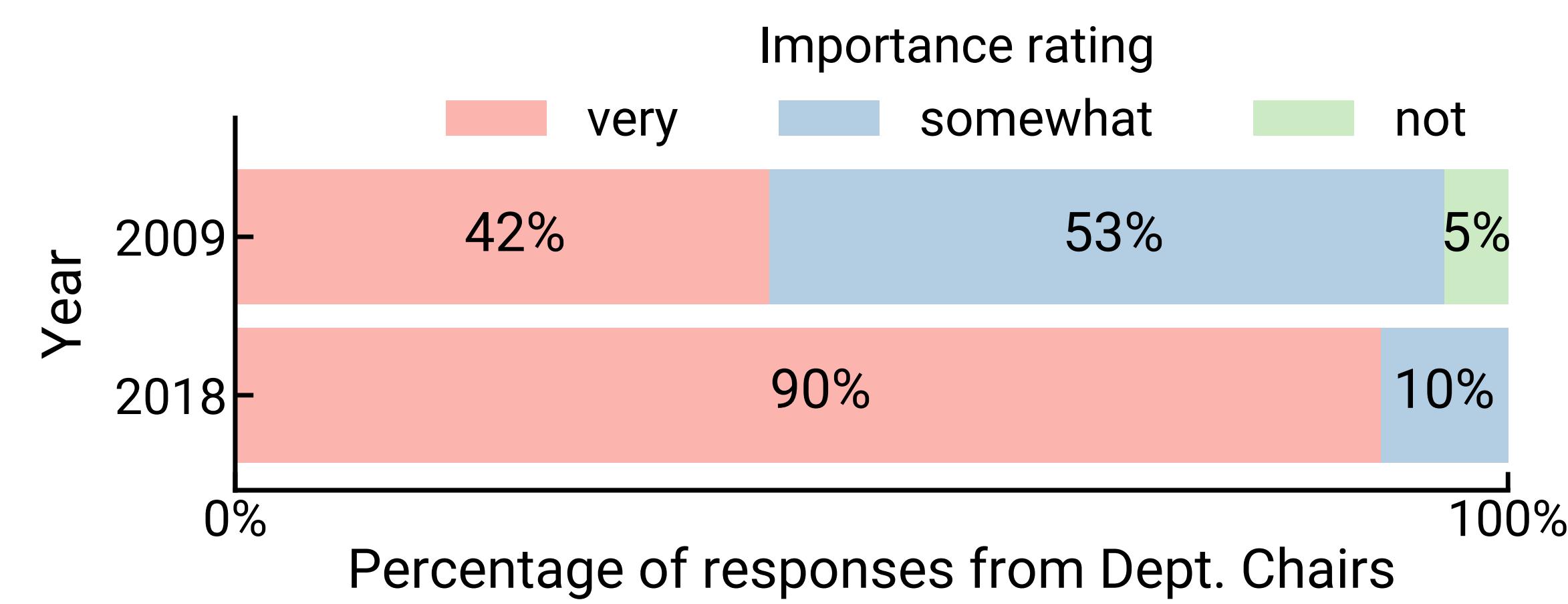


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Introduction and opportunities

Growth of computational MSE (CMSE) research heralds the growth of CMSE education, with broad alignment of vision from departments across the country.¹



Survey responses for Dept. Chairs to "How would you rate the importance of integrating CMSE into the required core curriculum?" Figure adapted from Enrique et al.¹

There exists an **urgent need for materials informatics (MI) education** and stronger data literacy in our next-generation workforce, yet institutional offerings are scarce (< 20%).²

How can we better develop curricula to promote data literacy in MSE?

