NVIDIA TEACHING KITS

Joe Bungo – Deep Learning Institute (DLI) Program Manager, NVIDIA

Sunita Chandrasekaran – Assistant Professor, University of Delaware

Zoran Kostic – Associate Professor, Columbia University

TODAY'S COMPUTING CHALLENGES

Facing Students

Computing skills are essential in all discipline studies

Data science and machine learning are becoming essential skills in majority of STEM

Almost all processors are multicore, from microcontrollers to supercomputers

Industry and scientific discovery requires AI and accelerated computing

TODAY'S STUDENT HIRING CHALLENGES

Facing Industry and Research

"..there are about 300,000 AI practitioners and researchers worldwide, but millions of roles available."

Forbes, "*The AI Skills Crisis And How To Close The Gap", June 2018*

"..finding people who can turn social-media clicks and user-posted photos into monetizable binary code is among the biggest challenges facing U.S. industry."

Bloomberg, "*This is America's Hottest Job", May 2018*

"..it would be useful to have students explore the role of a computer engineer in an era of machine learning and intelligent systems.. Future curricula reports are currently under discussion. Two of those under early discussion are cybersecurity and data science."

ACM and IEEE, "*Curriculum Guidelines for Undergraduate Degree Programs in CE", December 2016*

BARRIERS TO TEACHING NEW TECHNOLOGIES

TIME

Solution: Ready-made teaching material in a variety of content types

FUNDING

Solution: Free software tools, computing resources, hardware discounts

THEORY VS APPLIED

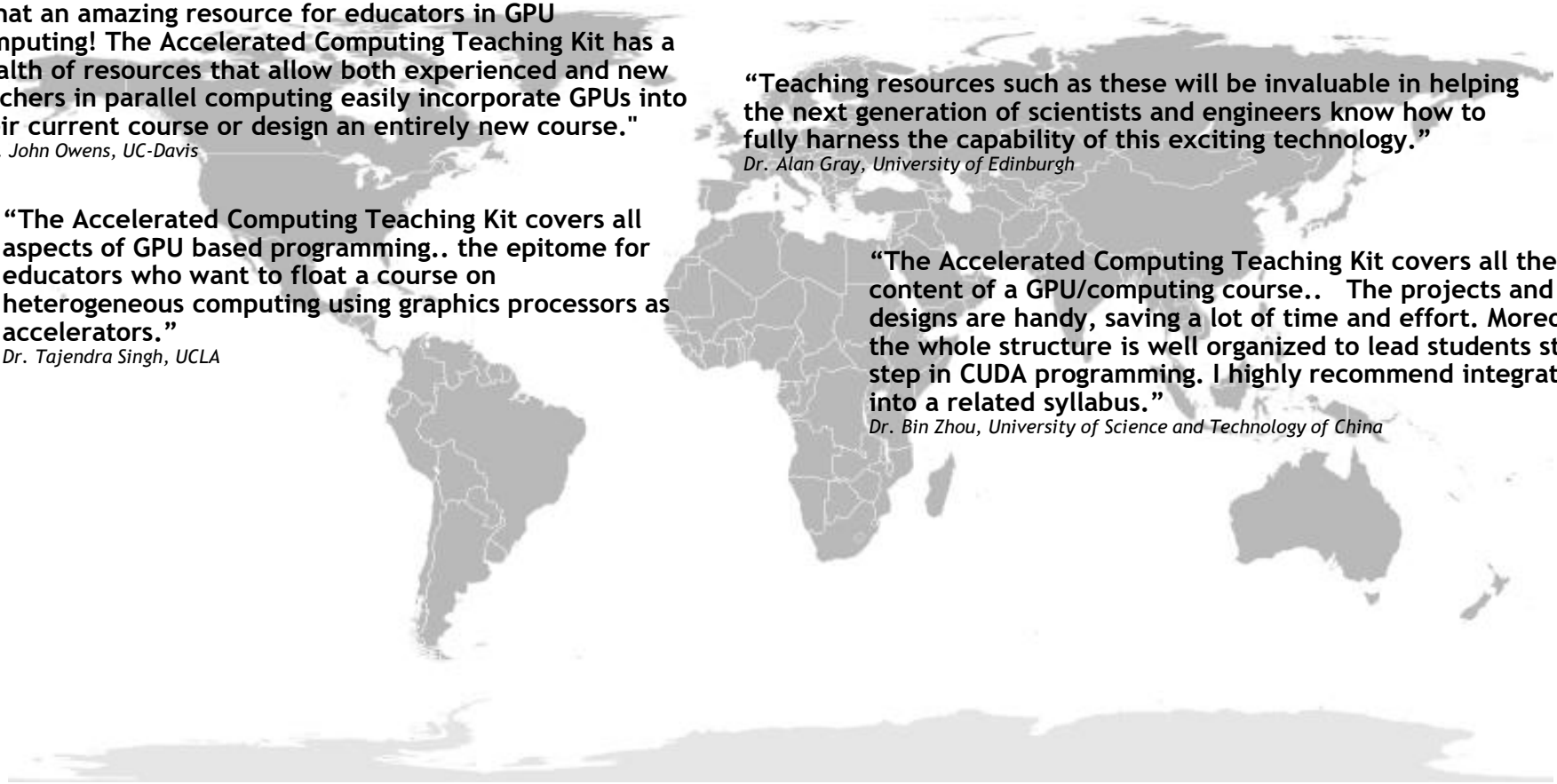
Solution: Content co-developed by NVIDIA and leading academic educators

CONTENT FAMILIARITY

Solution: Support from NVIDIA and educator community

NVIDIA TEACHING KITS

Advancing STEM Education with AI and Accelerated Computing



"What an amazing resource for educators in GPU computing! The Accelerated Computing Teaching Kit has a wealth of resources that allow both experienced and new teachers in parallel computing easily incorporate GPUs into their current course or design an entirely new course."
Prof. John Owens, UC-Davis

"Teaching resources such as these will be invaluable in helping the next generation of scientists and engineers know how to fully harness the capability of this exciting technology."
Dr. Alan Gray, University of Edinburgh

"The Accelerated Computing Teaching Kit covers all aspects of GPU based programming.. the epitome for educators who want to float a course on heterogeneous computing using graphics processors as accelerators."
Dr. Tajendra Singh, UCLA

