

UTSA CS 4593: CS-CURE

Course-based Undergraduate Research Experience in CS

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Spring 2024

Week 2: Research Basics

UTSA CS-CURE

Week 2

- Objectives:
 - Identify potential topics of research interest within your field
 - Learn to search for relevant research themes in a field
 - Learn about basic research tools for use this semester
- Deliverables:
 - SIG Meeting 0 (in class on Thursday)
 - Activity 2 (in class on Thursday)

UTSA CS-CURE

Week 2

- Today:
 - Topics: tools & basic research
 - Looking ahead in the semester
 - Research proposals & project info

Identifying Research Topics

Getting started in new fields

Terms:

- **field** = area within CS
- **topic** = concept within the field
- **problem** = specific focus within the topic
- **approach** = unique methods for addressing the problem

Example:

- *Artificial Intelligence / Machine Learning*
- *Explainable AI*
- *Deep learning models are not easily interpretable, which is problematic for some applications (e.g. healthcare)*
- *Integrated gradients attempt to explain why a model classifies an input as it does, by comparing it with a baseline input.*

Identifying Research Topics

Getting started in new fields

Terms:

- **field** = area within CS
- **topic** = concept within the field
- **problem** = specific focus within the topic
- **approach** = unique methods for addressing the problem

Example:

- *Data science*
- *Visualization & HCI (human-computer interaction)*
- *Visualizing real-time data streams can be overwhelming in the amount of data and therefore not useful to the user.*
- *Leverage data reduction techniques* in combination with AR/VR for live integration of data with relevant user tools (e.g. heads-up displays HUDs while driving)*

....so where do we start?

*be more specific!

Identifying Research Topics

Getting started in new fields

1. Find relevant research communities

2. Review recent work/questions in the field

- *Types of conferences & meetings*
- *Types of publications*
- *How to read a research paper*

3. Plug yourself into the community

- *Join the groups, meetings, etc.*
- *Automate your research*

Beginning Research: Basic Tools

Advanced tools coming soon!

CS Rankings

csrankings.org

- Listing of top conferences & universities by field.
- Useful for:
 - searching for a graduate program/advisor
 - identifying top conferences.

CSRankings: Computer Science Rankings

CSRankings is a metrics-based ranking of top computer science institutions around the world. Click on a triangle (►) to expand areas or institutions. Click on a name to go to a faculty member's home page. Click on a chart icon (the bar chart icon after a name or institution) to see the distribution of their publication areas as a bar chart. Click on a Google Scholar icon (g) to see publications, and click on the DBLP logo (db) to go to a DBLP entry. Applying to grad school? Read this first. For info on grad stipends, check out CSStipendRankings.org. Do you find CSRankings useful? Sponsor CSRankings on GitHub.

Rank institutions in USA by publications from 2014 to 2024

#	Institution	Count	Faculty
1	Carnegie Mellon University	19.2	173
2	Univ. of Illinois at Urbana-Champaign	13.9	112
3	Univ. of California - San Diego	12.3	128
4	Georgia Institute of Technology	11.0	143
5	Massachusetts Institute of Technology	10.2	92
5	Univ. of California - Berkeley	10.2	95
7	University of Michigan	10.1	100
7	University of Washington	10.1	81
9	Stanford University	9.6	68
10	Cornell University	9.3	83
11	University of Maryland - College Park	8.6	88
12	Northeastern University	7.7	87
13	Purdue University	7.1	74
14	University of Wisconsin - Madison	7.0	70
15	University of Texas at Austin	6.9	50
16	University of Pennsylvania	6.7	74
17	Columbia University	6.6	59
18	Princeton University	6.4	59
19	New York University	6.2	72
20	Univ. of California - Los Angeles	5.5	43
20	University of Massachusetts Amherst	5.5	60
20	University of Southern California	5.5	61
23	University of Chicago	5.4	48

Google Scholar

scholar.google.com

- Search engine specializing in research - papers and profiles.
- Useful for:
 - **free paper access**
 - **finding researchers**
 - **passive research (save articles & it recommends more).**

The screenshot shows the Google Scholar homepage. At the top, there are navigation links: a menu icon, "My profile" (with a graduation cap icon), and "My library" (with a star icon). Below the header is the Google Scholar logo. A search bar is centered with a magnifying glass icon. Underneath the search bar are two radio buttons: one selected for "Articles" and another for "Case law". To the right of the search area are icons for email and more options. The main content area is titled "Recommended articles" and lists three academic papers with star ratings, authors, titles, publication details, and "HTML" download links. Each article has a downward arrow icon to its right.

Article Rating	Title	Authors	Publication	Last Updated	Link
★	Diffusion models for out-of-distribution detection in digital pathology	J Linmans, G Raya, J van der Laak, G Litjens	Medical Image Analysis	3 days ago	HTML
★	Adversarial perturbation denoising utilizing common characteristics in deep feature space	J Huang, Y Dai, F Lu, B Wang, Z Gu, B Zhou, Y Qian	Applied Intelligence	4 days ago	HTML
★	Towards universal and sparse adversarial examples for visual object tracking	J Sheng, D Zhang, J Chen, X Xiao, Z Zheng	Applied Soft Computing	4 days ago	HTML

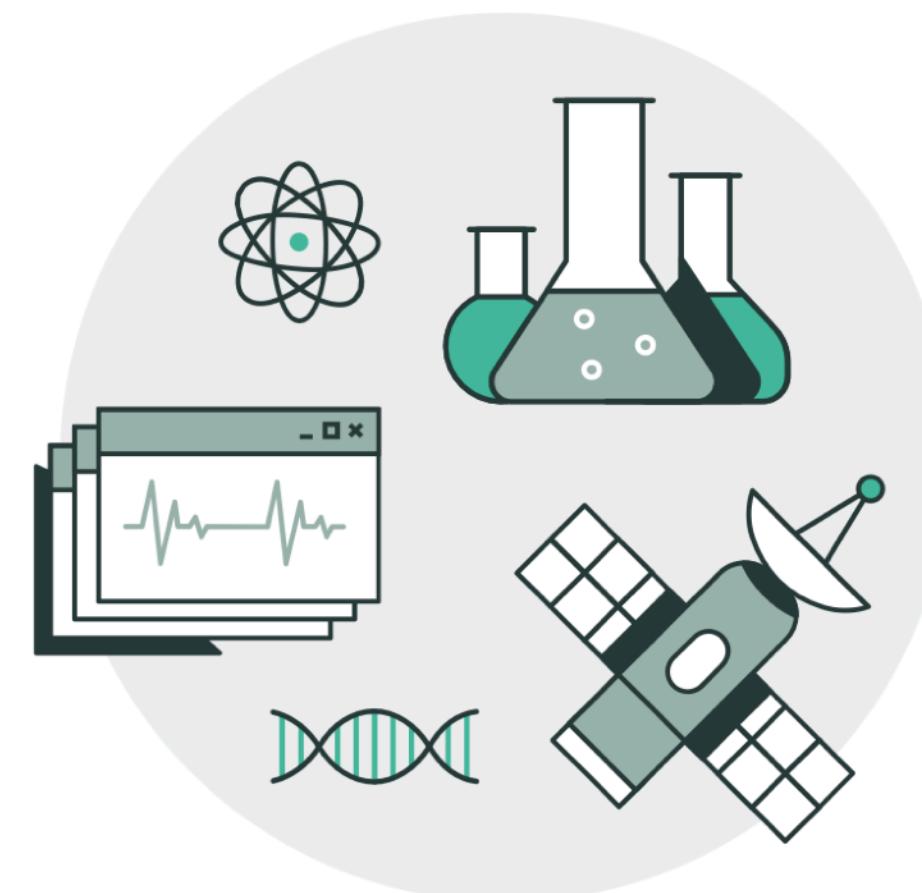
ResearchGate

researchgate.net

- Social media-like platform (profiles, newsfeed, messaging) for research.
- Useful for:
 - **networking**
 - **passive research** - enter your *interests* & it “learns” what new papers might be of interest.

