“Your Future. Your Move” Program powered by ID FUTURE STARS

A. Four-Week AI Fundamentals Course

Target Audience: Rising 9th–12th graders (with basic algebra skills).

Overall Goal: Provide foundational knowledge in the core mathematics, concepts, and simple coding that underpin AI techniques. Emphasis is on *understanding* how math drives AI, rather than jumping immediately to automation or black-box tools.

Week 1: Mathematical Foundations & Introduction to AI

1. **Course Orientation**
    - Overview of AI: What it is, real-world applications, and why math matters.
    - Setting up the programming environment (e.g., Python notebooks).
2. **Key Math Concepts Review**
    - Algebra Refresh: Variables, expressions, and functions.
    - Linear Algebra: Vectors, matrices, basic matrix operations (addition, scalar multiplication, matrix multiplication).
3. **Practical Lab**
    - Simple Python tasks to manipulate vectors and matrices (NumPy or similar).
    - Visualizing vectors in 2D or 3D to see how transformations work.
4. **Mini-Project**
    - Build a small “vector transformation” tool in Python: Students see how changing matrix values changes geometric transformations.

Week 2: Probability & Statistics for AI

1. **Introduction to Probability**
    - Random variables, probability distributions, expectation, variance.

    - Discrete vs. continuous distributions (e.g., Bernoulli, Gaussian).
2. **Statistics and Data**
    - Basics of descriptive statistics (mean, median, mode).
    - Understanding sampling, data representation, data cleaning.
3. **Practical Lab**
    - Use a small dataset to calculate mean, median, variance.
    - Visualize distributions, histograms, scatter plots.
4. **Mini-Project**
    - Exploratory Data Analysis (EDA) on a toy dataset.
    - Students practice summarizing data insights using Python libraries like pandas/matplotlib.

Week 3: Calculus & Optimization in AI

1. **Calculus Essentials**
    - Functions, limits (intuitive).
    - Derivatives and partial derivatives.
    - Introduction to gradient-based optimization: concept of gradient descent.
2. **Connecting Calculus to AI**
    - Why derivatives matter: error minimization in machine learning.
    - Small neural network or linear regression example: update rules using gradients.
3. **Practical Lab**
    - From-scratch linear regression: implement gradient descent to minimize error.
    - Hands-on demonstration of how derivatives drive parameter updates.
4. **Mini-Project**
    - Students code a linear regression model that predicts a simple outcome (e.g., house prices or toy data).
    - Visualize the loss function decreasing over iterations.

Week 4: Intro to Basic ML Algorithms & Capstone

1. **Fundamental ML Concepts**
    - Traditional ML vs. “AI” & deep learning.

    - Classification vs. regression.
    - Concept of overfitting, train/test splits.
2. **Algorithmic Overview**
    - Perceptron concept (simplest neural net).
    - K-Nearest Neighbors or simple classification problem to illustrate how math underpins decisions.
3. **Capstone Project**
    - Students pick a small dataset (classification or regression).
    - Implement one or two basic algorithms (e.g., Perceptron, KNN, or naive linear regression).
    - Evaluate performance and present final results.
4. **Wrap-Up**
    - Summaries of the mathematics that support AI.
    - Discussion of next steps and advanced topics.
    - Reflection on what students learned about building AI “from the ground up.”

B. Subsequent Advanced Courses

After finishing the 4-week foundation, students can choose specialized or advanced 4+ week modules to deepen knowledge and gain more practical experience.

1. Advanced Linear Algebra & Matrix Computations (4 weeks)

- In-depth look at matrix decomposition (SVD, Eigenvalues, Eigenvectors).
- Applications to dimensionality reduction (PCA) and data compression.
- Project: Implement a PCA-based feature reduction for a real dataset.

2. Deep Learning Fundamentals (4 weeks)

- Neural network architectures: feed-forward, convolutional, recurrent.
- Building a small Convolutional Neural Network (CNN) for image recognition.

- Project: Image classification on a simplified dataset (e.g., MNIST digits).