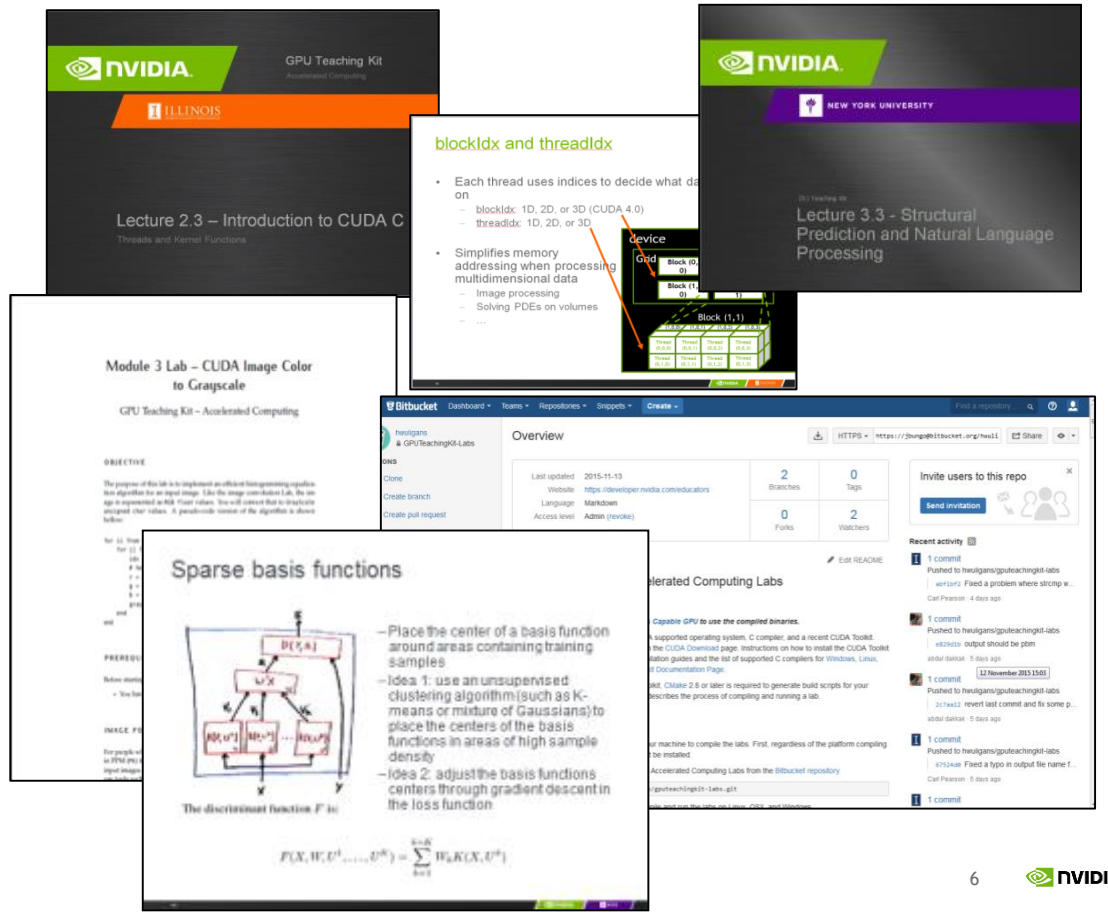
"The Accelerated Computing Teaching Kit covers all the needed content of a GPU/computing course.. The projects and quiz designs are handy, saving a lot of time and effort. Moreover, the whole structure is well organized to lead students step by step in CUDA programming. I highly recommend integrating it into a related syllabus."
Dr. Bin Zhou, University of Science and Technology of China

BREAKING THE TIME BARRIER

Ready-made Teaching Content

Comprehensive source-level materials:

- Lecture slides
- Lecture videos
- Hands-on coding labs/solutions
- Larger coding projects/solutions
- Quiz/exam questions/solutions



BREAKING COST BARRIERS

Free/Low-cost Computing Tools and Resources

Free AWS Educate cloud credits

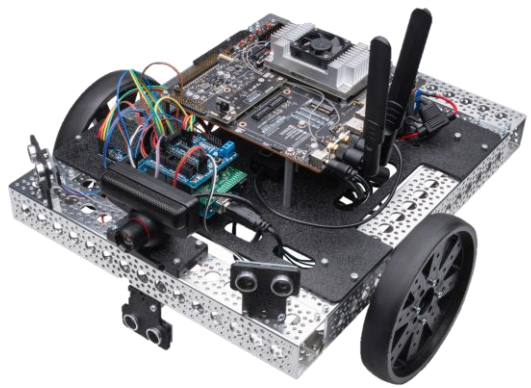
Free online, self-paced Deep Learning Institute (DLI) courses, electives, and student certification

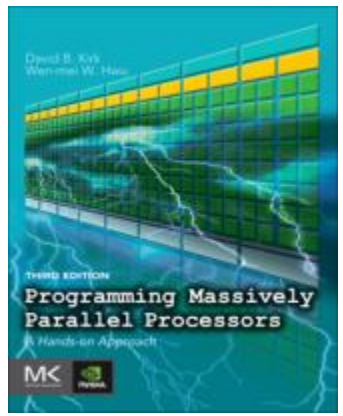
GPU hardware discounts

Textbooks/eBooks

NVIDIA DEEP LEARNING INSTITUTE

aws educate





QUALITY TEACHING MATERIALS

Co-developed With Academia

Different kits for different courses

- **Accelerated/parallel computing (CUDA)** ***(available now!)***
- **Deep learning** ***(available now!)***
- **Robotics** ***(available now!)***
- **Data Science** ***(coming soon!)***
- **Accelerated/parallel computing (OpenACC)** ***(coming soon!)***

CLOSING THE EXPERIENCE GAP

Supporting Expertise

Educator community and NVIDIA support

Educator roundtables, conferences, sponsorships/sessions and exhibit

Enablement web pages

Getting started guides, webinars, videos

Email updates

Feedback and enhancement requests

GPU Teaching Kit for Accelerated Computing

Available free to qualified educators now!

developer.nvidia.com/teaching-kits

GPU TEACHING KIT FOR ACCELERATED COMPUTING

Available Now Free for Qualified Educators!

Co-developed by Prof. Wen-Mei Hwu (UIUC) and NVIDIA

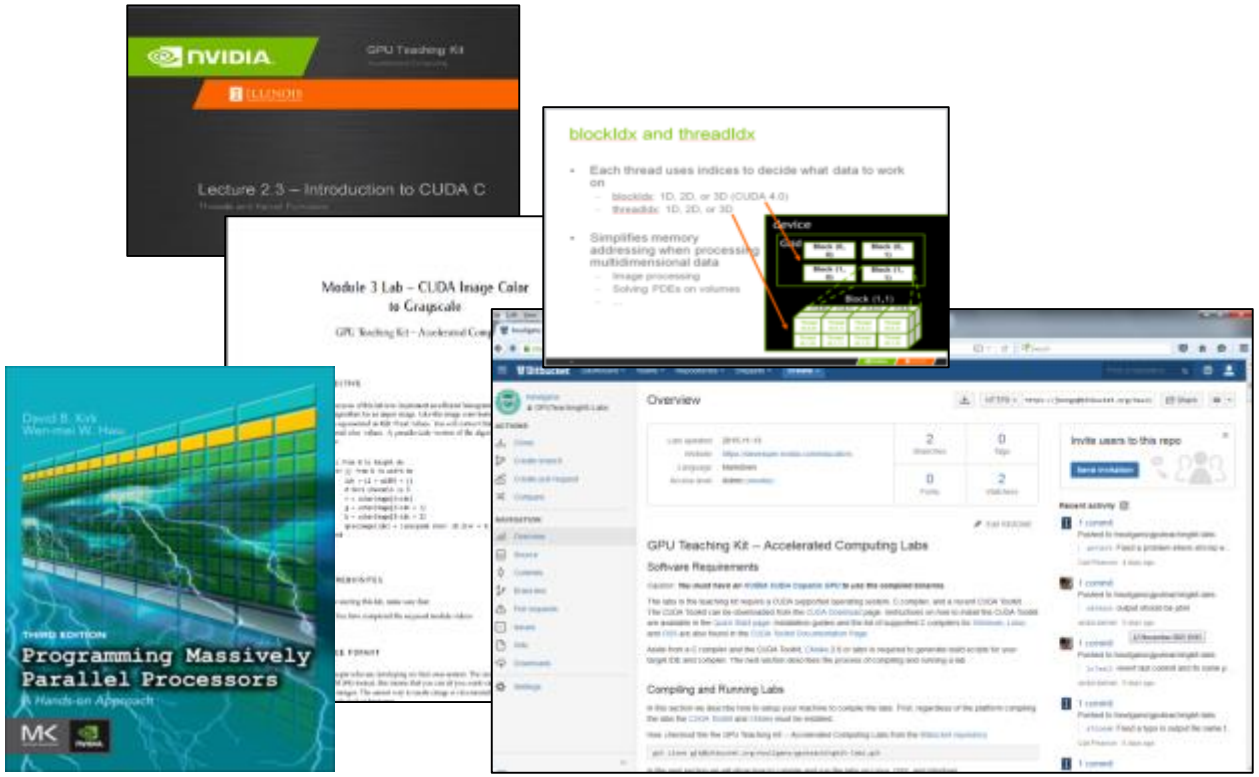
Comprehensive teaching materials:

