BRIGHT-CS

# Artificial Intelligence Learning Experience

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# Artificial Intelligence Learning Experience Overview



**To access the videos that accompany each unit, click on the corresponding icon**:

# Preface: A Word to Parents, Caretakers, and Teachers

As a field, Artificial Intelligence (AI) continues to grow its impact in our day-to-day lives. With an ever-expanding influence in education, medicine, economics, transportation and other sectors, AI is not only an intriguing field of study but a viable and lucrative career path for students to consider as they start thinking about their futures. Yet, for many K-12 students, academic exposure to even the most fundamental aspects of AI is limited and, as a result, so is the ability to explore opportunities in the field, to understand how those opportunities align with their aspirations, or to start actively planning for a professional future in AI. In turn, despite the raw talent and potential for success students already have, AI remains an elusive pathway for many.

Ensuring that students of all walks of life have the ability to discover, explore, and draw tangible lines between their talents and Computer Science (CS) is critical to the future of technology. With this in mind, the **Artificial Intelligence Learning Experience** was developed to expand students' exposure to AI and is one component of a three-pronged effort to broaden students' awareness of key CS fields. Collectively, the modules (which include lessons on software development and data science) amplify awareness about Computer Science concepts, provide a launch pad for middle and high school students to link their innate talents with CS areas, and seek to ignite students' interests in CS careers.

In addition to covering AI, this module integrates an active discovery approach that allows students to learn key technical concepts while simultaneously building and refining their ability to conduct research. As students complete the units, activities, and exercises that follow, they will build their fundamental understanding of AI while applying a set of research tools and approaches that can help them grow their ability to be independent learners and adequately prepare to maximize future learning experiences. By simultaneously expanding access to knowledge and guiding students' application of the research process, this module seeks to efficiently address students' need for both in a seamless way.

As a parent, caretaker, or teacher, you have an outsized influence in students' lives in helping them (1) understand the power and value of education and (2) identify future career paths of interest. This series is driven by the idea that, if students are able to draw tangible links between their interests and CS careers early on, they can begin to build those links in critical ways while simultaneously preparing themselves to excel as CS professionals.

In addition to introducing this (and the other two) modules to the students in your life and encouraging them to complete the materials, you can also help to ensure that students get the most out of this experience in another critical way. This learning experience heavily integrates research, in part, because our partners in K-12 education have cited it as a skill that is significantly underdeveloped in students, even at the 12$^{th}$ grade level. By actively and deliberately encouraging students to talk about their research findings as they navigate the **Artificial Intelligence Learning Experience**, you will help them refine another important skill: communication. Being able to share findings by both talking and writing about them is a critical aspect of the research process. By having students discuss what they've learned with you and share the written report they will build unit by unit, they can practice communicating technical concepts in a space where they can make mistakes and successfully recover from them with your support. In addition, students will get better at explaining key ideas, strengthen their grasp of the concepts learned, and lead conversations that heighten others' awareness of AI.

We invite you to review the materials in this series, get an idea for what students will learn, and glance at how the materials are presented. As you do, think about young people who could benefit from this learning experience and share as widely as you can. Let's work together to ensure that the next generation of Computer Scientists and Engineers have access to the learning experiences and materials they need to gain critical exposure, discover their capabilities early on, and build the foundation necessary to realize their full potential.

# Preface: A Word to Students

As you look toward your future and begin thinking about the wide array of career possibilities ahead of you, your most pressing questions probably include "**How do my interests and capabilities align with potential fields?**" and "**How should I start preparing for careers that interest me now?**" For sure, there are a myriad of opportunities for you to explore but, unless you get the needed exposure, the answers to those questions could remain limited at best. Recognizing that this is especially true for careers in Computer Science, the **Artificial Intelligence (AI) Learning Experience** is designed to help you begin exploring the realm of AI by actively discovering what it is, learning how AI currently impacts your day-to-day, and gaining insight on the future of the field. What's more, this module is driven forward by a research experience that will help you build key skills – in the short term – and strengthen your ability to become an independent learner – in the long term. Being an independent learner, and having the ability to power through challenging material, is critical for your success because it can help you build the tenacity needed to widen your knowledge base and make your learning experiences more meaningful.

AI is an area of Computer Science with ever-expanding influence in our daily lives. As a result, AI professionals are instrumental in enriching the landscape and contributing to the growth of the field. They are creative problem-solvers, working on cutting edge technology. AI professionals drive innovation and engineer game-changing systems. As a K-12 student, you are in an exciting position to explore careers of interest and make preliminary decisions about your future. Understanding base level ideas about the skills you will need to thrive in an AI career can help you (1) make important decisions about your academics; (2) identify the areas you need to strengthen for future success; and (3) draw clear links between your interests and the field. Yet, for many students, it is unclear where to begin exploring AI, how the exploration process should flow, or how to continue to build knowledge in the long term. This learning experience is designed to help you begin filling in those gaps.

The **Artificial Intelligence (AI) Learning Experience** will enable you to do three key things that can have significant impact well after you complete it. You will explore the past, present, and future of AI; build your ability to plan and execute a research project; and strengthen your communication skills. But, to fully realize the short- and long-term benefits of this rich learning experience, be sure to do the following:

- **Use this workbook as a companion to your learning experience.** The workbook provides an introductory overview of topics, space for you to write notes, exercises that deepen learning, access to additional resources, and opportunities to practice newly acquired concepts and skills. It also helps you develop and structure a research paper and track what you've learned over time – all of which can significantly enhance your outcomes.
- **Access and review the accompanying YouTube videos.** Clips that support and reinforce the learning process have been developed for select units. Each video is 7 minutes or less and allows you to pace your learning experience since you can watch, pause, and rewind as much as and whenever you need to.
- **Enlist a friend or a group of friends to go on this journey with you.** Expanding your understanding of AI while simultaneously sharpening your research skills is a process best done with others. Having friends, siblings, or classmates to discuss the series with, bounce ideas off of, and – perhaps – compare notes with, can help to make the learning process that much more enjoyable and help to keep you both on track and accountable. Consider asking someone to go through the process with you and then work together to complete the series.

Overall, using the full suite of resources provided, diligently completing each unit, and working through the exercises will provide overlapping benefits. You will gain the experience, training, and support you need to explore the basics of AI, build key skills, and start forming an opinion about whether a career in AI is the path for you. Exposure is the key to discovering interest, growing skills, and gaining access to critical tools – and this series is designed to support you in those efforts. By becoming familiar with critical ideas and building your skill set as an independent learner, you increase your potential to be prepared for future challenges and your prospects for future success.

# Unit 1: Mapping Out the Road Ahead and Preparing for Growth (Part I)

Welcome to the **Artificial Intelligence (AI) Learning Experience**, a journey of exploration designed to accelerate active discovery and provide a solid platform for skill enrichment. Throughout this journey, you will explore the past, present, and future of AI via research; broaden your awareness of AI as a potential career; and document your findings in small, manageable steps so that you can share what you've learned with others. If you're a pre-college student, namely a 6th grader or higher, this multimedia learning experience was specifically developed with you in mind. We're excited that you've decided to take this journey and hope that – as a result of it – you will gain much-needed exposure to the fundamentals of AI, expand your research skills, and broaden your understanding of the career options available to you.

A driving goal of this particular module – and the series as a whole, which includes modules for software development and data science – is to not only deepen your understanding of Computer Science (CS) but to also broaden your awareness of how your interests and aspirations align with the field. You see, CS isn't just about coding. Computer Scientists and Computer Engineers also collect, process, and apply data to implement AI-powered, machine-made models that influence everything from the ads we see, to the results showing up in our search engines, and much more.

Given the pace of technology, the demand for AI is only expected to increase over time and, in turn, drive the need for a large pool of adept AI talent prepared to push the envelope. Yet, for you to decide if a career in AI is in your future, having the opportunity to explore the baseline ideas that shape the field, investigate the future of AI, and understand how AI aligns with your professional aspirations is critical. The **Artificial Intelligence Learning Experience** provides the support you need to do each.

One of the best ways to enhance your educational experience is to approach all learning activities as an *independent learner*. Independent learners realize that taking on hard challenges, though uncomfortable at first, enhances their ability to explore their curiosities, propel and supercharge their academic pursuits, and advance their acquisition of knowledge both in and out of the classroom. In addition, independent learners understand that thought-provoking learning experiences, which challenge them to reach beyond their comfort zones, widen their knowledge base and prepare them for more advanced challenges in the future. The knowledge units, activities, exercises, and videos that follow collectively provide a launch pad for you to explore AI in a meaningful way while simultaneously applying the research skills that are vital for independent learning.

