Report on the 24-25th August 2021 Workshop on Algodynamics

Organized by Uttarakhand Open University (UOU) in collaboration with Commonwealth Educational Media Centre for Asia (CEMCA)

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Contents

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1 Executive Summary

Title of Workshop	Algodynamics (Teaching and Learning Algorithms through Interactive Virtual Experiments)
Dates of Workshop	24-25th Aug 2021
Organizers	CEMCA New Delhi and Uttarakhand Open University
Resource Person	Venkatesh Choppella, Associate Professor IIIT Hyderabad
No. participants	67

2 Motivation and Background

In university curricula across the world, algorithms is a foundational course in undergraduate programmes in computer science and information technology. It is also a course that presents many challenges to teachers and student alike. Part of the reason is in the inherent non-interactive nature of algorithms, which makes it difficult to 'open' them up, tinker and play with their parts and understand the design and construction of the algorithm in a modular fashion. At a more foundational level, there is a lack of uniform notation to express algorithms in a manner that is both independent of technology and programming notation and also unambiguous and precise.

Algodynamics is a novel way of thinking about algorithms that addresses the above challenges. First, it employs a uniform notation for expressing algorithms as transition systems. Second, it emphasises understanding algorithms via interaction through a practical online laboratory. Third, it follows a stepwise refinement approach in which the design of the algorithm unfolds through a series of interactive transition systems.

3 Pre-programme preparation

The idea of the workshop came up after several rounds of discussions with CEMCA. These discussions had started in early 2021. Earlier work with CEMCA on the design of the online experiments for Data Structures and Algorithms paved the way for the idea of a workshop to showcase the theory and pedagogy behind the interactive experiments.

The preparation of the workshop involved the following components:

Workshop proposal An initial workshop proposal was exchanged with Dr. Shiffon Chatterjee of CEMCA. Suggestions from Dr. Chatterjee where then incorporated to sharpen the focus of the workshop and its content.

Content Development The course content was developed a collection of slide decks, roughly one for each session. Some example web applications were created as part of the content. Exercise activities for students were planned and documented.

3.1 Course infrastructure

Once the content was ready, the online infrastructure was set up. This consisted of four platforms:

1. **Google Classroom** This was the online portal where the course content was hosted, along with exercises and other administrative information. All students used their Gmail id's to access the classroom. A screen shot of the Google classroom used is shown in Figure 1.

2. **Google Colab** This platform allowed the instructor to demonstrate running code interactively in live sessions. It was integrated with Google Classroom.

3. **Zoom** The workshop was conducted over Zoom, which was administered by the workshop coordinators. The chat facility on Zoom was used for Questions and Answers throught the workshop. A screen shot demonstrating a chat in progress is shown in Figure 2.

4. **Telegram** A channel on Telegram ('Algodynamics') was used to quickly broadcast information about the course, like urls of the classroom and zoom link.

5. Google forms These were used to collect pre and post-workshop feedback. The links to these are also accessible via the course google classroom.

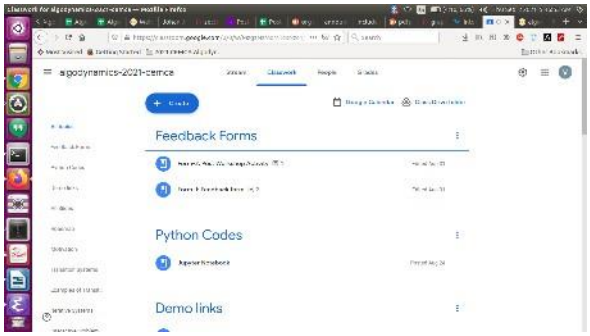

Figure 1: Screen shot of the Google classroom used in the workshop

Figure 2: Screen shot of a Chat session in progress on Zoom

4 Detailed Proceedings

4.1 Workshop Announcement and Publicity

The workshop flyer was created and circulated amongst various organisations by Uttarakhand Open University (Figure 20 in Appendix).