3. Probabilistic Modeling & Bayesian Methods (4 weeks)

- Bayesian statistics, priors, likelihood, posterior.
- Markov Chain Monte Carlo (MCMC) concepts (basic).
- Project: Compare frequentist vs. Bayesian approaches on a real dataset.

4. Applied AI in Python (4 weeks)

- End-to-end data pipeline: cleaning, feature engineering, model training, and deployment basics.
- Incorporating real-world data sets (finance, healthcare, social media).
- Project: Students build and deploy a basic ML web app or interactive dashboard.

5. Ethics, Fairness, and Responsible AI (2–4 weeks)

- Bias in data, fairness in algorithms.
- Regulatory environment and social considerations.
- Project: Students analyze a dataset, measure potential biases, propose mitigations.

(Any of these modules can be expanded or condensed as needed, but each is designed to give deeper coverage beyond the fundamental 4-week course.)

C. One-Week “AI Fundamentals Sampler” for IDFS Summer Program

Goal: Provide a hands-on crash course that piques curiosity about AI mathematics and algorithms, suitable as part of a broader summer experience.

Daily Breakdown:

1. **Day 1: What Is AI & Why Math Matters?**
    - Overview of AI fields, real-world examples.
    - Quick refresh of linear algebra basics (vectors, simple matrix operations).
2. **Day 2: Probability & Statistics Crash Course**
    - Quick introduction to probabilities, means, distributions.
    - Interactive class experiment (e.g., flipping coins, analyzing results in real time).
3. **Day 3: Intro to Neural Networks & Gradient Descent (Conceptual)**
    - Simplified explanation of how a neural network learns.
    - Students experiment with a small interactive tool that shows how changing learning rates and iteration affects convergence.
4. **Day 4: Simple Hands-On Project**
    - Classification or regression project with a small dataset (e.g., building a basic linear regressor or a “Guess the digit” mini-lab).
    - Students code or modify a pre-written Python notebook, see how the model learns, observe outcomes.
5. **Day 5: Presentations & Future Pathways**
    - Students give quick demos of what they achieved.
    - Discuss next steps (math courses, coding practice, advanced AI topics).
    - Inspire them with possible directions (robotics, game AI, NLP, etc.).

This 1-week version focuses on *big-picture engagement* and a taste of hands-on practice, without the deeper dive of a month-long program.

Additional Notes & Implementation Tips

- **Prerequisites:** The 4-week fundamentals course requires comfort with algebra. Prior exposure to Python is helpful but not mandatory if you allocate time for a coding primer.
- **Course Format:** Blend lectures, group problem-solving, coding labs, and guided mini-projects. Maintain a balance between conceptual math instruction and practical coding tasks.
- **Resources:**

    - *Mathematics:* “Mathematics for Machine Learning” (freely available online), interactive notebooks with step-by-step solutions.
    - *Coding Environment:* Jupyter notebooks, Google Colab, or similar.
    - *Projects & Data:* Use small, curated datasets (Kaggle, UCI Machine Learning Repository) to illustrate concepts without overwhelming.
- **Teaching Approach:** Emphasize *how the math applies* to building AI solutions so students appreciate why they’re learning linear algebra, calculus, probability, etc.

Resources for Student’s to Prepare for This Course

This structure ensures a solid foundation in the mathematics behind AI rather than just teaching AI “automation.” By walking students through algebra, probability/statistics, and calculus in the context of *why* these topics matter, you equip them with the conceptual tools to grasp more advanced AI techniques in later courses.

Advanced Math Learning Resources for High School Students (Grades 9-12)

Overview

To successfully complete the ID Future Stars Summer Program, students must master advanced high school math concepts, including Algebra, Geometry, Precalculus, and Calculus. This document provides a list of **self-paced, online, and low-cost or free** math courses to help students build their skills efficiently.

1. Free & Low-Cost Self-Paced Online Math Courses

A. Khan Academy (Completely Free)

- **Website:** Khan Academy
- **Courses Available:**
  - Algebra I & II
  - Geometry
  - Precalculus
  - AP Calculus AB & BC
  - AP Statistics
  - Multivariable Calculus (for advanced students)
- **Why Choose It?** Self-paced, interactive, free, and aligns with U.S. high school curriculum.