The main purpose of this unit is to provide you with a preview of (1) the ***pathway*** we will take, (2) the ***tools*** we will use, and (3) a way to ***track the growth*** you will experience once you've completed the module. Capturing what you know and think *before* starting the journey and comparing it to what you have learned *after* completing the module is a powerful way to track your growth and evolution. We will start that process in this unit.

## The Pathway

The pathway for this series seamlessly integrates two increasingly significant pursuits: learning more about AI and growing critical research skills. Research is a key focus of the **Artificial Intelligence Learning Experience** for a variety of reasons – all of which point to helping you to be the most aware and adept learner that you can be while also building a baseline set of skills you can leverage to propel your academic success. For many of us, research is a scary word that represents a big, complicated process – in our minds, at least. But, in truth, research is simply about asking a question and taking the steps necessary to arrive at a solution. How big or complicated that process becomes depends on the nature of the question, what the necessary steps are, and the nature of the solution. But, if you begin with a clear understanding that *questions*, *steps*, and *solutions* are the key factors in research, it may help to direct your focus in a constructive way, reduce the perceived complexity of the process, and springboard successful navigation of the research experience.

The act of starting out with a question and finding your way to an answer through a variety of logical steps may sound familiar; that's because, in addition to being critical to research, these activities are also intrinsic to **problem-solving**. Research is very much a problem-solving activity. Anytime you sharpen your ability to solve problems, you also strengthen your ability to tackle challenges in the future.

So far, we've talked generally about research and deconstructed its process to reduce its perceived complexity but we haven't discussed one of the most critical aspects of all: where to start. An effective start point for research – particularly when the driving goal is to learn more about a concept that is new to you – is to begin by asking questions about the *past*, *present*, and *future* of the given topic. Focusing your initial questions on these three areas will allow you to discover where a field has been, what's currently underway, and where the field is expected to go. From a very general perspective, that can mean asking the following questions:

- **Past**: what foundational information has *already* been established about the field?
- **Present**: what is the impact of the field in our daily lives?
- **Future**: what challenges in the field are shaping the conversation around way forward?

These general questions provide a great start point, but they are – in fact – *only* a start. To be meaningful and effective in practice, the general approach must be shaped to *fit the project*. For the **Artificial Intelligence Learning Experience**, we will *reframe* the general questions to explore AI via the following, more customized questions:

1. **Past**: What is the definition of AI?
2. **Present**: What tools or software do I, the reader, currently use that implement AI.
3. **Future**: What are the "hot topics" in AI? How might AI fit into my plans for my professional career?

We will delve further into these questions throughout this learning experience, apply key research practices, and document our findings in a research paper that we will build unit by unit. Following this pathway, mastering the key research steps, and truly understanding how to accomplish each will provide a strong foundational platform for independent learning and serve you well in future research projects.

The research questions that we will explore provide insight into the path that we will take but, to solidify your vision of what's ahead, the table below shows how we will implement key parts of the discovery process along with corresponding units.

| Research Focus | Key Goal(s) | Unit(s) |
|---|---|---|
| **Fundamentals of AI & Research** | Understanding base aspects about AI and conducting research | **2 & 3** |
| **The Present of AI** | Understanding AI's current impact | **4** |
| **Looking Toward the Future of AI** | Exploring the technical future of the field and AI as a career | **5, 6, & 7** |

*Table 1: Overview of the steps covered in this learning experience*

## The Tools

The process of conducting research is not only shaped by the kinds of questions asked but also by the tasks necessary to arrive at appropriate solutions. So far, we've modified the general research questions so that they specifically address the past, present, and future of AI. Based on the nature of the questions, each can be answered by finding resources with appropriate documentation. As a result, **our approach to conducting research in this project** will be to (1) find our answers in books, scientific journals, conference proceedings, and other resources on the web; (2) document what we find; (3) analyze the data we collect to derive meaning; and (4) cite the resources we have used. Our approach directly influences the kinds of tools we will need to navigate our journey and this section provides an overview of our toolset in advance.

Before we go any further, let's briefly discuss a skill that will be integral to this process and will influence some of the tools we will use: documenting your research findings. Being able to communicate effectively – whether vocally or in

written form – is an important skill that you must practice to improve. Moreover, to really get good at it, you need to be open to constructive feedback, willing to learn from your mistakes, and ready to apply what you've learned. As you complete the units ahead, you will build a research paper – piece by piece, in small steps – that you are encouraged to share with your teachers, friends, and parents or caretakers. You can find the outline of the paper here if you want to preview how it will be structured. As a reminder, you won't be expected to develop the paper all at once; instead you will develop it in manageable steps, one unit at a time.

We will use the following tools to expand our understanding of AI, structure and manage our research progress, and grow key research and communication skills:

| Category | Function | Tool |
|---|---|---|
| Search Tools | Find resource materials | **Google Scholar** |
| | Find information on careers | **Occupational Outlook Handbook** |
| Information Organizers | Manage research questions | **NTK Questions** |
| | Consolidate notes for Units 2 and 3 | **Evidence Accumulator** |
| | Maintain a list of new words and phrases | **KIMS** |
| | Track skills learned and improved | **KWHL** |
| Planning Tools | Provide an overview of key paper sections | **Paper Outline** |
| | Determine research questions | **Research Planning Map** |
| Resource Management | Verify the trustworthiness of sources | **ACLAP** |
| | Cite sources | **IEEE** |
| Reflection Tool | Explore the impact of the project | **What, So What, Now What?** |

*Table 2: Tools Used in the Artificial Intelligence Learning Experience*

In the meantime, other resources that will help you along in this process include:

- This workbook
- The YouTube videos that accompany Units 1 - 8
- Pen and paper

All combined, these tools will support your expanded understanding of foundational AI concepts and help to nurture good learning and research habits. As you navigate this module, get acquainted with the approaches/tools featured and feel free to re-use them in the future as you conduct research on topics of your choice. This leads us to our next point.

## The Transformation

Growth in your knowledge, understanding, ability, and interests is a key goal of the **Artificial Intelligence Learning Experience** and, as a result, having a way to track your growth is important. As you move forward on this journey of research and discovery, you will learn new concepts, pick up new words, and expand your technical knowledge. Tracking this growth and capturing how your thinking and knowledge evolve over time is key.

The next page contains a list of 7 questions designed to get a snapshot of your start point, *before* you start the learning experience. **Answer the questions as best you can**, before moving on to Unit 2, keeping in mind that it is OK if you do not know all of the answers at this point. After you complete the learning experience in Unit 8, you will revisit these same questions to see how much you've learned. For now, simply answer the questions that follow based on your current knowledge.

**Track Your Progress:** Take a look at the questions below and answer as well as you can, based on what you know right now. You will answer the same set of questions at the end, in Unit 8, to see how far you've come over time.

1. **What is Artificial Intelligence (AI)?**

2. **What tools or software have you used in the past that incorporate AI?**

3. **Name three "hot topics" in AI.**

4. **Name two universities that have high-ranking AI academic programs?**

5. **What aspects of your personality or interests might serve you well as an AI professional?**

6. **On a scale from 1 – 10: rate your understanding of AI.**

7. **On a scale from 1 – 10: rate your interest in AI.**

**Congratulations! You have finished Mapping Out the Road Ahead and Preparing for Growth (Part I). Let's move on to What is AI? – Starting With the Basics.**

# Unit 2: What is AI? – Starting With the Basics 

Artificial Intelligence (AI) is a broad field with increasing significance in the tools and technologies that we use. As companies, schools, and governments recognize its value, AI continues to be adopted, adapted, and applied in ways that impact critical aspects of our day-to-day lives in ways that aren't always immediately clear. In general, learning about AI is important because it allows us to deepen our understanding as informed citizens. As a student, learning about AI has the added benefit of potentially advancing your interest in the field and giving you the baseline information you need to decide whether it is a viable career path for you.

Our goal throughout the **Artificial Intelligence (AI) Learning Experience** is to explore AI using an active discovery approach that is driven by research. To shape our process and provide structure to our journey, we will systematically research the past, present, and future of the field. Broadly speaking, when exploring the past of a field, the main question to ask is: **what foundational information has already been established?** The underlying objective of this question is to discover fundamental, historical information that has been derived, refined over time, and agreed upon by scholars and practitioners.