4.2 Inaugural Session

The workshop commenced with an inaugural session. Prof. Madhu Parhar, Director, CEMCA New Delhi addressed the workshop. This was followed by an address by Prof. Durgesh Pant, Director, School of CS & IT, Uttarakhand Open University. Then there was a keynote address by the resource person Dr. Venkatesh Choppella. This was followed by the Presidential Address by Prof. OPS Negi, Honourable Vice Chancellor, Uttarakhand Open University. Prof. Jeetendra Pande, Associate Professor, Computer Science, Uttarakhand University, gave the vote of thanks. The entire event was coordinated by Dr. Shiffon Chatterjee, Senior Programme Officer, CEMCA. A screen shot of the inaugural session in progress is shown in Figure 3.

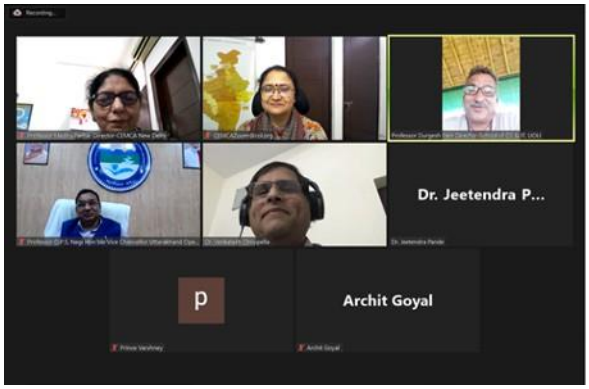

Figure **3**: Screen shot of the Inaugural Session in progress

5 Workshop Sessions

The inaugural was followed by a workshop. The workshop was divided into multiple sessions spread across two days. The lecture sessions were interspersed with activity sessions. During the activity sessions, the participants had access to the slides, which were made available on Google Classroom.

5.1 Day 1 Session Plan

The session plan for Day 1 is given in Table 1.

Table 1: Session plan on Day 1 of the Workshop

No.	Topic	Duration (Approx.)
1.	Motivation: Computation, Interaction and Systems	30min
2.	Activity Break	10min
3.	Transition Systems	20min
4.	Activity Break	10min
5.	Examples	30min
6.	Activity Break	15min
7.	Wrap up and Conclusion	5min

5.2 Roadmap session

The roadmap session was a brief introduction to the purpose of the course and the logistics of the workshop: classroom link, registration on telegram, etc., followed by a brief outline of the session plan of the workshop.

5.3 Session on Motivation

The purpose of the motivation session was to draw the attention of the participants to three different but related ideas: First, the idea that computation involves both calculation and interaction. Second, the idea of a system, and dynamics, and the third, the relation between computing and the engineering sciences. The session involved working out a simple example from physics relating displacement, velocity and force. The session lasted about 30 minutes. Figure 4 show a sample slide from the session.

5.3.1 Activity Break

The session was followed by an Activity Break. Participants were asked to fill in the details of the physics example done in the lecture.

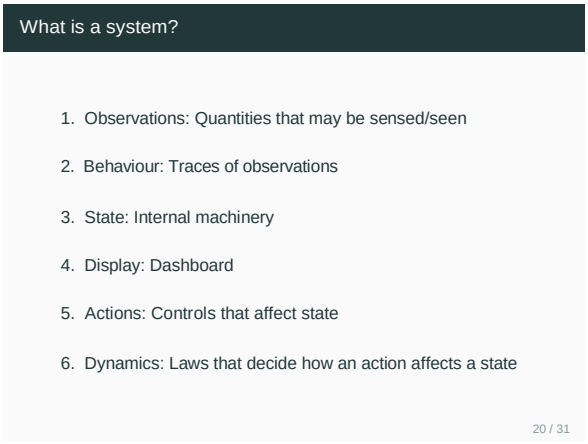

Figure **4**: Sample slide from the Motivation session of the workshop

5.4 Session on Transition Systems

In this session, the formal definition of transition systems was introduced, along with the notion of successor states. The different types of transition functions were examined. The notions of run, trajectory, trace and execution and behaviour were introduced. The example of a non-deterministic finite automaton (Figure 5) and a light bulb (Figure 6) and their respective dynamics were used to explain the key ideas.

