Particle Physics and Machine Learning in Education

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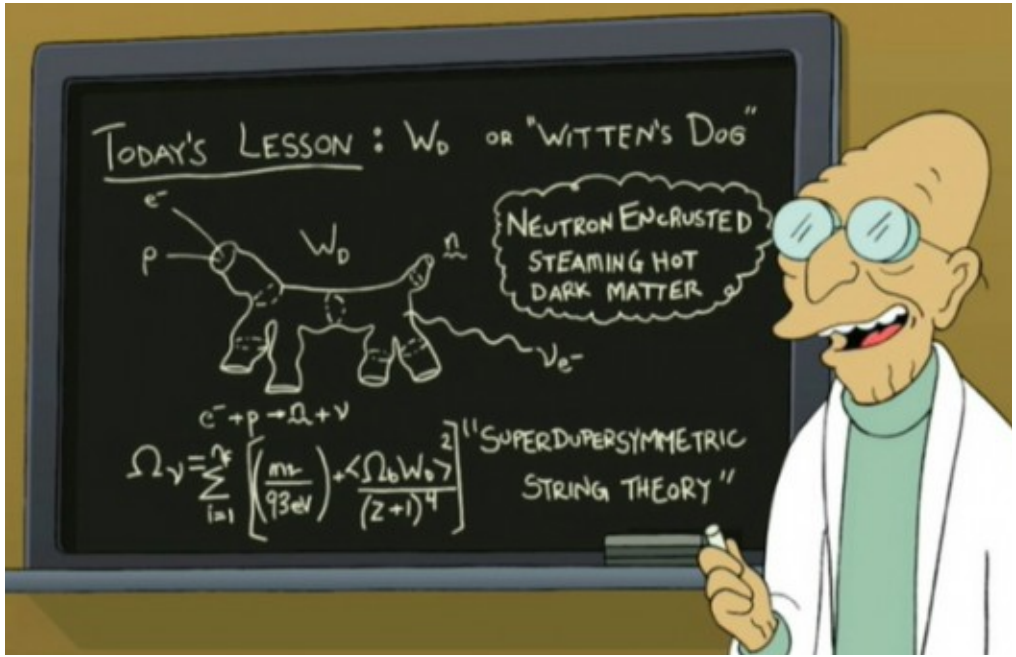
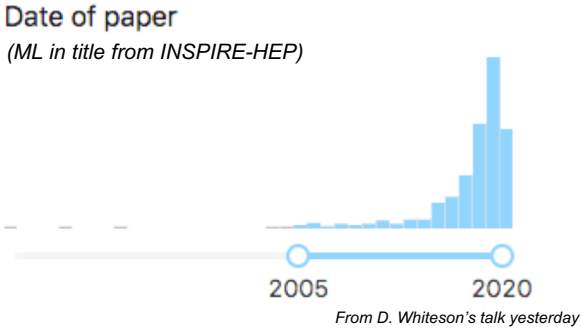
Particle Physics in Education

- Particle physics holds a prominent role within academic curriculum
  - ”Fundamental” physics
  - Historical development is interesting and compelling
  - Theory applies & develops advanced mathematics
  - Powerful applications and spin-off technologies



Rise of the Machines…

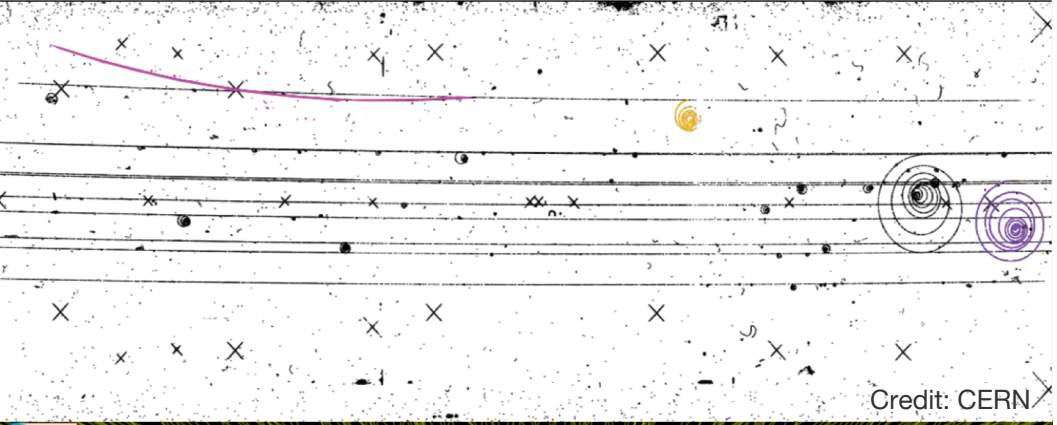
- ML has an increasingly prominent role within particle physics