In this unit, we will explore the past of AI by learning one of the most fundamental things that can be explored about a topic – its definition. Though basic, definitions can be instrumental in expanding awareness of fundamental information and serving as a potential launch pad for more questions. Since research is driven by the process of asking and answering questions, anything that sparks additional questions has the potential to enrich the process. Based on the kind of information we want to understand about the *past* of AI for this project, we will reframe the general question as follows: **What is the definition of AI?**

It's worth noting that, since definitions are considered elementary, they are often overlooked as an integral part of the research process. In some cases, researchers skip this step altogether because they believe they already have a clear understanding of what the key definitions are. However, unless you are an expert in a given field with deep and expansive knowledge, starting with definitions is actually a great way to familiarize yourself with a field, warm up your 'research muscle' before diving in further, and breaking ground for further exploration. This unit was designed to drive that point home.

## Finding Sources and Extracting Data

Once we have decided on the question(s) we will explore in a research context, the next step is to determine the best way to derive a solution. Given the nature of our research question, **What is the definition for AI?**, our approach will be to search for definitions of AI in reliable, trusted sources – namely, from scientific books, journals, and conference proceedings.

Search engines, like Google, are powerful tools for identifying critical resources on the Internet very quickly. Although you might be quite familiar with Google – and probably use it many times throughout the day – it is not always the most appropriate resource for scholarly discovery. Specifically, when conducting research that has a heavy scientific slant, one of the most critical steps to take is to gather information from trusted sources. As a result, for this part of our research project, we will use **Google Scholar** as our search engine. Google Scholar is a great tool for identifying trusted sources because it was specifically designed to[1]:

> "provide a simple way to broadly search for scholarly literature... across disciplines and sources... [including] articles, theses, books, and abstracts... from academic publishers, professional societies, online repositories, universities, and other web sites."

[1] https://scholar.google.com/intl/en/scholar/about.html (see Citations)

**To answer our research question on the *past* of AI, we will use Google Scholar to find three articles that define the field**. This approach requires that we gather appropriate information sources, extract pertinent data, and use the information gathered to develop our own definition. We call the last step 'making meaning' and will begin gathering the raw data needed to support that process in this unit.

## Searching for Articles via Google Scholar

To access Google Scholar, go to the following link: https://scholar.google.com/

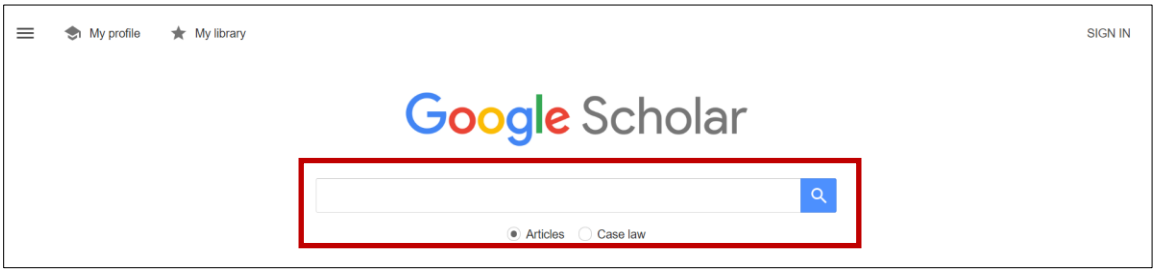


*Figure 1: Google Scholar homepage with the search box highlighted in red*

Once there, the next step is to create a *search query*. A ***search query*** is the set of keywords or phrases that search engines, like Google and Google Scholar, use to find a set of appropriate resources out of an expansive collection. Although you probably create and use several search queries throughout the day in the Google search box, there is a possibility that the ones you are using are not as efficient as possible; in this case, an efficient search query returns the most pertinent resources/documents within the first page of returns. There is actually a science to creating effective search queries and specific rules/formatting that facilitate the process. Understanding the science and rules is important. Ultimately, the strength of your search query significantly impacts the quality and relevance of the information returned, the order resources are listed, and – in turn – how quickly you can shift your focus from finding resources to reviewing them and actually collecting pertinent data.

To strengthen the efficiency of our Google Scholar search, one viable goal is to retrieve documents that contain exact matches of the term **artificial intelligence** and the word **definition** in them. As a result our query should look like this:

+"artificial intelligence" +definition

Putting *quotation marks* around **artificial intelligence** signals to the search engine to only return resources that have that exact term in them. Otherwise, the search results could contain documents that contain the word *artificial* and the word *intelligence* but in separate sections and not necessarily in a single phrase. The addition sign '**+**' is also key in the search query; it indicates that all returns **must** contain the given word or phrase in order to be an applicable resource. The search term listed above is helpful but only for our specific text. For more general information about how to develop effective search queries, particularly when using Google, visit the following link: Search Query Insight.

Once we have provided our query to Google Scholar and the search engine provides our returns, our next goal is to **find three separate articles with three distinctly different definitions of artificial intelligence**. We will then extract, or *copy*, the data (definition) from those documents and store, or *paste*, the data in ***Table 3*** on the next page for later analysis. In addition to extracting the definition from each relevant document, we also want to record the link we retrieved the document from by copying/pasting it into ***Table 3*** as well for later reference. More succinctly stated:

- **For each of three distinct definitions found in three different articles/documents**:
    - Copy/paste the definition, as is, into the first available (empty) row labeled "Definition" in ***Table 3***.
    - Next, copy/paste the link of the source document (from which the definition was retrieved) into the row labeled "Link" directly underneath the corresponding definition.

| **What is artificial intelligence (AI)?**<br>Find three definitions in three separate documents and copy/paste them below along with the associated URL/link. | |
|---|---|
| Definition #1 | |
| Link #1 | |
| Definition #2 | |
| Link #2 | |
| Definition #3 | |
| Link #3 | |

*Table 3: AI Definition Tracker*

## Wrapping Up the Process

A normal and rich truth about the research experience is this: as you explore a subject further, identify key resources, extract pertinent data, and begin to make meaning of it – it is inevitable that more questions will emerge. Keeping track of these questions is critical to managing your research process, especially since they can direct or re-direct your research path in a way that leads to deeper and, perhaps unexpected, discovery. As a result, you should make it a priority to log these need-to-know questions (NTKs) as they materialize via the Need to Know (NTKs) tool. Before you finish the project and as you move along, it's a good idea to constantly add to and review your NTKs.

Once you've found three sources and recorded both the definition and link for each in ***Table 3*** above, we're off to a great start! Specifically, we have the raw data we need to answer our question – **What is the definition of AI?** Now we have to make meaning of the data we've collected by developing (or synthesizing) our own definition for AI. Since we are pulling data from other documents, we also need to know how to credit our sources by properly adding citations to our research paper. We will tackle both of those steps in the next unit but, before moving on, please be sure to complete the Unit 2 exercises.

**Unit 2 Exercises:** A critical aspect of research is collecting raw data and analyzing it to extract meaning from it. In this case, the data we have collected is the definition of AI from relevant documents. In Unit 3, our analysis process will be to review each of those definitions and use them to generate our own definition of the field. We are going to lay the foundation for that process in the exercise below.

1. **Quickly review the three definitions you've accumulated and stored in Table 3 as a result of the work you did in this unit. Do you see any overlapping or recurring words or themes? If so, write them down below:**

2. **Review your answer to question #1 on page 7. Do the definitions you've found align with the definition of AI you had in your mind prior to beginning this research? Why or why not?**

3. **As you conduct research and get more practice using search engines to collect data, you will learn that all resources aren't reliable or trustworthy. One approach to analyzing the credibility of an article or document is to use the A-CLAP approach. For each of the resources you've collected so far, apply A-CLAP to determine its trustworthiness. What did you learn from that process?**

**Congratulations! You have finished What is AI? – Starting With the Basics. Let's move on to Key Research Fundamentals: Making Meaning and Citing Sources.**

# Unit 3: Key Research Fundamentals: Making Meaning and Citing Sources

In the previous unit, we began our process of exploring the past, or foundation of AI, by finding articles, book chapters, and other resources via **Google Scholar** that explicitly state the definition of the field. By doing so, we took an important first step in laying the foundation for continued discovery.