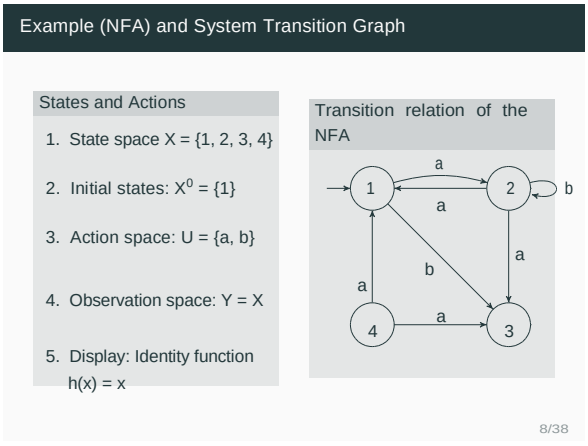

Figure **5**: Sample slide showing the NFA example

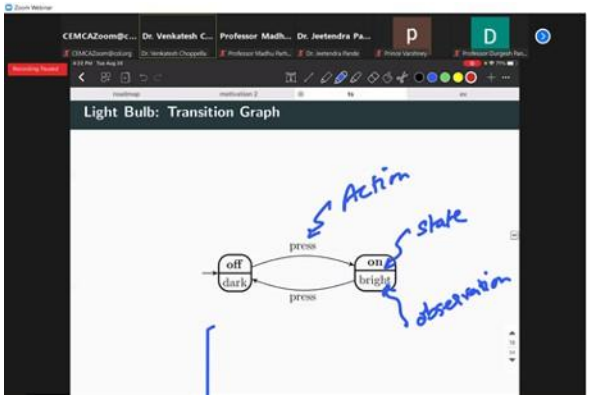

Figure 6: Sample slide taken during the session showing the light bulb example

5.4.1 Activity Break

In the activity break, the participants were required to define their own transition systems and show some traces of their systems.

5.5 Session on Examples

The third main session of workshop's first day was devoted to examples of transition systems. The first system example demonstrated was Grid Walk, in which the user interactively navigates along a grid to reach a destination. The second system example was interactively summing the elements of an array. In both examples, first the demo was shown and then the formal system definition was presented. Screen shots of the Grid Walk and Array Sum demos are shown in Figures 7 and 8 respectively.

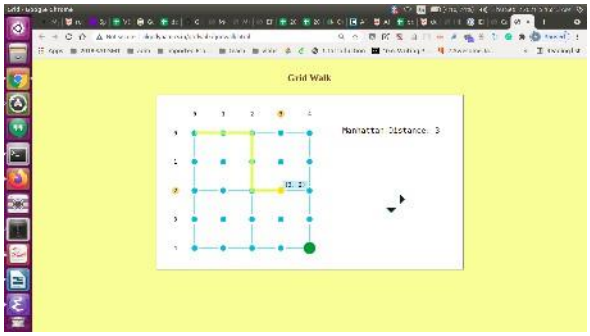

Figure 7: Screen shot of the Grid Walk demo.

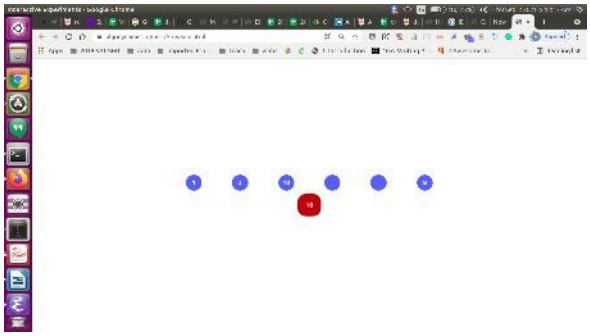

Figure 8: Screen shot of the Array Sum demo.

5.5.1 Activity Break

In the activity break, the participants were asked to write down sample runs of the examples done in the lecture, and also design some simple transition systems like a coin toss. Then, they were show two other demos (Water tank and bank ATM) and asked to model them as transition systems. These were given as projects to do.

5.6 Wrap up and Conclusion session

This was a very short session which wrapped up the main ideas of Day 1 and indicated what lay ahead for Day 2.

5.7 Day 2 Session Plan

The Day 2 session plan is shown in Table 2.

Table 2: Session plan on Day 1 of the Workshop

No.	Topic	Duration (Approx.)
1.	Iterative Systems with Examples	30min
2.	Activity Break	10min
3.	I(n)tera(c)tive Problem Solving	20min
4.	Activity Break	10min
5.	Bubblesort with Successive Refinement	30min
6.	Activity Break	10min
7.	Conclusion and Discussion	10min

5.8 Session on Iterative Systems

In this session, the important idea of iterative systems and its connection with algorithms was introduced. A sample slide of the session is shown in Figure 9.