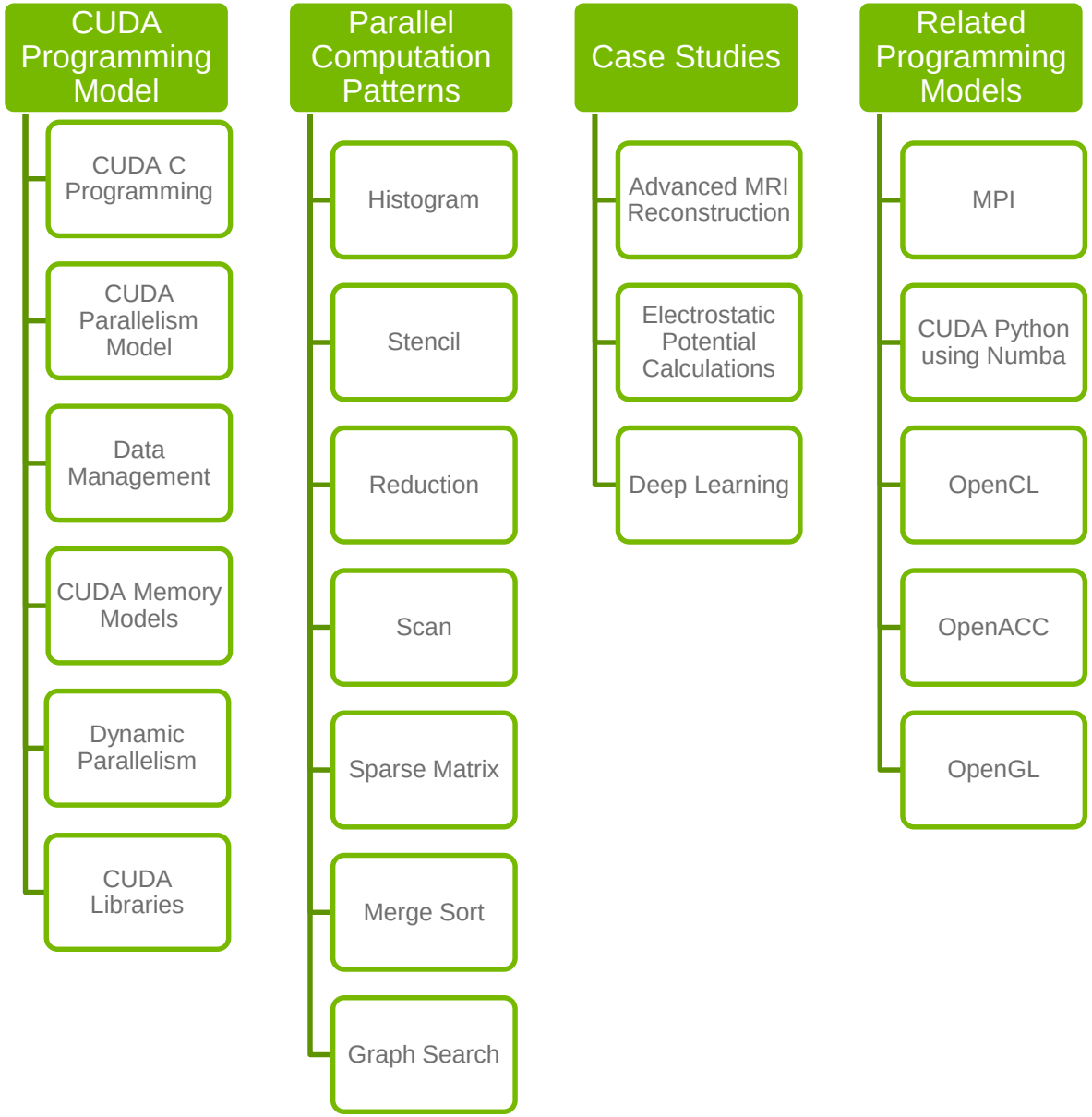
- 3rd Ed. PMPP E-book by Hwu/Kirk
- Lecture slides and notes
- Lecture videos
- Hands-on labs/solutions
- Larger coding projects/solutions
- Quiz/exam questions/solutions

GPU compute resources:

- Free DLI online content/certification
- Free AWS Educate credits

developer.nvidia.com/teaching-kits




CUDA Programming Model
CUDA C Programming
CUDA Parallelism Model
Data Management
CUDA Memory Models
Dynamic Parallelism
CUDA Libraries
Parallel Computation Patterns
Histogram
Stencil
Reduction
Scan
Sparse Matrix
Merge Sort
Graph Search
Case Studies
Advanced MRI Reconstruction
Electrostatic Potential Calculations
Deep Learning
Related Programming Models
MPI
CUDA Python using Numba
OpenCL
OpenACC
OpenGL

NEW YORK UNIVERSITY

DLI Teaching Kit

Available free to qualified educators now!

developer.nvidia.com/teaching-kits

DLI TEACHING KIT

Available Free Now for Qualified Educators!

