Flatiron Internal Conference: Flatiron-wide Algorithms and Mathematics

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Report of Contributions

https://indico.flatironinstitute.org/e/101

Contribution ID: **7** Type: **not specified**

Optimization landscapes - a gentle multi-disciplinary introduction to optimization

Wednesday, October 30, 2019 9:10 AM (1 hour)

In this lecture, I will give an introduction to the field of continuous optimization. I will emphasize instances of optimization problems that appear in biology and physics through the concept of optimization landscapes. I will review sampling-based approaches as well as gradient-based methods and focus on concepts rather than derivations of specific algorithms. The lecture is intended to set the stage for the latter focused talks, and will provide links to other topics covered in the FWAM conference.

Presenter: MUELLER, Christian L. (CCM / LMU)

Session Classification: Optimization Introductory Lecture 1

Contribution ID: **8** Type: **not specified**

Tutorial: Optimization for Machine Learning

Wednesday, October 30, 2019 10:20 AM (1 hour)

A 1-hour version of the MLSS Buenos Aires tutorial notes, focusing on parts 1 and 4, available at the links below.

Presenter: HAZAN, Elad (Princeton U)

Session Classification: Optimization Introductory Lecture 2

Contribution ID: **9** Type: **not specified**

A practical introduction to adjoint methods

Wednesday, October 30, 2019 11:40 AM (25 minutes)

Presenter: GREENGARD, Leslie (CCM / NYU)

Session Classification: Optimization Short Talk

Contribution ID: **10** Type: **not specified**

Research Applications of Optimization: Data-Driven Spectroscopy

Wednesday, October 30, 2019 12:05 PM (25 minutes)

Presenter: BEDELL, Megan (CCA)

Session Classification: Optimization Short Talk

Contribution ID: **11** Type: **not specified**

Introduction to interpolation, integration and spectral methods

Wednesday, October 30, 2019 2:00 PM (1 hour)

I overview key concepts and practical methods for efficient and accurate numerical function approximation, integration and differentiation. This is the basis for spectral and other ODE/PDE solvers coming up in the next talk. I will teach concepts such as convergence rate, local/global, adaptivity, rounding error, polynomial and Fourier bases. The focus is on 1D, with pointers to higher-dimensional methods and codes.

Lecture notes (see Lecture I) and codes for demo figures at:
https://github.com/ahbarnett/fwam-numpde

Presenter: BARNETT, Alex (CCM)

Session Classification: Function Approximation and Differential Equations Introductory Lecture

Contribution ID: **12** Type: **not specified**

Overview of various methods to solve differential equations

Wednesday, October 30, 2019 3:10 PM (30 minutes)

We overview various numerical methods to solve ODEs and PDEs.

For source of notes see: https://github.com/ahbarnett/fwam-numpde

Presenter: BURNS, Keaton (MIT / CCA)

Session Classification: Function Approximation and Differential Equations Introductory Lecture

Contribution ID: **13** Type: **not specified**

PDEs: The long and the short.

Wednesday, October 30, 2019 4:00 PM (25 minutes)

Presenter: SHELLEY, Michael (CCB)

Session Classification: Function Approximation and Differential Equations Equations Short Talk

Contribution ID: **14** Type: **not specified**

Introduction to Integral Equation Methods

Wednesday, October 30, 2019 4:25 PM (25 minutes)

Presenter: WANG, Jun (CCM)

Session Classification: Function Approximation and Differential Equations Equations Short Talk

Contribution ID: **15** Type: **not specified**

Wavelets

Wednesday, October 30, 2019 4:50 PM (25 minutes)

Presenter: ANDÉN, Joakim (CCM)

Session Classification: Function Approximation and Differential Equations Equations Short Talk

Contribution ID: **16** Type: **not specified**

Introduction to Markov chain Monte Carlo

Thursday, October 31, 2019 9:00 AM (45 minutes)

Presenter: FOREMAN-MACKEY, Dan (CCA)

Session Classification: Sampling Introductory Lecture

Contribution ID: **17** Type: **not specified**

Scalable Bayesian Inference.

Thursday, October 31, 2019 9:55 AM (45 minutes)

In this short tutorial, I will review variational inference (VI), a method to approximate posterior probability distributions through optimization. VI became popular as it provides faster convergence than more traditional sampling methods.

This tutorial aims to provide both an introduction and an overview of recent developments. First, I will provide a review of variational inference. Second, I describe some popular advancements such as stochastic variational inference, and variational autoencoders. During the talk, I will establish some connections with mathematical problems in different centers at Flatiron.

Presenter: GABITTO, Mariano (CCB)

Session Classification: Sampling Introductory Lecture

Contribution ID: **18** Type: **not specified**

The quantum-ness in quantum Monte Carlo: mathematical and algorithmic implications

Thursday, October 31, 2019 11:00 AM (40 minutes)

Presenter: Prof. ZHANG, Shiwei (CCQ)

Session Classification: Sampling Short Talk

Contribution ID: **19** Type: **not specified**

Hierarchical Modeling and Stellar Velocities

Thursday, October 31, 2019 11:50 AM (20 minutes)

An introduction to Bayesian hierarchical modeling, with an example from my own research modeling repeated velocity measurements of distant stars in the Milky Way.