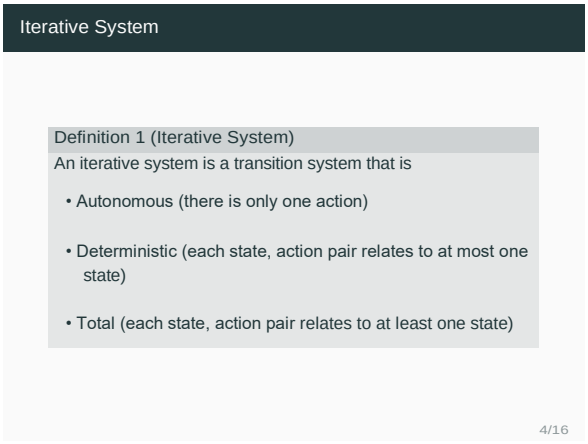

Figure **9**: Sample slide from the Iterative Systems session

The connection between iterative systems and the 'while loop' in programming was demonstrated. For this part of the session, a Google Colab notebook was used to interactively write code and demonstrate examples of iterative systems. Figure 10 is a screen shot of the Google Colab environment is shown.

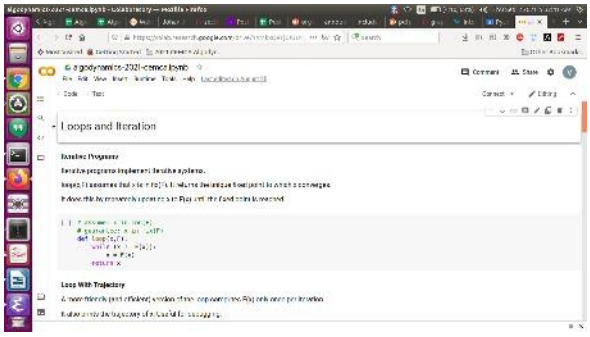

Figure **10**: Screen shot of the Google Colab notebook used in the Workshop.

5.8.1 Activity Session

The activity session following the session on Iterative Systems asked the participants to construct their own iterative systems.

5.9 I(n)tera(c)tive Problem Solving

In this session, the participants were introduced to the formal definitions of interactive and iterative problem solving. The array sum example was used and a comparison between the two notions of problem solving were made. Figure 11 shows a sample slide from the session.

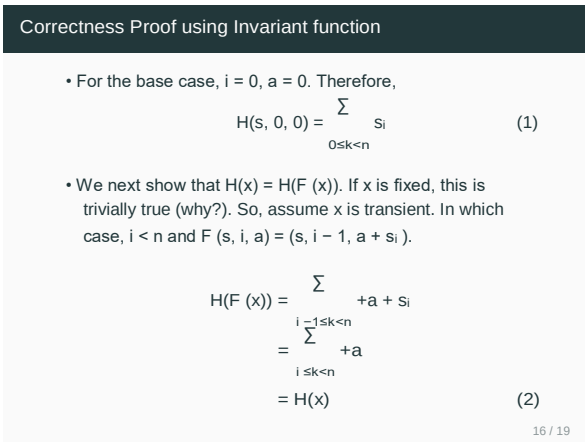

Figure 11: Sample slide from the session on I(n)tera(c)tive Problem Solving.

5.9.1 Activity Break

Due to paucity of time, the activity break was skipped.

5.10 Bubblesort

In this session, successive refinement — the transformation from an interactive solution to an iterative solution — was demonstrated using the Bubblesort example. Five different systems (‘machines’) were demonstrated. The motivation for the transition from each machine to the next was presented. A screen shot of the first system (‘swap machine’) is shown in Figure 12.