Jupyter infrastructure

Jupyter notebook merges code, text, figures, and more into a *computational narrative*.³

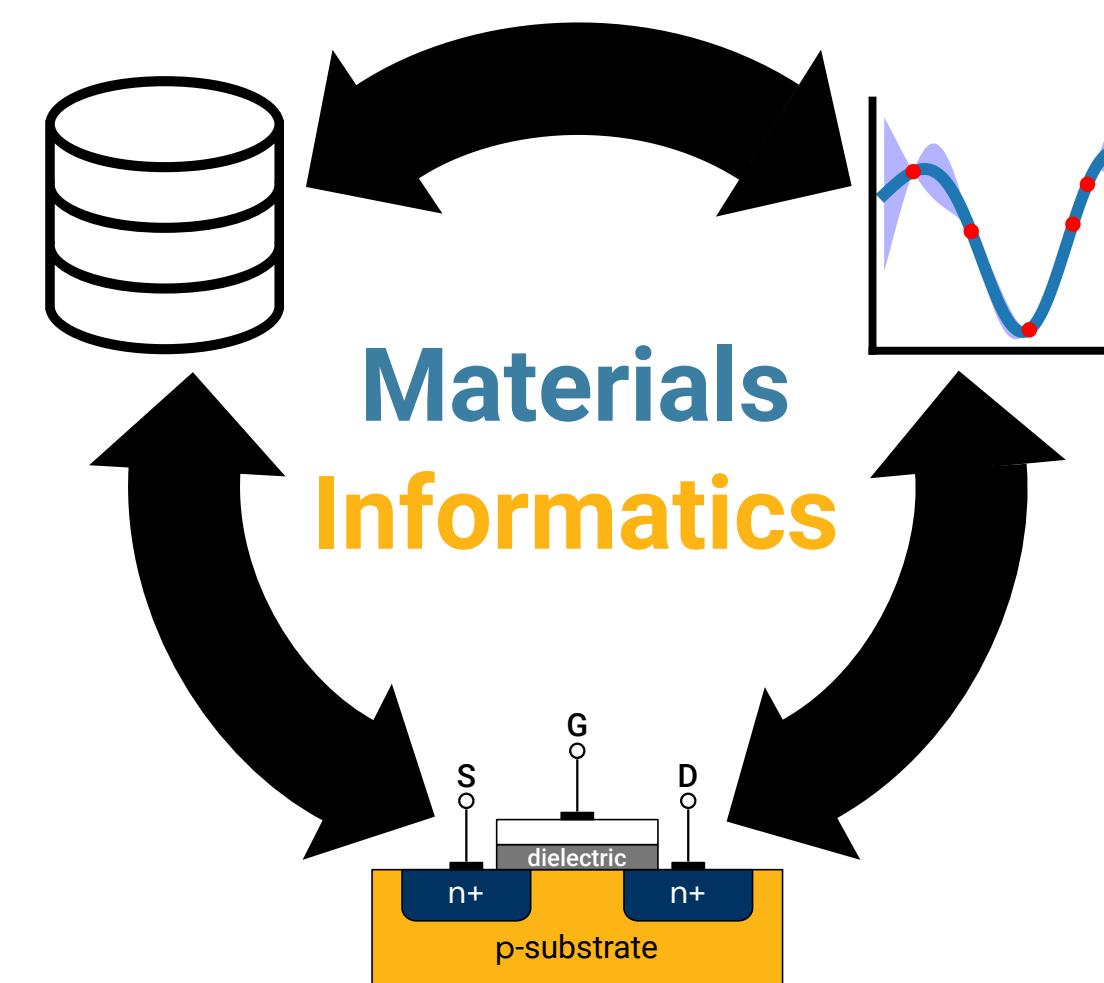
JupyterHub provides a *scalable, uniform environment* for interactive learning.⁴

Jupyter Book transforms Markdown text and Jupyter notebooks into *interactive digital textbooks* that are published open-source.⁵



Our MI curriculum

3-week summer research internship studying data-driven design of high- κ dielectrics using the Materials Project.⁶



1 week of tutorials on Python, MI, electronic properties, scientific communication; followed by 2 weeks of self-directed research.

