



# ML Engineer Program Syllabus

## About FourthBrain

FourthBrain educates aspiring Machine Learning engineers on the technical and practical skills required to provide immediate value to an AI product development or R&D team. Our programs emphasize open collaboration and communication, and our unique approach to cohort-based learning is aimed at helping you achieve your personal career goals while giving you the best chance to develop strong, lasting relationships with other ML practitioners on similar journeys.

## Your Learning Transformation

By the end of this course, you will be able to contribute to high-performing AI product teams by leveraging real-world data to **build**, **package**, and **deploy** state-of-the-art ML models as containerized web applications in cloud-based production environments.

## Capstone Project

Capstone projects are designed to demonstrate your understanding of MLE software development and its implications. This includes understanding the potential business-value of your application and its extensibility, as well as the tools required to build, optimize, package, and deploy your ML models in a production software development environment. Projects are typically developed in groups of two or three; solo projects are possible, especially in situations where external support (i.e., your colleagues or other collaborators are available). Final deliverables will include a final presentation and GitHub repo, which together will allow you to share the details of what you've accomplished with your potential users, collaborators, employers, or the wider open-source ML community. You can see past capstone projects [here](#).

## Career Growth

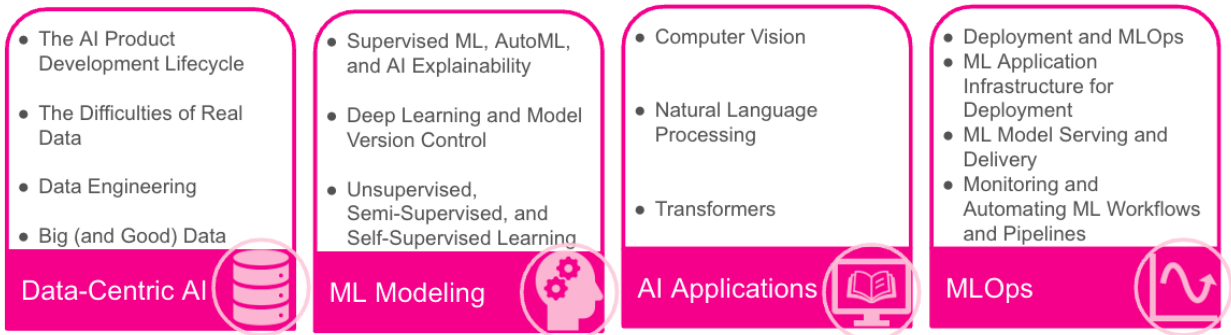
The Machine Learning Engineer program is designed for you to acquire the skills and knowledge required to work on a Machine Learning Engineering team. Whatever your reason for taking the program - to get a new role at a new company, to gain skills for your current job, or just for fun - we will support your career growth by helping you connect to professionals and employers, via guest speaking events and inviting employers to the final project presentation day. Career services assistance is available during the program and after graduation to help ensure that all candidates achieve their career goals.



## Program Format

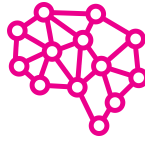
Each week, we will curate content related to the weekly topic for you to review asynchronously. You will come together with your instructors and peers to discuss, contextualize, and practice the concepts for the week.

The Machine Learning Engineer program is divided into four pillars: Data Centric AI, Machine Learning Modeling, AI Applications, and MLOps.



During our first week we kick off the course with a review of important ML software engineering tools. We get our development environment set up and test out that we can build basic ML models.

Our last week is completely focused on Demo Day for your projects!



# Weekly Schedule

Week	Live Session Concepts	Coding Exercise(s)	Capstone
Week 1 Saturday Dec. 3  Getting Started with ML Engineering	<ul style="list-style-type: none"> <li>• Program Overview</li> <li>• Software Development Environment setup</li> </ul>	MLE Basic <u>Tools</u> : <ul style="list-style-type: none"> <li>• Unix CLI, Git, Conda, Pip, Jupyter</li> <li>• Pandas, Matplotlib, Seaborn, Sci-Kit Learn</li> </ul>	<ul style="list-style-type: none"> <li>• Networking</li> </ul>
Week 2 Saturday Dec. 10  AI Product Development	<ul style="list-style-type: none"> <li>• AI Product Development Lifecycle &amp; ML Project Scoping</li> <li>• Data Centric AI</li> <li>• Responsible ML Principles</li> </ul>	<ul style="list-style-type: none"> <li>• Creating a sentiment analyzer</li> <li>• <u>Tools</u>: Hugging Face Transformers Library, Twitter API</li> </ul>	<ul style="list-style-type: none"> <li>• Ideation Workshop</li> <li>• AI Product/ML Project Scoping</li> </ul>
Week 3 Saturday Dec.17  Building ML App Prototypes	<ul style="list-style-type: none"> <li>• Ensuring High Quality Data</li> <li>• Fine-Tuning Pre-Trained Models</li> <li>• Building ML Proofs-of-Concept (POCs) and Minimum Viable Products (MVPs)</li> <li>• Application Programming Interfaces (APIs)</li> </ul>	<ul style="list-style-type: none"> <li>• Collect real data from Twitter and Reddit APIs</li> <li>• Fine-Tune a pre-trained transformer for sentiment analysis</li> <li>• Develop a data-centric proof of concept</li> <li>• <u>Tools</u>: Hugging Face Trainer API, Reddit API</li> </ul>	<ul style="list-style-type: none"> <li>• Peer Review and Teaming</li> </ul>