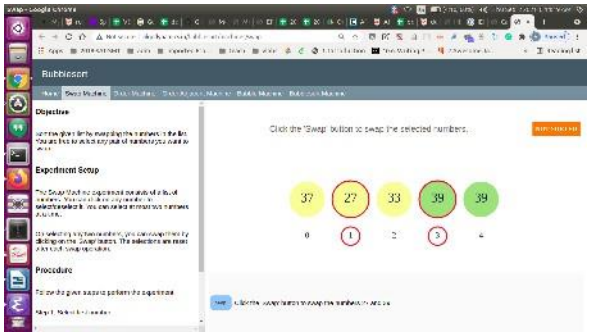

Figure 12: Screen shot of the swap machine, part of the Bubblesort demo.

5.10.1 Activity Break

Due to time running out, the activity break was skipped.

5.11 Concluding Session

In the concluding session, a summary of the workshop was presented. Points for discussion were raised. Figure 13 shows a sample slide from the concluding session.

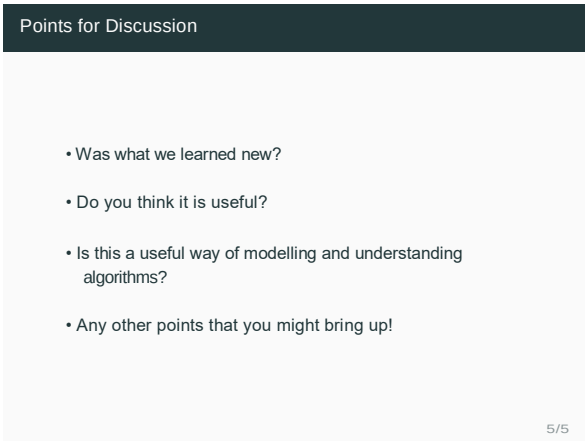

Figure 13: Sample slide from the concluding session.

6 Feedback analysis, challenges, and programme evaluation

The feedback was collected via three forms. The forms along with the total number of participants who filled it is given in Table 3.

Table 3: Surveys conducted as part of workshop

Survey	No. of Responses
Participant Background	31
Workshop Feedback	42
Post-workshop activity	21

6.1 Participant Background

The main data from the participant background is summarised in Table 4.

Table 4: Break up of basic participant data

Background Domain (Fig. 14) (31 responses)	CS or IT 21	Physical Sc. or Engg. 9	AI & Data Science 1	
Familiarity with Algorithms (Fig. 15) (31 responses)	A little bit 12	Quite familiar 10	Not familiar at all 6	Have taught Algorithms 3

6.1.1 Background Domains of Participants

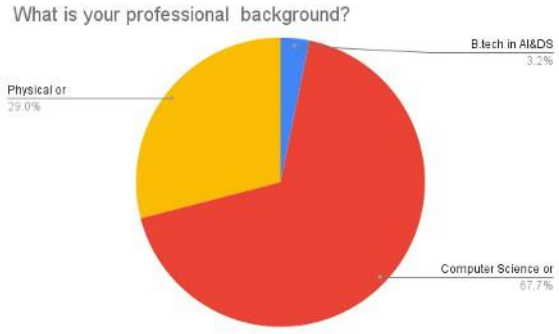

Figure 14: Pie chart showing background domain of participants

Amongst those who filled the form, about two-thirds were from a computing background. The others were from science and engineering backgrounds.

6.1.2 Familiarity with Algorithms

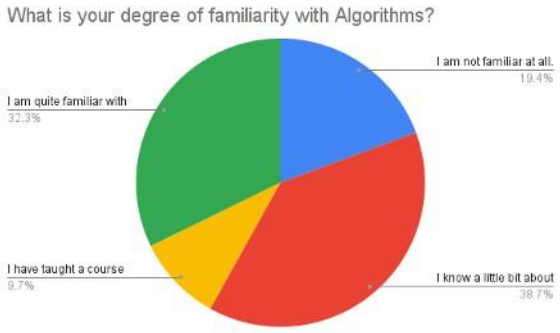

Figure 15: Pie chart showing familiarity of participants with algorithms

Almost a fifth of those who filled the feedback form had no familiarity with algorithms, and about 40% had only limited familiarity; yet they attended the workshop.

6.1.3 Challenges faced when teaching or learning algorithms

The responses to the question on “what was challenging about learning algorithms ” are summarised in Table 5. The responses point to lack of good examples, converting algorithm to code, implementation in real-world and time-space complexity.

