



PDC Unplugged: A Free Repository of Unplugged Parallel & Distributed Computing Activities

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Motivation – Need for PDC

- New ABET curriculum guidelines for computer science programs:
“3. **Exposure to** computer architecture and organization, information management, networking and communication, operating systems, and **parallel and distributed computing.**”
- ACM/IEEE Joint Taskforce on Computing Curricula’s 2013 report ([CS2013](#)) recommends at least 15 hours of PDC in the undergraduate curricula.
- NSF/IEEE TCPP Curriculum Initiative on Parallel & Distributed Computing ([TCPP 2012](#)) suggests over 100 PDC topics and maps them to undergraduate courses.
- Many faculty interested in incorporating PDC into their courses but unsure how to begin.



Unplugged Activities

- One way to rapidly introduce PDC concepts is to use unplugged activities.
 - Includes analogies, role-playing, games, dramatizations, etc.
 - Often a welcome break from the usual lecture format.
 - Engages many senses.
 - Recent research suggests that unplugged activities aid in improving student understanding of PDC.
- Unplugged activities for PDC are widely scattered and generally hard to find.
 - Makes it difficult to identify available unplugged activities.
 - Can cause authors to “reinvent the wheel” when creating unplugged activities.
- CS Unplugged not an optimal choice.
 - Geared toward K-12
 - Custom repository would allow mappings to CS2013, TCPP2012, and specific courses



PDC Unplugged

- PDC Unplugged (pdcunplugged.org) is a repository of unplugged activities curated from thirty years of the PDC literature.
- Unplugged activities are viewable through several filters, making it easy for educators to rapidly identify activities for use.
- Research Questions:
 - What unplugged activities currently exist for PDC?
 - How do unplugged activities cover TCPP Topic Areas and CS2013 PD Knowledge Units?
 - Where should educators concentrate on developing new content?



Site Overview – Activity Structure

```
---  
title:  
date:  
tags:  
---  
  
## Original Author/link  
  
---  
  
## CS2013 Knowledge Unit Coverage  
  
---  
  
## TCPP Topics Coverage  
  
---  
  
## Recommended Courses  
  
---  
  
## Accessibility  
  
---  
  
## Assessment  
  
---  
  
## Citations
```

- PDC Unplugged created with Hugo and GitHub.
- Each activity is written in Markdown and contains all details for implementation.
- Educators can contribute activities by initiating a GitHub pull request or sending an e-mail.



Site Overview - Taxonomies

- Custom taxonomy system helps classify individual activities.
- Hidden taxonomies (not shown) give a finer grain of classification control.

Markdown header

```
---  
title: "FindSmallestCard"  
cs2013: ["PD_ParallelDecomposition", \  
        "PD_ParallelAlgorithms"]  
tcpp: ["TCPP_Algorithms", "TCPP_Programming"]  
courses: ["CS1", "CS2", "DSA"]  
senses: ["touch", "visual"]  
---
```



Rendered header

FindSmallestCard

PD_ParallelDecomposition PD_ParallelAlgorithms TCPP_Algorithms TCPP_Programming CS1 CS2
DSA touch visual



Site Overview - Demo

The screenshot shows a web browser window displaying a site overview page. The page title is "Activities (38)". The browser's address bar shows the URL "http://www.illustrativemathematics.org/activities/38". The page content includes a list of activities, each with a title, date, and a set of colored tags. The activities listed are:

- MessagePassingAcrotials** (January 8, 2018) with tags: **100%**, **100%**, **100%**, **100%**, **100%**
- FlowerJoinAnalogy** (January 8, 2018) with tags: **100%**, **100%**, **100%**, **100%**, **100%**, **100%**, **100%**, **100%**
- SurvivorAnalogy** (January 8, 2018) with tags: **100%**, **100%**, **100%**, **100%**, **100%**, **100%**, **100%**, **100%**
- BuildingCommunicationAnalogy** (January 8, 2018) with tags: **100%**, **100%**, **100%**
- PlantingTrees** (January 8, 2018) with tags: **100%**, **100%**

[Link to Demo Video](#)



Curation Overview

- ACM Digital Library, IEEE Xplore and Google Scholar used to build curation.
 - Used various keywords (e.g. “unplugged”, “analogy”, “metaphor”, “parallel”, “concurrency”) to seed search.
 - Scanned each paper’s list of references to identify earlier activities.
 - Used Google Scholar to find citing publications.
- In some cases, separate papers describe the same or similar activities.
 - PDC Unplugged merges these descriptions as “variations” of a single activity.
 - Other papers listed multiple activities → split into multiple distinct activities.
- Existing curation identifies ~40 unique activities.
 - Earliest identified paper published in 1990.
 - Sorting algorithms and analogies most described.
 - Older activities typically do not include assessment or external resources.



CS2013 and TCPP Coverage

TABLE I
CS2013 COVERAGE

Knowledge Unit	Num. Learning Outcomes	Num. Covered Outcomes	Percent Coverage	Total Activities
Parallel Fundamentals	3	2	66.67%	2
Parallel Decomposition	6	5	83.33%	21
Parallel Communication and Coordination	12	6	50.00%	9
Parallel Algorithms, Analysis, and Programming	11	6	54.54%	12
Parallel Architecture	8	7	87.50%	9
Parallel Performance (E)	7	6	85.71%	10
Distributed Systems (E)	9	1	11.11%	2
Cloud Computing (E)	5	1	20.00%	3
Formal Models and Semantics (E)	6	1	16.66%	1

TABLE II
TCPP COVERAGE

Topic Area	Num. Topics	Num. Covered Topics	Percent Coverage	Total Activities
Architecture	22	10	45.45%	9
Programming	37	19	51.35%	24
Algorithms	26	13	50.00%	22
Crosscutting and Advanced Topics	12	7	58.33%	8

- Uneven coverage over CS2013 and TCPP.
- Topics and outcomes that are highly specific (e.g. particular language or library), ask for theoretical definitions, ask to implement code or overly broad have the lowest coverage.
- Purely elective knowledge units have lowest coverage for CS2013.

E = elective



Where are the gaps?

- Distinct lack of activities related to distributed computing principles
 - Web-searches and peer-to-peer computing
 - Distributed communication constructs (scatter/gather, broadcast, multicast)
 - Cloud computing and power consumption also lacking in activities
- Distinct lack of activities that engage the sense of touch or sound.
 - Most activities have a strong visual component.
 - Developing activities that engage other senses aids more diverse students.
 - Only 9 activities marked as “generally accessible”.
- Assessment appears to be a relatively recent trend.
 - There is value in assessing existing unplugged activities.
 - PDC Education community should also encourage authors to submit papers that evaluate existing unplugged activities.
 - Depositing materials in a repository should be a recommended practice.



Conclusions & Future Work

- PDC Unplugged will be a valuable resource for CS Educational Community.
- Anyone using or developing unplugged activities are encouraged to submit descriptions to PDC Unplugged.
- Future work will consist of reaching out to authors currently represented in curation and asking them to deposit materials into PDC Unplugged.



Thank You!

- Funding for this work is provided by the National Science Foundation (NSF) Collaborative Research Grant DUE-1855761, *Collaborative Research: CSinParallel: Experiential Learning of Parallel and Distributed Computing Through Sight, Sound and Touch*

The views expressed are those of the authors and do not reflect the official policy or position of West Point, the Department of the Army, the Department of Defense, or the US Government.