Integrating Computation into STEM Curriculum

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Computation is increasingly important in all STEM fields, especially math, physics, and engineering

- Computation is now ubiquitous in many fields
- Computational thinking provides a different way of approaching the subject, leading to new insights and deeper understanding
- Computational methods allow one to solve a much wider range of problems
- Computational skills are valuable for a wide variety of careers in and outside your field
- Many professional societies (AAPT, NCTM, AMTE, and others) have made official statements and reports promoting the integration of computation into education in their field

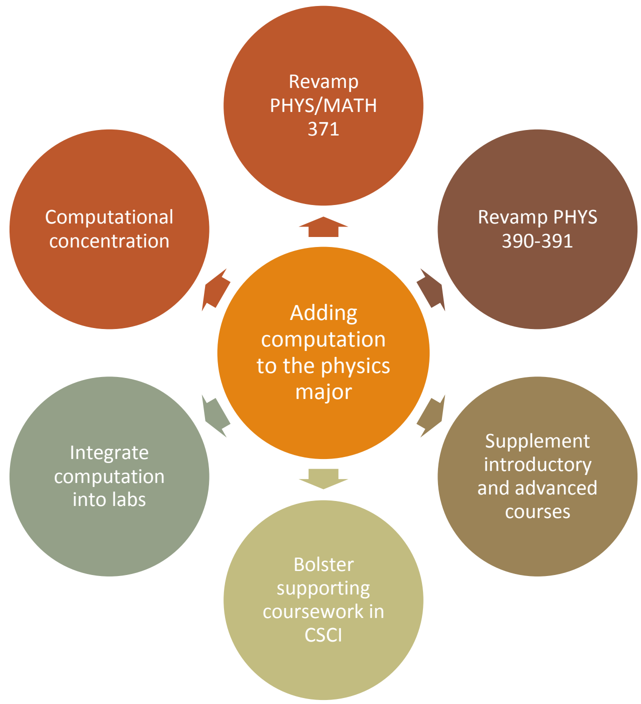
Important skills include

- Fundamental computer skills
  - operating systems
  - file systems
  - coding
  - using computational tools
- Technical computing skills
  - process data
  - visualize data
- Computational skills
  - translate models or algorithms into code
  - write/test/debug code
  - divide problem into manageable computational tasks
  - make meaning of results

Important tools include

- General-purpose programming languages like Python and C++
- Specific packages for these languages like SciPy, Jupyter, and matplotlib (for the Python ecosystem)
- Integrated mathematical computing environments like Mathematica, Maple, and MATLAB
- Spreadsheets like Excel

Physics at TLU is in the process of making a comprehensive update to the major to include computational elements according to best practices



- Revamp PHYS/MATH 371 Mathematical Methods for Scientists and Engineers to include use of computer algebra systems for symbolic calculations
- Revamp the dedicated computational course PHYS 390 Applied Computational Physics I to focus on computational modeling, important computational methods, and algorithms
- Revamp the dedicated computational course PHYS 391 Applied Computational Physics II as a project-based course to focus on practical tools and skills important in industry
- Supplement all existing courses where appropriate
  - Best practices indicate that development of computational skills should be integrated into the curriculum, rather than taught as isolated skills.

Sensible opportunities for including computational elements into your courses

- ____
- ____
- ____

Recommendations include

- Considering available tools and standardizing on a limited set sufficient for your needs
- Being strategic about where to add new material to curriculum or where to augment existing material
- Providing scaffolding to help students acclimate to computational ideas and tools, which are likely to be unfamiliar environments

References

- *AAPT Recommendations for Computational Physics in the Undergraduate Physics Curriculum*. AAPT Undergraduate Curriculum Task Force. October 2016. https://aapt.org/Resources/upload/AAPT_UCTF_CompPhysReport_final_B.pdf