Break	Winter Holidays		
Week 4, Saturday Jan. 7  Data Engineering	<ul style="list-style-type: none"> <li>• Data Engineering Workflows</li> <li>• Data Wrangling &amp; Exploratory Data Analysis</li> <li>• Feature Selection &amp; Engineering</li> <li>• Data Leakage</li> <li>• Building ETL Pipelines</li> </ul>	<ul style="list-style-type: none"> <li>• Exploring and wrangling structured data to predict sales with simple ML pipeline</li> <li>• Track and manage datasets</li> <li>• Build an ETL workflow</li> <li>• <u>Tools</u>: Airflow, DVC</li> </ul>	<ul style="list-style-type: none"> <li>• Project Proposals</li> <li>• Project Pitch Day I</li> </ul>
Week 5 Saturday Jan. 14  Big (and Good) Data	<ul style="list-style-type: none"> <li>• Types of Distributed Computing for ML</li> <li>• Data Preparation</li> <li>• Big Data Tool Landscape</li> <li>• How Good Data Becomes Big Data</li> </ul>	<ul style="list-style-type: none"> <li>• Build an ML pipeline and perform distributed hyperparameter tuning to predict subscriptions &amp; promotions</li> <li>• <u>Tools</u>: Spark, Delta Lake, MLlib</li> </ul>	<ul style="list-style-type: none"> <li>• Exploratory Data Analysis and Data Lineage Documentation</li> </ul>
Week 6 Saturday Jan. 21  Supervised ML, AutoML, and Explainability	<ul style="list-style-type: none"> <li>• Essential Regression &amp; Classification Algorithms</li> <li>• Data Imbalance</li> <li>• Accuracy Metrics</li> <li>• AutoML Libraries</li> <li>• AI Explainability</li> </ul>	<ul style="list-style-type: none"> <li>• Detect data imbalances and predict electronics purchases with explainable ML pipelines</li> <li>• Perform AutoML to search for an optimal tree-based pipeline</li> <li>• <u>Tools</u>: TPOT, SHAP, Streamlit</li> </ul>	<ul style="list-style-type: none"> <li>• Establish ML Modeling Baseline</li> </ul>



<p>Week 7 Saturday Jan. 28</p> <p>Deep Learning and Model Version Control</p>	<ul style="list-style-type: none"> <li>• Neural Network Basics</li> <li>• Recurrent Neural Networks (RNNs)</li> <li>• Long Short-Term Memory Networks (LSTMs)</li> <li>• Generative Adversarial Networks (GANs)</li> <li>• ML Model Version Control</li> </ul>	<ul style="list-style-type: none"> <li>• Build, train, and evaluate a neural network for fuel efficiency prediction from scratch</li> <li>• Compare neural network performance based on type</li> <li>• <u>Tools</u>: MLflow Tracking</li> </ul>	<ul style="list-style-type: none"> <li>• Initial GitHub Documentation</li> </ul>
<p>Week 8 Saturday Feb. 4</p> <p>Unsupervised, Semi-Supervised, and Self-Supervised Learning</p>	<ul style="list-style-type: none"> <li>• Dealing with Unstructured Data</li> <li>• Clustering</li> <li>• Dimensionality Reduction</li> <li>• Label propagation/label spreading</li> <li>• Co-training algorithms</li> <li>• Zero-shot learning</li> </ul>	<ul style="list-style-type: none"> <li>• Performing Customer Segmentation</li> <li>• Predicting product sales using semi-supervised learning</li> <li>• <u>Tools</u>: Sk-learn (pca, Kmeans, Silhouette Analysis)</li> </ul>	<ul style="list-style-type: none"> <li>• Data &amp; Model Iterations</li> </ul>
<p>Week 9 Saturday Feb. 11</p> <p>Computer Vision</p>	<ul style="list-style-type: none"> <li>• Convolutional Neural Networks (CNNs)</li> <li>• Computer Vision Benchmarks</li> <li>• Dealing with Images</li> <li>• Object Detectors</li> <li>• Semantic Segmentation</li> <li>• Explainability &amp; Saliency</li> </ul>	<ul style="list-style-type: none"> <li>• Few-shot dog detection dogs through fine-tuning of a pre-trained single shot multibox detector</li> <li>• <u>Tools</u>: TensorFlow Model Garden</li> </ul>	



