Topics Covered in CS 565

Lecture Number	Topics Covered
Lecture 01	• Introduction • Grading Scales • Office Hours • Motivation • Applications of SC • SC Books • Programming Tools o Mathematical Modeling o Computational Simulation Stochastic Implementation o Interdisciplinary Applications o Matlab for Scientific Comp. o Octave for Scientific Comp. o R for Scientific Comp. o Python for Scientific Comp. o C++/Java for Sci-Comp. GPUs for Scientific Comp. o High Performance Sci-Comp
Lecture 02	• Programming Tools continues • Integrative SC • Opportunities&Trends o Robotics o Mobile o Biomedical Computing
Lecture 03	• List of Program Languages & tools used in SC • Introducing Python for SC o Numpy Library o Simple Python Examples in sorting data and reading files
Lecture 04	• Introducing Python for SC continues o Linspace,poly1d,random functions o Matplotlib library o Plotting example • Python setup Lab Activity 01 introduced See Table 2
Lecture 05	• Mathematical Modeling • DSP -Digital Signal Processing
Lecture 06	• DSP continues • Mathematical Modeling continues with python examples o Curve Fitting examples • Interpolation and Curve Fitting
Lecture 07	• Data Science • Spark for data science and big data • SC & Spark • Downloading Spark and setup o Simple code examples • Resilient Distributed Dataset • Spark and RDD o Spark actions and RDD operations

Lecture Number	Topics Covered
Lecture 08	• Spark for data science and big data continues • Spark and DNA o Videos about using SC and Spark in biology

Lecture 09	• Spark as a platform for neuroscience & neurobiology
	• Why Spark ?
	  o Passing functions to Spark code examples
	  o Scala , python code examples
	• Spark session
	  o Code examples
	• Spark SQL
	  o Code examples

Lecture 10	• Monte Carlo Strategies in SC
	• Monte Carlo & Spark
	• Machine leaning in Python
	  o Search code example
	  o IBM robot
	• Spark SQL
	  o Creating dataset
	  o Interpolating with RDD
	  o Inferring using Reflection
	  o Code examples
	Lab Activities 02 and 03 introduced
	See Table 2

Lecture 11	• Monte Carlo Strategies in SC continues • Beauty of Monte Carlo's methods • Markov Chain Monte Carlo • Motivation • Monte Carlo principle • Importance sampling • Sequential Monte Carlo • Applications • Scipy optimize library
Lecture 12	• Genetics • Robotic system for industrial safety optimization • Optimization • Detecting collisions o Code example • Genetic Algorithm • Genetic Algorithm Libraries
Lecture 13	• Monte Carlo and data science Midterm project introduced See Table 2
Lecture 14	• Fuzzy Optimization • Motivations • History of fuzzy sets • Fuzzy sets operations • Generalized fuzzy sets • Decompositions of fuzzy sets • Approximate reasoning and its Approaches • Advantages of Approximate reasoning

Lecture Number	Topics Covered
Lecture 15	• Fuzzy Optimization and fuzzy logic continues
Lecture 16	• Fuzzy Optimization and fuzzy logic continues Final exam project introduced See Table 2
Lecture 17	• Fuzzy Optimization and fuzzy logic continues
Lecture 18	• Fuzzy Optimization and fuzzy logic continues • Fuzzy for biomagnetism improvements video
Lecture 19	• Tabu Search • Basic Tabu Search Algorithm • Examples • Extensions • Diversification • Intensification • Pros and Cons • Fuzzy for biomagnetism improvements video
Lecture 20	• Using Spark GraphFrames to analyze Facebook connections • Steps to do that • Spark and Facebook code example Project 01 introduced See Table 2
Lecture 21	• MPI for Python
Lecture 22	• POSIX • Threads • Thread synchronization
Lecture 23	• Integral calculus o Integral and derivatives are complements o Estimating area under points o Overestimating and underestimating area o Left and right hand sums o Definite integral o Total change o Computational science vs calculus o The area problem o The definite integral o Evaluating integral o Probertites of definite integral o The fundamental theorem of calculus o Differentiation and integration as inverse processes o Importance of The fundamental theorem of calculus o in definite integral or antiderivatives o table of definite integrals o applications of net change theorem o substitution rule o symmetry in definite integral o the logarithm defined as an integral o laws of logarithms o the exponential function o areas and definite integrals o area under the curve
Lecture 24	• Simplex Algorithm and Linear Programming • Final task introduced – see table 2

