

Teaching Multivariable Math in DASC 2594

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Materials

- Available on gitHub at <https://github.com/jtipton25/dasc-2594-teaching-2022>
- Lecture notes at <https://jtipton25.github.io/multivariable-math/>

Guiding principles

- Teach the fundamental multivariable math needed for data science
- Focus on the math and concepts, leave the computation to the computer
- Focus on the key ideas needed for data science from linear algebra and (multivariable) calculus III
 - Matrix and vector operations
 - Solving systems of equations
 - Understanding rank and invertibility
 - Matrix factorizations
 - Gradients
- Omit topics in traditional multivariable calculus courses
 - cross-products
 - line integrals
 - multiple integration over irregular boundaries
 - vector fields

Fundamental concepts

- Matrix operations (multiplication, addition)
- Solving systems of linear equations
 - Applying this to least squares problems (linear regression)
- Demonstrating concepts like rank through data-science applications
 - Fitting models with basis expansions
- Applying calculus to optimization/gradient descent problems

Learning Evaluation

- Goal: Make this a challenging but applicable course
- Homeworks (traditional paper and pencil problems)
- Labs (application using programming)
- Exams (In class and take home)

Continuous Improvement

- Students actually wanted more, smaller exams
- Homeworks and labs were challenging, make these more approachable
- Onboarding students (freshman) with that are Cal III ready but don't have programming experience
- Developing mini-problems and quizzes for more, but lower stakes, practice
 - e.g., how many pivot columns, what is the rank, multiply these matrices, etc.

Examples (RREF)

```
library(dasc2594)
A <- matrix(1:9, 3, 3)
print(array_to_latex(A))
```

```
## [1] "\\begin{pmatrix} 1 & 4 & 7 \\\\ 2 & 5 & 8 \\\\ 3 & 6 & 9 \\\end{pmatrix}"
```

Can display the matrix (in Rmarkdown) with

```
$\begin{pmatrix} 1 & 4 & 7 \\\ 2 & 5 & 8 \\\ 3 & 6 & 9 \\\end{pmatrix}$
```

to get

$$\begin{pmatrix} 1 & 4 & 7 \\ 2 & 5 & 8 \\ 3 & 6 & 9 \end{pmatrix}$$

Examples (RREF)

```
rref(A)
```

```
##      [,1] [,2] [,3]  
## [1,]    1    0   -1  
## [2,]    0    1    2  
## [3,]    0    0    0
```

- Using the **matlib** R package

```
library(matlib)  
gaussianElimination(A, verbose=TRUE, latex = TRUE)
```

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