In this unit, we will build upon our previous work by (1) analyzing the data – namely, the definitions – we collected in ***Table 3*** in order to synthesize, or make, meaning and (2) understanding how to cite the resources from which we retrieved our data. Being able to complete these steps accurately is critical for most research projects and this unit provides you with an opportunity to practice and refine both.

## Making Meaning through Your Prism

One of the most important, and significantly creative, aspects of conducting research is not so much finding sources with relevant information – like we did in Unit 2 – but extracting pertinent data and analyzing it to synthesize meaning. In the context of your current work, synthesizing meaning entails reviewing the three definitions of AI stored in ***Table 3***, extracting key information from each one, allowing your mind the time and space to process the data, and then creating a new definition of AI, in your own words, that is both factual and somewhat unique. This definition should be unique to you because it will be derived based on your thoughts and your interpretation of the data you collected.

To implement the steps described above, do the following:

1. Read each of the definitions stored in ***Table 3*** and **highlight the key terms and phrases** that stand out to you. These shouldn't be full sentences – just very specific key words and very short (two- to three-word) phrases.
2. Next, take the key words and phrases you have highlighted and record (**copy/paste or type**) **them into *Table 4*** (on the next page). This is an important step. By sifting through the data, extracting key data points, and storing them in a separate space, you can review them in isolation – without looking at the original definitions. This can be critical in the synthesis process as you form your own perspective.
3. After placing key words and phrases into ***Table 4***, **look over them briefly, put them away, and do another task – like doodling, meditating, or talking a walk – for about 5 to 10 minutes**. This will give your brain an opportunity to shift from intense mental focus and allow it the space necessary to be creative and generate new ideas.
4. Once the 5-10 minutes is over, **write a draft definition of AI in the box below based on your memory of the key terms and phrases you extracted** in step 2. Do this without looking at ***Table 4***.
5. After you have your draft definition written out, return to ***Table 4*** and review the key words and phrases you extracted. If there are any words or phrases that you forgot to add in your draft definition, fit them in appropriately and then edit for clarity. At the end of this step, you should a draft definition of AI in the box below that consists of full sentences and captures your interpretation of the data you collected.
6. Finally, compare the definition you've just created to the three you originally collected and stored in ***Table 3***. Make sure that your draft definition is distinctly different – in its phrasing – from the others.

| **Use the space below to draft your definition of AI.** |
| --- |
| |

Combined, these steps will allow you to synthesize a definition that is informed by critical resources but unique to you. Note, in step #3 in the process above, the goal is to, figuratively, step away from the list of words/phrases you extracted and put some mental space between your review of ***Table 4*** and your attempt to develop your own definition. Why? Science has shown that taking a break from mentally intensive tasks enables creativity[2] by allowing the brain the freedom it needs to *wander* into innovation. The critical, and yet, not-so-straightforward thing to do here is to give yourself *just the right amount of break time*. For instance, too much time away from your notes may make you lose track of your train of thought altogether. Understanding what the time constraints are for you is a very personal undertaking and, in large part, will only become more clear the more often you practice this synthesis process. Use exercises like these and your own self-guided research experiences to build that knowledge about yourself and then leverage it in future research projects to maximize your success. In the meantime, 5-10 minutes is a great baseline.

**AI Definition Data Points**

Review the definitions you collected in ***Table 3*** and record the pertinent key words and phrases associated with each in the space below. Return to this table to enter citations once you've completed the **Creating Citations** section on the next page.

| | |
|---|---|
| Key Notes for Definition #1 | |
| Citation for Source #1 | |
| Key Notes for Definition #2 | |
| Citation for Source #2 | |
| Key Notes for Definition #3 | |
| Citation for Source #3 | |

*Table 4: Key Definition Data Points*

[2] https://www.inc.com/thomas-oppong/for-a-more-creative-brain-take-breaks.html (see Citations)

## Creating Citations

Because our research approach requires us to identify source documents and extract data from them, a critical part of our process (throughout the remainder of this module) will be reviewing and citing sources. There are a variety of approaches you can use to format citations[3]; the model that is most appropriate can be based on the type of writing you are doing or requirements that have been specified in advance (e.g., by your instructor for coursework). For this project, we will select our citation format based on the type of writing we are doing. In this case, we are exploring and will ultimately present information on science – and Computer Science, in particular. As a result, we will use the Institute of Electrical and Electronics Engineers (IEEE) citation model.

To get familiar with the IEEE citation model[4], consider the examples that follow:

- **Journal Article in Scholarly Journal**
  - J. Wing, "Computational Thinking," *Communications of the ACM*, vol. 49, no. 3, pp. 33 – 35, March 2006. [Online Serial]. Available: https://dl.acm.org/doi/10.1145/1118178.1118215. [Accessed September 9, 2022].
- **E-book**
  - E. Simon, A.I. Hacked: A Practical Guide to the Future with Artificial Intelligence. Bloomington, IN: Archway Publishing, June 2019. [E-book] Available: https://www.google.com/books/edition/A_I_Hacked/RIifDwAAQBAJ
- **Internet Site**
  - J. Manyika, J. Silberg, and B. Presten, "What Do We Do About the Biases in AI?" Harvard Business Review, October 25, 2019. [Online]. Available: https://hbr.org/2019/10/what-do-we-do-about-the-biases-in-ai. [Accessed September 10, 2022].

The video that accompanies this unit provides more insight into how to apply the IEEE citation model. For additional information, examples, and formats for IEEE citation, please visit the following link: https://pitt.libguides.com/citationhelp/ieee

Based on the examples provided above, return to ***Table 4*** and add a citation for each of the resources in the space provided. For a more general template that you can use to consolidate data, links, and citations in one table, visit the Data Accumulator in the appendix.

## Beginning Your Research Paper

Now that you have collected your raw data, extracted key data points, synthesized your definitions, and formatted your citations, you're ready to begin building your research paper. That process will begin in this unit, on the next page, and end in Unit 7. The steps for building your research paper have been strategically divided across several units to make the process more manageable. Aim to complete the prescribed chunks as you complete each the unit.

[3] https://pitt.libguides.com/citationhelp (see Citations)
[4] https://ieee-dataport.org/sites/default/files/analysis/27/IEEE%20Citation%20Guidelines.pdf (see Citations)

## Writing Your Paper: Part I: The Past of AI

1. Review the definition of AI you drafted (on **page 12**) and correct any spelling or grammatical mistakes. Ask for help if you need assistance identifying errors and follow up to make sure you understand why the corrections were suggested.

2. Next, add a sentence like the following in front of your definition:
    **a.** "After reviewing 3 documents that described the foundation of artificial intelligence, I synthesized the following definition: [add your definition here][add your citations here]" (see below).

| **Past of AI Paragraph Section Draft**<br><br>Update the draft of your paragraph about the definition of AI below and then copy/paste it in the appropriate location in your draft paper outline. |
|---|
| After reviewing 3 documents that described the foundation of artificial intelligence, I synthesized the following definition: [add your definition here][add your citations here]. |

**Congratulations! You have finished Key Research Fundamentals: Making Meaning and Citing Sources. Let's move on to The Impact of AI Today.**

# Unit 4: The Impact of AI Today 

Now, that we've taken the *past* or foundation of AI into consideration by exploring its definition, our next step will be to conduct research on the *present* of AI. In general, when surveying the present of a field, a key question to ask is: **What is the impact of the field in our daily lives?** The underlying objective of this question is to formally characterize the footprint of the topic in day-to-day activities.

To reframe the general question so that it applies to our project, we will address the following in this unit: **What tools or software do I, the reader, currently use that implement AI?**

Much like in Units 2 and 3, our process for exploring the present impact of AI, via our reframed question, will be to gather key resources, extract pertinent data from them, and make meaning of what we find. In this case, our goal is to **identify three separate sources that list examples of tools that currently use AI** and document those tools in ***Table 5*** below. For this phase of our research, you may use Google Scholar, Google, or any other search engine to gather resources. As you find viable sources, record the names of the tools/technologies listed and copy/paste the link for later reference. In addition, use the IEEE format on **page 14** to develop a citation for each source and store in ***Table 5*** as well.

| **What tools/systems currently implement AI?**<br>Find three sources with lists of tools that use AI, copy/paste each list and the associated link below, develop a citation for each source, and store all of that information below in this table. | |
|---|---|
| Current AI Uses #1 | |
| Link #1 | |
| Citation | |
| Current AI Uses #2 | |
| Link #2 | |
| Citation | |
| Current AI Uses #3 | |
| Source #3 | |
| Citation | |

*Table 5: Tools and Technologies that Implement AI*

## Making it Personal and Making Meaning

Now that you have a list of tools and technologies that implement AI, the key to making meaning for this part of our process is to identify those tools that you are most familiar with, and then focus squarely on those that you use daily to weekly. Begin by reviewing the lists you have stored in ***Table 5***, highlight each tool that you are familiar with, and then go back and circle each tool you personally use in your daily or weekly life. Highlights and circles will be helpful visual cues here because they can help you to focus your attention later during the analysis phase.