Table 5: Challenges faced in teaching or learning algorithms

Difficulty with Coding
Lack of good examples
Implementation in real-world scenarios
Time-space complexity

6.2 Workshop Feedback

There were 42 respondents who filled the feedback form.

6.2.1 Age of Participants

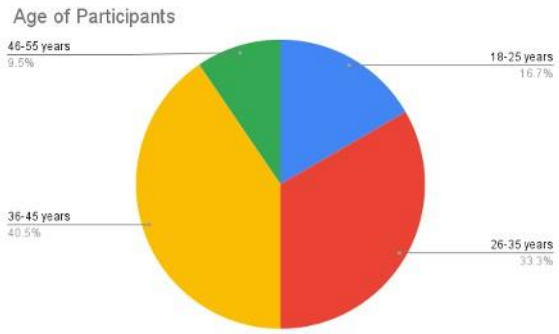

Figure **16**: Pie chart showing age distribution of sample of participants who filled the feedback form

As seen in Figure 16, close to two-thirds were from the age grounp 25-45 years. Only 16.7% were in the 18-25 group. The rest (9.5%) were in the age group 46-55 years.

6.2.2 Gender of Participants

Amongst those who filled the feedback, the gender division was approximately 43% females vs. 57% males.

6.2.3 Workshop rating

As seen in Figure 17, majority participants rated the workshop as excellent.

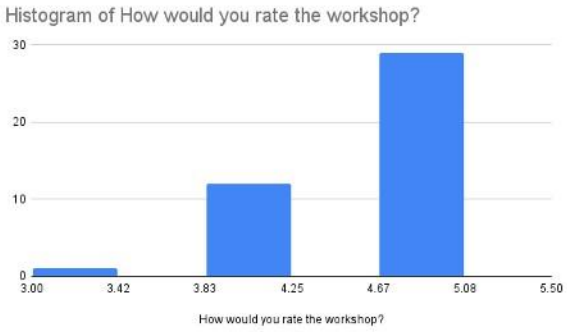

Figure **17**: Pie chart showing workshop rating 1 (poor) to 5 (excellent).

6.2.4 Utility of what was learnt in the workshop

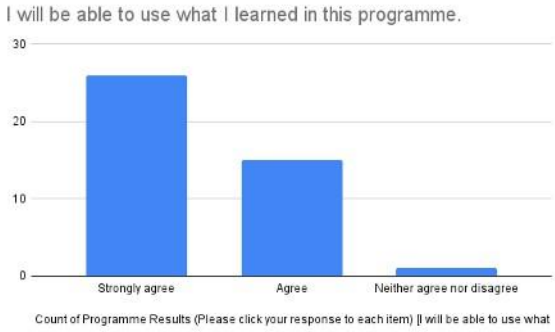

Figure **18**: Perception amongst participants that they will be able to use what they learned in the workshop.

As shown in Figure 18, a majority of the respondents felt that they will be able to use the material they learned in the workshop.

6.2.5 Feedback on "what was the best aspect of this workshop?"

Selected responses to identifying the best aspect of the workshop are given in Table 6. The interactive nature of the workshop and examples was appreciated.

Table 6: Selected responses to the question "What was the best aspect of the workshop?"

Teachers were so amazing
Interactive Sessions
The interactive websites which allowed us to simultaneously use while it was being explained.
Practical and in depth learning methodology.
Excellent demonstration of algorithms and interactive experiments
The content designed to explain the course was very precise and easy
Learned the way how to teach the difficult topics.

6.2.6 Feedback on the most important/significant ideas that learnt while attending this workshop.

Table 7: Selected responses about the most important ideas learnt in the workshop.

Teaching and learning algorithms
Transition system concepts
Besides course terms the important thing I learnt how the lecturer is explaining each and every term so easily and so precisely
Great insight about Algorithms
We can learn algorithms interactively

6.2.7 More such programmes

As shown in Figure 19, almost all the participants felt that more programmes on the Algodynamics topic would be useful to them.

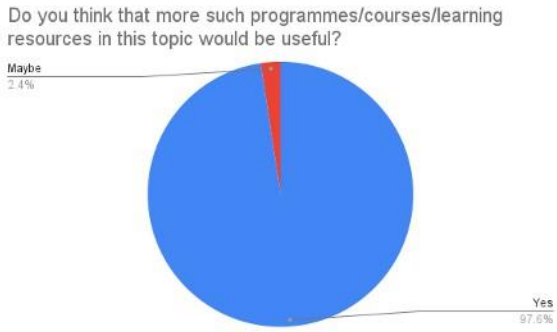

Figure **19**: Responses on whether more programmes on the topic of Algodynamics would be useful.