ResearchGate

Log in Join for free



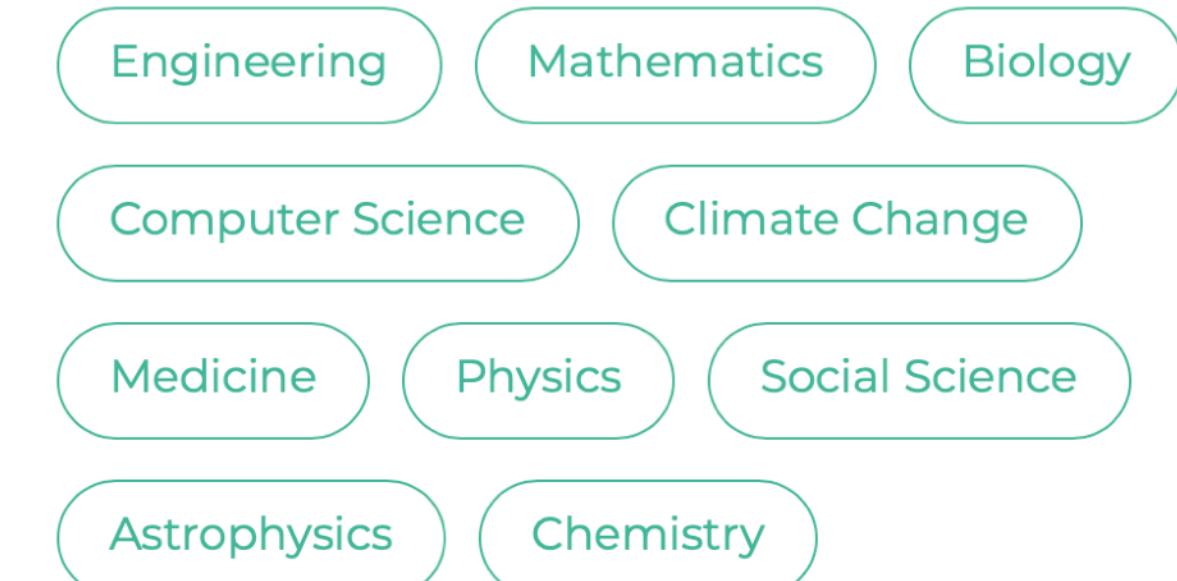
Discover research

Access over 160 million publication pages and stay up to date with what's happening in your field.

Connect with your scientific community

Share your research, collaborate with your peers, and get the support you need to advance your career.

VISIT TOPIC PAGES



IEEE Collabratec

ieee-collabratec.ieee.org

- Social media-like platform (profiles, newsfeed, messaging).

- Useful for:

- **networking**
- **searching for a graduate advisor**
- **job search**

Collaborate with a Global Network of Innovators

If you want to build your career and your professional network, this is the community for you. With the tools made for discovering what's important to your work, connecting to technical communities and collaborating with people on ideas that can move technology forward, IEEE Collabratec will help you own your future.

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Sharing Insights Inspires Me
"Being able to share insights with others like me is very inspiring."



Networking with People All Over the World
"I've been able to network with people all over the world."



Realizing the Power of the Platform
"I've realized what a powerful tool Collabratec is."



Advancing My Career
"It's helping me build the knowledge I need in order to advance in my career."



Passing On My Experience
"After 30 years in the field, I have experience and expertise I want to pass on."

AI for Research

Tools

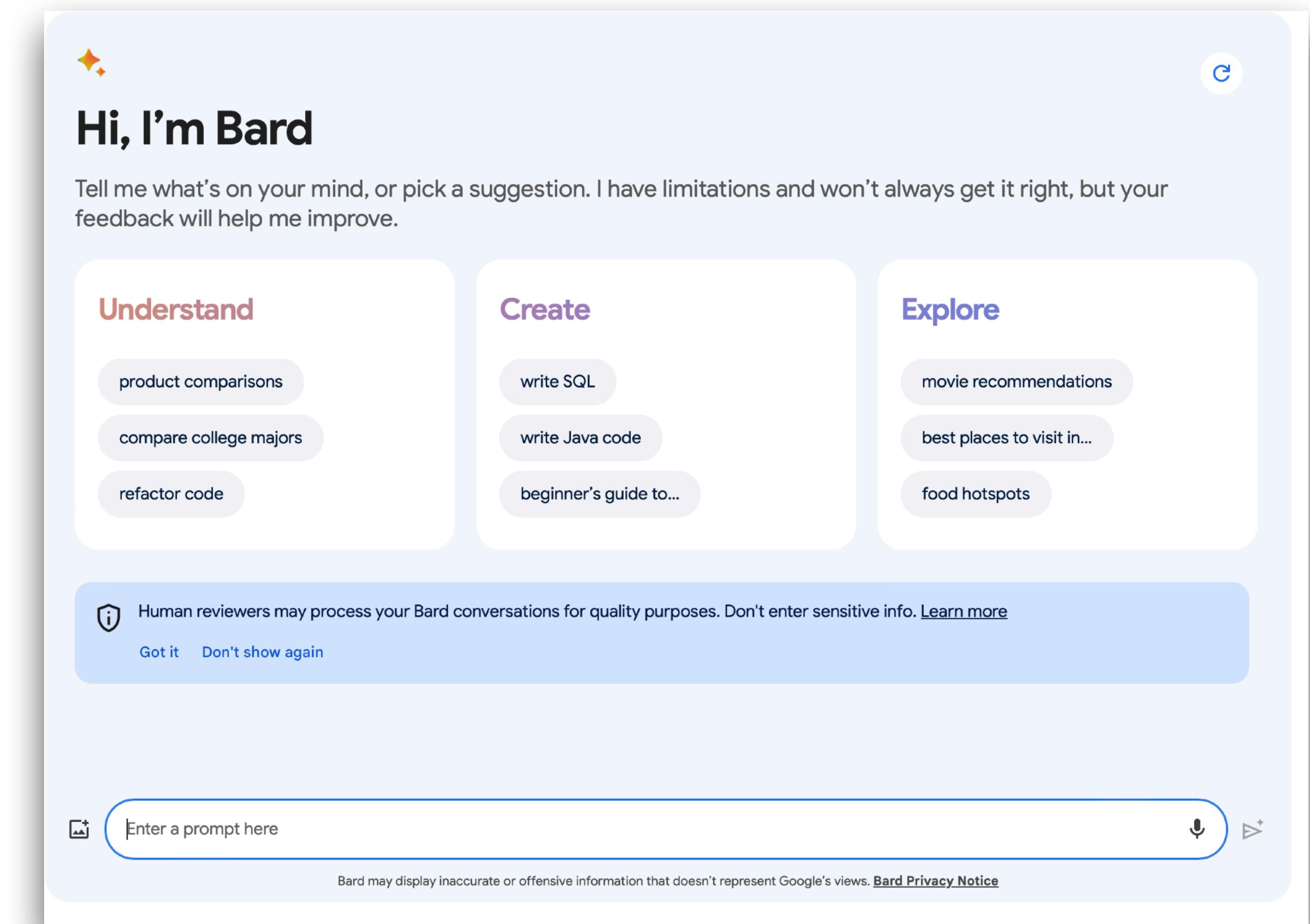
LLMs are very helpful, but also very prone to **hallucination** (*inferring invalid information when exact answers aren't available*).

Plenty of free options...

- Google Bard
- OpenAI ChatGPT 3.5

I like...

- Perplexity (free mobile app for GPT 3.5)
- listening.io (paid mobile app for listening to research papers)



AI for Research

Do's & Don'ts

Do:



- **Start a chat** about your research field/topics of interest.
- **Verify** any “facts” it provides.
- **Download an app** for easy access.
- **Get specific & ask for help** creating presentations, etc.

Don't:



- **Cite** any LLM as a source.
- **Pay** for a service just for research (*not worth it, yet!*)
- **Upload** any material from any class, research, or employer.
- **Generate** anything you were supposed to write.
- **Fall for** the “made easy” services (e.g. for summarization, etc)

AI for Research

Prompt Engineering

It's important to format your **prompt** to the LLM in a way which optimizes your desired response.

