# Majors and Minors

The costs and considerations of various common majors and minors
for learning artificial intelligence

Cross Trained Mind
ALWAYS THINKING, ALWAYS LEARNING

[Matthew Emerick](#)
[Cross Trained Mind Site](#)
[Cross Trained Mind Channel](#)

# Table of Contents

When going to university to study artificial intelligence, it's important to have an idea of what you hope to achieve so you can work out how to get there.  A large part of that is determining the majors and minors you want to work toward as an undergraduate student.  Graduate school is a completely different animal and will be discussed in a different workbook.  This workbook looks at the pros and cons of various technical and non-technical majors and minors that most benefit your studies.

Before you begin, however, you will want to determine how you want to focus your career afterward.  Do you want to do machine learning at a corporation?  Or maybe have a say on government policy for AI research.  You could also teach at a university.  And don't forget about working with spatial data for an NGO.  There are many roles available, some of which don't exist yet, and may require more of a generalist education.  The clearer you know what you want to do, the easier it is to pick a set of majors and minors.

One thing that I feel like I need to point out is this:  <u>there is nothing wrong with taking an extra semester or two in order to take all of the courses you're interested in.</u>  Unless you go to a university that selects your timetable for you, you have complete freedom other than which courses are offered which semester.  This is your time to build your foundation; make the most of it.

Let's get started!

# Computer Science

Computer science can be considered the cornerstone of the technical side of AI.  While its focus is on the theoretical underpinnings of computation, you get a good foundation of programming, from beginner to advanced, and can offer a wide range of useful electives.  Nearly all universities offer this or something similar.

## Major

If you are technically inclined or choose to work in a more technical career, this might be the best major for you.  Programming is one of the top technical skills you'll need to work in artificial intelligence, and this major is a good way to get it.  This major gives you a strong technical foundation that you can build upon.

## Minor

For many, a minor in computer science might make more sense.  You are required to take the most useful courses and can still typically choose one or more electives.  This can be a good balance between taking the important courses for AI and not taking courses that won't help you as much.

## Courses

The core courses you will want include the introductory course, data structures, algorithms, and any artificial intelligence course you can get.  If you want to work in computer vision, you should take computer graphics to learn the core data structures.  If you have an interest in natural language processing, you might want to take a course on programming language concepts, which is usually included in a major.

## Notes

Either a major or minor in computer science will require some mathematics courses, which gives you a lead in a math major or minor.  If you have initiative, you could learn to program on your own while taking different majors and minors, but that has its own ups and downs.  It's easy to cut corners when you can custom fit your own education by learning everything outside of a university.  I caution against it as it leads to overfitting.

# Mathematics

Math is a subject that everyone loves to hate.  If you haven't developed a strong number sense, it can be extremely difficult.  Something you might hear is that so and so isn't a 'math person'.  I can tell you right now that there is no such thing as a math person.  There are simply those who understand math and those who don't understand math yet.  This is a subject anyone can learn with enough time and effort.

## Major

Going deep in mathematics has advantages.  You'll have a great understanding as to why certain algorithms work as well as they do.  You'll also understand how to make them better or to develop your own. If research is your focus, this might be a good major for you.

## Minor

At many universities, you earn half of the mathematics minor simply by completing a computer science major.  That makes the two of them a good pairing.  If there's ever a chance that you can add a minor by taking two or three more courses, do it.  It will help cement the knowledge you gain and give you one more credential for those who care about them.

## Courses

The core courses from mathematics are calculus I, calculus II, linear algebra, and discrete mathematics.  If you want to learn about neural networks in detail, you might want to take a course on differential equations as well.  Most of these courses are included in the math minor at many universities, so a mathematics major is overkill for most people.

## Notes

Mathematics is a difficult topic that requires a LOT of work and practice.  If you go this route, make sure to spread your courses out enough that you're not overwhelmed, but not so much that you forget in between.

# Statistics

There are a lot of AI researchers with Ph.D.s in statistics.  That is not to say that this is the route you should take.  The Ph.D. is a specialty area and is not necessary to work in AI.  That said, knowledge of statistics is very important.  I highly recommend that you take at least two or three statistics courses, focusing on the major points.

## Major

This is a good choice if you're going to focus on machine learning more than any other area.  However, it's not necessary for the majority of AI roles.  What you get from this is a deep sense of what's going on in your data.

## Minor

This is a good minor to have but is not for everyone.  It's a great minor to pair with a mathematics major as you should see some double counting.  It also gives you enough statistics background to be useful.

## Courses

You'll want to take the first two statistics courses that are considered core by the minor as well as anything on regression and time series analysis.  The regression and time series analysis courses are extremely important as they are two of the most used techniques used in data analysis.

## Notes

If you take up a computer science or mathematics major, you'll likely be required to take at least a few statistics courses.  Make sure to see how well they line up with the statistics minor to see how many more courses you'll need.

# Data Science

The data science major is the new kid on the block.  It can be very different depending on which university you attend.  If this is offered, it's worth a look to see if the courses are pulled from multiple departments versus being its own department.  Double counting may make this an easy selection as you could pick up multiple minors without too much trouble.

