

UTSA CS 4593: CS-CURE

Course-based Undergraduate Research Experience in CS

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Week 3: Research Problems

UTSA CS-CURE

Week 3

- Objectives:
 - Identify potential topics of research interest within your field
 - Learn to clearly articulate research problems in a field
 - Learn from expert(s) in diverse fields within CS
- Deliverables:
 - Guest Research Lecture survey (*in class on Thursday*)
 - **Research proposal** - *due on Canvas this Saturday!*

Beginning Research: **Finding Relevant Themes**

Continued....

Finding Research Topics

Starting out in your field

- **Debrief on Activity 2**
 - Identifying specific topics & problems in your field (*S/G-specific flowchart*)
 - *Did you discover anything new?*

Finding Research Topics

Starting out in your field

- **Debrief on SIG Meeting 0**
 - Finding the top 3 conferences for your field
 - *Were they difficult to identify?*
 - *Did you find any you might want to attend? (virtually?)*

Finding Research Topics

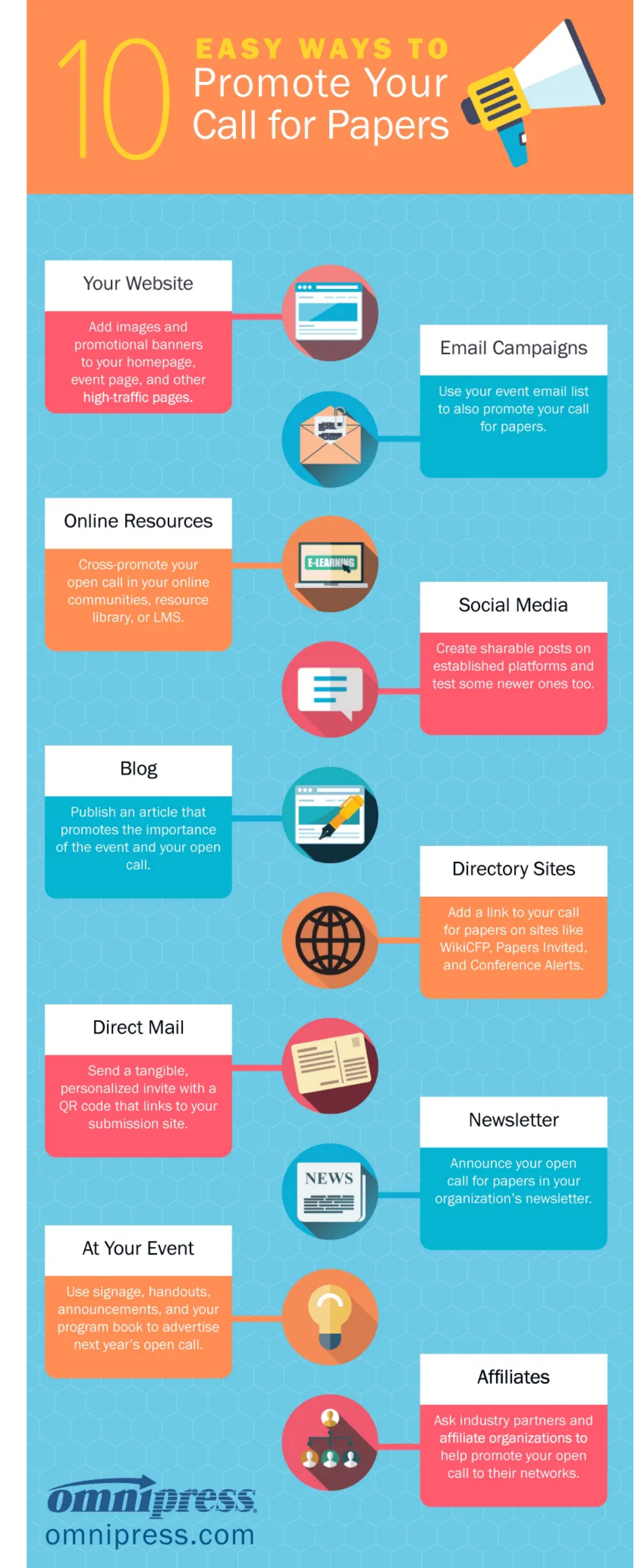
Starting out in your field

- **Debrief on Activity 2 & SIG Meeting 0**
 - Discovering what is relevant to your community via a CFP
 - *What did you learn about your community?*