Co-developed by Prof. Yann LeCun (NYU) and NVIDIA

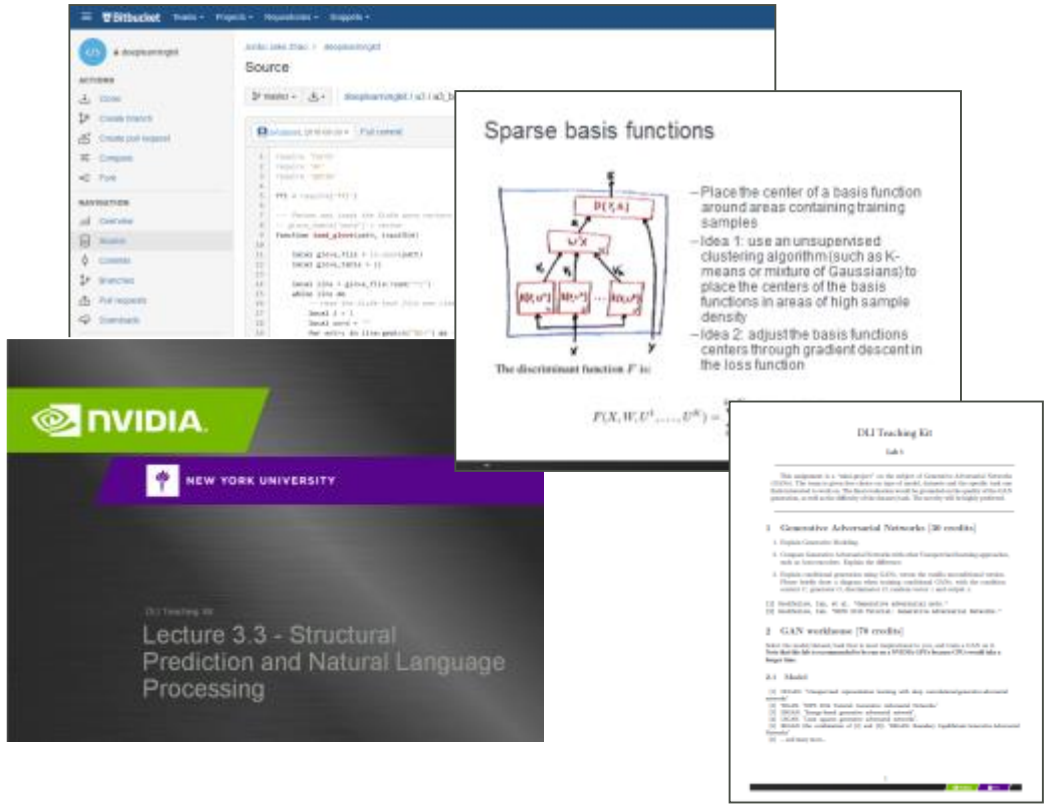
Comprehensive teaching materials:

- Lecture slides
- Hands-on labs/solutions with optional assessment rubric using Kaggle
- Quiz/exam problem sets/solutions

GPU compute resources:

- Free DLI online content/certification
- Free AWS Educate credits

developer.nvidia.com/teaching-kits



DLI TEACHING KIT

Module Goals

Teach academic theory and application of DL harnessing the PyTorch and Torch frameworks

Technical subjects:

Intro to ML/DL Applied Image Classification Applied Object Detection Convolutional NNs Applied Image Segmentation Energy-based Learning	Unsupervised Learning Generative Adversarial Networks Optimization Techniques Recurrent NNs Natural Language Processing And more!

NVIDIA

CAL POLY
SAN LUIS OBISPO

Robotics Teaching Kit with ‘Jet’

Available to qualified educators now!

developer.nvidia.com/teaching-kits

ROBOTICS TEACHING KIT WITH 'JET'

Available Now Free for Qualified Educators!

Co-developed by Prof. John Seng (CalPoly) and NVIDIA

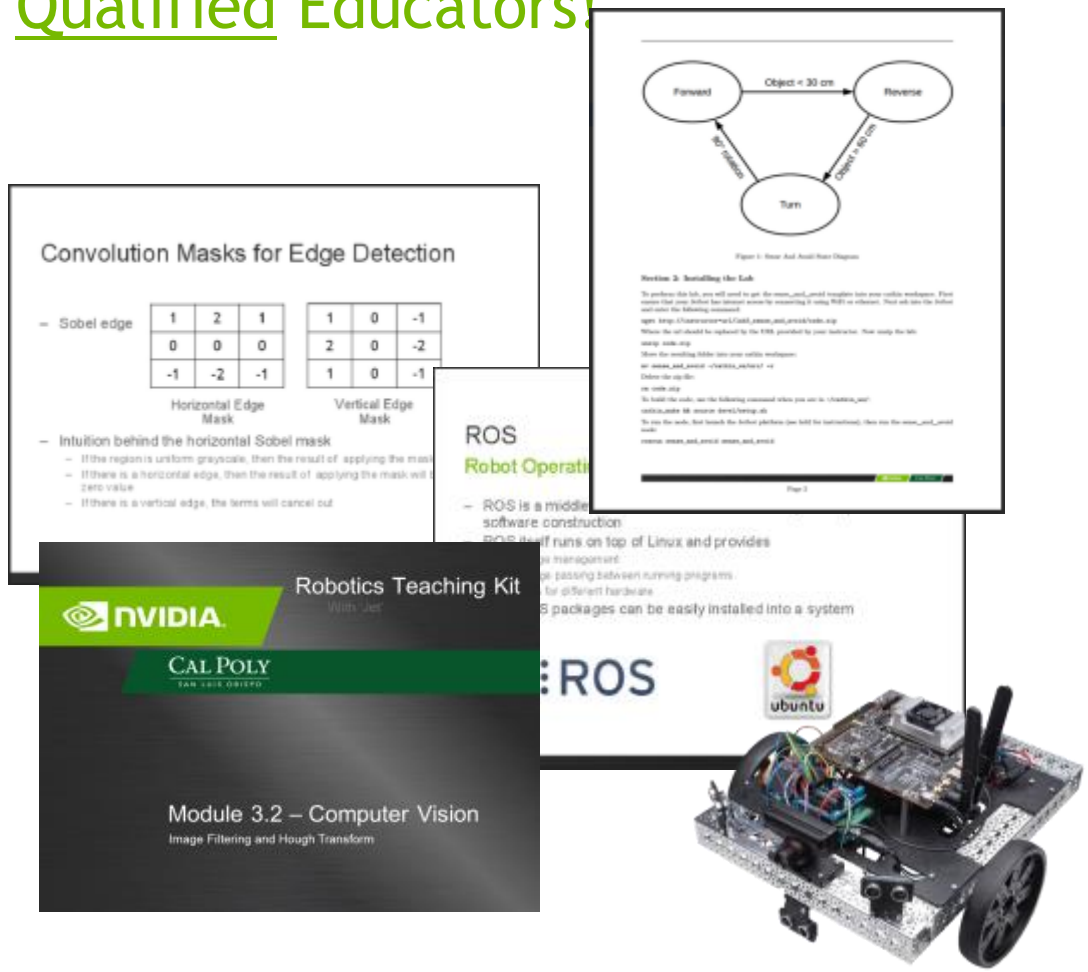
Comprehensive teaching materials:

- Lecture slides
- Hands-on labs/solutions
- Quiz/exam problem sets/solutions
- Open-ended coding projects

Robot hardware kit via Servocity includes:

- NVIDIA Jetson TX1 (with TX2 support)
- All mechanical, chassis, electronics
- https://www.servocity.com/tx1-jet-robot-kit

developer.nvidia.com/teaching-kits



ROBOTICS TEACHING KIT WITH ‘JET’

