Online Workshop on
Algodynamics: Teaching and Learning Algorithms through Interactive Virtual Experiments

24-25 August 2021

Organised by
Commonwealth Educational Media Centre for Asia, New Delhi
in collaboration with
Uttarakhand Open University, Haldwani

Introduction

Experiments are an integral component of science, technology, and engineering education. Virtual experiments augment existing access to physical laboratories and quality educational resources. In many disciplines, like Computer Science, such experiments provide crucial insight into understanding of concepts that are hard to access via more traditional means like tracing, algorithm animation or programming. There is an urgent need for effective access, use, and integration of virtual experiments in teaching and learning to promote sustainable solutions for extending reach to quality education.

Recognising this need, CEMCA aims to support a capacity building workshop on Algodynamics: Teaching and Learning Algorithms through Interactive Virtual Experiments in partnership with Uttarakhand Open University for faculty members from Universities in Uttarakhand.

Background: What is Algodynamics?

Algodynamics is the study of algorithms as if they were systems. The conceptual vocabulary of systems: states, actions, flows, trajectories, control, and behaviour are widely used in all branches of engineering, yet they are rarely taught to students of computing. Dynamics is the study of change and in the engineering sciences this is expressed through models represented as differential equations.

In computing, there is no widely used standard for expressing algorithmic models. Instead, algorithms are expressed as code in programming languages. Algodynamics employs transition systems to express models. Transition systems (also called automata) are taught to all students of computing, but seldom used as part of problem solving.

Algorithms are closed (or 'batch') systems. Once an algorithm starts, it runs to completion without the need (or possibility) of intervention or interaction. This worked very well for computers of the 20th century, where computers were mostly used as giant calculators. The computers of the 21st century, like mobile phones and smart watches, are not only much smaller, but more importantly, are open systems where interaction, concurrency and distribution are the dominant paradigm. Today's student experiences computing as interaction more than calculation.

Interaction is also an important route to understanding. One reason algorithms may be hard to understand is because, unlike with open systems, we cannot interact with them. Algodynamics approaches the understanding of algorithms by situating them in the space of interactive systems, i.e., by opening them up. This allows a student to 'tinker' with the algorithm, drive it and discover new strategies for problem solving. In Algodynamics, an algorithm is arrived at by successive refinement of a series of interactive system, trading interaction for automation at each stage. This 'laboratory' approach complements the coding approach to understanding algorithms.

Aim and Objectives

The workshop is intended to be an introduction to Algodynamics. The workshop will

- Introduce the basic vocabulary of Algodynamics
- Show examples of modelling simple open and closed systems
- Demonstrate, using virtual experiments, algorithmic problem solving by successive refinement

Workshop Methodology and Activities

The two-day online workshop will consist of 2.5-hour sessions each day. The material in the workshop will be covered by small teaching sessions by the expert and with the help of presentation slides. The teaching sessions will be regularly interspersed with problem solving sessions. Participants are expected to solve small problems and share or discuss their attempts. Finally, there will be laboratory sessions where participants will work with interactive versions of searching or sorting algorithms. There will be no programming or coding exercises.

Date, Duration, and Modality

This workshop will be held on **24-25 August 2021**. The live sessions will be conducted from **2.30pm to 5pm** using videoconferencing technology. In addition to the synchronous online sessions, participants would be encouraged to further explore the virtual experiments and share comments and queries in the asynchronous mode.

Participants

Participants include faculty of Computer Sciences, Computer Applications, Information Sciences, Information Technology, and related disciplines.

Outcome

Participants build awareness and capacity in the use of virtual experiments and the theoretical basis of Algodynamics.

Session Plan

24 August 2021	
Time	**Session Topic**
2.30pm to 2.40pm	Inaugural session
2.40pm to 3.10pm	Motivation: Computing, Systems, and Interaction
3.10pm to 3.20pm	Activity Break
3.20pm to 3.50pm	Transition Systems
3.50pm to 4pm	Activity Break
4pm to 4.30pm	Demonstration of Examples
4.30pm to 4.45pm	Activity Break
4.45pm to 5pm	Discussion and Concluding Session

25 August 2021	
Time	**Session Topic**
2.30pm to 2.35pm	Opening remarks
2.35pm to 3.05pm	Iterative Systems with Examples
3.05pm to 3.15pm	Activity Break
3.15pm to 3.35pm	Iterative Problem Solving
3.35pm to 3.45pm	Activity Break
4pm to 4.30pm	Bubblesort with Successive Refinement
4.30pm to 4.40pm	Activity
4.40pm to 5pm	Discussion and Concluding Session

Expert for the Workshop

Dr. Venkatesh Choppella is an Associate Professor of Software Engineering at IIIT Hyderabad. He has also taught at the IIITs at Bangalore and Trivandrum. He holds a PhD from Indiana University, Bloomington, USA, and has held research and engineering positions at Xerox PARC, Hewlett-Packard, Oakridge National Labs, and the Ohio State University. Dr. Choppella's current research interests are in programming languages, software architectures, concurrent algorithms, and innovations in Computer Science Pedagogy. He has an interest in computer science education and FOSS-based educational technology. He has published over 75 research papers and technical reports in the automated deduction, programming languages, design of compilers for high-performance computing, software engineering, web accessibility and security, educational technology, and computer science pedagogy. A full bio of Dr. Choppella is available at https://iiit.ac.in/~vxc.

Coordinators:

Dr. Shiffon Chatterjee	Dr. Jeetendra Pande
Senior Programme Officer, CEMCA	Associate Professor, Uttarakhand Open University
schatterjee@col.org	jpande@uou.ac.in