## Major

The major is typically a combination of computer science, mathematics, and statistics with a few odds and ends thrown in.  It's not quite known yet how well regarded this major is going to be, but as long as you learn the skills and do some projects to show what you know, it's nothing to worry about.

## Minor

If you're going for the non-technical side of artificial intelligence, then this might be a good fit for you.  It will give you some of the math, stats, and programming courses you need without making you go too deep.  Then you can better focus on your major.  If you are a technical person, then this might be an easy add-on without taking many more courses.

## Courses

You'll typically see a couple of programming courses, a math course or two (likely calculus and linear algebra), and a few statistics courses as well as some data-specific courses.  If you're not seeing this, you might want to reevaluate what you're thinking regarding this major or minor.  Like cognitive science, though, it's a good add-on.

## Notes

Looking over this major or minor, if it's offered, can give you insight as to which electives you might want to take for other majors.  If you can earn this by simply taking a few more courses, or if this is the direction you really want to go in, then the major or minor may be a good match.  Otherwise, you may want to skip past it at the undergraduate level.

# Cognitive Science

This is another tricky degree choice to find, but I feel it's very valuable.  Full disclaimer, it's one of my majors, though my alma mater doesn't offer it anymore.  This is typically a combination of computer science, philosophy, and psychology with a sprinkling of courses from other departments.  It's a very interdisciplinary choice.  It's also very different at every university, more so than most other majors and minors discussed here.

## Major

The major will likely require you to take something along the lines of the required courses for the computer science major; psychology courses like learning and memory, cognitive neuroscience, and perception; and philosophy courses like logic, theory of mind, and epistemology.  If you're lucky, you'll only need a couple more courses to earn a minor in one or more of those three fields.  The electives will include courses such as linguistics, game theory, and ethics.

## Minor

The minor will likely be a watered-down version of the major, but the courses will probably have prerequisites that make it as bulky as the major.  If you're thinking about the cognitive science minor, you might want to simply take a minor in one of its focus areas, computer science, philosophy, or psychology, instead.

## Courses

For those with a technology focus, this is a good balance to learn about the human side of intelligence.  There were many great courses that I enjoyed and that helped form my understanding of artificial intelligence.  Some of those courses include Philosophy of Mind, Perception, and Behavioral Neuroscience.

## Notes

While this is a great major or minor to take, it's not offered everywhere.  If you see, please think about adding it to your education portfolio.  It's one of the best majors to have when double counting for some of the other minors we're discussing.

# Psychology

Psychology is a very popular program, though by itself is most valuable when going at least as far as a mastery.  For the study of artificial intelligence, this is a great way to gain foundational knowledge on how human intelligence works, though you have to select your courses carefully.  Most courses offered by a psychology department aren't very useful for AI, as they are meant to understand humans specifically.  You'll want to look at the more general courses.

## Major

Many universities offer a very flexible major, as there are many career choices to pick from.  This is to your benefit, as you can really tailor your course selection toward the study of intelligence in general and not take courses about psychological testing or industrial psychology.  Many psychology courses will double count toward some of the other majors and minors as well.

## Minor

The psychology minor almost always offers great flexibility without requiring so many specific courses.  And there are usually enough courses that are useful to make this minor worthwhile.  This is a great addition if you are technology-focused.

## Courses

There are a lot of courses to mention here, possibly too many.  Some of the key courses include Developmental Psychology, Perception, Learning and Memory, Behavioral Neuroscience, and Functional Neuroanatomy.  These, and the typically required Introduction to Psychology, can probably make a good minor by themselves.

## Notes

There really isn't much to say here that hasn't already been said.  This is a highly recommended minor for someone focusing on the technical side of AI or as a major with a focus on cognitive or developmental psychology.  Some of these courses can also fill in your general electives.

# Philosophy

There are many jokes about philosophy majors, and I've heard most of them. This is an often misunderstood field that has tremendous implications in artificial intelligence. Most arguments against the ability to create a true AI, if it's possible, are philosophical in nature. As someone entering the field, you'll be fending off hype a lot, and knowing the philosophical arguments can help. Another benefit is that some of the courses you take in this department really change how you view the way forward in the field.

## Major

This is one area I would caution you against taking a major in as you'll be required to take several courses that are of little use to your interest in AI. These mostly deal with reading philosophical works from over a thousand years ago. While it will make you a better thinker and writer, there is often little connection to what will take you forward.

## Minor

The minor is a far better option, in my opinion. There are several courses, noted below, that can really inform your understanding of the human mind and therefore how an AI might work (if a true AI ends up working similar to a human, of course).

## Courses

An informal logic course is one I would recommend for anyone; you'll have to search for it, as it could be under one of many names. It will emphasize skills rather than theory. A formal logic course is good, though may not be for everyone. A course on ethics or business ethics is almost a must given today's focus on ethics in AI. One of the two most important courses is Theory of Knowledge, or Epistemology, which talks about how we can know things as humans. The other is Theory of Mind, for obvious reasons. In Theory of Mind, you will talk about the brain/mind dichotomy and what the mind might be.