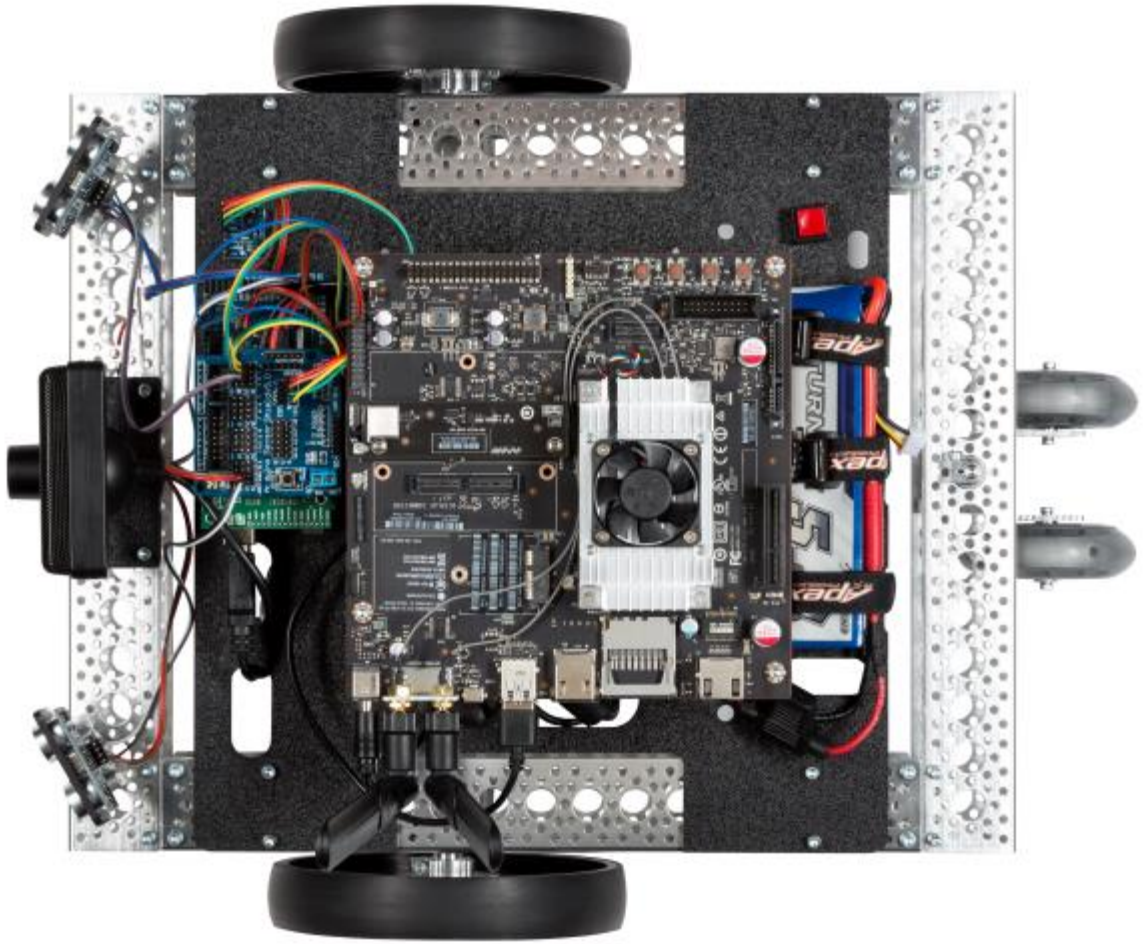
Module Goals

Learn interdisciplinary, GPU-accelerated, autonomous Robotics

Technical subjects

- Sensors
- Computer Vision
- Machine Learning
- Dead Reckoning
- Path Planning
- Localization
- Control
- Obstacle Avoidance

ROS



SUNITA CHANDRASEKARAN

ASSISTANT PROFESSOR

UNIVERSITY OF DELAWARE

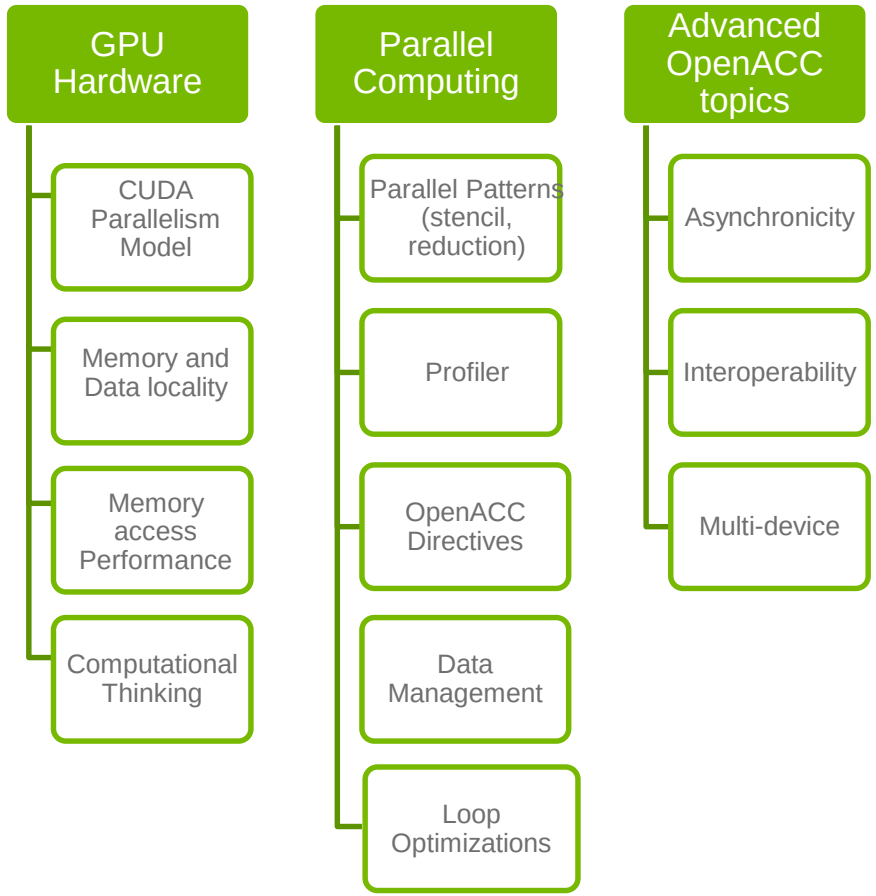
ACCELERATED/PARALLEL COMPUTING

Courses and Structure

Teaching computer architecture & advanced concepts at both the undergraduate (CISC360) and the graduate levels (CISC662), Vertically Integrated Project (VIP) (a research-based course for undergraduates) (CISC/CPEG467)

Using Accelerated Computing (AC) Teaching Kit for introducing GPU hardware, GPU parallelism and memory model, techniques such as memory coalescing, parallel computing patterns

Using the *new* OpenACC teaching kit for lectures/labs on the directive-based model