Once you have completed your highlights and circles, review your list, and select one circled item to talk more about in your research paper (see question #3 below) – place an asterisk (*) next to that item. If you don't have any items circled in your list, select one of the tools you highlighted instead.

One important thing to mention: for this project, the process of answering our questions has taken a similar approach throughout. Namely, we use a search engine to find applicable resources, review the returns to identify documents of interest, and then extract key data points from documents with pertinent information. From there, we analyze the extracted data points further to begin making meaning. Take note of this approach and use it as often as it applies in future research endeavors.

## Writing Your Paper: Part II: The Present of AI

To structure the second major section of your paper, documenting the present of AI, answer the questions below and then combine your answers in the box that follows (next page) to start developing and refining your section draft.

1. Document the list of tools you discovered during your research that currently use AI; you can choose to show the complete list or just a subset of the most interesting items. Start your summary with a sentence like the following: "Over the course of my research, I found the following [number] tools that currently use AI[add your citations here]: [list the tools you found here]."

2. Share your perspective on/reaction to the list of tools you discovered. As an example, is there anything that you were surprised to see on the list?

3. Share more insight about the tool you put the asterisk beside. Namely, discuss what it is, how often you use it, and why it is important to you.

**Present of AI Section Draft**

Use the space below to draft and refine your write up for the present of AI that will go into your draft paper outline. To draft your write up, put the answers to questions 1 – 3 on the previous page in the space below, in order, without the wording in the preceding questions. Edit your write-up for grammar, spelling, and clarity. Once you have finished with your draft, copy/paste it in the appropriate section in your draft paper outline.

**Congratulations! You have finished The Impact of AI Today. Let's move on to Bias in AI and Your Pick!**

# Unit 5: Bias in AI and Your Pick!

Up to this point, our research efforts have focused on exploring the *past* and *present* of AI to broaden our understanding of its foundation and identify its footprint in our day-to-day activities. After learning what AI is and becoming more aware of its current impact, a natural next step is to look toward the future and get a sense for where the field is going.

In general, when exploring the future of a field, an important question to ask is: **what challenges are shaping the conversation scholars and practitioners are having about the way forward?** The underlying objective of this question is to identify critical *beacons of insight* that indicate how – for now, at least – experts expect the field to advance beyond the state-of-the-art.

As you'll remember, one of our consistent practices in this project is to mold general research questions to fit our field of study. In this unit, we will go about exploring the future of AI by identifying research challenges that are expected to have long-term impact on the trajectory of the field. As a result, we will reframe the general question for exploring the future of a field as follow: **What are the hot research topics in AI?**

In exploring hot topics in AI, we will begin with a targeted look at the impact of bias in the field. We will then take a more expanded view of key research challenges, by accumulating a list from trusted sources, in order to get a good overview of the landscape. Lastly, we will identify one topic to explore further at a later time.

Before going forward, it's important to note that our exploration of the future of AI will actually take place over two units – and via two different paths. Here, in Unit 5, we will focus on the "hot topics" in AI with an emphasis on the technical direction of the field. In the next unit, we will shift our focus to exploring AI as a potential career pathway. These are two very different perspectives of the future but, understanding each is important given the overall goals of our work.

## Bias in AI

Considering how computers can process large amounts of data very quickly, the field of AI was initially considered an innovative way to leverage powerful machines to assist humans with sense- and decision-making. The conventional thinking was that computers could produce accurate, impartial outcomes from significant amounts of information in very short order. However, as AI has matured and been examined under a more nuanced lens, it is clear that many of the outcomes supported by AI actually *reflect* human prejudices. As a result, a critical challenge to address in AI is something called *bias*.

As we saw in Unit 2, one of the most important things to do when exploring a subject is to get a firm handle on its definition. As a result, before we delve into bias in AI, let's start by defining the word bias in general. For this exercise, look up one definition from one source, copy/paste the definition into ***Table 6,*** and write your citation in the space provided below.

| **What is bias (in general)?**<br>Copy/paste or record the definition from your source, record the URL, and cite your source using the IEEE format. | | |
|---|---|---|
| | Definition | |
| | Source | |
| | Citation | |

*Table 6: Understanding Bias*

As we've discussed, definitions are helpful in providing foundational insights – but they are also important in another way. Consider this: as you explore a new topic, you will inevitably come across words you either don't know or need clarified for the given context; some words actually take on a different or more nuanced meaning in a particular field of study. This is a normal and highly *valuable* part of the process. See these **new words** or **new definitions for words** as rich opportunities to grow your vocabulary and use the KIMS tools to track them. Also, include a few of these words in your write-up to make sure that you maximize your learning experience by using what you have learned.

## Bias in Artificial Intelligence: An Example and an Anti-Bias Champion

Now that we've defined bias, let's explore what it means to have bias in AI. With that in mind, consider the following exercise.

| **What does it mean to have bias in AI?**<br>Using the search engine of your choice, and after reviewing at least 3 sources, provide one example of bias in AI in the space provided below. Record the link and format the citation (IEEE) for your source as well. | |
|---|---|
| Example of Bias in AI | |
| Link | |
| Citation | |

*Table 7: Example of Bias in AI*

Now that we've taken a look at bias in AI, let's take a look at a high-profile story on this topic that got a lot of traction in December of 2020. Do the exercise below to begin building an understanding of the people and ideas that are looking to change bias and impact the future of AI in a positive way.

| **Who is Dr. Timnit Gebru and what is her relationship to fairness/bias in AI?**<br>List your answer, the link you used to get your information, and the citation in IEEE format below. | |
|---|---|
| Answer | |
| Link | |
| Citation | |

*Table 8: Dr. Timnit Gebru, An Anti-Bias Champion*

**Your Pick**

Bias is just one of several hot topics in AI and, while it is an important one to consider, there are many others shaping the conversation around AI. In the exercise that follows, identify a list of AI hot topics and begin documenting them**. Try to find a total of 3 hot topics from at least three resources and store your findings in *Table 9* below**. Once you have developed your list, highlight any areas of interest. Finally, circle one topic that you would like to explore further.

| **What are some of the hot topics in AI?**<br>Find three hot topics and copy/paste them below along with the associated URL, and citation for each in IEEE format. | |
|---|---|
| Hot Topic #1 | |
| Source #1 | |
| Citation | |
| Hot Topic #2 | |
| Source #2 | |
| Citation | |
| Hot Topic #3 | |
| Source #3 | |
| Citation | |

*Table 9: Hot Topics in AI*

## Writing Your Paper: Part III: The Technical Future of AI

This unit was primarily about peering into the future of AI by taking (1) a targeted look at the impact of bias in the field and (2) a wider view of other 'hot topics' shaping the conversation around AI. To draft the third major section of your paper, documenting the technical future of AI, answer the questions below and then combine your answers in the box that follows (next page).

1. What is bias in AI, why is it a problem, and what is one example?

2. Write a summary of the 3 hot topics you discovered. Start with a sentence like: "After conducting research on hot topics in AI, I found the following [add your citations here]: [list the topics you found]."

3. Identify one of the three hot topics you discovered earlier that interests you the most, discuss why you find it interesting, and whether you plan to explore it more in the future.

**Technical Future of AI Section Draft**

Use the space below to draft and refine your write up for the technical future of AI that will go into your draft paper outline. To draft your write up, put the answers to questions 1 – 3 on the previous page in the space below, in order, without the wording in the preceding questions. Edit your write-up for grammar, spelling, and clarity. Once you have finished with your draft, copy/paste it in the appropriate location in your draft paper outline.

**Congratulations! You have finished Bias in AI and Your Pick! Let's move on to Careers in AI.**

# Unit 6: Careers in AI

In the previous unit, we looked at the future of AI from a technical perspective – specifically, exploring the "hot topics" that are shaping its trajectory. In this unit, *the future of AI* takes a more personal slant by focusing on factors you should consider if you're interested in AI as a potential career path.

