



THE SCHOOL OF ARTIFICIAL INTELLIGENCE

# Machine Learning Engineer



NANODEGREE SYLLABUS

# Overview

This Nanodegree is Built in Partnership With



This goal of this Nanodegree program is to help you learn the key skills necessary to perform well as a machine learning engineer.

A graduate of this program will be able to:

- Test Python code and build a Python package of their own.
- Build predictive models using a variety of unsupervised and supervised machine learning techniques.
- Use Amazon SageMaker to deploy machine learning models to production environments, such as a web application or piece of hardware.
- A/B test two different deployed models and evaluate their performance.
- Utilize an API to deploy a model to a website such that it responds to user input, dynamically.
- Update a deployed model, in response to changes in the underlying data source.

This program is comprised of 4 courses and 4 projects. Each project you build will be an opportunity to demonstrate what you've learned in the lessons. Your completed projects will become part of a career portfolio that will demonstrate your acquired skills in feature engineering, building machine learning algorithms, and model deployment.

## Program Information



### TIME

3 months; study 10 hrs/week



### LEVEL

Practitioner



### PREREQUISITES

Intermediate Python programming knowledge, including:

- At least 40 hours of programming experience
- Familiarity with data structures like dictionaries and lists
- Experience with libraries like NumPy and pandas

Intermediate knowledge of machine learning algorithms, including:

- Supervised learning models, such as linear regression
- Unsupervised models, such as k-means clustering
- Deep learning models, such as neural networks



### HARDWARE/SOFTWARE REQUIRED

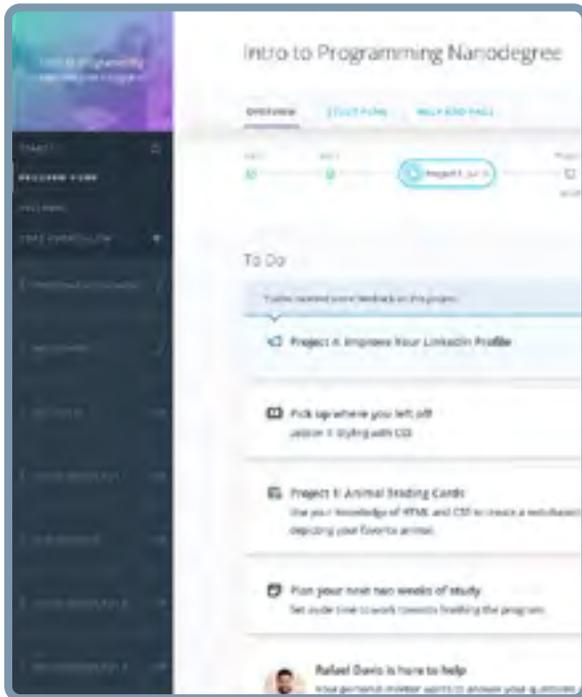
Computer running a 64-bit operating system with at least 8GB of RAM, sufficient permissions to install programs including Anaconda with Python 3.6 and supporting packages.



### LEARN MORE ABOUT THIS NANODEGREE

Contact us at [enterpriseNDs@udacity.com](mailto:enterpriseNDs@udacity.com).

# Our Classroom Experience



## REAL-WORLD PROJECTS

Learners build new skills through industry-relevant projects and receive personalized feedback from our network of 900+ project reviewers. Our simple user interface makes it easy to submit projects as often as needed and receive unlimited feedback.

## KNOWLEDGE

Answers to most questions can be found with Knowledge, our proprietary wiki. Learners can search questions asked by others and discover in real-time how to solve challenges.