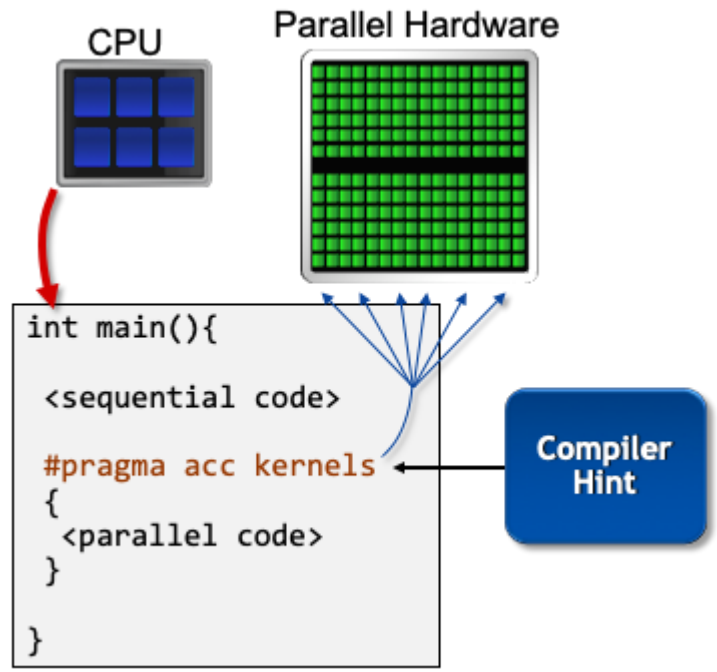
ACCELERATED/PARALLEL COMPUTING

Course Content

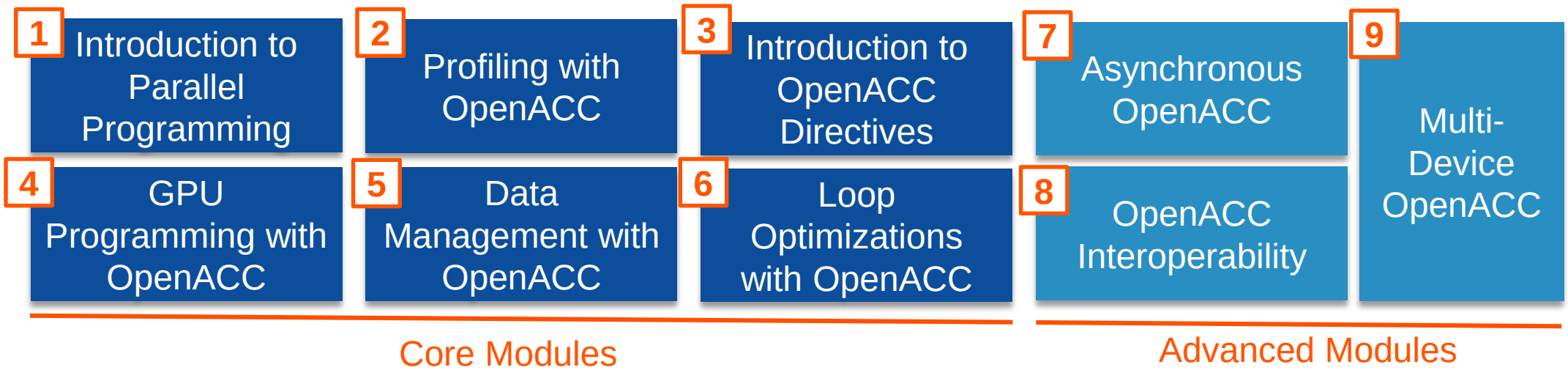
AC Teaching Kit content + AC DLI online content + *new* OpenACC teaching kit for teaching and research (productive and students loved it)

- Used vector addition lab from AC Teaching Kit for homework assignments (Very inspirational)
- Used Jacobi Iteration from the *new* OpenACC Teaching Kit as examples for hands-on exercises

Turned most of the OpenACC webinar office hours information into quizzes! (Very helpful)



NEW OPENACC TEACHING KIT



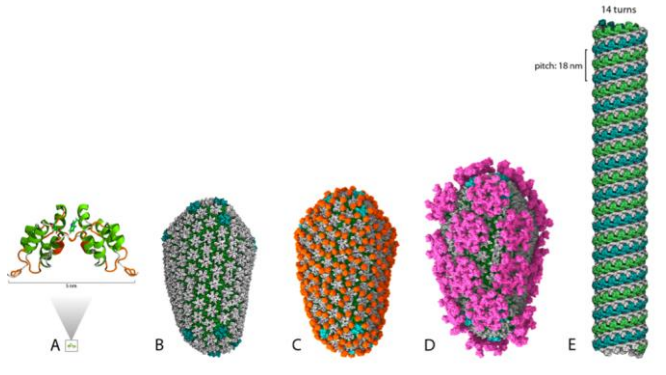
- Each module includes: slides with speaker notes, hands-on labs with Jupyter notebooks, source codes for exercises.
- Labs will be packaged in a docker container with PGI compiler and Jupyter notebook and available for download from NVIDIA GPU Cloud (www.nvidia.com/gpu-cloud/) starting March 18th, 2019
- Acknowledgement: Julia Levites (NVIDIA), Eric Wright & Sunita Chandrasekaran (UDEL)

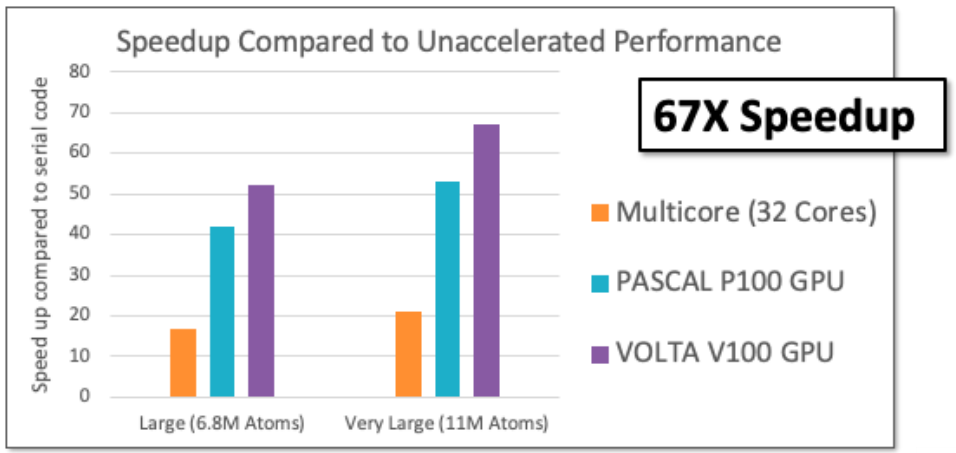
ACCELERATED/PARALLEL COMPUTING

Outcome: Research Project

Undergraduate VIP research project at UDEL

- Accelerating Chemical Shift Prediction for Large-scale Biomolecular Modeling in **8 months**
- Parallelized/Accelerated scientific code
- 67x Speedup respectively when compared to single core optimized performance
- Won the **Best Research Poster** in an undergraduate mid-atlantic project competition