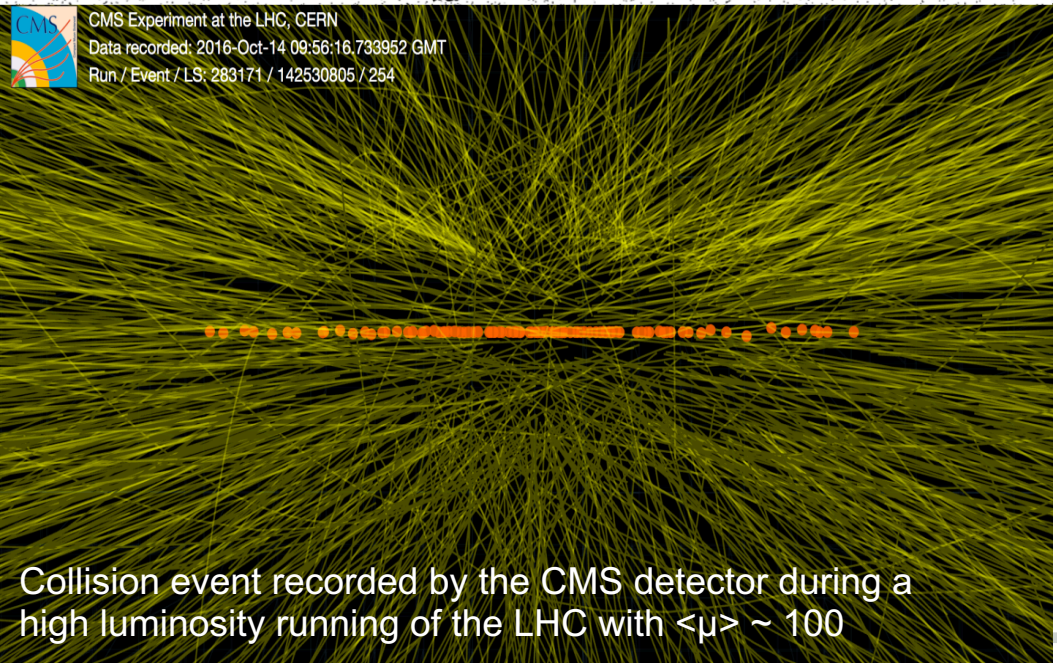


From D. Whiteson's talk yesterday

and of the Physicists (in ML)…

- Physicists are increasingly collaborating with CS and industry partners to develop physics-driven ML approaches





Collision event recorded by the CMS detector during a high luminosity running of the LHC with <μ> ~ 100

Bender: *Come on, Fry. I really wanna see it [the year 2000]. You know how I yearn for a simpler time... a time of barn dances and buggy rides before life was cheapened by heartless, high-tech machines.*

Leela: *But, Bender, you are a—*
Bender: *[dismissive] blah blah blah blah …*

We've come a long way!

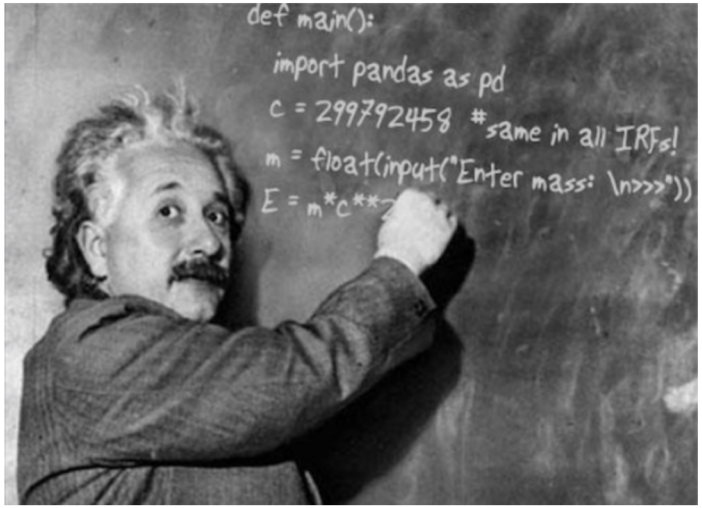
ML in Physics Education: Opportunites

- Physics departments are increasingly offering curricula to their (under)graduate students at the intersection of physics, data science and ML
- These courses provide opportunities for particle physicists to
  - Describe synergies between ML and particle physics research
  - Make connections with colleagues from other departments and those in your department in other research domains
  - Recruit students interested in ML ∩ particle physics
  - Learn ML ;)

My Experience

- I developed a new course in our Department titled "Data Analysis and Machine Learning Applications for Physicists"
  - Taught it Spring 2018 & Fall 2019
  - Teaching in Spring 2021
  - Developing a grad-level version

HEP postdoc Matthew Feickert and HEP grad student Dewen Zhong helped develop the course



ML in Physics Education: Challenges

- Not trying to do too much
  - Stick to our strengths of analysis and interpretation of large scientific data sets and physics-inspired AI
  - Leave the foundational AI pedagogy to the CS courses
- Open Data for education
  - Projects based on ML applications to physics data are a strength of these courses → A curated set of data for education is critical
  - Role of Snowmass study data sets for education?
- ML for education, outreach and engagement is an integral part of Snowmass
  - Would be great to curate a list of courses → feel free to reach out