Unplugged Activities to Introduce Parallel Computing in Introductory Programming Classes: An Experience Report

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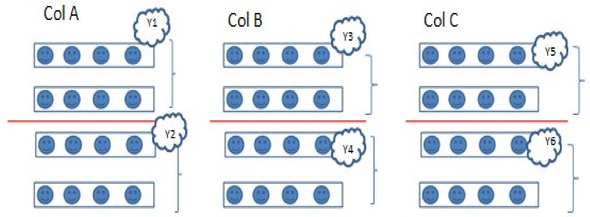
Overview

- Early programming courses present complex concepts to novice students
- Introducing parallel programming in early classes alongside traditional sequential programming is challenging
  - ACM recommends PDC as a required Knowledge Area for undergraduate CS curricula
- Unplugged activities, which are activities done without programs and which usually have physical activity with visual component have shown to engage students and convey concept in a way that enhances learning[3].
  - Unplugged activities may help alleviate some of difficulties for students
  - Unplugged activities have been shown to increase student interest, and to enhance student understanding of CS programming concepts [1]
  - We have used unplugged activities to teach PDC concepts before introducing parallel programming.

FINDING THE YOUNGEST IN CLASS

- Students are asked to find the youngest student in the class
- The student on the aisle side is in charge of finding the youngest in their row
  - Told to communicate column-wise and then row-wise to find the youngest in the class



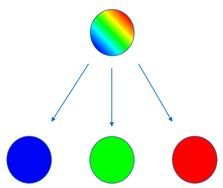
PDC Concept	Bloom Level
Distributed Computing Architecture	K
Communication Pattern	K
Parallel Overhead	K
Sequential Dependency	K
Load Imbalance	K

- Extensions
  - Let the class partition themselves
  - If there were 1,000 students, could they find the youngest faster than if there were only 100?

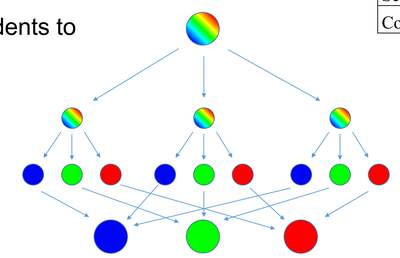
M&M SORTING

- Sorting M&Ms according to color
- Have one student sort M&Ms into separate bowls and have another student time it
- Have three students sort the M&Ms and have another time it
- Compare the time taken by three students to single student

PDC Concept	Bloom Level
Serial vs Parallel (Speed UP)	K
Decomposition	K
Parallel Overhead	K
Sequential Dependency	K
Concurrency	K



Serial (1 student)



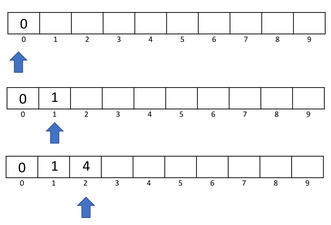
Parallel (3 students)

- Extensions
  - Add task of counting each color M&M after sorting is finished
  - Distribute M&Ms in different way

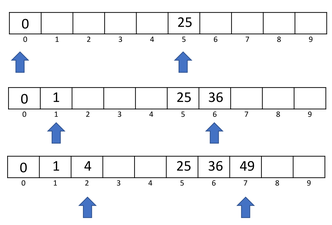
ARRAY IN PARALLEL

- Draw an array on the whiteboard with boxes
- Have a student populate the array using some function and time it
- Have one student start at beginning and another student start in the middle and time it
- Compare the two times

PDC Concept	Bloom Level
Serial vs Parallel (Speed UP)	K
Data Dependency	K/C
Concurrency	K/C



Serial (1 student)



Parallel (2 students)

- Extensions
  - Have more students work at once
  - At a critical point, adding students will actually result in a slower time

Evaluation

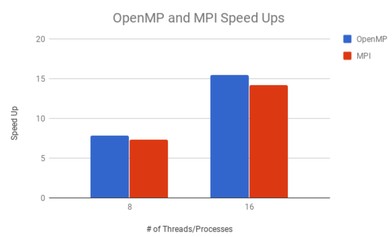


Fig:

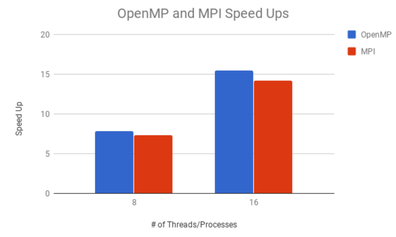


Fig:

CONCLUSION

- Our experiences show that using unplugged activities to introduce the PDC concepts reduce the barrier to learn parallel programming.
- Our preliminary evaluation indicates that students learns better when unplugged activities are used with traditional plugged activities compared to using traditional plugged activities only.

REFERENCES

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[2] C. Watson and F. W. B. Li, "Failure rates in introductory programming revisited," in Proceedings of the 2014 conference on Innovation & technology in computer science education - ITiCSE 14, 2014, pp. 39 – 44.
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[4] "iPDC Modules", https://www.csc.tntech.edu/pdcincs/index.php/ipdc-modules/

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