ACCELERATED/PARALLEL COMPUTING

Take Away

Parallel programming made mandatory in UDEL since Fall 2017

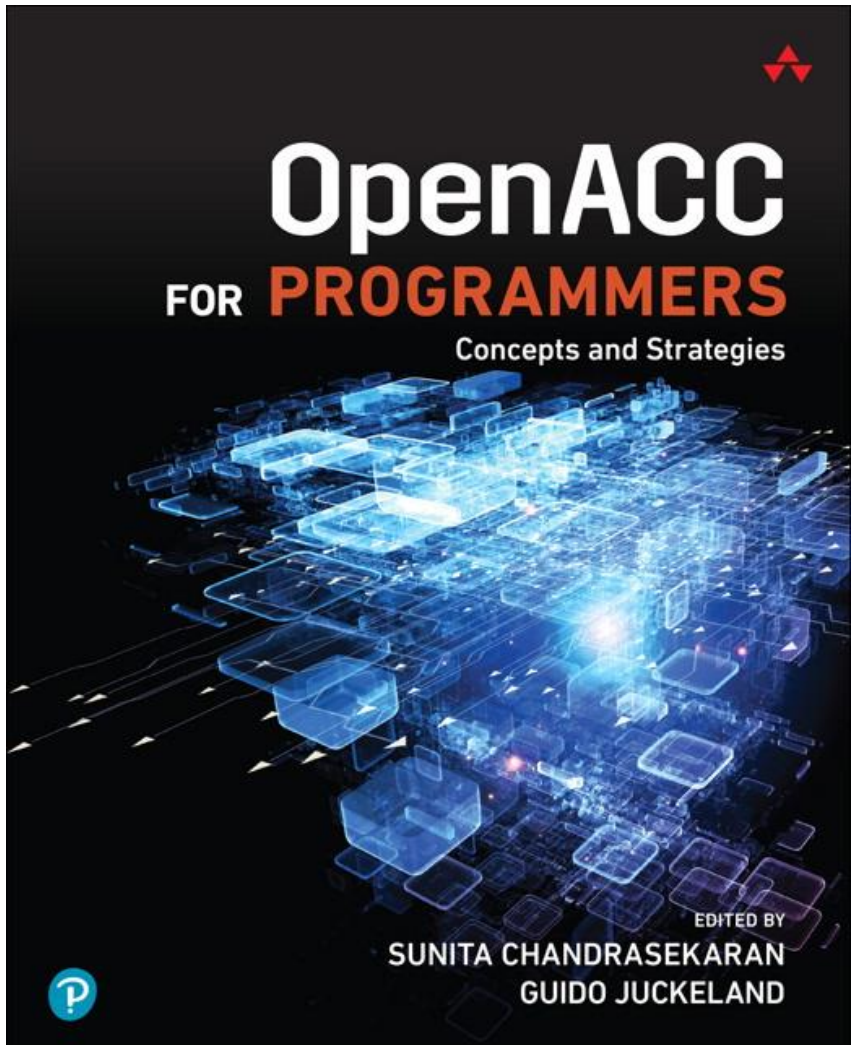
Teaching Kits very timely and effective

Saves a lot of lecture-preparation time **- A huge plus!!**

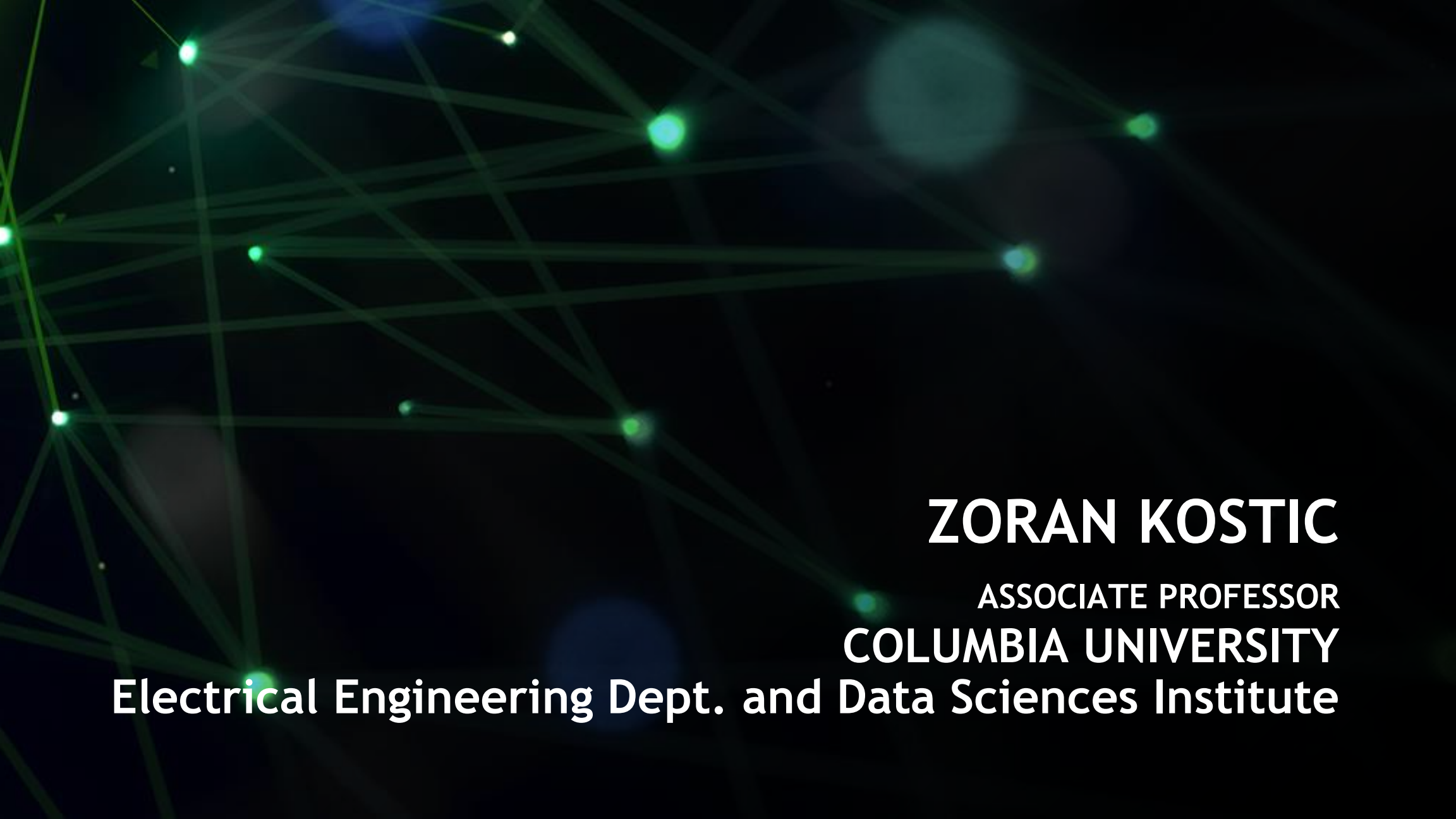
Labs and quizzes are readily-available for immediate use

Students loved DLI content and the concept of using AWS to do their labs

New OpenACC teaching kit with AWS Linux Academy labs will be released at GTC 2019. Available at https://www.openacc.org/events/openacc-online-course-2018



- Refer to the OpenACC Textbook edited by
  - Sunita Chandrasekaran,UDEL, USA
  - Guido Juckeland, HZDR, Germany
- The OpenACC teaching kit uses ideas and lab samples from the textbook for some of its modules
- https://www.amazon.com/OpenACC-Programmers-Strategies-Sunita-Chandrasekaran/dp/0134694287



ZORAN KOSTIC

ASSOCIATE PROFESSOR

COLUMBIA UNIVERSITY

Electrical Engineering Dept. and Data Sciences Institute

PARALLEL COMPUTING AND DEEP LEARNING

Columbia University School of Engineering and Applied Sciences

Course Offerings:

EECS E4750 Heterogeneous Computing for Signal and Data Processing
ECBM E4040 Neural Networks and Deep Learning
ECBM E6040 Neural Networks and Deep Learning Research

Graduate level courses open to students with engineering, computer science, data science and natural science degrees

Created and presented by a signal processing/communications expert with 25 years of industry experience in wireless, SoC and multimedia industries

For more details see: https://sites.google.com/site/mobiledcc/people/zk-my-page

HETEROGENEOUS COMPUTING FOR SIGNAL AND DATA PROCESSING

Columbia University School of Engineering and Applied Sciences

Course Overview

Introducing students to heterogeneous computing on multiple platforms and in two languages: **CUDA and OpenCL**

Open to students with a variety of backgrounds, without strict requirements about prior programming knowledge

Required **textbook**: David Kirk and Wen-mei Hwu, "Programming Massively Parallel Processors -A Hands-on Approach,". Using slides developed by Prof. Hwu, interspersed with other material about OpenCL and parallel programming applications

Using select material from the **Accelerated Computing Teaching Kit**.