Consider the task and subtasks, ask for what you need.

Learn the general guidelines for interacting with an AI to optimize your time.

Remember: it's a conversation, not a one-time search query!

- **Be specific.** If there are certain libraries, APIs, or approaches that you'd like to use, include them in your question.



Do

How do I add camera support to my app using CameraX?



Don't

How do I add camera support to my app?

- **Describe the structure of the desired answer.** If you want to insert code generated by Studio Bot into your app and need it in a certain format, give it those instructions.



Do

Insert comments into this code. Use double slashes for the comments, and put each comment above the line of code it describes.



Don't

Write code comments for this code.

- **Break up complex requests into a series of simpler questions.** Especially when you're asking for code, asking a series of simpler questions yields a more comprehensive answer overall.



Do

1. Give me the `MainActivity.kt` file for an app with a login screen.
2. Can you add a class that represents a user profile?
3. Can you add code that supports multiple user profiles?



Don't

How do I create an app with a login screen that supports multiple user profiles?

AI for Research

Prompt Engineering

- Describe the task
- Describe the context
- Provide examples of preferred results
- Provide some details
- **Continue the conversation** (do not look for the “optimal” single search)

Find research in data science.

*I'm interested in research in data science.
What topics should I get started with?
List open problems in the field, along with a link to a relevant tutorial or blog for each.*

AI for Research

Getting started (fill in your research field/topic!)

Who are some of the top researchers in the field of _____ ?

What are some good tutorials for getting started on _____ ?

Generally when are the conferences on _____ held?

Beginning Research: Finding Relevant Themes

Continues next week!

Identifying Research Topics

Getting started in new fields

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Identifying Research Topics

Beginning Research

Resources for keeping up with the SOTA in your field

- SIGs - ACM, IEEE, ...?
- Meetings - conferences, workshops, symposia, etc.
- Papers - proceedings from conferences, journal papers
- Other technical content
 - Blogs
 - Code repositories (repos)

Feature	Conference	Workshop	Symposium
Frequency	Held annually or biannually	Typically one-time events, though some may recur annually	One-time events, often focused on a specific topic or issue
Size	Large, with hundreds or even thousands of attendees	Smaller, with typically fewer than 100 attendees	Small, with usually less than 50 attendees
Scope	Broad , covering a wide range of topics within computer science	Narrow , focused on a specific research area or problem	Narrow , focused on discussing and debating a specific issue or topic
Format	Presentations, tutorials, panels, networking events	Hands-on activities, interactive sessions, demonstrations	Presentations, discussions, Q&A sessions
Target audience	Researchers, academics, industry professionals, students	Researchers, students, practitioners interested in a specific area	Experts, stakeholders, interested public
Goals	Disseminate research findings, share knowledge, network	Develop skills, brainstorm ideas, solve problems	Discuss and explore a specific issue, reach consensus or recommendations
Cost	Higher, due to larger size and venue	Lower, due to smaller size and simpler format	Variable, depending on organizer and format
Examples	CVPR, ICCV, NeurIPS	AI For Science (@NeurIPS), I Can't Believe It's Not Better (@NeurIPS)	Symposium on the Future of Artificial Intelligence, Symposium on Ethical Implications of Computing

Identifying Research Topics

Beginning Research

Types of Research Presentations

- **Technical Talks** - *presentations of research within the context of SOTA, including motivation, approach, experiments/evaluation.*
 - **Spotlights** - *short 5-10min technical talks*
 - **Lightning Talks** - *short 2-5min technical talks*
- **Keynotes** - *presentations from established experts, often focused on a high-level look at the field and upcoming relevant themes/questions (rather than just their own research/findings). Usually 30min-1hr.*
 - **Invited Talks** - *presentations from established experts, focused on their own research.*
- **Posters** - *scientific poster sessions with structured templates that reflect the research paper in visual format.*
- **Panels** - *groups of experts providing different perspectives on a predetermined topic, moderated and with audience input.*
 - **BoF** (birds of a feather) - *typically a panel that is not moderated, more of a roundtable with less audience input.*

Identifying Research Topics

Beginning Research

Call For Papers/Participation (CFP)

- Invitation from an organization to submit work for **peer review and publication.**
 - For conferences/workshops/etc, also for **presentation.**
- *Includes:* topics of interest to the community, dates, length, style, and all information authors need to participate in this meeting.

Identifying Research Topics

Beginning Research

How to Read a Research Paper

- Find one relevant to you - *if it's in your field, you will care more :)*
- Leverage the structure - *all papers follow a similar format!*
 - abstract, introduction, related work, methods, results, conclusion, references
 1. Read (skim) the **abstract, introduction, & conclusion** first, to get an idea of what the problem is at a high level.
 2. Read the **related work** next to discover how *others* have already approached this problem.
 3. Read the **introduction** again to put the new approach in context - *what are they doing differently?*
 4. *Read the rest of the paper only if you're still interested in their approach.*

Next week

Next week

Looking ahead...

- Tuesday: **Identifying research problems**
- Thursday: **Guest Research Lecture - Dr. Sushil Prasad**
- Research Project: **Proposals due! (2/3)**

Research Project

Research Project

Guided research in your CS field

- See Canvas for the “**call for papers**” (CFP)
- Objectives:
 - Participate in a research community (*low risk!*)
 - Learn about the research process
 - End the semester with a solid research review of a relevant topic

Research Project

Guided research in your CS field

- Which **SIG** will you participate in for the rest of the semester?
- In 1 sentence, concisely state the **topic** you propose to research this semester.
- In 1 sentence, concisely state **why your chosen topic/problem is important**.
- Identify **3 specific problems/questions** you would be interested in researching this semester. Limit them to 1 sentence each, and order them by preference (where 1st is your favorite). *Your instructor will provide feedback on which may be most viable*.
- For each problem, **cite 1 relevant research paper** (it's ok if the same paper fits more than 1 of your identified problems). The citation must be in the following format: author, title, conference/journal, year. Include a link if possible.
- If you are working on research outside of this class **disclose it here!** Remember this project must be your own work.

Q&A

Wrap-Up

Tuesday

- Tools for getting started in a new research field
- Finding research topics within a field
- To Do:
 - Decide on your research **field** (+ *start thinking about topics*)

See you Thursday!

SIG Meeting 0: **Getting Started**

SIG Meeting 0

Getting Started

1. Form SIGs
 - *Try to commit to a field this week!*
2. Complete the group worksheet
3. Stay together for Activity 2...

Activity 2: Identifying Research Problems

Activity 2: Identifying Research Problems

Thursday

1. Introduction
2. Finding relevant themes
3. Searching for gaps
4. In-class activity (*turn in by end of class*)
5. Wrap-up discussion

Activity 2: Identifying Research Problems

Finding Themes in Fields

The CFP for a SIG meeting can be reflective of the community's research interests. It may include..

- What topics are of interest (and specific problems)
- What topics/problems that are not of interest

Also should include (or link to):

- How long is the paper?
- What format?
- When is it due? When will it be reviewed & notified?
- When is the meeting? Where?

