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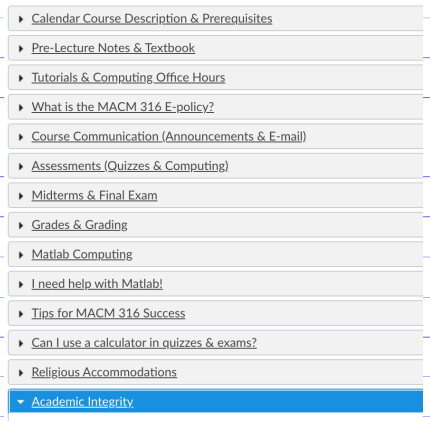
A) WELCOME TO MACM 316

- CANVAS information → see FAQ for MACM 316



- MACM 316 COURSE STRUCTURE

TUTORIALS	LECTURES + TEXTBOOK	COMPUTING. WORKSHOPS
problems + QUIZZES	computing + REPORTS	
MIDTERMS + EXAMS		

- MACM 316 is the mathematics of the + of the

- QUIZ: next FRI 11 JAN on basic math

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- Matlab is the computing environment
  - Matlab WARM-UP: due MON 14 JAN
- see lectures + assessments pages for updates

B) WHAT IS NUMERICAL COMPUTING?

- with numerical values
  - operations { , , , , ... }
- Trefethen's Maxims

> 9. The fundamental law of computer science: As machines become more powerful, the efficiency of algorithms grows more important, not less.
>
> 14. Most problems of continuous mathematics cannot be solved by finite algorithms.
>
> 16. If rounding errors vanished, 95% of numerical analysis would remain.
>
> 17. Just because there's an exact formula doesn't mean it's necessarily a good idea to use it.
>
> 21. The purpose of computing is insight, not pictures (or numbers).
>
> 31. Computational mathematics is mainly based on two ideas: Taylor series, and linear algebra.

- - truncations of real numbers ( )
  - integers have exact representations (& does 1/2 = .1 =)
  - but $\pi = 3.14159\ldots$ has no finite digital representation
  - standard NUMERICAL PRECISION: 16 decimal digits

- arithmetic → computer rules for the arithmetic of finite-prec numbers
  - computations with $\sqrt{\ }$ are truncated to finite-prec

Decimal approximation: More digits

1.41421356237309504880168872420969807856967187537694807317 6...

Input interpretation:

simplify $\frac{1}{1+\sqrt{2}}$

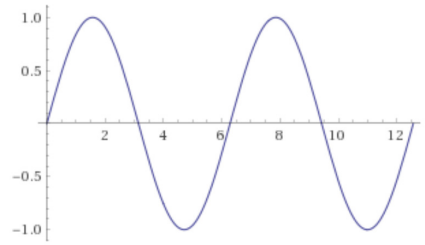
Result: $\sqrt{2}-1$ symbolic answer.

- arise from the need to approximate functions

Input interpretation:

plot $\sin(x)$ $x = 0$ to 4π

Plot:

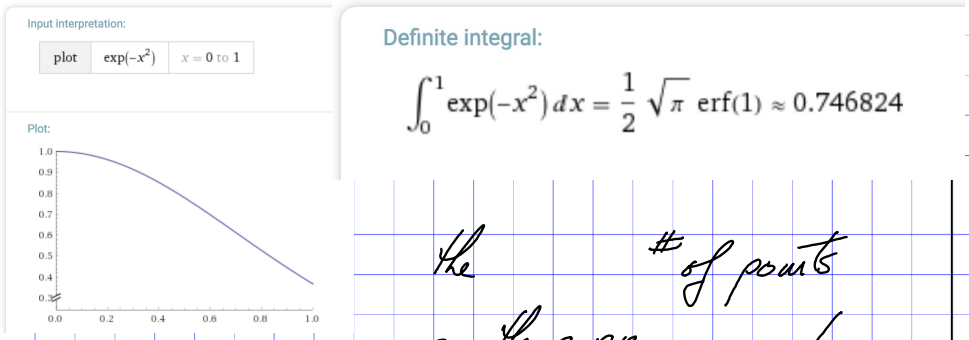


  - this not a continuous graph
  - it is constructed from a finite of finite- values displayed on a finite- (·) screen

- we also have discretely (frames/sec) data of continuous reality →

- how might we estimate ? numerical differentiation

• differentiation & integration are finite



the # of points on the curve be used in this calculation

(how do we control ?)

numerical approximations of integrals

• – algorithms → computer ( )

• many algorithms are iterative (even)

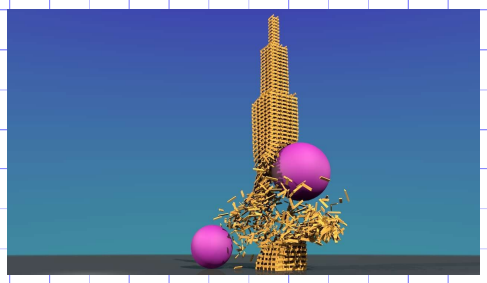
macm 316 is about the transcription of mathematical operations of the calculus (of continuous functions) and linear algebra (vectors & matrices) to (finite-precision) digital algorithms (in finite-operations).

c) ALGORITHM COMPLEXITY

• modern algorithms are quite sophisticated ( )

• image & music processing / simulation

- + LIMITATIONS.



6 differential equations per +

"PHYSICS ENGINE"

- algorithm reliability / ROBUSTNESS: is being 99.99% reliable over all inputs enough?

.
.
.

MODERN → flops = 10 flops

3) WHY NUMERICAL ANALYSIS?

- exhaustive verification of algorithms
- design of new/better algorithms cannot be done by

- THREE key for MACM 316

→ how / are the approx?
→ how much / is needed?
→ how reliable is the algorithm? ( )

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E) THE MACM 316 EXPERIENCE

- understand the basic & the mathematical they solve
- address the 3 key questions of the main algorithms. (BENCHMARK, performance)
- critically evaluate &
- RUN SCRIPTS invoking
  - coding of testcases & diagnostic
  - produce graphics of performance

F) MATLAB DEMOS

- in-class & for computing reports

1) what MATHEMATICS & ALGORITHMS are involved?
2) what are the numerical observations?
3) how do the results reflect on the 3 performance questions? (ACCUR. EFFIC, ROBUST)

G) THE FIRST DEMO ...