HETEROGENEOUS COMPUTING FOR SIGNAL AND DATA PROCESSING

Columbia University School of Engineering and Applied Sciences

Course Structure

Lectures by an instructor and guest lecturers:

- Covering all topics from the textbook, with emphasis on thorough understanding of convolution

Four assignments using PyCUDA/PyOpenCL and CUDA/OpenCL kernel code:

- Topics lean toward signal processing problems and more recently deep learning

Assignments executed on **NVIDIA-donated GPU boards** (K-40)

Final group project

HETEROGENEOUS COMPUTING FOR SIGNAL AND DATA PROCESSING

Columbia University School of Engineering and Applied Sciences

Sampling of project topics

Parallel Methods for Image Deblurring
Parallel Locality-Sensitive Hashing In Movement and Gesture Recognition
3D Wifi Mesh Generation
Sudoku Solver with Parallel Backtracking
3D Image Reconstruction (Stereo Vision Based Depth Perception & 3D Spatial Reconstruction)
Vector representation for words
Iris detection in biometrics
Parallel Computation in Image Registration

For details see
https://sites.google.com/site/mobiledcc/documents/sigproccommonmmulticore

NEURAL NETWORKS AND DEEP LEARNING

Columbia University School of Engineering and Applied Sciences

Course Overview

EECS E4040 - Introduction to theory and applications of neural networks

From ML to DL, CNNs, RNNs
TensorFlow on Google cloud
Three assignments, exam, and final group project

EECS E6040 - Advanced topics and research

Study of contemporary papers
PyTorch on Google Cloud
Two group projects

NEURAL NETWORKS AND DEEP LEARNING

Columbia University School of Engineering and Applied Sciences

Course Structure

Introductory lectures, some slides based on **DLI Teaching Kit slides** (i.e. CNNs)

Four assignments in PyTorch, some inspiration/basis from **DLI Teaching Kit labs**:

Lab on batch normalization basis for more complex assignment
Lab on language modelling inspired another assignment

NVIDIA DLI online labs run by students individually:

DLI online, self-paced course “Fundamentals of Deep Learning for Computer Vision” (with student certification)
DLI online self-paced elective “Image Segmentation with TensorFlow”
www.nvidia.com/dli

Final group project: Google Cloud GPUs

NEURAL NETWORKS AND DEEP LEARNING

Columbia University School of Engineering and Applied Sciences

Sampling of project topics

SeqGAN: Sequence Generative Adversarial Nets with Policy Gradient
Neural Image Caption Generation with Visual Attention
To Better Understanding of Arts with Deep learning
DeblurGAN: Blind Motion Deblurring Using Conditional Adversarial Networks
Dialogue Generation with Reinforcement Learning
Dynamic Routing Between Capsules
Performance Profiling for Deep Learning
Generative Adversarial Text to Image Synthesis
Music Separation using Image Segmentation Networks (U-Net)
Real time object detection using Faster RCNN

For details see https://sites.google.com/site/mobiledcc/neuralnetworksanddeeplearningresearch

NVIDIA

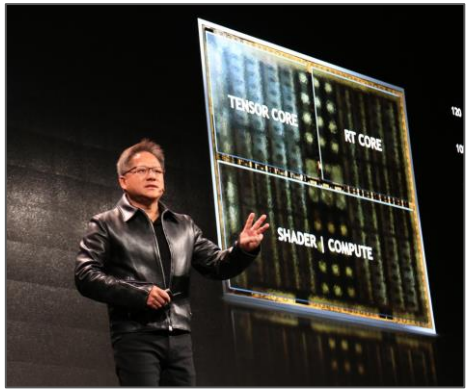
GTC SILICON VALLEY MAR 17-21 2019

CONNECT

Connect with technology experts from NVIDIA and other leading organizations

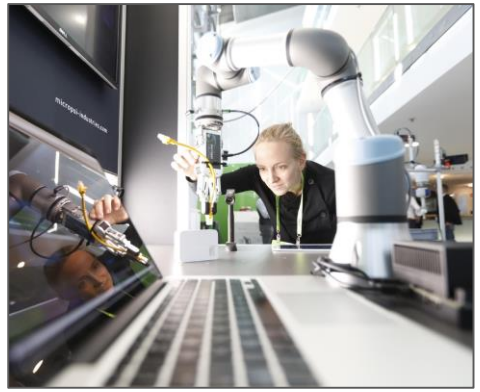
LEARN

Gain insight and valuable hands-on training through hundreds of sessions and research posters



DISCOVER

See how GPU technologies are creating amazing breakthroughs in important fields such as deep learning



INNOVATE

Hear about disruptive innovations as early-stage companies and startups present their work

LEARN MORE AT GPUTECHCONF.COM | USE CODE NVJBUNGO TO SAVE 25% ON TOP OF ACADEMIC RATE!

Join us at the premier conference on AI and deep learning
March 17—21, 2019 in Silicon Valley

GPU Bootcamp at GTC 2019

1 day event March 17

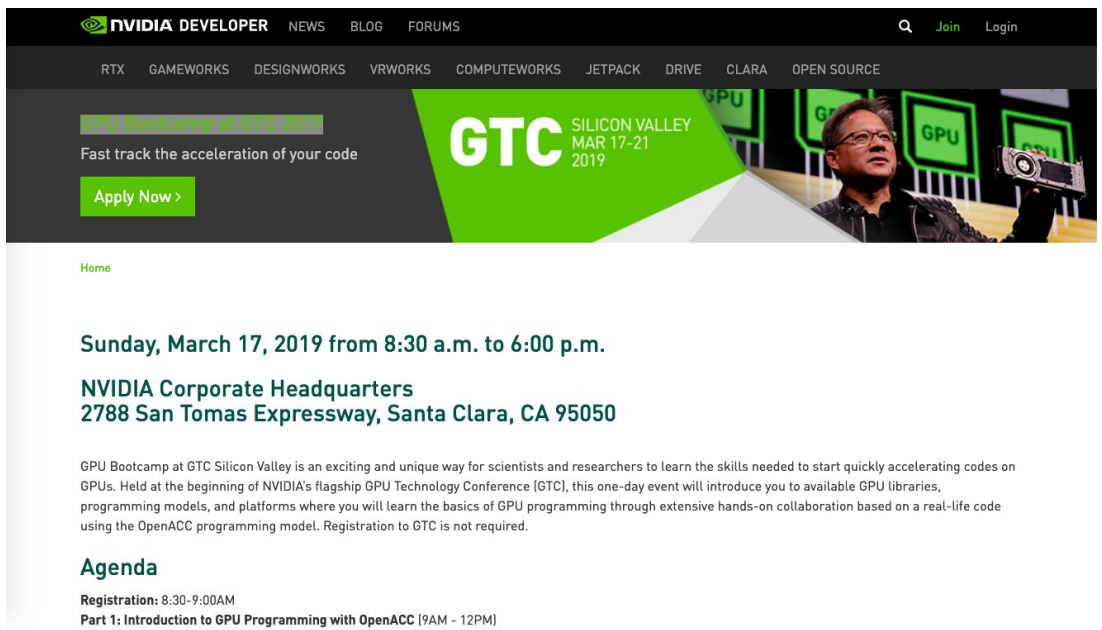
Learn to quickly accelerate codes on GPUs using OpenACC

Take part in the Mini-Application Challenge

Open to all (Need not be a registered GTC attendee)

Free for all admitted participants

APPLY NOW

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developer.nvidia.com/teaching-kits
Questions?