

MATERIALS SCIENCE & ENGINEERING

WITH PROFESSOR DANE MORGAN
AND DR RYAN JACOBS

Talking points

KNOWLEDGE

1. What is machine learning?
2. What are the main uses of materials science and engineering (MS&E) in society?

COMPREHENSION

3. How is MS&E benefiting from increased computational power and access?
4. Why is natural language processing needed for analysing existing scientific papers, rather than just numerical data analysis?

APPLICATION

5. Based on Dane and Ryan's article, what skills would be valuable for the next generation of MS&E researchers? How are these different from current desirable skills, or skills needed 50 years ago?

ANALYSIS

6. Can you think of any potential drawbacks or caveats of autonomous laboratories?
7. Why do you think so many algorithms are open-source, rather than resources that researchers have to pay for?

EVALUATION

8. Some people are concerned that the rise in automation throughout society will lead to fewer available jobs for people. Do you think this concern is applicable in a MS&E context? Why or why not?
9. Many institutions believe that AI and ML could pose serious risks to the future of humanity. Why do you think this is? Do you think the types of ML discussed in the article could pose such a risk? To what extent do you believe the benefits outweigh these risks?

Activity

As Dane and Ryan highlight, ML is revolutionising every type of science. Use the internet to find an interesting example of how ML is being used in each of the following fields:

- MS&E (different examples to those in the article)
- Biomedicine
- Climate science
- Astronomy
- Neurology
- Agriculture

If you are having trouble finding accessible resources, the 'News' tab on search engines like Google might help you – this directs you to press releases and online articles typically designed to be more understandable to non-scientists.

Use these examples to construct a slideshow presentation that begins with an overview of what ML is, before exploring your chosen examples and concluding with what ML means for society at large. Make it engaging, exciting and inspiring! Think about:

- What are your key messages?
- How can you make your slides visually appealing?
- How will you explain your slides in an accessible way?

Present to your classmates, and watch theirs too. Collect any feedback they may have.

- What interesting examples have they come across?
- Have they reached different conclusions?
- To what extent has this research encouraged you and your peers to pursue ML further? Can you see yourself working with ML in the future and, if so, in which field and why?

More resources

- Python is the most common programming language used for scientific computing. There are many resources available online to teach you how to use it – find Python's own here:

www.python.org/about/gettingstarted

- For those familiar with Python, Ryan and Dane developed an open-source Python package called the Materials Simulation Toolkit for Machine Learning, which aims to simplify ML analysis found in MS&E research: github.com/uw-cmg/MAST-ML

- The Informatics Skunkworks group is helping the next generation of scientists gain the skills needed to effectively use ML within their field, by undertaking practical projects with real-world utility. The results of the students have been significant, with some going on to publish peer-reviewed scientific papers. Find out about their projects here: skunkworks.engr.wisc.edu/projects

- There are many educational videos available on YouTube about MS&E and ML, which Ryan recommends exploring to see if the subject interests you. This series of lectures gives an introduction to materials science: www.youtube.com/watch?v=z0zfJHLGJBc&list=PLLOSWeFqypCm4xCn64xO7RS62PPzy-oP8