## LEARNER HUB

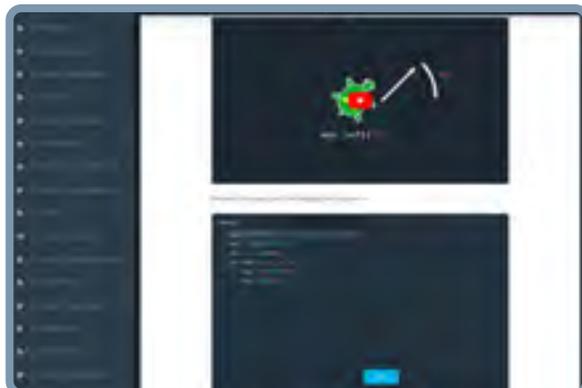
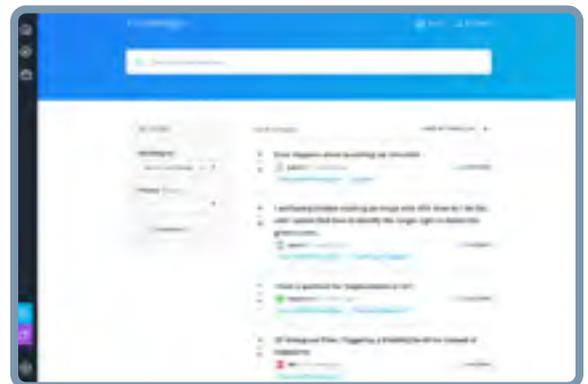
Learners leverage the power of community through a simple, yet powerful chat interface built within the classroom. Learner Hub connects learners with their technical mentor and fellow learners.

## WORKSPACES

Learners can check the output and quality of their code by testing it on interactive workspaces that are integrated into the classroom.

## QUIZZES

Understanding concepts learned during lessons is made simple with auto-graded quizzes. Learners can easily go back and brush up on concepts at anytime during the course.



## CUSTOM STUDY PLANS

Mentors create a custom study plan tailored to learners' needs. This plan keeps track of progress toward learner goals.

## PROGRESS TRACKER

Personalized milestone reminders help learners stay on track and focused as they work to complete their Nanodegree program.

# Learn with the Best



**Jennifer Staab**

INSTRUCTOR

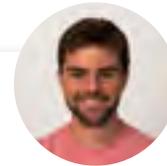
Jennifer has a PhD in Computer Science and a Masters in Biostatistics; she was a professor at Florida Polytechnic University. She previously worked at RTI International and United Therapeutics as a statistician and computer scientist.



**Sean Carrell**

INSTRUCTOR

Sean Carrell is a former research mathematician specializing in Algebraic Combinatorics. He completed his PhD and Postdoctoral Fellowship at the University of Waterloo, Canada.



**Josh Bernhard**

DATA SCIENTIST AT NERD WALLET

Josh has been sharing his passion for data for nearly a decade at all levels of university, and as Lead Data Science Instructor at Galvanize. He's used data science for work ranging from cancer research to process automation.



**Cezanne Camacho**

CURRICULUM LEAD

Cezanne is a computer vision expert with a Master's in Electrical Engineering from Stanford University. As a former genomics and biomedical imaging researcher, she's applied computer vision and deep learning to medical diagnostics.



**Mat Leonard**

INSTRUCTOR

Mat is a former physicist, research neuroscientist, and data scientist. He completed his PhD and Postdoctoral Fellowship at the University of California, Berkeley.



**Dan Romuald Mbanga**

INSTRUCTOR

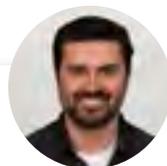
Dan leads Amazon AI's Business Development efforts for Machine Learning Services. Day to day, he works with customers—from startups to enterprises—to ensure they are successful at building and deploying models on Amazon SageMaker.



**Jay Alammar**

INSTRUCTOR

Jay has a degree in computer science, loves visualizing machine learning concepts, and is the Investment Principal at STV, a \$500 million venture capital fund focused on high-technology startups.



**Luis Serrano**

INSTRUCTOR

Luis was formerly a Machine Learning Engineer at Google. He holds a PhD in mathematics from the University of Michigan, and a Postdoctoral Fellowship at the University of Quebec at Montreal.



**Andrew Paster**

INSTRUCTOR

Andrew has an engineering degree from Yale, and has used his data science skills to build a jewelry business from the ground up. He has additionally created courses for Udacity's Self-Driving Car Engineer Nanodegree program.



## Course 1: Software Engineering Fundamentals

In this lesson, you'll write production-level code and practice object-oriented programming, which you can integrate into machine learning projects.

### Project

### Build a Python Package

This program is all about understanding how to build machine learning algorithms and prepare them for scalable, production systems. A first step towards building these systems is to gain an understanding of writing production level code, which you have the option of doing by writing a Python package of your own.