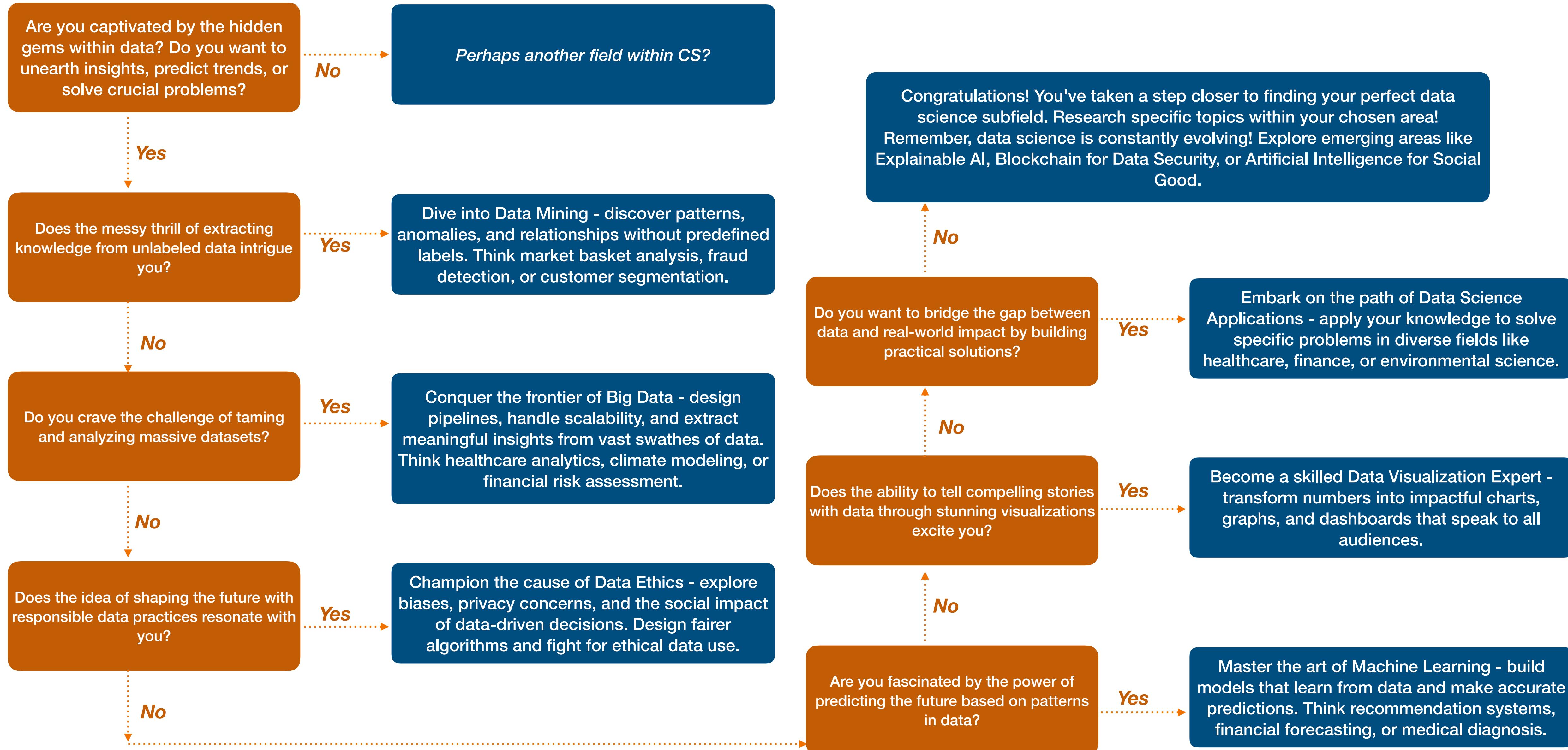
Activity 2: Identifying Research Problems

Finding Themes in Fields

- **Part 1: Getting Specific About Topics in Your Field**
 - *Activity:* SIG-specific flowcharts
 - *Goal:* answer fun questions to discover topics & problems of interest within your field (and importantly, what is *not* of interest)
- **Part 2: Discussions & Activity 2 Worksheet**
 - *Activity:* complete the Activity 2 worksheet (***to be turned in at the end of class***)
 - *Goal:* discuss specific topics of interest among peers, discover larger (international) SIG peer communities & their resources, conferences/workshops.

Activity 2: Identifying Research Problems

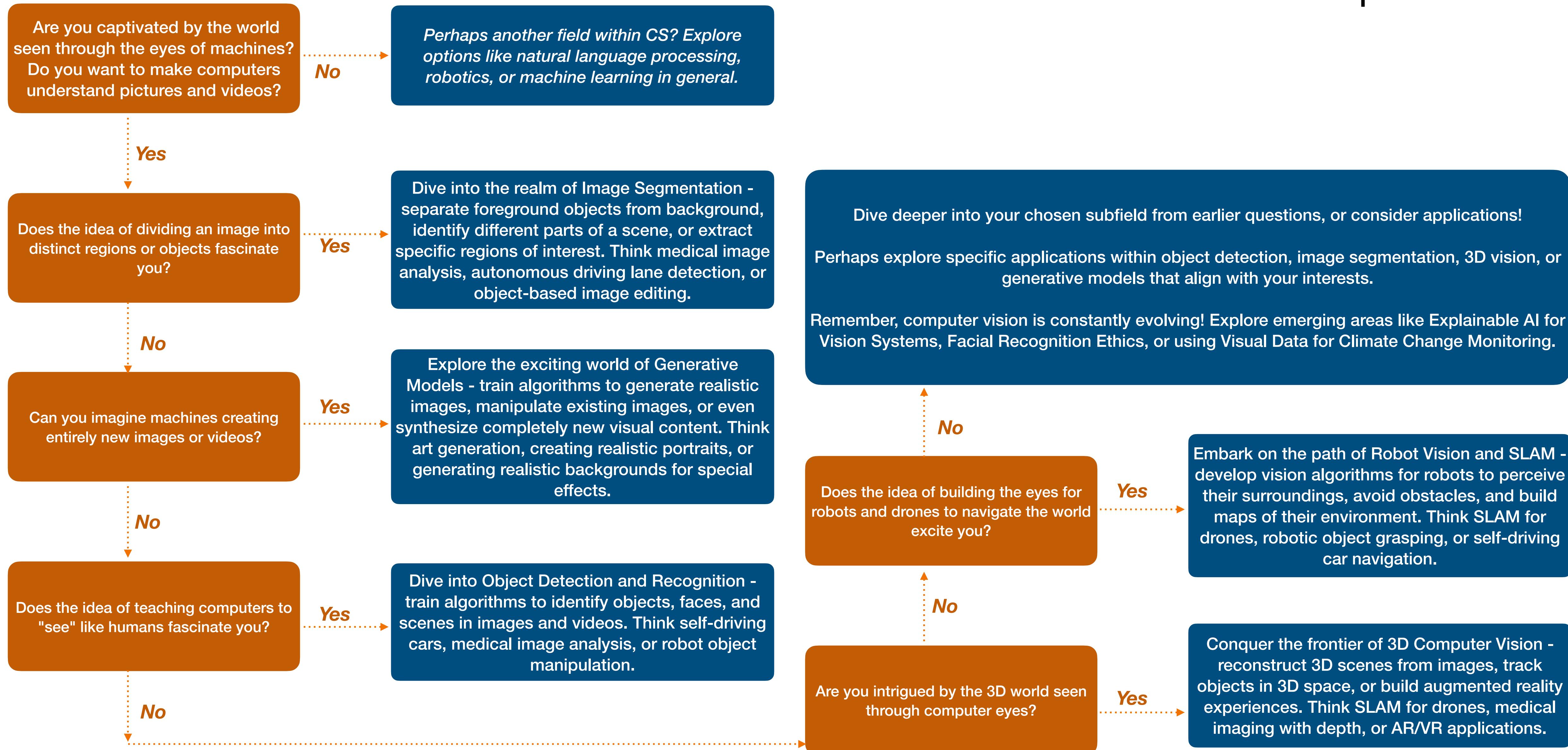
Data Science



Instructions: Beginning at the top, answer the questions (honestly!) to discover which research topics & problems might be of interest within your field. **Circle** the blue boxes that correspond with a good match to your answers, and **cross out** any that are not of interest. Leave the rest unmarked.

Activity 2: Identifying Research Problems

Computer Vision



Instructions: Beginning at the top, answer the questions (honestly!) to discover which research topics & problems might be of interest within your field. **Circle** the blue boxes that correspond with a good match to your answers, and **cross out** any that are not of interest. Leave the rest unmarked.

Activity 2: Identifying Research Problems

Cybersecurity

Page 1/2

Flip to back page!

Are you fascinated by protecting the digital world from malicious threats? Do you want to outwit attackers and keep data safe?

No

Perhaps another field within CS?
Explore options like software engineering, artificial intelligence, or game development.