Careers in AI are not only *lucrative*, they thrive on *creativity* and *innovation*. As an AI professional, you will be a key player in the process of bringing technologies from forward-leaning concepts into reality. This unit will guide your exploration of AI as a career and provide insight into how to prepare, academically, to be an AI professional.

## A Career In AI

As you consider becoming an AI professional, one question you might have: "Is there a such thing as an Artificial Intelligist?" In fact, the answer is no. That prompts a critical question: Namely, what job title should you explore if you want to learn more about a professional future in the field? To get an idea, we will leverage the Occupational Outlook Handbook, a reference published by the U.S. Bureau of Labor Statistics to handle questions like these. In short, the handbook is an invaluable resource for exploring careers and learning about key occupational factors including, annual salary, working conditions, integral skills, and projections for job growth within the decade. We will use the handbook heavily in this phase of our research, but, now that you know about it, feel free to use it as often as you would like to explore any careers that may interest you.

To access the Occupational Outlook Handbook, visit the following link: https://www.bls.gov/ooh/

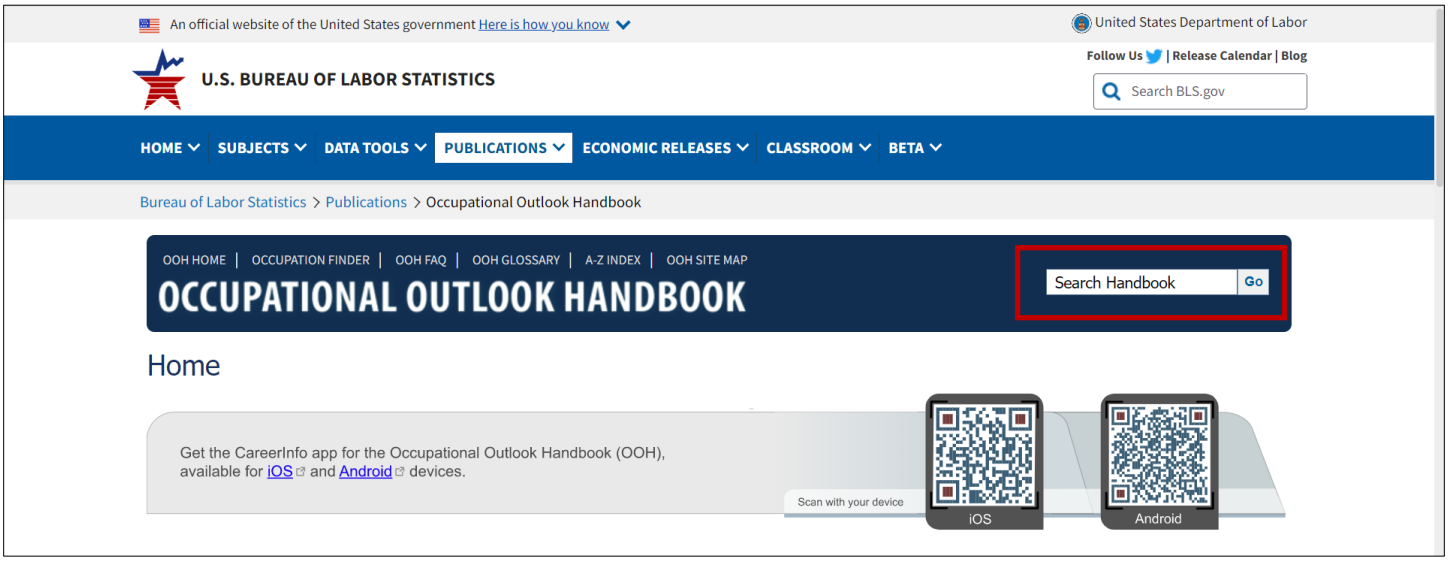


*Figure 2: Occupational Outlook Handbook homepage with the search box highlighted in red*

After arriving at the site, type the following query into the search box (shown in red in Figure 2):

artificial intelligence

Note that this search query is formatted very differently from the one we used to maximize our search results in Google Scholar (In Unit 2, on **page 9**). That is, in part, because different search engines can respond differently to query formatting; in this instance, the search query **artificial intelligence**, with no quotation marks, provides the most efficient

results. This is just a reminder that one size doesn't always fit all and, to ensure that you have the most efficient listing of search results, you may need to play with query formatting from time to time.

As a result of the search query we have used, the first return we will see is **Computer and Information Research Scientists**. After clicking the link and navigating to the corresponding web page, you will have access to important information regarding duties, work environments, how to become one, similar occupations, and more.

Complete the exercise below, in ***Table 10***, to record key data about Computer and Information Research Scientists.

| **AI as a Career**<br>Record information about the salary, duties, and skills for Computer and Information Research Scientists below. | |
|---|---|
| Median Salary | |
| Duties | |
| Integral Skills | |

*Table 10: AI as a Career*

## Identifying a College or University of Choice

One of the most traditional ways to launch a career in Artificial Intelligence is to attend a college or university and begin by earning an undergraduate degree in Computer Science, Electrical Engineering, or Mathematics. Next, as the Occupational Outlook Handbook indicates, AI Professionals tend to go beyond the undergraduate level and earn a Master's Degree as well.

So, how should you start thinking about the educational process for becoming an AI Professional? One way is to begin identifying a potential undergraduate/graduate institution of choice by conducting research to discover the colleges and universities with strong AI programs. To identify institutions that fit the bill, do a Google Search on the top institutions in artificial intelligence using the following query:

+"artificial intelligence" +top + colleges

In your search returns, look for a U.S. News & World Report article labeled, **Best Artificial Intelligence Programs – US News Rankings**:

1. Click the link and then record the top 10 institutions in ***Table 11*** (on the next page).
2. Next, take a look at your list and identify at least one institution that would be of interest to you as a college/university to attend. Place an asterisk beside that institution.
3. Finally, do a little bit of research on the institution you placed the asterisk beside. In particular, identify where the institution is located in the U.S. and find the homepage for the institution online. Copy/past the link to the institution's home page in ***Table 11*** as well.

By completing this exercise, you will not only get an idea about the institutions with high-quality AI programs , you will begin taking the steps necessary to learn about a future college or university of choice. Although your institution of choice may change several times between now and when you actually start college, getting the ball rolling on this process as early as possible can be very beneficial in the long run.

| **Top U.S.-based Colleges and Universities in Artificial Intelligence**<br><br>Record U.S. News & World Report's top 10 AI Institutions below, identify an institution of interest on the list, and record key information about that institution below. | | |
|---|---|---|
| | Top Ten Institutions | |
| | Institution of Interest | |
| | Location (City, State) | |
| | Homepage Link | |

*Table 11: College and Universities to Consider in AI*

## Writing Your Paper: Part IV: The Career-Oriented Future of AI

This unit focused on the future of AI as a potential career for you. To structure the fourth major section of your paper, answer the questions below and then develop your draft in the box on the next page.

1. What are the duties of a **Computer and Information Research Scientist**, what is the median salary, and what are key skills for the role?

2. Write are the top 10 U.S.-based universities for studying AI?

**3.** Of the 10 schools featured in the list, which is most interesting to you and why?

**Career-Oriented Future of AI Draft**

Use the space below to draft and refine your write up for the career-oriented future of AI that will go into your draft paper outline. To draft your write up, put the answers to questions 1 – 3 on the previous page in the space below, in order, without the wording in the preceding questions. Edit your write-up for grammar, spelling, and clarity. Once you have finished with your draft, copy/paste it in the appropriate location in your draft paper outline.

**Congratulations! You have finished Careers in AI. Let's move on to Diving In and Next Steps.**

# Unit 7: Diving In and Next Steps 

We have made a lot of progress so far! In particular, we have defined what AI is in Units 2 and 3, examined how it impacts our day-to-day lives in Unit 4, and explored the future of AI from a technical (Unit 5) and career-oriented (Unit 6) perspective. Along the way, you have applied key research skills and tools, drafted a research paper, exercised your communication skills, and applied some of the pertinent skills you need to be an independent learner.

In this unit, we will wrap up your research paper, reflect on the **Artificial Intelligence Learning Experience**, and get mentally prepared to implement another research project. The goal of this unit is to encourage you to keep studying, growing, and evolving as an independent learner even after you complete this module.