Vignettes of the learning experience

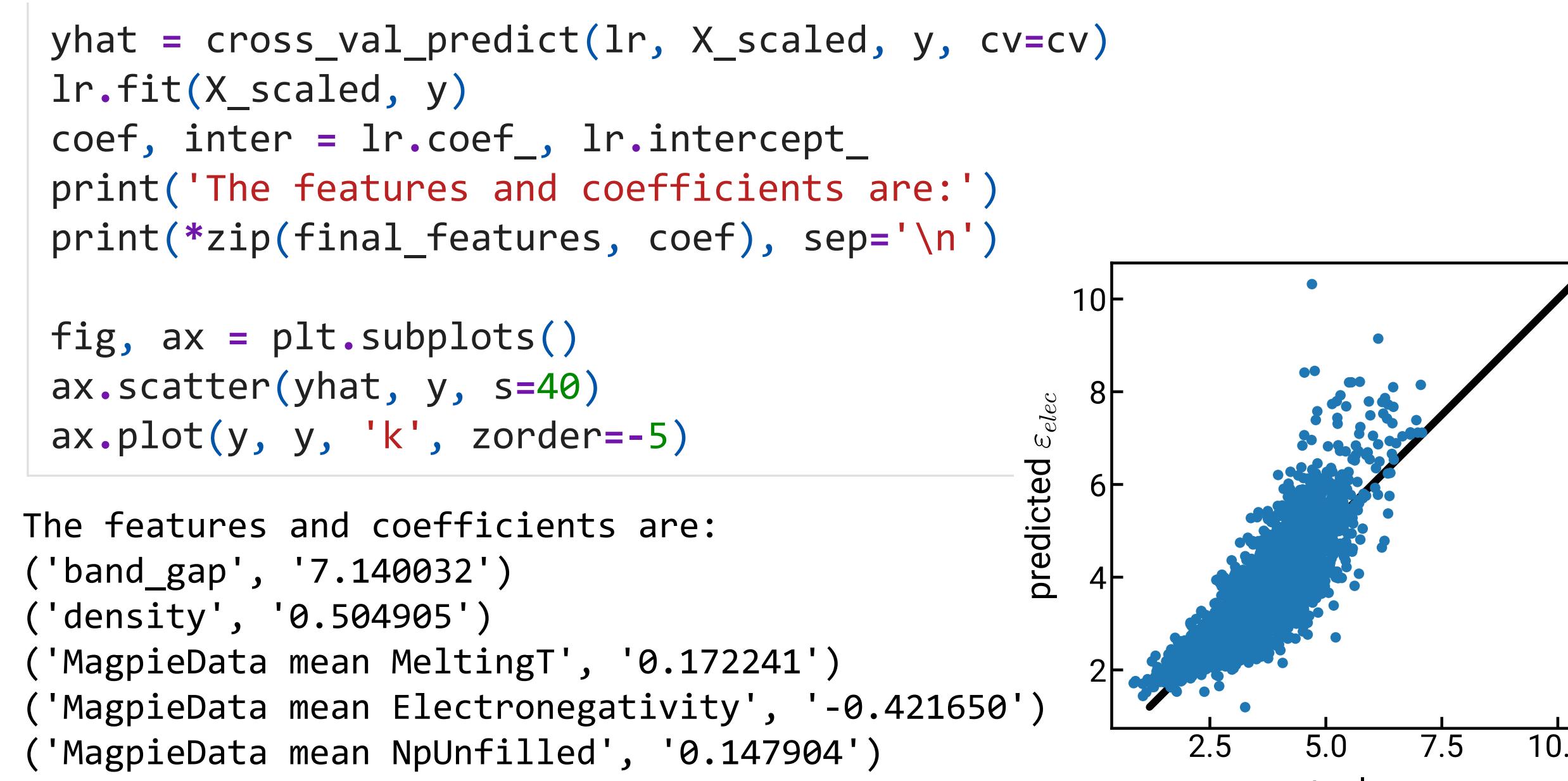
Course materials are designed and published using Jupyter Book. Check it out!

<https://enze-chen.github.io/mi-book>

The screenshot displays the Jupyter Book interface. It shows a sidebar with chapters like 'Introduction to Materials Informatics', 'Week 1', and 'Week 2'. The main content area shows a 'Making requests for data' section with code snippets for importing requests and interacting with the Materials Project API. Annotations highlight features such as 'Launches interactivity (JupyterHub, Colab, etc.)', 'Auto-generated page navigation', 'Powerful Markdown capabilities (e.g., MyST) enable rich content to be easily designed', 'Highly customizable Table of Contents', and 'Jupyter code cells can run when published; output is cached'.

Ask to see a demo!

Students leverage open-source, industry-standard tools to solve problems and learn data science in context, allowing them to **integrate their MSE domain knowledge**.