Presenter: CUNNINGHAM, Emily (CCA)

Session Classification: Sampling Short Talk

Contribution ID: **20** Type: **not specified**

Introduction to Deep Learning

Thursday, October 31, 2019 2:00 PM (45 minutes)

A Deep Learning 101 to get familiar with machine/deep learning principles, neural networks, back-propagation, convolution nets and representation learning.

Presenter: CONTARDO, Gabriella (CCA)

Session Classification: Deep Learning Introductory Lecture

Contribution ID: **21** Type: **not specified**

Introduction to Deep Learning

Thursday, October 31, 2019 2:55 PM (45 minutes)

We will introduce state of the art deep learning methods and showcase some of its applications to astrophysical challenges.

Presenter: HO, Shirley (CCA)

Session Classification: Deep Learning Introductory Lecture

Contribution ID: **22** Type: **not specified**

Deep Generative Modeling for Statistical and Quantum Physics

Thursday, October 31, 2019 4:25 PM (25 minutes)

Presenter: CARLEO, Giuseppe (CCQ)

Session Classification: Deep Learning Short Talks

Contribution ID: **23** Type: **not specified**

Biological neural network algorithms

Thursday, October 31, 2019 4:50 PM (25 minutes)

Although traditional artificial neural networks were inspired by the brain they resemble biological neural networks only superficially. Successful machine learning algorithms like backpropagation violate fundamental biophysical observations suggesting that the brain employs other algorithms to analyze high-dimensional datasets streamed by our sensory organs. We have been developing neuroscience-based machine learning by deriving algorithms and neural networks from objective functions based on the principle of similarity preservation. Similarity-based neural networks rely exclusively on biologically plausible local learning rules and solve important unsupervised learning tasks such as dimensionality reduction, clustering and manifold learning. In addition, to modeling biological networks, similarity-based algorithms are competitive for Big Data applications. For further information please see http://www.offconvex.org/2018/12/03/MityaNN2/

Presenter: CHKLOVSKII, Mitya (CCB)

Session Classification: Deep Learning Short Talks

Contribution ID: **24** Type: **not specified**

Uncertainty Estimation with Neural Networks

Thursday, October 31, 2019 4:00 PM (25 minutes)

Presenter: LEVASSEUR, Laurence (CCA / U. de Montreal)

Session Classification: Deep Learning Short Talks

Contribution ID: **25** Type: **not specified**

Fast algorithms for hierarchically structured matrices

Friday, November 1, 2019 10:50 AM (45 minutes)

In this talk, I will discuss what hierarchically structured matrices are, where they occur in practice, and present algorithms for factorizing these structured matrices. I will demonstrate how the factorization enables subsequent matrix operations (applying the matrix, computing its inverse, and its determinant) in linear CPU time.

Presenter: RACHH, Manas (CCM)

Session Classification: Dimension Reduction and Factorization Introductory Lecture

Contribution ID: **26** Type: **not specified**

Randomized linear algebra and matrix approximation

Friday, November 1, 2019 9:15 AM (25 minutes)

The goal of this talk is to show how probabilistic methods can be used to accelerate standard matrix factorizations (e.g. SVD) with provable characteristics in terms of speed and accuracy.

Presenter: PNEVMATIKAKIS, Eftychios (CCM)

Session Classification: Dimension Reduction and Factorization Short Talk

Contribution ID: **27** Type: **not specified**

Spectral Clustering and Dimensionality Reduction

Friday, November 1, 2019 9:40 AM (25 minutes)

Presenter: SPIVAK, Marina (CCM)

Session Classification: Dimension Reduction and Factorization Short Talk

Contribution ID: **28** Type: **not specified**

Clustering in low dimensions

Friday, November 1, 2019 10:05 AM (25 minutes)

I will focus on clustering data points in low dimensions (mostly 2d) and provide an overview of some popular clustering algorithms.

The accompanying live notebook is linked from my homepage: https://users.flatironinstitute.org/~magland

Presenter: MAGLAND, Jeremy (CCM)

Session Classification: Dimension Reduction and Factorization Short Talk

Contribution ID: **29** Type: **not specified**

The why and how of nonnegative matrix factorization

Friday, November 1, 2019 11:35 AM (25 minutes)

Nonnegative matrix factorization (NMF) has become a widely used tool for the analysis of high-dimensional data as it automatically extracts sparse and meaningful features from a set of nonnegative data vectors. I first illustrate this property of NMF on some applications. Then I address the problem of solving NMF, which is NP-hard in general, and review some standard NMF algorithms. Finally, I briefly describe an online NMF algorithm, which scales up gracefully to large data sets.

Presenter: FRIEDRICH, Johannes (CCB)

Session Classification: Dimension Reduction and Factorization Short Talk

Contribution ID: **30** Type: **not specified**

Introduction to Tensor Network Methods

Friday, November 1, 2019 12:00 PM (20 minutes)

Tensor network methods are a family of variational algorithms used to simulate many body quantum systems in a variety of situations. With some brief motivation from physics, I'll explain why anyone would want to use these methods, why it is that they are so effective for certain classes of problems, and some extensions to other fields like machine learning.

Presenter: HYATT, Katharine (CCQ)

Session Classification: Dimension Reduction and Factorization Short Talk