## Reflecting

Given all that you have accomplished while completing this module, it can be easy to forget about critical parts of your experience without deliberately documenting it. As a result, it is important that you take the time to write your thoughts down while they are still fresh. Complete the What, So What, Now What? exercise to document the knowledge and experience gained so far, start thinking about how you can leverage what you've learned in the future, and explicitly state your next steps.

## Putting the Finishing Touches on Your Research Paper

Over the course of this experience, you received prompts in Units 3, 4, 5, and 6 to develop draft write-ups on the past, present, and future of AI. You have also been encouraged to refine your write-ups and incorporate them in the Paper Outline in the appropriate locations. If you've been doing this diligently, you have developed a strong draft of a paper that documents the past, present, and future of AI based on the sources you've collected, your perspective, and the meaning you've made throughout the process.

Additionally, this paper is considered a very important part of the research process because it will help you to grow and evolve your ability to communicate in written form. To complete your paper and share your work, follow these steps:

1. Complete the writing task at the end of this chapter, **Writing Your Paper: Part V: Next Steps**.
2. Navigate to the Paper Outline, review and edit what you have so far. Next, decide if want to add any additional sections. As an example, if you would like, you can summarize your reflection from the What, So What, Now What? exercise and add it as the last section. If you decide to add anything else, update your paper and add an appropriate heading to your addition.
3. Next, share your reviewed, refined, and edited paper with a teacher who can take a look at your work and give you helpful insights on how to improve it. Make sure you take the feedback seriously, correct your mistakes, and try not to make the same mistakes in the future; learning from any corrective comments is the key to improving.
4. Once you have completed your corrections, share the latest version of your paper with your parents, caregivers, peers, and siblings. Be open to making improvements based on their suggestions for improvement as well.

## Conducting Another Research Project

In this module, you've exercised the process of conducting research. The key to continually refining and expanding the skills you have developed is to continue to exercise them. Think about questions you may have about other fields/careers in Computer Science and make the decision to explore your questions further using the process that we have just completed.

Replicating this research approach as soon and as often as possible will help you get more familiar with, comfortable with, and faster at certain steps. It will also help you understand how to modify the approach to fit you better (e.g., the right amount of break time to take when synthesizing meaning). To realize these benefits, identify a topic of interest and then implement the steps you used for this project to explore the past, presence, and future of a topic of your choice. Begin by molding the questions below to fit the specific subject area. You can use the space below or the Research Planner.

- **Past**: what baseline or foundational information has already been established about the field?
- **Present**: what is the impact of the field in our daily lives or how is the topic currently applied on a daily basis?
- **Future**: what challenges in the field are shaping the conversation about the way forward?

| **Mold the General Questions to fit a New Area**<br>Use the space below to reframe the general questions provided to your specific research area. | |
|---|---|
| Past | |
| Present | |
| Future | |

*Table 12: Past, Present, and Future Question Development*

## Writing Your Paper: Part V: Next Steps

This unit was primarily about reflecting on your experience, and planning your next research project. To structure the fifth major section of your paper, answer the question below, refine your response, and then add it to the box on the next page as your draft.

1. What is the next research project you want to do and why?

**Next Steps Draft**

Use the space below to draft and refine your write up for the fifth major section of your draft paper outline. Put the answer to question 1 above in the space below, without the wording in the preceding question. Edit your write-up for grammar, spelling, and clarity. Once you have finished with your draft, copy/paste it in the appropriate location in your draft paper outline.

**Congratulations! You have finished the Diving In and Next Steps. Let's move on to Reflecting on the Road Traveled and Measuring Growth (Part II).**

# Unit 8: Reflecting on the Road Traveled and Measuring Growth (Part II)

Artificial Intelligence (AI) has permeated just about every aspect of our daily lives, guiding and influencing everything from spam filters to medical diagnoses. Having a working knowledge of what AI is, how it impacts your daily life, and its future trajectory is not only integral to being an informed citizen but, also, empowering yourself to explore Computer Science and AI as a potential career path.

The **Artificial Intelligence Learning Experience** was designed to help you explore key aspects of AI through a learning experience driven by research and exploration. In all, this experience was designed to build your knowledge base and capabilities in ways that open new doors and provide long lasting insights into how you conduct research, solve problems, explore potential careers, and document your findings. The ability to thoughtfully and carefully explore topics and synthesize meaning as a result of your work will serve you well as you continue to navigate your middle and high school years and can underpin a lifetime of discovery as an independent learner. In addition, the tools and skills you have used throughout this experience can be re-used in other contexts and, hopefully, teach and reinforce good research habits.

A key take-away from this experience should be that, at base level, research is all about asking questions. But, on a more expanded level, how and why research is conducted, the question or series of questions posed, the steps necessary to derive a solution, the expected outcomes, and how and where results are presented can vary significantly from project to project and ultimately shape the experience. Being able to conduct research can help you to be better prepared to take control of your own learning and explore your curiosities independently.

One important note: the research approach presented here is just one way to explore topics of interest. There are many others ways to conduct exploratory work and document your findings. As you encounter different experiences and different approaches, the key is to use the skills you've already built as they apply and to learn new skills as needed. By taking advantage of other opportunities to conduct research, you can learn more about the different approaches and further build your skills. This experience was designed to give you a strong base and, hopefully, the confidence you need to take on and successfully navigate other research opportunities.

In all, we hope this learning experience has provided you with an opportunity to grow awareness of the past, present, and future of AI; explore whether a career in AI is applicable to your interests and innate capabilities; and grow your communication skills. Moreover, by completing this journey, we hope you have grown as a researcher, that the process of conducting research feels more accessible than it did before, and that you replicate this process with another topic of your choosing in the near future.

You've accomplished quite a bit in this series and one of the last tasks to complete is measuring your growth in understanding the past, present, and future of AI. On the next page, you will find the same set of questions you answered in Unit 1. The answers you provided before you completed the units are effectively a snapshot of where you were. To see how far you've come, complete the questions on the next page and then compare your responses with the answers you gave before. The results of that comparison will not only provide insight into how you've advanced your understanding but will also shed light on areas that may need additional review. Celebrate the growth but, also, take note of opportunities to improve and fully capitalize on them!

In closing, thank you for taking the journey! We'd love to hear about your experience and how, from your perspective, it can be improved. Be sure to reach out to us at the link below and share your thoughts:
https://forms.gle/t5dYQzLthehLT3aJ8

**Track Your Progress:** Take a look at the questions below and answer as well as you can, based on what you've learned. Compare your responses here with the answers you provided in Unit 1 to see how far you've come over time.

1. **What is Artificial Intelligence (AI)?**

2. **What tools or software do you use today that uses AI?**

3. **Name three "hot topics" in AI.**

8. **Name two universities that have high-ranking AI academic programs?**

4. **What aspects of your personality or interests might serve you well as an AI professional?**

5. **On a scale from 1 – 10: rate your <u>understanding</u> of AI.**

6. **On a scale from 1 – 10: rate your <u>interest</u> in AI.**

# Citations

[1] Google Scholar, “About”. [Online]. Available: https://scholar.google.com/intl/en/scholar/about.html [Accessed: July 11, 2022].

[2] T. Oppong, “For a More Creative Brain, Take Breaks”, *Inc.* [Online]. Available: https://www.inc.com/thomas-oppong/for-a-more-creative-brain-take-breaks.html [Accessed: August 3, 2022].

[3] University of Pittsburgh Library System, “Citation Styles: APA, MLA, Chicago, Turabian, IEEE,” *Course & Subject Guides*. [Online]. Available: https://pitt.libguides.com/citationhelp [Accessed: August 4, 2022].

[4] IEEE DataPort, “How to Cite References: IEEE Documentation Style”. [Online]. Available: https://ieee-dataport.org/sites/default/files/analysis/27/IEEE%20Citation%20Guidelines.pdf [Accessed: August 4, 2022].

# Draft Paper Outline

## I. Part I: The Past of AI

[Provide the definition of Artificial Intelligence you drafted in Unit 3 (on page 15) in the space below.]

[Paste text here!]

## II. Part II: The Present of AI

[Paste the write up you developed about the present of AI in Unit 4 (on page 18) in the space below. Your write up should consist of three paragraphs, each of which addresses the following questions:

a. Write a summary of the tools you discovered that currently use AI and then list around 10 tools. Start with a sentence like: "Over the course of my research, I found the following [number] tools that currently use AI: [list the tools you found]."
b. Share your perspective/reaction to the list of tools you discovered. As an example, is there anything that you were surprised to see on the list?
c. Single out one of the tools you listed above and discuss what it is, how often you use it, and why it is important to you.]

