Lecture Calculus with CalcLib API Lab … Teach ALL to Code!

Everett George (12-Sep-24) **card §1**

CalcLib API (Application Programming Interface) is a collection of **C/C++** mathematical calculation class templates used in numerical analyses (ref **[1]**). Colleges can / do teach lecture Calculus with lab Numerical Analyses using ref **[1]**. The API w / CalcLib.zip using Doxgen can aid the student. Documented examples will demonstrate:

- **Calc::Cheb** complex Chebyshev curve-fits with integration / differentiation**.**
- **Calc::Intg** integration of test function by 3 methods, for complex number solutions
- **Calc::Mtx** least squares test polynomial, for complex number solutions.
- **Calc::Ode** 3-axis Runge-Kutta application for Special Relativity (ex: odeSRel.zip).
- **Calc::NIntp** N-Dimensional Monte-Carlo simulations for IR sensor evaluations.

C/C++ template support of Partial Differential Equations (ref **[2]**) is discussed later.

References:

[1] Press, WH, et al, *Numerical Recipes*, 3rd Ed, Cambridge Press, 2007.

[2] Darian, HM, *Investigation of C++ Variadic Templates for Numerical Methods & Finite Difference Schemes*; SIAM, 2022.

Computer Modeling with JavaDoc, Teach ALL to Code Well!

Everett George (12-Sep-24) **card §2**

Document Generators were originally developed to support JavaDoc of Application Programming Interface (API) info in Java programming (1995). This format is being adapted to support common code documentation & applied across several programming languages through software like Doxygen & JSDoc.

CalcLib API documentation shows traditional API support of a Numerical Analysis Library. Numerical Analysis is a primary tool in STEM Modeling. Two examples are given in JavaScript documentation of E-Field & B-Field plot source code.

Variable Naming Conventions should also be developed for STEM Modeling. Different name types include:

is_Query (Boolean)

flatcase	snake_case	SCREAMING_CASE
PascalCase	camelCase	UPPERCASE

STEM Degrees Should Implement Structured Study Groups

Everett George (12-Sep-24) **card §3**

STEM projects are a collaboration of many people. Undergrad STEM education should emphasize after-class study groups. A general rule is 3:1 study to lecture hours. Monetary costs of STEM grads require that they are trained for the office setting.

Differences: Study groups allow tutoring to equalize disparate US schooling. Study groups should be chosen random or self-selected to reflect different office groups.

Teach & Learn: Let each study group member teach & be taught by other members. Design an overload of homework to rely on student-to-student teaching.

Evaluate: Let each group member evaluate other members to highlight areas of student improvements.

Weed Out: STEM degrees are a “weed out” process. If one does not like working with other diverse technical people, reveal that in the training process.

Share Knowledge: Swap results with other schools, modify study groups as needed, get feedback. Study Group training sets campus above online degrees.

Enhanced College Advisors for STEM Students

Everett George (12-Sep-24) **card §4**

STEM degrees can have an assembly-line approach w/large lecture halls full of students & teaching assistants grading their work. Mandatory prof advisor sessions per semester should be implemented for any campus STEM education.

Degree Markers: Advisors should know extra-curricular indicators for their field implemented through student hobbies. On-Campus student hobby groups should be funded & supported by colleges, with applicable students encouraged to attend.

Realistic Evaluation: Advisors should indicate alternate majors for students when applicable. Possibly, students w/no hobbies but good in Math should be Math majors.

Improved Social Skills: Nerds deemed to have poor social skills can work on improvement. Intramural team sports or hobby groups may be suggested.

Alumni Feedback: Colleges should maintain lifetime contact w/alumni; get feedback; bring the Statistics Department of STEM schools to evaluate successes of each degree. Advisors can update students w/real time job market trends.

Divestment of PDE Research into College Super Laptops

Everett George (12-Sep-24) **card §5**

Summary: Divest some R&D center modeling research of Partial Differential Equations (PDE's) using supercomputers into university labs using super laptops. Apply low-cost laptops to non-traditional PDE applications.

Super Laptop: Lenovo 2023 ThinkPad P16, £3.2k ($4k), 128GB RAM, 2TB SSD, Intel Core I9-12950HX 16-Core 5 GHz, Win 11 Pro (typical)

RAM Grid Capacity: typical 400 by 400 by 400 3D grid = 64M grid cells. 128,000M bytes/64M cells = 2 KB per grid cell = 125 double float value per cell @ 16 bytes/value.

Documented PDE Applications:

[1] Baumgarte, Thomas W, et al, *Numerical Relativity: Solving Einstein's Equations on the Computer,* Illustrated Ed, Cambridge University Press, 2010.

[2] Coiffier, Jean, et al, *Fundamentals of Numerical Weather Prediction*, Reprint Ed, Cambridge University Press, 2012.

Divestment of NASA - esa Research into Super Laptops

Everett George (12-Sep-24) **card §6**

Recurring Mantra: As laptop computers increase in computing power, super-computer knowledge that NASA / esa have gained across decades can be tailored to low-capital computing on laptops. ***Divestment*** should be the mantra of NASA - esa going forward. Less established colleges can then participate in high-level Astronomy & Cosmology. Cross-applications can also be generated since Partial Differential Equations (PDE's) occur in many terrestrial applications.

New Funding: NASA - esa funding should @ a minimum increase with inflation & possibly increase beyond inflation to support ***Divestment*** & new supercomputer applications. Limitations exist since supercomputers boast +10k parallel processors & the new laptops can muster only +10 parallel threads. Nevertheless, PDE knowledge is another example of NASA - esa research applied through enhanced laptops in multi-cultural democracies throughout their military & non-military sectors.

Zoom in: This graphic reminder lists more NASA spinoffs we are thankful for!

Cultural Diversity in STEM

(Click a Flag to ID)

Everett George (12-Sep-24) **card §7**

English written anywhere is virtually identical on the printed page! Survey educational text & reference books of STEM from the English speaking countries & apply the best that cultural diversity has to offer. The following anecdotal points demonstrate international scientific collaboration in a common language.

Point #1: At the end of this article is a proposed bitmapped firing zone format for naval weapons. The article also mentions that weapon zones are normally checked before use. However, a means to check bitmapped zones was still a hurdle to their implementation.

The British read the article, identified a solution & relayed it back to US naval weapon designers**.**

Point #2: Three decades ago, I submitted an article for publication discussing software integration of Special Relativity (SR) equations of motion. The article was rejected by the 3 referees because my work was a typical application of Runge-Kutta, in part. The rejected publication draft along with my SR vector equations were placed on the web; **NASA** recognized nothing significant, either.

Recently, I passed my SR work to **IOP** members in the UK knowledgeable of both SR & General Relativity (GR). From this, they proposed visualization software from the perspective of a Star Trek spaceship underway through "warp drive" GR technology. They knew the Hollywood personnel to secure a grant from. I am grateful my basic SR work sparked follow-on research & my ideas did not have to be re-discovered!