Yes

Does the idea of creating virtual replicas of physical systems to predict and prevent cyberattacks intrigue you?

Yes

Dive into the exciting realm of Digital Twins for Cybersecurity - develop and integrate digital models of critical infrastructure, test security scenarios virtually, and predict potential attacks. Think power grid cybersecurity, healthcare system simulations, and industrial control systems protection.

No

Are you captivated by the unbreakable promise of quantum cryptography and its potential to revolutionize digital security?

Yes

Explore the frontier of Quantum Security - understand how quantum computing can break certain encryption algorithms, design post-quantum cryptography resistant to these threats, and build future-proof secure systems. Think quantum-resistant key exchange, secure communication protocols, and post-quantum network infrastructure.

No

Can you imagine teaching machines to fight back against cyberattacks in real-time?

Yes

Embark on the path of AI for Cyberdefense - develop and deploy AI-powered tools to detect anomalies, predict attacks, and automate threat response. Think intrusion detection systems powered by AI, malware analysis with machine learning, and autonomous security bots.

No

No

Does the thrill of the chase in network security excite you?

Yes

Embark on the path of Network Security and Defense - monitor network traffic, detect and prevent intrusions, and protect against vulnerabilities. Think intrusion detection systems, firewalls, and network anomaly detection.

No

Are you captivated by the art of building secure systems from the ground up?

Yes

Explore the world of Security Engineering - design secure systems, implement robust authentication and authorization mechanisms, and prevent vulnerabilities. Think secure coding practices, network security architecture, and cloud security.

No

Does the detective work of digital forensics intrigue you?

Yes

Dive into the realm of Incident Response and Forensics - analyze systems after an attack, gather evidence, and track down cybercriminals. Think network intrusion investigations, data breach analysis, and malware analysis.

No

Does the critical responsibility of protecting vital infrastructure from cyber threats excite you?

Yes

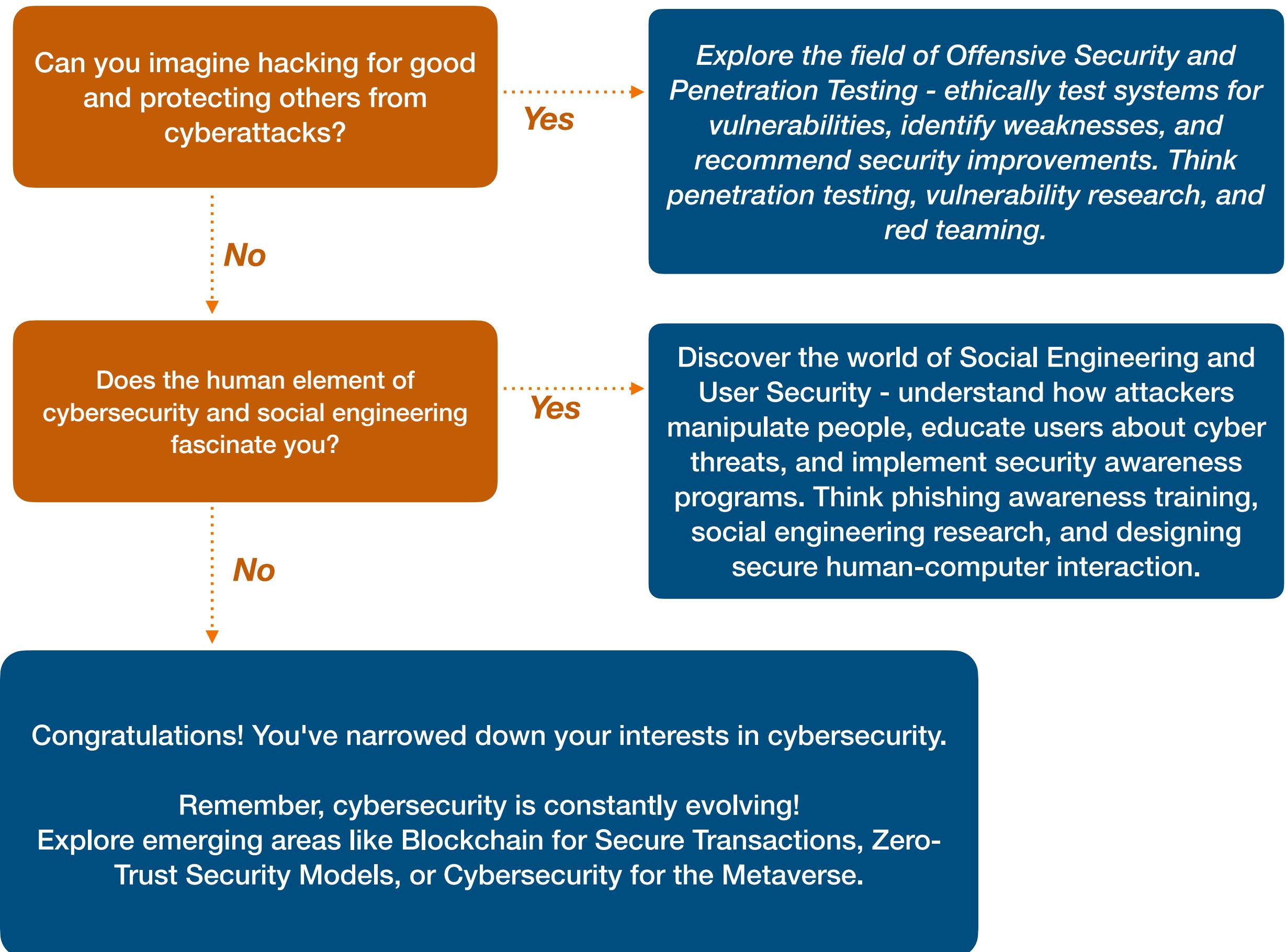
Explore Cybersecurity for Critical Infrastructure - assess vulnerabilities in power grids, transportation systems, & other critical systems, develop secure protocols and incident response plans, and safeguard national security. Think securing energy grids, protecting industrial control systems, & defending against targeted attacks on vital infrastructure.

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Activity 2: Identifying Research Problems