More About CFPs & Papers

What to know

- **CFPs** are released on a predictable schedule - conferences are held around the same time(s) each year (or every other year).
 - Conferences generally change location
 - The **1st day “opening” talk** usually contains stats - acceptance rate for papers that year, total # of attendees, h-index, ...
 - Most require authors to **attend & present** their work if accepted for publication.



More About CFPs & Papers

Terms to know

- **citation** = reference to a source
 - Papers include citations *directly in the text* to identify sources, giving credit and allowing readers to find the source.
 - *Some fields within CS have higher citations on average than others.*
- **h-index** = the # of papers with the same # or more citations
 - e.g. h-index of 10 means they have at least 10 papers that have at least 10 citations each.
- **i-index** = the # of papers with x or more citations
 - e.g. i10 index refers to the # of papers with 10+ citations

Finding Research Topics

Starting out in your field

- **...So how do we refine research questions?**

Quick demo activity:

1. Identify topic or set of keywords
2. Go to the website of the top conference in your field (from this year if already held, or last year if not yet held)
3. Find the list of accepted papers
4. Search the list for 1 or more keywords
5. Skim/review the paper

Paper Reading:

1. The research problem should be justified briefly in the **abstract**.
2. Toward the end of the **introduction**, the authors should additionally state & motivate the research questions.

Outline of every* research paper:

Abstract
Introduction
Related work
Method
Experiments & Results
Conclusion

Characteristics of a Good Research Problem

Refining a topic

- Novelty / significance
- Feasibility / solvability
- Alignment with your expertise & resources
- Potential impact & real-world relevance

Characteristics of a Good Research Proposal

Identifying Research Problems

- Clear & concise
- Measurable
- Open-ended

Poorly-framed research questions:

- **Unoriginal** - lack novelty
- **overly broad**: address questions already extensively explored
- **Subjective or vague**: lack clear objective measures or definitions for key terms
- **Unfeasible**: exceed practical limitations or available resources
- **Leading or biased**: frame the question with a predetermined answer or ignore alternative perspectives
- **Unfocused**: lack a clear direction or potential contribution to the field

Brainstorming Techniques

Refining a topic

- Finding gaps
- Alternate applications
- Social & ethical implications
- Mind mapping

Mind Mapping

Brainstorming activity

CS Topics

(What fields and/or topics are you interested in within CS?)

Personal interests / side projects

(Where do you *enjoy* spending your time?)

short-term goals

(let these set the scope)
e.g. 1 semester course
e.g. finishing grad degree

Skills & experience

(What can you already do?
What other skills can you learn quickly?)

Resources

(What do you already have access to?)

long-term goals

(Are your career goals related to this at all?)

Mind Mapping

Brainstorming activity

Articulating Research Problems/Questions

Example: Computer Vision

Can computer vision be used
to improve driving?

How can convolutional neural
networks be made more robust
to image distortions caused by
fog and rain conditions in
autonomous driving
applications?

Articulating Research Problems/Questions

Example: Software Engineering

Are microservices better than traditional software development approaches?

How can the adoption of microservices architecture be optimized for large-scale software development projects, balancing agility and maintainability?

Articulating Research Problems/Questions

Example: Cybersecurity

How can we make
cyberattacks less successful?

How can blockchain technology
be leveraged to enhance the
security and accountability of
data sharing in healthcare
systems, while mitigating
privacy concerns?

Articulating Research Problems/Questions

Example: Natural Language Processing (NLP)

How can computers
understand language?

Can the integration of sentiment
analysis and topic modeling
techniques improve the
effectiveness of automated
news summarization for low-
literacy audiences?

Articulating Research Problems/Questions

Example: Human-Computer Interaction (HCI)

Are AR headsets good for learning?

How can augmented reality interfaces be designed to promote collaborative learning and engagement in STEM education for visually impaired students?