Key Skills Demonstrated:

- Object-oriented programming
- Clean and modular code
- Code documentation

LESSON TITLE	LEARNING OUTCOME
SOFTWARE ENGINEERING PRACTICES	<ul style="list-style-type: none"><li>• Write clean, modular, and well-documented code.</li><li>• Refactor code for efficiency.</li><li>• Create unit tests to test programs.</li><li>• Track actions and results of processes with logging.</li><li>• Conduct and receive code reviews.</li></ul>
PROGRAMMING	<ul style="list-style-type: none"><li>• Understand when to use object-oriented programming.</li><li>• Build and use classes.</li><li>• Learn how large, modular Python packages and use object-oriented programming.</li></ul>
UPLOAD A PACKAGE TO PYPI	<ul style="list-style-type: none"><li>• Portfolio Exercise: Build your own Python package.</li></ul>

# Nanodegree Program Overview

## Course 2: Machine Learning in Production

Learn how to deploy machine learning models to a production environment using Amazon SageMaker.

### Project

### Deploy a Sentiment Analysis Model

In this project, you will be provided a dataset reflecting data collected from an experiment. You'll use statistical techniques to answer questions about the data and report your conclusions and recommendations in a report.

Key Skills Demonstrated:

- Text analysis
- Model deployment via SageMaker
- APIs for web deployment

LESSON TITLE	LEARNING OUTCOME
INTRODUCTION TO DEPLOYMENT	<ul style="list-style-type: none"><li>• Gain familiarity with cloud and deployment terminology.</li><li>• Understand the machine learning workflow in production.</li><li>• Learn about workplace use cases of machine learning.</li></ul>
DEPLOY A MODEL	<ul style="list-style-type: none"><li>• Deploy a model within SageMaker.</li><li>• Predict housing prices in Boston using XGBoost on SageMaker.</li><li>• Determine movie review sentiment using XGBoost on SageMaker.</li></ul>
WEB HOSTING	<ul style="list-style-type: none"><li>• Learn to provide access to an endpoint from a website.</li><li>• Use API Gateway and Lambda to integrate ML models into a web app.</li></ul>
MODEL MONITORING	<ul style="list-style-type: none"><li>• Learn how to monitor the behavior of your models over time.</li><li>• Tune hyperparameters of an XGBoost model using SageMaker's automatic hyperparameter tuning tools.</li><li>• Run an A/B test on SageMaker to compare the tuned model to the untuned model.</li></ul>
UPDATING A MODEL	<ul style="list-style-type: none"><li>• Update your model to account for changes in the data that we are discovered during model monitoring.</li><li>• Explore how to handle new phrases introduced to your model during your sentiment analysis.</li></ul>



## Course 3: Machine Learning Case Studies

Apply machine learning techniques to solve real-world tasks; explore data and deploy both built-in and custom-made Amazon SageMaker models.

### Project

### Plagiarism Detector

Use your machine learning skills to compare two text sources and identify cases of plagiarism. In this project, you will extract relevant text features and train a model of your own design to do plagiarism detection. Then, you will deploy your trained model using Amazon SageMaker.

Key Skills Demonstrated:

- Feature engineering
- Model design and evaluation
- Model deployment via SageMaker

LESSON TITLE	LEARNING OUTCOME
POPULATION SEGMENTATION WITH SAGEMAKER	<ul style="list-style-type: none"><li>• Learn the breadth of algorithms available using AWS SageMaker.</li><li>• Understand how you can use unsupervised algorithms to analyze data with SageMaker.</li><li>• Deploy an unsupervised model using SageMaker.</li><li>• Draw insights about your data by extracting model attributes.</li></ul>
DETECTING CREDIT CARD FRAUD	<ul style="list-style-type: none"><li>• Build and improve a linear model to identify cases of payment fraud.</li><li>• Handle cases of class imbalance in the training data.</li><li>• Tune a model in SageMaker to improve its performance according to a specific metric.</li></ul>
DEPLOYING CUSTOM MODELS	<ul style="list-style-type: none"><li>• Deploy a custom PyTorch model using SageMaker.</li><li>• Write a custom training script to train a model of your own design.</li></ul>
TIME-SERIES FORECASTING	<ul style="list-style-type: none"><li>• Process time-series data and format it for training a machine learning model.</li><li>• Use SageMaker's DeepAR algorithm for time-series forecasting.</li><li>• Deploy a model and use it to predict future data points.</li></ul>

# Nanodegree Program Overview

## Course 4: Machine Learning Capstone

In this capstone lesson, you'll select a machine learning challenge and propose a possible solution.