Cybersecurity

Page 2/2

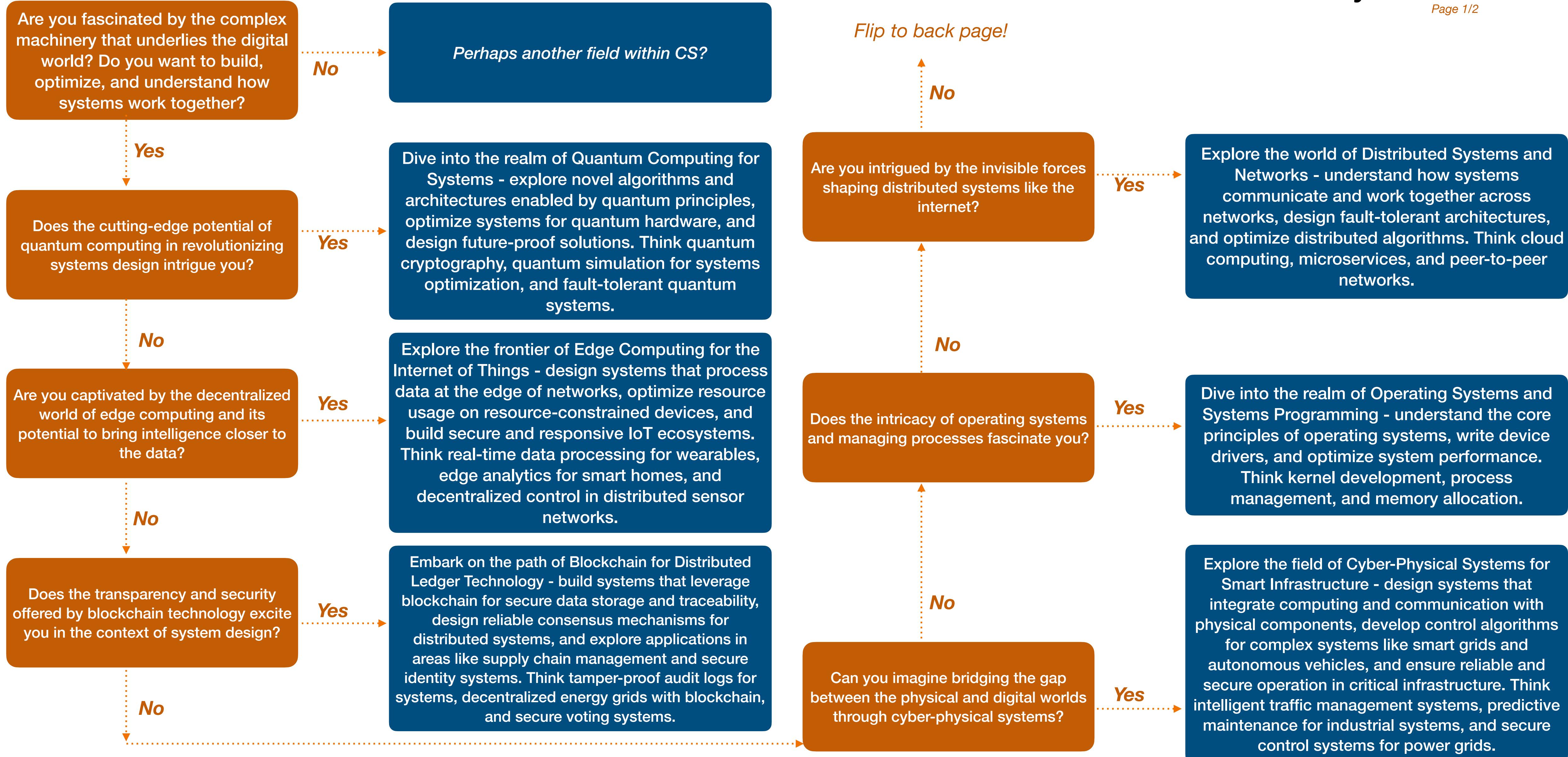


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Activity 2: Identifying Research Problems

Systems

Page 1/2

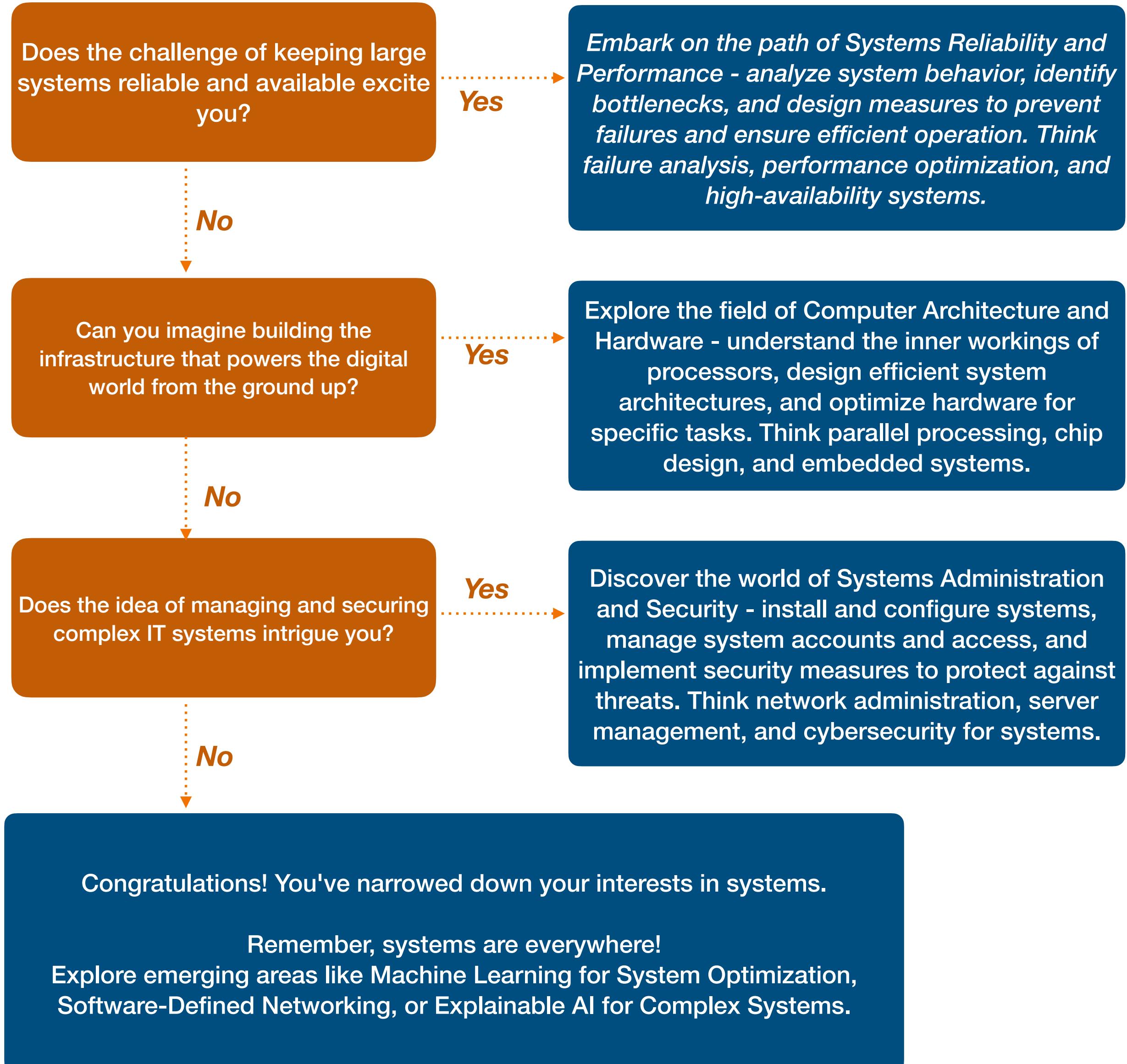


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Activity 2: Identifying Research Problems