B. edX (Free Courses with Paid Certificates)

- **Website:** edX
- **Recommended Courses:**
  - **HarvardX – Introduction to Algebra** (Harvard University)
  - **MITx – Calculus 1A: Differentiation** (MIT)
  - **Georgia Tech – Linear Algebra**
- **Why Choose It?** Ivy League & top-tier university content, can earn certificates, free to audit.

C. Coursera (Free to Audit, Paid Certificates)

- **Website:** Coursera
- **Recommended Courses:**
  - **University of Sydney – High School Algebra to Calculus**
  - **Imperial College London – A-Level Mathematics for University Readiness**
  - **Johns Hopkins – Introduction to Probability and Statistics**
  - **Stanford – Mathematical Thinking**

- **Why Choose It?** University-quality content, self-paced, free to audit.

D. MIT OpenCourseWare (Free)

- **Website:** MIT OpenCourseWare
- **Recommended Courses:**
  - Single Variable Calculus
  - Multivariable Calculus
  - Differential Equations
  - Linear Algebra
- **Why Choose It?** The **gold standard** in math education from MIT, totally free.

E. Art of Problem Solving (AoPS) - Advanced Problem Solving

- **Website:** Art of Problem Solving
- **Recommended Courses:**
  - Algebra, Geometry, Number Theory, Precalculus
  - AMC 10/12, AIME, and Olympiad Math
- **Why Choose It?** Best for students aiming for **elite problem-solving skills** in math competitions.

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2. Advanced Placement (AP) & College Credit Options

A. Arizona State University (Universal Learner Program)

- **Website:** ASU Universal Learner
- **Courses Available:**
  - College Algebra ($25 + $400 for credit option)
  - Precalculus ($25 + $400 for credit option)
  - Calculus for Engineers ($25 + $400 for credit option)
- **Why Choose It?** Can earn **college credit** at a low cost, fully online & self-paced.

B. Outlier.org

- **Website:** Outlier
- **Courses Available:**
  - Calculus I ($49/month with college credit option)
  - Precalculus
- **Why Choose It?** Engaging video content with credit from **University of Pittsburgh**.

C. Saylor Academy (Free College-Level Math)

- **Website:** Saylor Academy
- **Courses Available:**
  - MA005: Calculus I
  - MA121: Introduction to Statistics
  - MA103: College Algebra
- **Why Choose It?** 100% **free**, self-paced, college-level courses.

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3. Coding, Data Science & Computational Math

If a student is interested in **data science, AI, and advanced applied math**, these courses are great additions:

- **Harvard CS50: Introduction to Programming & Computational Thinking** – CS50 (Free)
- **Introduction to AI & Python for Data Science (IBM, Coursera)** – Coursera AI (Free)
- **Machine Learning (Stanford, Andrew Ng, Coursera)** – ML by Stanford (Free to Audit)
- **San Diego University Courses:** San Diego University
  - Intro to AI Part 1 and 2
  - Data Analytics with Python
  - Data Engineering Fundamentals
  - Practical Data Engineering Capstone

- Essential Analytics in Excel

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4. Final Recommendations: Best for Different Needs

Goal	Best Option
Basic Algebra to Precalculus	**Khan Academy, ASU Universal Learner**
Calculus & Beyond	**MIT OpenCourseWare, Saylor Academy, ASU**
College Credit	**Arizona State, Outlier.org, Saylor Academy**
AP Prep & Competitive Math	**AoPS, edX (Harvard & MIT Courses)**
Data Science & AI Focus	**CS50, Coursera ML & AI Courses, San Diego University**

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5. Next Steps for Students

1. **Choose a platform** that fits their learning style and goals.
2. **Set a schedule** for at least **5-10 hours per week** of self-study.
3. **Take assessments** to track progress (many platforms have quizzes & practice tests).
4. **Combine multiple resources** (e.g., Khan Academy for basics, MIT OCW for advanced topics).

These programs **prepare students well for competitive summer programs** and help them **excel in STEM fields**.

For More Information:

For guidance on choosing the best course or structuring a study plan, please reach out to **ID Future Stars**.