Student feedback (emphasis ours)

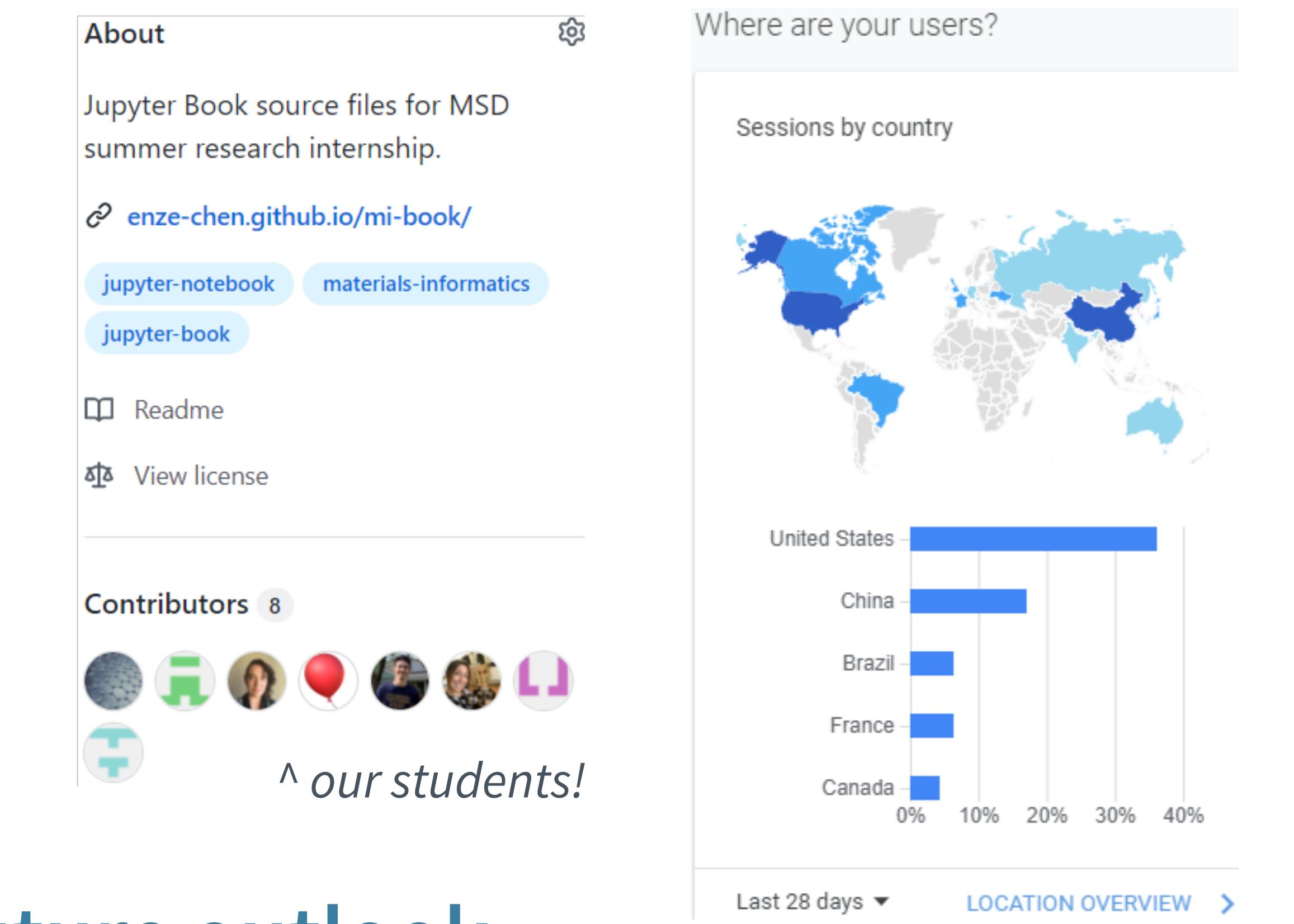
"Jupyter Book is fantastic! I appreciate the *user friendliness* and having your information (and code!) in a centralized location."

"I really enjoyed how well organized everything was. Very helpful and fun interactive model!"

"This module truly helped me to see the beauty (and fun!) in research!"