Systems

Page 2/2

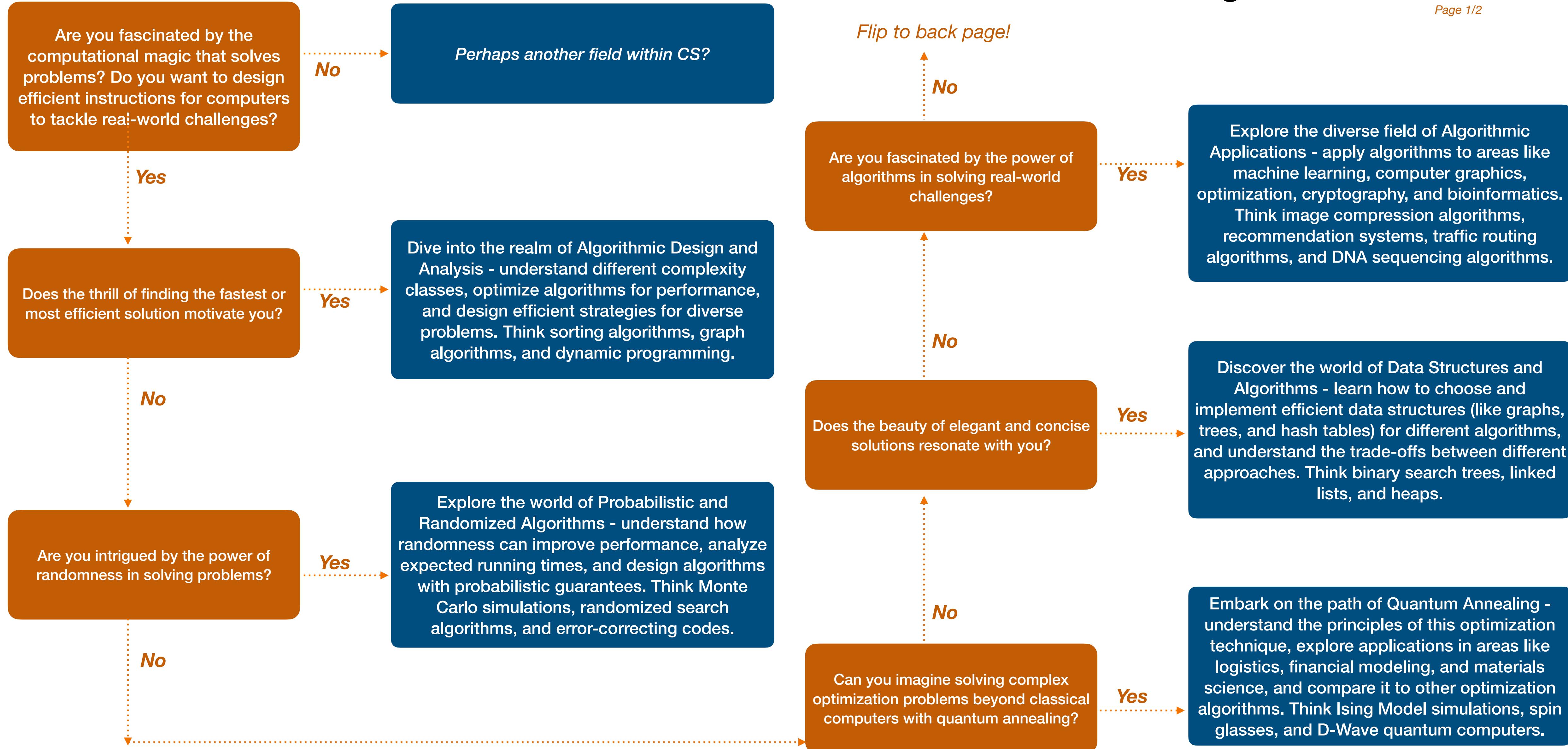


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Activity 2: Identifying Research Problems

Algorithms/Quantum

Page 1/2



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Activity 2: Identifying Research Problems

Algorithms/Quantum

Page 2/2

Does the need for transparency and trust in AI algorithms intrigue you?

Yes

Dive into the realm of Explainable AI for Algorithm Transparency - understand the inner workings of complex AI models, develop methods to explain their decisions, and advocate for transparency in algorithmic systems. Think interpretable machine learning models, explainable reasoning frameworks, and human-centered explanations.

No

Are you passionate about ensuring fairness and ethical considerations in algorithms?

Yes

Explore the field of Algorithmic Fairness for Addressing Bias - identify and mitigate biases in algorithmic systems, understand ethical implications of algorithms, and design algorithms that uphold fairness principles. Think counterfactual reasoning for fairness analysis, mitigating bias in AI models, and algorithmic discrimination detection.

No

Congratulations! You've narrowed down your interests in algorithms.

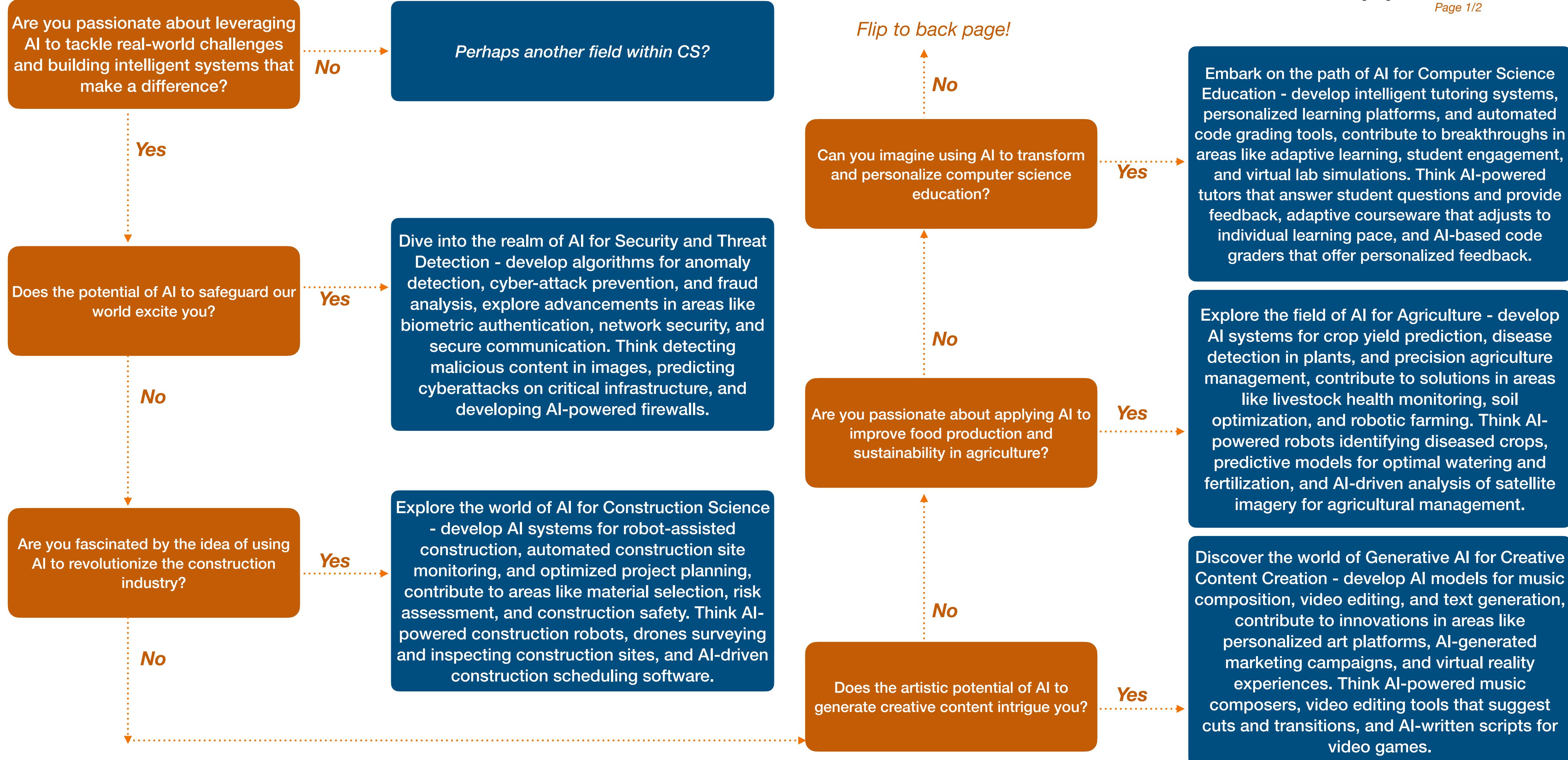
Remember, algorithms are constantly evolving! Explore emerging areas like Algorithmic Optimization for AI, Quantum Machine Learning, or Natural Language Processing with Neural Networks.

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Activity 2: Identifying Research Problems