6.2.8 Further feedback about the workshop

Table **8**: Selected responses for further feedback about the workshop

Looking forward for such programs in future.
Excellent work
excellent workshop
Good & Useful

6.3 Post-Workshop Activity Questionnaire

The post-workshop activity questionnaire was given to assess any new understanding of the participants based on the ideas presented in the workshop.

There were two three kinds of questions: basic information, feedback about the workshop, and technical questions related to algorithms. Basic information was also covered in the Workshop Feedback form and are therefore omitted here. Some additional feedback about the workshop was collected and summarised in the next two subsections below:

6.3.1 Overall Feedback

Selected response to the question 'Overall Feedback' are shown in Table 9.

Table 9: Selected responses on overall feedback

The event was new and very good providing new approaches towards study of algorithms and teaching them as well.
Very amazing session
Excellent session, thanks to Sir for interactive demonstration, way of teaching, explanation and all
Nice

6.3.2 Responses to "The one thing that you will apply out of your learning from this workshop"

Table 10 lists some of the selected responses to the question of the one thing that participants think they can apply from the learnings of the workshop.

Table 10: Selected responses to what partipants could apply from their learning from the workshop.

Looking at algorithms as systems and transition machines. Breaking down an algorithm into parts and creating a state machine visualisation for every step.
Develop algorithms,computation and transition systems
Approaching problems as a system of transitions.
Examples

6.3.3 Response to "what is an algorithm?"

As seen in Table 11, most respondents still identified an algorithm as a sequence of steps to solve a problem. This indicates that the connection between an algorithm and a transition system was not firmly evident to the participants. This in turn suggests that more time and practice is needed with the material before the main ideas of algodynamics get internalised.

Table **11**: Selected responses to what is an algorithm?

Step by step procedure to perform a task
Algorithm is a sequence of steps for solving a problem.
A process or set of rules to be followed in calculations or other problem-solving operations, especially by a computer.

6.4 Analysis and Challenges

6.4.1 Analysis

The feedback and other data shows that the workshop successfully engaged the participants. They found the presentation of the material with the help of interactive experiments novel and useful. The participants also indicated that they would like to have more workshops on the same topic. Overall, the feedback is very encouraging.

6.4.2 Challenges

The main challenge faced by the students, and to some extent the presenter was the paucity of time. Despite carefully dividing the workshop into multiple sessions, the overall time was insufficient and this resulted in rushing through the last session on Bubblesort. Another challenge faced by the students was the lack of familiarity with the course infrastructure tools: Google classroom and the Colab platform for writing and running code. As a result, almost no one was able to attempt the exercises.

7 Way Forward

Going forward, it is clear that more workshops on Algodynamics will need to be organised. The workshops should be ideally spread over 5-6 days with 90-105 minute sessions each day. Rather than trying to increase the scope of the workshop by covering more new concepts, the course should involve more hands-on activity and exercises.

Many participants were unfamiliar with the technology used in the workshop. This is likely to be the case in the future as well. Each workshop needs to be preceded by a short boot camp session in which the participants are introduced to the technologies that form the workshop infrastructure.

8 Conclusion

The workshop on Algodynamics was organised by CEMCA and Uttarakhand Open University. It was conducted on 24-25th Aug, 2021. The feedback from the workshop was overwhelmingly positive. More events should be planned to increase the dissemination of the ideas presented in the workshop. The workshop format and length could be adjusted so that partipants have more time to digest the new material and gain confidence using it.

Appendix

Workshop Publicity Flyer

See Figure 20.

List of Participants

See Figures 21 and 22.