## Notes

Philosophy is a very tricky subject and best taken as a couple of courses. If you happen to enjoy it, there is no reason to not make it a minor. If your focus is entirely on the philosophical side, then perhaps the major is the right way to go. You'll be a better thinker for it, though most of your degree won't focus on AI at all.

# Other Considerations

I could go on and talk about other majors and minors, but we've already discussed the main ones.  New ones will likely appear in the future and others will raise or lower in usefulness.  One thing we haven't discussed is a domain, where you are applying AI to if you're in the business world.  If you only want to work in an industry, go ahead and earn a minor in the area most closely connected to it.  It will help you understand the business problems better.  Otherwise, let's continue and look at other viable majors, minors, and courses.

## Majors and Minors

If you're going to focus on natural language processing (NLP), you will probably want to take at least one course in **linguistics**.  If you are going to a university that offers a minor in the subject, then it's a great option.  Or you could take a linguistics major and a computer science minor where you focus on AI.  This combination would make you a strong candidate for further studies or starting a career in NLP.

One interesting way to approach AI is through a degree in **child studies**, which can mesh nicely with a major or minor in psychology.  The reason why you might want to focus on how humans develop in order to apply the knowledge to develop an AI.  A degree in this is great for research into a type of AI that grows from nothing to something.  It's a unique approach that may give you some insight into AI that we haven't really seen before.

If you're into robots, a **computer hardware** major might be a good idea.  An alternative might be an **electrical engineering** minor with a computer science minor, which is nearly the same thing.  Take a human anatomy course or even a biology minor to get inspiration for how the robot is structured.  There are a lot of ways you can go with this.

Or maybe you're focused on how AI can help a business succeed.  You might want to major in **business** and minor in computer science or statistics while building a portfolio.  Knowing the business perspective is a major advantage that a purely technical or social focus on AI might have a hard time with.

One of the most freeing paths to take is by having an **individualized studies** major, or whatever it's called at your university.  There is far more freedom in creating your own major that you can then tailor to artificial intelligence.  One warning, though, is that this can lead to overfitting.  You might be sp specific in your courses that the only thing you can do is AI, which you might want to move away from or even change your mind about.  Working with traditional majors and minors still gives you plenty of freedom while making you capable in many areas in and around AI.

If you're interested in AI from a policy standpoint, which is becoming more important, you might think about earning in **international relations**.  There is more and more tension between nations like the United States and China with how they're creating and using AI systems.  As of

this writing, the European Union recently released a policy document on how AI should be used and regulated when necessary.

As artificial intelligence is used more widely both within businesses and when interacting outside of the business, legal proceedings will start cropping up. As such, a **law** degree might be a good idea for you with this specialty in mind. Just make sure that you know the nuances of AI, especially from the philosophical, psychological, and economic perspectives.

You might be surprised that **neuroscience** isn't mentioned earlier. The major difference between neuroscience and cognitive science is that neuroscience focuses almost entirely on the human brain, not the mind. And it's typically a clinical focus, which is not as useful for the AI practitioner.

# Courses

There are a number of courses, some already mentioned that can be useful in certain applications of AI. We'll cover some of them here, but I highly recommend you check to see what your specific university offers. These particular courses are specific to Central Michigan University, but you'll probably find something similar where you study.

- Debate - You'll want to get your ideas across and this can prepare you to make your case.
- Game Theory - This is a mathematical look at transactions between two or more individuals. It can be a good place to look at how an AI can better interact with humans.
- History of Technology - It's difficult to know where technology is taking us, but it can be helpful to know where we've been and the challenges we've been through.
- Networking - If you're going to work with distributed AI, then this is a great class to learn the fundamentals.
- Cybersecurity - This is a growing topic that is gaining more importance in the AI field.
- Information Theory - Data is the nutrition of AI and information theory better prepares you to use that data efficiently and effectively.
- Communication Theory - Like information theory, communication theory is a fundamental area that underlies creating any system that uses data.
- Systems Theory - Any AI will be a system of systems simply based on the fundamental complexity that we expect. Being better prepared will make it that much easier to create such a system.

# Notes

There is a huge degree of flexibility in choosing your majors, minors, and extra courses. Makes sure to take the time to look over every option available. Just beware of some majors which seem like they may be a good fit but are not. **Information technology** is the more practical side of computer science but doesn't work well for AI.

You might be surprised that **neuroscience** isn't mentioned earlier.  The major difference between neuroscience and cognitive science is that neuroscience focuses almost entirely on the human brain, not the mind.  And it's typically a clinical focus, which is not as useful for the AI practitioner.

One of the most important points I want to stress is that <u>you should take courses that you find interesting or fun as well</u>.  Don't be too narrow-minded and enjoy university.  It's a short part of your life but will affect you for many years afterward.  Meet new friends, try new things, learn something completely outside of your specialty.  In fact, take a single low-level course your final year of university that has nothing to do with anything you've ever done before.  You never know what you'll get out of it.