AI Applications

Page 1/2

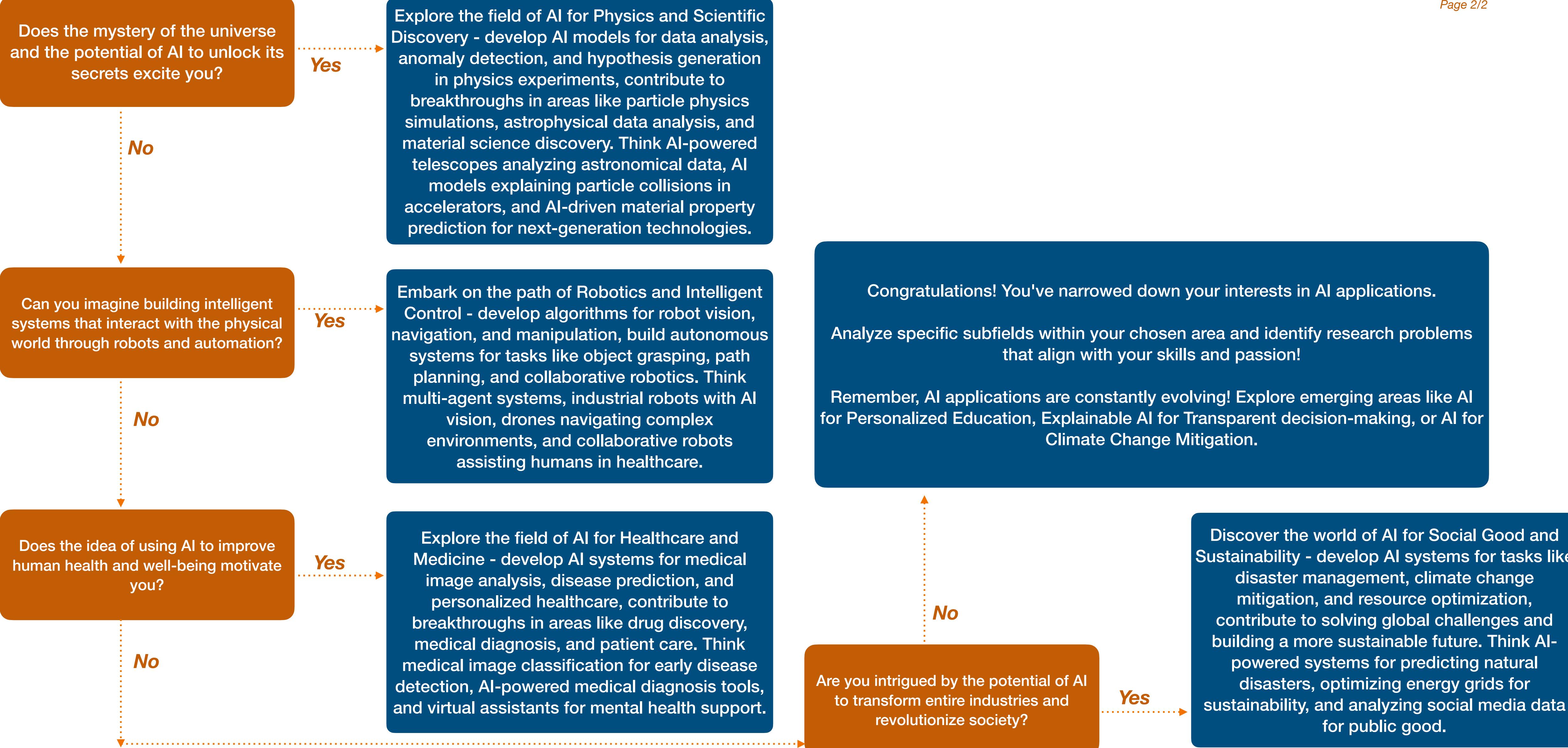


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Activity 2: Identifying Research Problems

AI Applications

Page 2/2

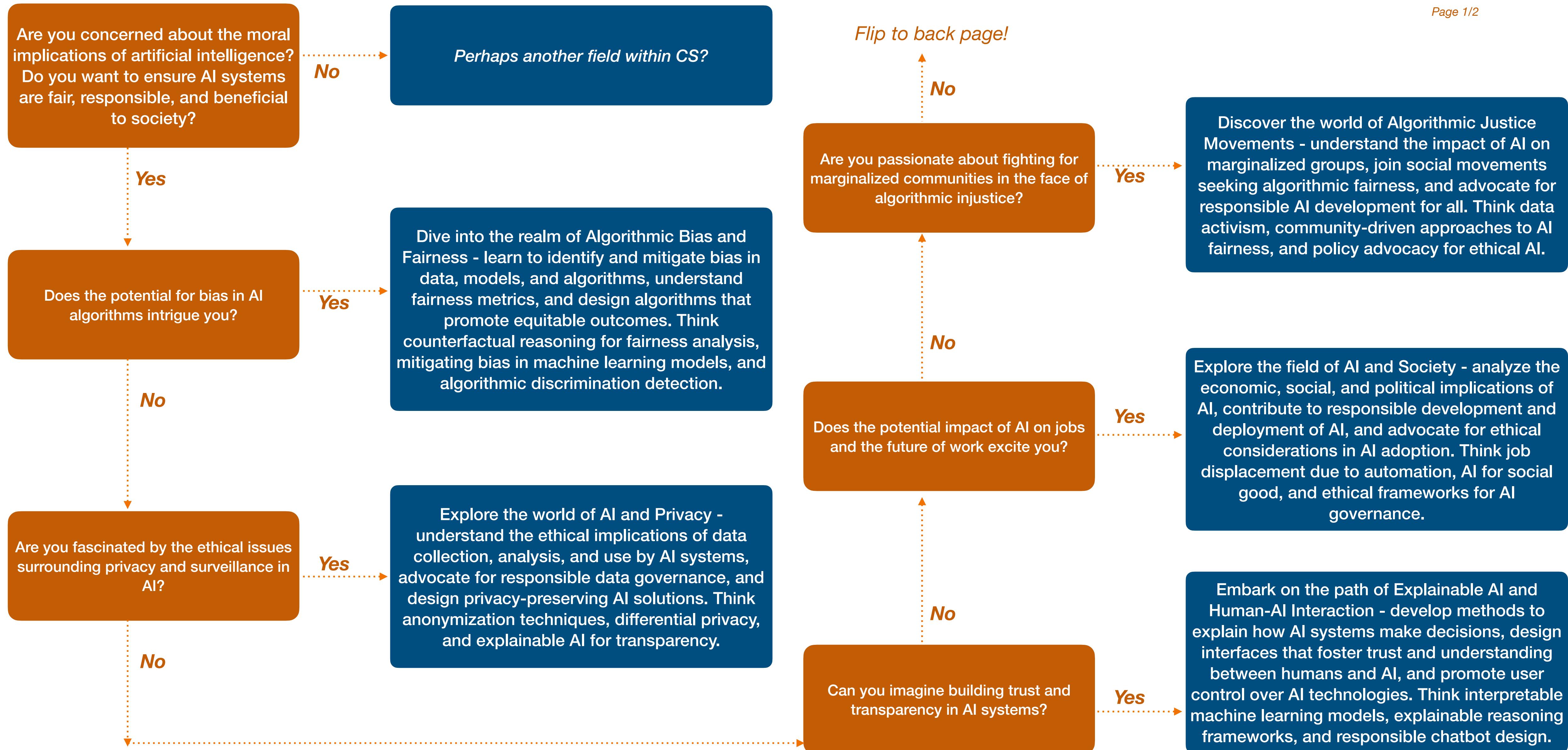


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Activity 2: Identifying Research Problems

AI Ethics/Fairness

Page 1/2



Instructions: Beginning at the top, answer the questions (honestly!) to discover which research topics & problems might be of interest within your field. **Circle** the blue boxes that correspond with a good match to your answers, and **cross out** any that are not of interest. Leave the rest unmarked.

Activity 2: Identifying Research Problems

AI Ethics/Fairness

Page 2/2

Does the design of AI systems from a human-centered perspective intrigue you?

Yes

Dive into the realm of Human-Centered AI Design - understand the needs and expectations of users, design AI systems that are accessible, inclusive, and user-friendly, and promote responsible human-AI collaboration. Think inclusive design principles for AI, user experience research with AI, and designing for trust and empowerment.

No

Can you imagine the ethical challenges and opportunities presented by emerging technologies like quantum computing?

Yes

Explore the field of Quantum Computing and its Ethical Implications - understand the unique ethical considerations of quantum AI, analyze potential impacts on privacy, security, and fairness, and contribute to responsible development and governance of quantum technologies. Think quantum cryptography and its impact on privacy, bias in quantum algorithms, and responsible AI governance frameworks.

No

Congratulations! You've narrowed down your interests in AI ethics and fairness.

Remember, AI ethics and fairness is a rapidly evolving field!

Explore emerging areas like Algorithmic Accountability Frameworks, Explainable AI for Explainable Policies, or AI for Global Public Good.

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Wrap-Up

Thursday

- Exploring research topics of interest to you
- Investigating tools for research in your field
- Discussion of relevant themes in your research community
- To Do:
 - Turn in the **SIG Meeting 0** group worksheet
 - Turn in the **Activity 2** individual worksheet
 - Decide on your research field - proposal discussions next week!

See you next week!