Research Methods in computer science
Spring 2023

Lecture 5

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Agenda

Research and Startups
Anatomy of Research Papers
HW2
Parallels to Products

Research can be thought of as a Product

Product Viability Evaluation

Companies do this all the time

Let's look at some examples
Viability of Product Idea

1. What is the potential market size or demand?

2. Who are your competitors?

3. Is it a trend, fad, flat or growing market?

5. Who are your target customers?

6. What is your potential selling price?

Research vs Startups

What should you work on? Are you working on the right problem? MVP.

Usually resource constrained and must prioritize. Small team.

Selling process. Marketing.

(Thanks to Guo)
Research Papers

Understanding what papers look like
Anatomy of a Research Paper

Abstract
Introduction
Related Work
Design and Implementation
Evaluation
Conclusion
Some of the contents in the next few slides from Jennifer Widom’s notes on Writing Technical Papers.
Abstract

Summary of motivation, state of the art, your algorithm or system, and results each in 1-3 sentences.
Abstract MadLibs!!

This paper presents a ________ method for ________
(synonym for new) (sciencey verb)
the ________. Using ________, the ________ was measured to be _______ +/- _______. Results show ________ agreement with
(noun few people have heard of) (something you didn’t invent) (property) (number) (number)
(units) (sexy adjective) theoretical predictions and significant improvement over
(previous efforts by ________, et al. The work presented
(Loser) here has profound implications for future studies of
(buzzword) and may one day help solve the problem of
(buzzword) (supreme sociological concern)

Keywords: ________, ________, ________
(buzzword) (buzzword) (buzzword)

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Introduction

What is the problem?

Why is it interesting and important?

Why is it hard? (E.g., why do naive approaches fail?)

Why hasn't it been solved before? (Or, what's wrong with previous proposed solutions? How does mine differ?)

What are the key components of my approach and results? Also include any specific limitations.

Summary of results and contributions.
Related Work

You want to give a sense of the old and new work in this area.

Where to look for these?

Organized is better than not organized
Organizing Related Work

Lists
Figures
Diagrams
Tables
Sub-sections
Competition table
Fig. 1. Selected classes of dissemination protocols in sensor network. CodeDrip uses network coding to make dissemination of small data efficient and fast.
Table 1: Comparison of different non-intrusive people identification methods.

<table>
<thead>
<tr>
<th>Paper</th>
<th>Sensor</th>
<th>Accuracy (%)</th>
<th>population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hnat et al. [6]</td>
<td>Ultrasonic</td>
<td>94</td>
<td>5</td>
</tr>
<tr>
<td>Pan et al. [18]</td>
<td>Geophone</td>
<td>96</td>
<td>5</td>
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<td>Zeng et al. [24]</td>
<td>Wi-Fi</td>
<td>93</td>
<td>4</td>
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<tr>
<td>Jenkins et al. [9]</td>
<td>Pressure</td>
<td>80</td>
<td>15</td>
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<tr>
<td>Khalil et al. [13]</td>
<td>Ultrasonic</td>
<td>95</td>
<td>20</td>
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Table I: State of the Art People Counting Solutions

<table>
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<tr>
<th>Solution</th>
<th>Application</th>
<th>Cost ($)</th>
<th>Privacy Preserving Level</th>
<th>Scalability</th>
<th>Real Time</th>
<th>Flexibility</th>
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</thead>
<tbody>
<tr>
<td>Break Beam Sensors</td>
<td>Counting</td>
<td>≤ 10</td>
<td>High</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>PIR Sensors</td>
<td>Presence</td>
<td>≤ 10</td>
<td>High</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Ultrasonic Sensor</td>
<td>Counting</td>
<td>≤ 100</td>
<td>Moderate</td>
<td>No</td>
<td>Training Required</td>
<td>No</td>
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<tr>
<td>RGB Cameras</td>
<td>Counting</td>
<td>≤ 100</td>
<td>Low</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>IR Imager</td>
<td>Counting</td>
<td>≤ 25</td>
<td>High</td>
<td>Yes</td>
<td>Training Required</td>
<td>No</td>
</tr>
<tr>
<td>Our Solution</td>
<td>Counting</td>
<td>≤ 25</td>
<td>High</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 1. Performance for state-of-the-art embedded VLC.