Articulating Research Problems/Questions

Example: AI Applications

Is AI dangerous?

What are the ethical and social implications of using facial recognition technology in law enforcement, and how can we design responsible AI systems that mitigate bias and protect privacy?

Beyond this course:
Finding Relevant Themes

Finding Relevant Themes

Refining research directions

- How do we know if the research question is ***relevant***?
- **Ask an LLM** (*really!*) - Google Bard is connected with search and does an OK job at this.
- **Ask an expert** - *much better, but you may get varying opinions..*
 - *Ask a community of experts - online forums, at meetings/conferences*
- **Look for a resource on it** - *does a paper on this exact topic already exist?*
 - *Are there YouTube videos, GitHub repos, or tutorials already teaching this?*
 - *If so, this is when you begin to **look for gaps & differences***

Finding Relevant Themes

Refining research directions

- That time Google scooped me..
- That time Google scooped Google..

Finding Relevant Research

Graduate Students

- Good research problems additionally...
 - Align with the research of your advisor
 - Scoped within a timeframe that is reasonable for you to graduate
 - Set you up for success after graduation

Check the institution too!

e.g.:

<https://research.utsa.edu>

Finding Relevant Research

Postdoctoral Researchers

- Good research problems additionally...
 - Allow you to make significant progress during your contract
 - Align with recent job postings
 - Align with recent grant funding opportunities

Finding Relevant Research

Industry Researchers

- Good research problems additionally...
 - Align with the strategic goals of the company
 - Enable you to grow your career
 - Do not require company resources (*unless legal arrangements are made*)

Finding Relevant Research

Academic Researchers & Faculty

- Good research problems additionally...
 - Align with the strategic goals of the university
 - Align with the strategic goals of the funding agency
 - Extend beyond a single project (*open-ended enough to expand on*)

WINNERS ANNOUNCED

THE NSF 2026 IDEA MACHINE



Home About Why Enter? How to Enter Judging Eligibility & Rules FAQ Resources Toolkit

The NSF 2026 Idea Machine!

NSF priorities require bold approaches, built on core research. For our long-term agenda to have the greatest effect, we must venture beyond traditional paradigms to invite input from trusted stakeholders as well as new and unconventional partners. In this way, we ensure our future research themes are inclusive, innovative and in touch with the interests and priorities of the American people. Therefore, we devised a new, creative way to engage and seek input from a broad range of contributors. In the summer of 2018, NSF invited the scientific community, industry, nonprofits, and the public at large to participate in the NSF 2026 Idea Machine, a competition to help set the U.S. agenda for fundamental research in science and engineering. The Idea Machine encouraged individuals from all walks of life, age 14 or older, to submit pressing "grand challenges" in fundamental research or STEM education that have potential for great impact. We received about 800 entries from nearly every state in the U.S.; from established researchers, undergraduate and graduate students, teachers on behalf of their classes, and even high school and middle school students.

Interesting video!

https://www.nsf.gov/news/special_reports/nsf2026ideamachine/index.jsp

Q&A

?

- *Questions about...*
 - *CFPs or conferences*
 - *Your research topic or problem*
 - *Life (research) after this course*

Wrap-Up

Tuesday

- Identify potential topics of research interest within your field
- Learn to clearly articulate research problems in a field
- To Do:
 - Guest Research Lecture survey (*in class on Thursday*)
 - **Research proposal** - *due on Canvas this Saturday!*

See you Thursday!

Guest Research Lecture:
Dr. Sushil Prasad

Guest Research Lectures

Questions for experts in the field - ask them anything

- **About their research..**

- What challenges did you face during this research, and how did you overcome them?
- What are the real-world applications of your research?
- What are the existing approaches to your research work?

- **About their research field..**

- What emerging trends do you see? What promising new areas?
- What advice would you give to an undergraduate student interested in this research field?
- What resources or communities can you recommend?

- **About careers & skills..**

- What skills do you find important in your field?
- What was your career path?
- How do you balance your research with other academic & personal commitments?

Wrap-Up

Thursday

- Learning from experts in research
- To Do:
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See you next week!