Lecture Number	Topics Covered

Lecture 25	• Simulation and 3D visualization
	  o MORSE
	  o PyDy
	  o VTK
	  o Mayavi
	  o CanoPy
	• Challenging projects introduced – see table 2

Lecture 26	• Simulation and 3D visualization – continues o Numpy and Mayavi and code examples

Lecture 27	• Simulation and 3D visualization – continues
	  o Computer Graphics
	  o Games

Lecture 28	• Simulation and 3D visualization – continues
	  o GlumPy
	  o Python and OpenGL for scientific visualization
	  o Code examples

Lecture 29	• Midterm Presentations

Lecture 30	• Simulation and 3D visualization – continues
	  o OpenGL vs Vulkan
	  o Code example

Lecture 31	• Simulation and 3D visualization – continues
	  o OpenGL vs Vulkan
	  o Applications
	  o Next Generation GPU APIs
	  o Vulkan explicit GPU control
	  o The power of 3 layers ecosystems
	  o Vulkan multithreading efficiency
	  o SPIR-V transforms language ecosystem
	  o Vulkan working group
	  o Vulkan loader
	  o Vulkan window system integration

Lecture 32	• Simulation and 3D visualization – continues
	  o Low level memory control
	  o Sparse memory
	  o Recourse management
	  o Populating vidmem
	  o Descriptor sets
	  o Multiple Descriptor sets
	  o SPIR-V for content pipeline
	  o Vulkan shader object
	  o Pipeline state object
	  o Pipeline cache
	  o Pipeline layout
	  o Dynamic state
	  o Push constants
	  o Multi-pass rendering
	  o Command buffers and pools
	  o Command buffers performance

Lecture Number	Topics Covered
Lecture 32	○ Multi-threading ○ Compute ○ Resource hazards ○ Avoiding hazards ○ Queue submission ○ Presentation ○ Good practices • Bounty 01 activity introduced- see table 2
Lecture 33	• Simulation and 3D visualization – continues ○ Vulkan code example • Bounty 02 activity introduced- see table 2
Lecture 34	• Review Lecture

Table 1: Topics Covered During Class Time

Labs / Projects	Description
Lab Activity 01	• Applied Sci- Computing : Fitting a Pump Curve . • Given a dataset in a .txt file • Read the data from the .txt file with Python • And use the fit function to plot the curve
Lab Activity 02	• Create a Google cloud platform • Set up the Virtual Private Server (VPS) • Installing apache and My SQL on the virtual server • Installing Putty • Installing FileZilla • Installing My SQL server • Installing Cygwin
Lab Activity 03	• Installing Spark on the VPS • Installing Scala on the VPS • Input simple code to see if they are working properly • Create RDD • Show that spark works with numpy and scipy
Midterm Exam Project	• Implement a solution for the problem of crude oil pipeline operation using Genetic Algorithm
Final Exam Project	• Use the Fuzzy System for Control Applications: the Truck Backer-Upper ((make a truck park itself automatically using fuzzy systems))
Project 01 Note : solve it or solve the Final task The earned grade will be applied to both We asked him to do that due to the stress	• Spark with Facebook data. • Using spark on Facebook data extract the users who tend to have older friends and the users who tend to have younger friends
Challenging projects Note : he told us choose one and solve it **OR** solve the final exam project the earned grade will be the final exam grade.	Simulation and 3D visualization: • Humanoid robot walking from A to B • Fill cup of coffee with and overpour it using blender • Elevation map – simulate irregular surface and color it according to elevation
Final Task	• formulate Linear Programming model and solve it using Scipy
Bounty 01	• Draw a triangle with Vulkan
Bounty 02	• Draw a cube with Vulkan

Table 2: Labs and Projects Descriptions

Note : each lecture he give us a quiz to solve it after the lecture . is a short activity that takes few minutes and we should submit it on canvas on the same day of the lecture – so , we took 34 quizzes so far.