### Project

### Capstone Proposal and Project

In this capstone project, you will leverage what you've learned throughout the program to build a machine learning project of your choosing. You will define the problem you want to solve, investigate and explore the data, identify and explore the data, then perform your analyses and develop a set of conclusions. You will present the analysis and your conclusions in a blog post and GitHub repository. This project will serve as a demonstration of your ability as a machine learning engineer, and will be an important piece of your portfolio.

Key Skills Demonstrated:

- All of the machine learning workflow, from data exploration to model training and evaluation.

LESSON TITLE	LEARNING OUTCOME
<b>ELECTIVE 1: STARBUCKS</b>	<ul style="list-style-type: none"><li>• Use purchasing habits to arrive at discount measures to obtain and retain customers.</li><li>• Identify groups of individuals that are most likely to be responsive to rebates.</li></ul>
<b>ELECTIVE 2: ARVATO FINANCIAL SERVICES</b>	<ul style="list-style-type: none"><li>• Work through a real-world dataset and challenge provided by Arvato Financial Services, a Bertelsmann company.</li></ul>
<b>ELECTIVE 3: CONVOLUTIONAL NEURAL NETWORK</b>	<ul style="list-style-type: none"><li>• Complete a project to identify dog breeds based on images.</li></ul>
<b>ELECTIVE 4: YOUR CHOICE</b>	<ul style="list-style-type: none"><li>• Build a new project entirely of your own choosing.</li></ul>

# Our Nanodegree Programs Include:



## Pre-Assessments

Our in-depth workforce assessments identify your team's current level of knowledge in key areas. Results are used to generate custom learning paths designed to equip your workforce with the most applicable skill sets.



## Dashboard & Progress Reports

Our interactive dashboard (enterprise management console) allows administrators to manage employee onboarding, track course progress, perform bulk enrollments and more.



## Industry Validation & Reviews

Learners' progress and subject knowledge is tested and validated by industry experts and leaders from our advisory board. These in-depth reviews ensure your teams have achieved competency.



## Real World Hands-on Projects

Through a series of rigorous, real-world projects, your employees learn and apply new techniques, analyze results, and produce actionable insights. Project portfolios demonstrate learners' growing proficiency and subject mastery.

# Our Review Process

## Real-life Reviewers for Real-life Projects

Real-world projects are at the core of our Nanodegree programs because hands-on learning is the best way to master a new skill. Receiving relevant feedback from an industry expert is a critical part of that learning process, and infinitely more useful than that from peers or automated grading systems. Udacity has a network of over 900 experienced project reviewers who provide personalized and timely feedback to help all learners succeed.



**Vaibhav**  
UDACITY LEARNER

*"I never felt overwhelmed while pursuing the Nanodegree program due to the valuable support of the reviewers, and now I am more confident in converting my ideas to reality."*

\_\_\_\_\_ now at \_\_\_\_\_  
**CODING VISIONS INFOTECH**

## All Learners Benefit From:



Line-by-line feedback for coding projects



Industry tips and best practices



Advice on additional resources to research



Unlimited submissions and feedback loops

## How it Works

Real-world projects are integrated within the classroom experience, making for a seamless review process flow.

- Go through the lessons and work on the projects that follow
- Get help from your technical mentor, if needed
- Submit your project work
- Receive personalized feedback from the reviewer
- If the submission is not satisfactory, resubmit your project
- Continue submitting and receiving feedback from the reviewer until you successfully complete your project

## About our Project Reviewers

Our expert project reviewers are evaluated against the highest standards and graded based on learners' progress. Here's how they measure up to ensure your success.

**900+**

**Expert Project Reviewers**

Are hand-picked to provide detailed feedback on your project submissions.

**1.8M**

**Projects Reviewed**

Our reviewers have extensive experience in guiding learners through their course projects.

**3**

**Hours Average Turnaround**

You can resubmit your project on the same day for additional feedback.

**4.85 /5**

**Average Reviewer Rating**

Our learners love the quality of the feedback they receive from our experienced reviewers.



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