<p>Week 10 Saturday Feb. 18</p> <p>Natural Language Processing</p>	<ul style="list-style-type: none"> <li>• Recurrent Neural Networks and Long Short-Term Memory Networks (RNNs, LSTMs))</li> <li>• Natural Language Benchmarks</li> <li>• Dealing with Text</li> <li>• Tokenization &amp; Word Embeddings</li> <li>• Bag of Words</li> <li>• Large Language Models (LLMs)</li> </ul>	<ul style="list-style-type: none"> <li>• Analyze tweets using basic NLP tasks</li> <li>• Build hate speech detectors using a naive Bayes classifier and a bidirectional LSTM</li> <li>• <u>Tools:</u> Tensorboard Embedding Projector, LIME Text Explainer</li> </ul>	<ul style="list-style-type: none"> <li>• Project Pitches II</li> </ul>
<p>Week 11 Saturday Feb. 25</p> <p>Foundation Models: Transformers and Diffusion Models</p>	<ul style="list-style-type: none"> <li>• Encoder and Decoder Networks</li> <li>• General Pre-Trained Transformers (e.g., GPT-3)</li> <li>• Fine-Tuning Foundation Models</li> <li>• Diffusion Models (e.g., DALL·E 2)</li> </ul>	<ul style="list-style-type: none"> <li>• Build a transformer model for news article text classification from scratch</li> <li>• Fine-tune a pre trained transformer</li> <li>• <u>Tools:</u> Hugging Face Models</li> </ul>	<ul style="list-style-type: none"> <li>• GitHub Documentation Revisions</li> </ul>
<p>Week 12 Saturday Mar. 4</p> <p>Manual MLOps Deployments</p>	<ul style="list-style-type: none"> <li>• MLOps Level 0: Manual</li> <li>• Intro to VS Code</li> <li>• Branch Development</li> <li>• AWS (Browser)</li> <li>• AWS via VS Code</li> <li>• FastAPI &amp; Web App Frameworks</li> <li>• File Structure for Web Applications</li> </ul>	<ul style="list-style-type: none"> <li>• Deploy a public API stock prediction service</li> <li>• <u>Tools:</u> VS Code, Git, AWS, FastAPI</li> </ul>	<ul style="list-style-type: none"> <li>• Deploy your ML Application Locally</li> <li>• Deploy your ML App to AWS</li> </ul>



<p>Week 13 Saturday Mar. 11</p> <p>ML Application Infrastructure for Deployment</p>	<ul style="list-style-type: none"> <li>• Fast API Architecture (Swagger UI, Uvicorn)</li> <li>• Def: Deploy, Endpoint, Ports</li> <li>• Review API/HTTP</li> </ul>	<ul style="list-style-type: none"> <li>• Build and deploy a containerized stock prediction service</li> <li>• Manage model versions with a model registry</li> <li>• <u>Tools</u>: Docker, MLflow Model Registry</li> </ul>	<ul style="list-style-type: none"> <li>• Containerize and deploy your ML web application and deploy locally and to AWS</li> <li>• Infrastructure Diagramming</li> </ul>
<p>Week 14 Saturday Mar. 18</p> <p>Containers</p>	<ul style="list-style-type: none"> <li>• OS and VM Basics</li> <li>• Containers and Container Orchestration</li> <li>• Model Management and Model Registries</li> </ul>	<ul style="list-style-type: none"> <li>• Implement stock prediction app within a serverless computing service</li> <li>• Deploy stock prediction service</li> <li>• <u>Tools</u>: AWS Lambda, API Gateway</li> </ul>	<ul style="list-style-type: none"> <li>• 1-Page Narrative</li> <li>• Final GitHub Documentation Revisions</li> <li>• Last-Minute Feature Additions</li> </ul>
<p>Week 15 Saturday Mar. 25</p> <p>MLOps Pipeline Monitoring</p>	<ul style="list-style-type: none"> <li>• ML Metric Monitoring</li> <li>• Ops Monitoring</li> <li>• Logging and the ELK Stack</li> <li>• Observability</li> <li>• MLOps L1: Pipeline Automation &amp; Retraining Triggers</li> </ul>	<ul style="list-style-type: none"> <li>• Tools for detecting monitoring drift in Diabetes prediction</li> <li>• <u>Tools</u>: Prometheus, Grafana</li> </ul>	<ul style="list-style-type: none"> <li>• Elevator Pitch</li> <li>• Final Capstone Presentation and Live Demo Practice and Submission</li> </ul>
<p>Week 16 Saturday Apr. 1</p> <p>Demo Week!</p>	<ul style="list-style-type: none"> <li>• Storytelling Workshop</li> <li>• Capstone Practice</li> </ul>	<ul style="list-style-type: none"> <li>• Final Capstone GitHub submission!</li> </ul>	<ul style="list-style-type: none"> <li>• Demo Day!</li> </ul>