[Paste text here!]

## III. Part III: The Technical Future of AI

[Paste the write up you developed about the future of AI in Unit 5 (on page 23) in the space below. Your write up should consist of three paragraphs, each of which addresses the following questions:

a. What is bias in AI, why is it a problem, and what is one example?
b. Write a summary of the 10 hot topics you discovered. Start with a sentence like: "After conducting research on hot topics in AI, I found the following: [list the topics you found]."
c. Choose one of the 10 topics you found above and indicate why it is of interest to you and whether you plan to explore it more in the future.]

[Paste text here!]

## IV. Part IV: The Career-Oriented Future of AI

[Paste the write up you developed about the future of AI in Unit 6 (on page 27) in the space below. Your write up should consist of three paragraphs, each of which addresses the following questions:

a. What are the duties of a Computer and Information Research Scientist, what is the median salary, and what are key skills for the role?
b. What are the top 10 U.S.-based universities for an AI program?
c. Of the 10 schools featured in the list, which is most interesting to you and why?]

[Paste text here!]

## V. Part V: Next Steps

[Paste the write up about your next steps after finishing this module you developed in Unit 7 (on pages 30) in the space below. Your write up should address the following question:

a. What is the next research project you want to do and why?]

[Paste text here!]

## VI. Citations

[List your citations below, numbered, and in order.]

See Citations for an example of how this section should be formatted.

# Appendix A: Research Planning Map

Research is all about asking and answering questions but, when you're taking on a new subject, it may not be clear where to start. Use this guide to help navigate this process.

The chart below lists three key areas to explore about a topic, namely – its past, present, and future, along with the general questions that address each area. When beginning a project, start your process by molding each general question to your specific project. Space has been provided below to implement that process.

| Component | General Question | Question Specifically for this Project |
|---|---|---|
| **Past** | What baseline information has already been established about the field or area? | |
| **Present** | What is the impact of the field or topic on day-to-day activities? | |
| **Future** | What are the challenges in the field that impact the conversation on how to structure the field moving forward? | |

## Appendix B: Need to Know Questions

A critical part of the research process is asking and answering questions. This graphical organizer was designed to help you keep track of the questions that arise when conducting research, to encourage you to brainstorm how you might go about answering the question, and then indicating whether you have actually answered, or resolved, the question over the course of your work.

| # | Question | Potential Process for Retrieving Answer | Resolved? (Yes or No) |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |
| 11 | | | |
| 12 | | | |

# Appendix C: Data Accumulator

This handy accumulator allows you to specify the question you want to answer, gather information from your sources, maintain an account of the link, draft your citation, and start interpreting what you're learning.

| | | |
|---|---|---|
| **[Question Goes Here]**<br>Find three definitions and copy/paste them below along with the associated URL, and citation. Highlight key words and phrases of interest to begin making meaning. | | |
| | Definition #1 | |
| | Link | |
| | Citation | |
| | Definition #2 | |
| | Link | |
| | Citation | |
| | Definition #3 | |
| | Link | |
| | Citation | |

# Appendix D: A-CLAP[5,6]

This strategy promotes critical thinking when analyzing information sources for research purposes. A-CLAP provides a framework for evaluating the credibility of a website, article, book, or other source.

When exploring the credibility of a source, answer questions about authority, currency, leaning, accuracy, and purpose as listed below:

1. **Authority**: Is there an author, an editor, publisher, or institution provided? Does the individual or organization list their qualifications or credentials?
2. **Currency**: Is there a date that shows when the source was published or last updated? Keep in mind that not knowing the date of publication of factual or statistical information can call its accuracy into question.
3. **Leaning**: Look for objective sources that present information with minimal bias and without the intention to persuade. If a debatable issue is covered, are multiple perspectives presented in a balanced way?
4. **Accuracy**: Based on the reading you have already done on the subject, can you corroborate this information with other sources? Is factual information referenced in the footnotes or a "Works Cited" list?
5. **Purpose**: Judge whether the source is geared to a scholarly or non-professional audience. Is the information relevant to your needs? If online, use the URL or other linked websites to help you determine its purpose.
6. Given the criteria listed above, assess the reliability of this source and summarize evidence supporting your position. Ask for help if you need additional insight.

[5] https://learn.k20center.ou.edu/strategy/183
[6] Schrock, K. (2019, September 7). Critical Evaluation. https://www.schrockguide.net/critical-evaluation.html

# Appendix E: KIMS[7,8]

KIMS is the acronym for a strategy that supports the exploration of words and can help you build your vocabulary knowledge across any content area. The acronym stands for keyword (K), important information (I), memory clue (M), and sentence (S). To assist with the KIMS process, a graphic organizer has been provided below with each column labeled accordingly.

To implement the KIMS approach when encountering a term you don't know, apply the following steps:

1. Add the new term to the ***Keyword*** column. [**ex**. corpus]
2. Identify or locate the definition for the term and record it in the ***Important Information*** column. [**ex**. A large dataset that can be used to train a machine.]
3. Think about a memory clue that could help you remember the keyword's definition? Write or draw this ***Memory Clue*** in the third column. [**ex**. A corporation is a group of people working toward the same purpose, so a corpus is a dataset being used for the same thing.]
4. Finally, develop a sentence that correctly uses the word. Write this ***Sentence*** in the last column and circle the keyword in the sentence. [**ex**. I collected every picture of dogs I could find to create a corpus for teaching the AI what a dog is.]

| # | Keyword | Important Information | Memory Clue | Sentence |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | | | |
| 11 | | | | |
| 12 | | | | |
| 13 | | | | |
| 14 | | | | |

[7] https://learn.k20center.ou.edu/strategy/780

[8] Vibas, K. (1970, January 10) K.I.M "A Highly Effective Strategy to Build Vocabulary Across Any Content Area", http://www.awalkinthechalk.com/2016/12/kim-highly-effective-and-simple.html

# Appendix F: KWHL[9]

K-W-H-L charts can help you organize information before, during, and after a unit or a lesson. They can be used to explore a new topic, support open-ended brainstorming, activate prior knowledge, or keep track of your learning.

It is important to note that learning is a lifelong, interconnected process, that is driven by cycles of asking and answering questions. By using the KWHL chart, you can maintain an account of prior knowledge about a concept or skill, set personal goals for learning, and then reflect on what you've learned. To use this tool, answer the following questions in the space provided:

- **What Do I Know?** Even if this is your first time conducting research, you will likely have a few of the key insights you need to navigate this process. What knowledge do you already have that can move this project along?
- **What Do I Want to Know?** Being curious and having the ability to generate 'good questions' is critical to the research process. Independent learners are constantly wondering and realize that not knowing something isn't a sign of deficiency but an opportunity to grow. With that in mind, what information do you want to learn?
- **How Will I Find Out?** To answer questions and find out what you want to know, you will likely need to use a series of resources and approaches. What tools or strategies might be helpful in your research process?
- **What Did I Learn?** After you find out the answer to a question, it is helpful to record your discovery for later reference. What new insights have you gained as a result of your research process?

| # | What Do I Know? | What Do I Want to Know? | How Will I Find Out? | What Did I Learn? |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | | | |
| 11 | | | | |
| 12 | | | | |

[9] https://www.redesignu.org/project/kwl-kwhlaq/

# Appendix G: What, So What, Now What?

The goal of the **What, So What, Now What** exercise is to put the knowledge and experience you have gained as a result of this project into perspective and to think critically about the content learned by answering the questions, "What?", "So What?", and lastly "Now What?"

By answering these three overarching questions, you will explicitly state the big idea from your learning, determine why it matters, and maximize your ability to apply this learning to other situations. It may take practice over time to get familiar with **What, So What, Now What**; start where you feel most comfortable and keep building out your responses until you have completed the exercise. Use the space below to answer the questions listed:

- **What?**
  - What did you learn? See? Think?
  - What did you observe?

- **So What?**
  - Why does what you've learned matter?
  - How has what you've learned added to or changed your thoughts?

- **Now What?**
  - How might you use this learning in other situations?
  - How might you do something differently based on what you've learned?
  - What follow-up is needed to address any challenges with this concept?