Vanderbilt-QuarkNet Coding Workshop

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Taken from the 2-day template Virtual Coding Workshop by QuarkNet staff. Special thanks to Adam Lamee who also has his CodingK12 organization. This version edited by Bill Gabella, Ken Cecire, and others for the Vanderbilt-QuarkNet 2021 in-person coding workshop with some CMS activities mixed in.

Objectives

Participating teachers will:

- Apply physics principles to reduce or explain the observations in data investigations.
- Examine simulated and experimental data. Identify patterns within the data and consider causes of those patterns.
- Create, organize and interpret data plots; make claims based on evidence and provide explanations; identify data limitations.

- Develop a plan for taking students from their current level of data use to subsequent levels using activities and/or ideas from the workshop.

CMS Coding Workshop

Pre-workshop (before Wed 23 Jun)

Homework:

- Workshop registration
- Video: Pair programming how-to (YouTube) (Amara w/Sp subtitles)
- Video: What Most Schools Don't Teach
- Video: An Introduction to the CMS Experiment at CERN

Wed 23 June

9:00 Kick-off

- Welcome & introductions
- Create/login to Google account
    - (preferred) Google Colaboratory for Python/Jupyter notebooks https://colab.research.google.com
    - (alternative) Conda/Anaconda3 install on your own computer https://www.anaconda.com/products/individual

9:30 Working together

- Norms, APS STEP UP poster & Fermilab norms poster
- A look at the Data Activities Portfolio
- Must do by Friday lunch
    - Update your profile on quarknet.org
    - If you completed a 2019 or 2020 teacher survey, fill out the survey update
    - If you have not, fill out the full survey

10:15 Coding activities

- Introduction to Jupyter
    - Skills: run, edit, & save a notebook
- Probability

    - Task: Simulate flipping a coin and make a histogram of the number of heads for each trial.
    - Skills: generate random numbers, create and format a histogram

11:15 All hands meeting

- Share observations, challenges
- How do you think your students would handle these tasks?

12:00 Break

- Lunch
- Create/update your Quarknet.org account

13:30 More coding activities

- Position graphs
    - Task: analyze Position graphs
    - Skills: modify a loop, define a function, format a plot, add a grid
- Velocity graphs
    - Task: Analyze Velocity graphs
    - Skills: modify a loop, define a function, format a plot
- Projectile in Air
    - Task: Model the motion of a projectile in air
    - Skills: modify a loop, define a function, format a plot
- Analysis of a neutral particle in CMS
    - Basic skills
    - Analyze daughter particles

15:30 All hands meeting

- Share observations, challenges
- How do you think your students would handle these tasks?

Thurs 24 June

9:00 Welcome back

- Recap from yesterday
- What stood out? Any new thoughts?

9:30 CMS Data Analysis

- Analysis of a neutral particle in CMS (continued)
- Find muon energy and momentum spectra

- Make invariant mass plot

10:30 Change from student hat → teacher hat!

- NSTA Position Statements are great. Adam mentioned the one on professional development.
- Where might these (or your own) coding activities fit into your course?
- Develop a lesson using Colab notebooks.
    - See Adam's CODINGinK12.org site and the UCI Machine Learning repository for data sets

12:00 Break

- Lunch
- Get help on coding issues
- Finish your coding activity

13:30 Try out different datasets from CMS and CERN Open Data

- Luminosity, http://opendata.cern.ch/record/1054/files/2012lumibyls_pxl.csv (info)
- 100K dimuon events, http://opendata.cern.ch/record/700/files/MuRun2010B.csv (info)
- 100K dielectron events, http://opendata.cern.ch/record/304/files/dielectron.csv (info)
- Z → mumu, http://opendata.cern.ch/record/5208/files/Zmumu.csv (info)
- Upsilon → mumu, http://opendata.cern.ch/record/5206/files/Ymumu.csv (info)
- Find something else: http://opendata.cern.ch/

15:00 Share out

- Teachers take turns (5 min each) sharing a link to your notebook or activity while the group tests it out.

15:30 All hands meeting

- Share observations, challenges
- Closing thoughts? Where to next?

Miscellaneous Links

Cheat Sheets

Google "Python Cheat Sheet" and maybe a topic

- Basics, an example (there are lots) https://intellipaat.com/blog/tutorial/python-tutorial/python-cheat-sheet-basics/
- Notebook Markdown https://sqlbak.com/blog/jupyter-notebook-markdown-cheatsheet
- Function to run on a Pandas DataFrame (like getting columns names or seeing unique values) and some Pandas statistical functions
- Some Numpy functions
- Some Pyplot functions
- Matplotlib cheat sheets
- GitHub 2021