<table>
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<th></th>
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<tbody>
<tr>
<td>Data Rate</td>
<td>250 bps</td>
<td>800 bps</td>
<td>1 kbps</td>
<td>16 kbps</td>
<td>1 mbps</td>
<td>1-10 kbps</td>
<td>100 kbps</td>
</tr>
<tr>
<td>Distance</td>
<td>~10 cm</td>
<td>~2 m</td>
<td>~1 m</td>
<td>~5 m</td>
<td>NA</td>
<td>~20 cm</td>
<td>6 m</td>
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<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
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<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<td>Implementation</td>
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<td>MCU</td>
<td>MCU</td>
<td>ARM</td>
<td>FPGA+MCU</td>
<td>MCU</td>
<td>ARM + PRU</td>
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<td>Antenna</td>
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<td>LED-to-LED</td>
<td>LED-to-PD</td>
<td>LED-to-LED/DP</td>
<td>LED-to-PD</td>
<td>RGB-to-RGB</td>
<td>RGB/LED-to-LED/DP</td>
</tr>
</tbody>
</table>
IV. RELATED WORK

In this section, we overview the types of tools the networking community has built to evaluate network protocols.

**Link Emulation:** Single link emulation can be done on hardware (using channel emulators) or on software (using tools such as Netem). Prior work has shown that when correctly configured, Netem provides a realistic estimation of impaired network conditions and is sufficient for most networking experiments [15].

**Network Emulation:** Mininet [4] [5] uses light-weight virtualization by isolating certain OS resources, thus allowing emulation of large networks in a single machine. However, scalability becomes an issue when we want to emulate larger networks than can be tested in a single physical machine. Emulab [16] light-weight virtualization technique, FreeBSD jails, to setup multiple virtual interfaces per process group, similar to Mininet and CloudNet. CloudNet provides better resource isolation across the emulated nodes than Emulab and shows how we can use it on the commodity clouds. There is some prior work in data centers to optimize VM placement and routing [17]. CloudNet uses the concept of placement groups in Amazon EC2 where the virtual machines are placed as close to each other so that we can efficiently use the resources.

**Network Emulation Timing:** Time-Warp [18] explores the possibility of using time dilation in network emulation experiments. Future version of CloudNet may use this technique to offer added consistency in performance for emulations that requires very high-bandwidth. Slicetime is another effort to provide scalable and accurate network emulation [19]. Slicetime makes the simulations independent of real time constraint thus allowing simulation of complex and high performance networks when we have limited physical resources.
## Competition

$90M raised on concept of SMB loyalty in 2011 and 2012…
LevelUp, FiveStars, BellyCard, Mogl, Shopkick, etc.

*Loyalty in nightlife is wide open!*

<table>
<thead>
<tr>
<th>Feature</th>
<th>Flowtab</th>
<th>SOPAGO</th>
<th>coaster</th>
<th>TabbedOut</th>
<th>BarTab</th>
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<tr>
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<td>✔️</td>
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</table>
Related work variations

Merged with Introduction
Inter-mingled with relevant sections
Placement of Related Work
HW2 - Research Formulation

What are you trying to do? Articulate your objectives using absolutely no jargon.

How is it done today, and what are the limits of current practice?

What's new in your approach and why do you think it will be successful?

Who cares?

Heilmeier
HW2 - Research Formulation

If you're successful, what difference will it make?

What are the risks and the payoffs?

How much will it cost?

How long will it take?

What are the midterm and final "exams" to check for success?

Heilmeier