MATH CAMP 2018 SYLLABUS

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List of prerequisites:

- Basics of univariate calculus: differentiation, integration and integration techniques, Taylor expansion, Fundamental Theorem of Calculus and Leibniz integral rule.

- Basic understanding of vectors and matrices, at the level of Gilbert Strang (Introduction to Linear Algebra), Ch. 1-6 in 5th ed.

- Basics of probability, at the level of Sheldon Ross (A First Course in Probability), Ch. 1-7 in 8th ed.

- Basics of OLS and IV, at the level of Jeffrey M. Wooldridge (Introductory Econometrics - A Modern Approach), Ch. 1-9 and 15 in 6th ed. (not to be confused with Econometric Analysis of Cross Section and Panel Data)

- Familiarity with either Matlab or R

Calculus and Real Analysis (2 lectures by Ali)

- Set operations

- The Real numbers

- Limits and sets

- Continuous functions and IVP

- Seq. of functions and modes of convergence

- Taylor Expansion

- Differential equations

- Fixed-point problems and their applications

- Integration

- Fatou's lemma, DCT, ... (if time permits)

Linear Algebra (1 lecture by Jianfei)

- vector space

- linear transformation and matrix

- projection and invertibility

- geometric interpretation of OLS

- eigenvalue and eigenvector

- eigenvalue decomposition
- solving simple dynamic system

Statistical Inference (3 lectures by Jianfei)

- hypothesis testing and confidence region
- fixed and random design
- linear model and OLS
- solving edogeneity: IV and Heckman correction
- MLE, GMM and extremum estimator
- panel data: fixed effects and Fama-MacBeth estimator

Optimization Theory (2 lectures by Jianfei)

- Separating Hyperplane Theorem
- unconstrained and constrained optimization
- KKT conditions
- Theorem of Maximum
- Envelop Theorem

Probability Theory (2 lectures by Ali)

- What is a random variable?
- Examples of random variables and different distributions
    - Uniform distribution, binomial distribution ...
    - Normal distribution and sums of random variables
    - Arrival and interarrival times (Poisson and Exponential distributions)
    - Maximum of random variables (What is type 1-extreme value?)
    - ...
- Markov Chains
- Still not convinced what a ranodm variables is? (Probability spaces)
- Correlation vs. Independece
- Modes of convergence
- Weak and Strong law of large numbers
- Central limit theorem

Dynamic Programming (2 lectures by Ali)

- Dynamics and forward looking behavior
- Formulating a dynamic program
- Finite and infinite horizon problems
- Bellman equations

- Contraction Mapping Theorem

- Policy and value iterations

- Solving a dynamic programming problem with Matlab (if time permits)

- Euler Equation (if time permits)

- Optimal control (if time permits)