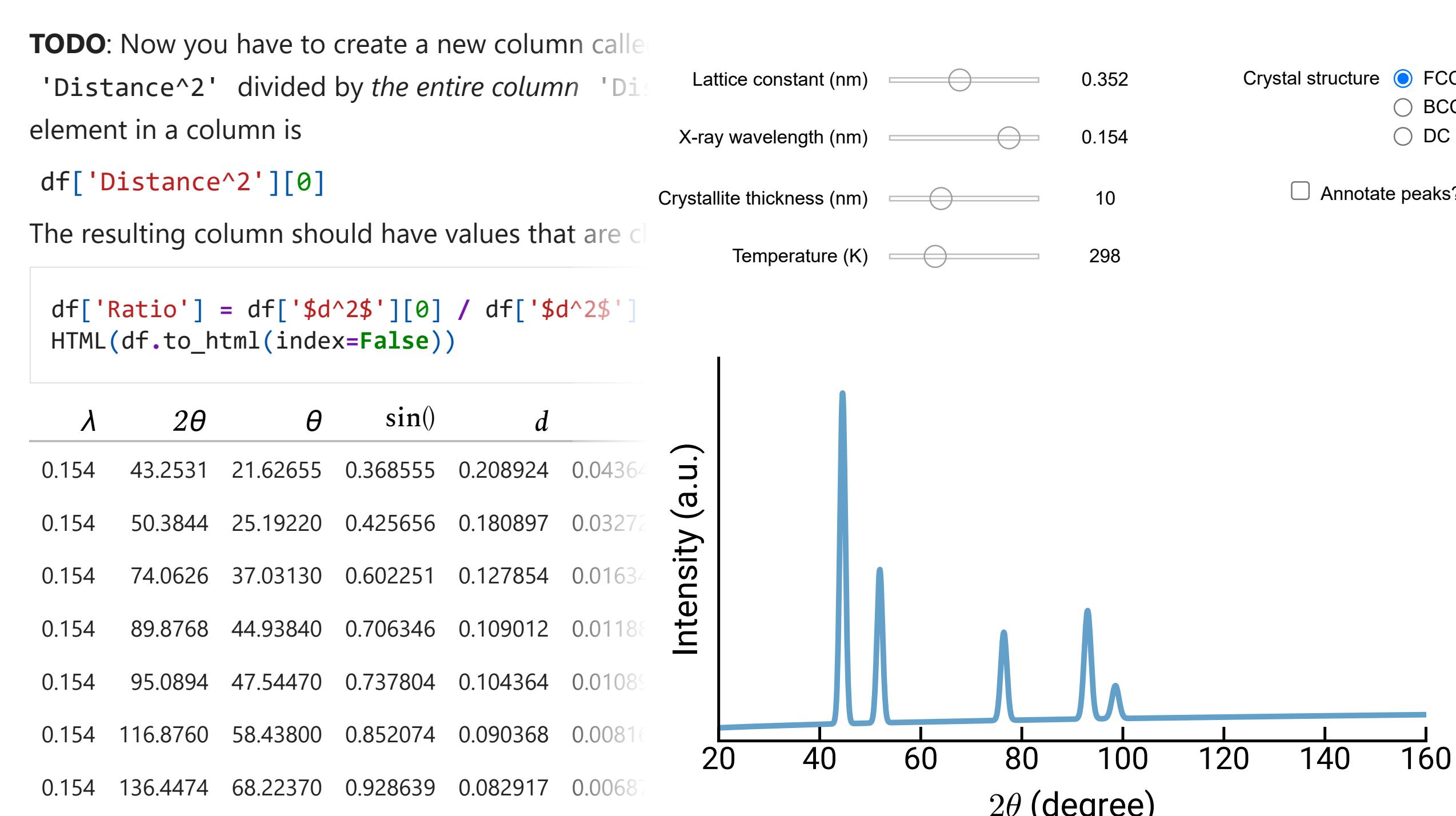
Learning at scale

Increased **accessibility and scalability** of CMSE education to reach diverse populations.



Future outlook

Similar modules can **enrich existing curricula** such as materials characterization.



What new narratives can we craft using digital, open-source tools?

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- 4 JupyterHub, <https://jupyter.org/hub>.
- 5 Jupyter Book, <https://jupyterbook.org/>.
- 6 A. Jain et al. *APL Materials*, 1, 2013.