Figure **20**: Publicity Flyer for the Workshop

Sl. No	Name	Designation	Department
1	Anita Dayanand Mhatre	Assistant Professor	Information Technology
2	Anurag Bhatt	Assistant Professor	Computer Science and Engineering
3	Arpita Joshi	Assistant Professor	Computer Science
4	Balam Singh Dafauti	Assistant Professor (AC)	Computer Science
5	Chitradevi B	Assistant Professor	Computer Science
6	Chitralekha singh	Electronic engineer	Electronic
7	Darpan Anand	Professor	CSE
8	Deepak Singh	Student	Computer Science
9	Dhirendra Kumar Sharma	Assistant Professor SG	Computer Science
10	Dr.Anamika Pant	Assistant Professor	Computer Science
11	Dr. Ashok Kumar	Assistant Professor	Electronics
12	Dr Ashutosh Kumar Bhatt	Associate professor	School of Computer Science and IT
13	Dr. Devendra Singh Chauhan	Assistant Professor	Physics
14	A Nanda Kishore Reddy	Student	ECE
15	Akshay Shenoy	Professional	Information Science and Engineering
16	Dr. Mukesh Joshi	Associate Professor	SOC
17	Dr. Naresh Kumari Gill	Lecturer	CSE
18	Dr. Nitin Deepak	Associate Professor	Technology and Sciences
19	Dr. Shiv Om Pratap	Professor and Head	Biosciences
20	Dr. Atul Chand	Assistant Professor	Defence & Strategic Studies
21	Dr. Bhawna Pant	Assistant Professor	Zoology
22	Dr. Neha Singh	Assistant Professor	Zoology
23	Dr. Nitish Kumar Ojha	Assistant Professor	Computer Science and Engineering
24	Dr. Sandeep Kumar Budhani	Associate Professor	CS & E
25	Dr. Sangram Panigrahi	Assistant Professor	CS & IT
26	Dr. Vikas Tayal	Assistant Professor	Physics
27	Dr.Chandrakant Kumar Singh	Assistant Professor	Computer Science
28	Dr.Deependra Singh Topwal	Assistant Professor	Defence Studies
29	Dr.M.Natarajan	Assistant Professor	Computer Science
30	Dr.S.Yuvarani	Assistant Professor	Computer Applications
31	Dr.V.Poongodi	Assistant Professor	Computer Applications
32	Gayathri. A	Student	Zoology
33	Gokul.H	Student	CSE
34	Shlok Pandey	Student	Computer Science
35	VJS Pranavasri	Student	Computer Science
36	Govind Nagila	Junior Engineer	PTCUL
37	Harsh Vardhan Pant	Assistant Professor	Computer Science
38	Irene Aswal	Student	Information Technology
39	Jyoti Khubchandani	Research Scholar	Mathematics
40	Jyotheeswar Ganne	Student	CSE
41	K.Jeyalakshmi	Assistant Professor	Computer Science
42	Krishnanand Tripathi	Student	Forensic Science
43	Kshitij Naresh Raut	Student	CSE

Figure **21**: List of Participants: Page 1

44	Kunwar Deep Narayan	Assistant Professor	MCA
45	Mahima Sah	Student	Computer science
46	Mandar Karande	System Software Engineer	Information Technology
47	Md.Zakir Hossain	Computer Science	Computer Science
48	Mohan Singh	Student	Information Technology
49	Neha Goyal	Information Technology Specialist	Information Technology
50	Vinod Singh Pangtey	Manager	Food Corporation of India
51	Pawan Kumar	NA	NA
52	Payal Khubchandani	Research Scholar	Mathematics
53	Prabhat Priyadarshi	Student	Computer Science and Information Technology
54	Preethy Jemima P	Assistant Professor	Computer Science and Engineering
55	Priyanka Gupta	Assistant Professor	Home Science
56	Trilok Singh Negi	MIS Coordinator	Education Department
57	Rajdeep Jung	Programmer	USERC Dehradun
58	Rohit Singh Deopa	Web page	Programming
59	Sanni	Student	Information Science and Engineering
60	Santhosh B	Associate Professor	MCA
61	Santosh Kumar	Research Scholar	Computer Science
62	Seema Rawat	Student	Computer science
63	Shilpa Aneja	Research Scholar	Computer science
64	Shiv Dutta Mishra	Assistant Professor	Computer Science and Engineering
65	Sowmya Narasimhaiah	PI	KSP
66	Swati Kandpal	Student	PGDCA
67	Thinaharan N	Assistant Professor	Computer Science

Figure **22**: List of Participants: Page 2