IOAI 2025 Syllabus

The International Olympiad in Artificial Intelligence (IOAI) is a premier global competition for high school students, aiming to cultivate both a strong theoretical foundation and hands-on expertise in Artificial Intelligence. This syllabus outlines the topics contestants should master to excel in the competition. Each year, the IOAI International Scientific Committee (ISC) updates the official syllabus to reflect the latest research findings and educational priorities in the field.

Topic Classifications

The topics are categorized into three distinct sections, indicating the level and nature of knowledge contestants need:

1. **Theory (How it works)**
   Contestants should thoroughly understand core concepts and theoretical underpinnings—essentially, the "why" behind AI. This may involve studying textbooks courses, and other resources to delve into the mechanics that power AI algorithms.

2. **Practice (What it does, when to use it, and how to implement it)**
   Contestants should develop the practical skills necessary to implement AI methods in code. This includes knowing how to use library functions effectively, call the method on a particular data, and interpret outputs.
   Example: While a contestant need not fully dissect the internal workings of the Adam optimizer, they should be able to decide when and how to employ it.

3. **Both**
   Certain topics require knowledge of both theoretical principles and practical application.

This structured approach ensures that contestants acquire the right balance of conceptual insight and hands-on proficiency across the diverse array of AI topics.

Section 1: Foundational Skills & Classical Machine Learning

Topic	Subtopic	Category
Programming Fundamentals	Python Basics (Loops, Functions, etc.)	Practice
	NumPy and Pandas for Data Handling	Practice
	Matplotlib and Seaborn for Visualization	Practice
	Scikit-learn for ML	Practice
	PyTorch Basics	Practice
	Tensor (multi-dimensional array) Manipulation	Practice
	Reproducibility Basics (seed, devices, inference)	Practice
	Training Models on CPU and GPU	Practice
	Weights and Biases (experiment tracking)	Practice
Supervised Learning	Linear Regression	Both
	Logistic Regression	Both
	K-Nearest Neighbors (K-NN)	Both
	Decision Trees	Both
	Random Forests	Practice
	Gradient Boosting (e.g., XGBoost)	Practice
	Support Vector Machines (SVM)	Both
Unsupervised Learning	K-Means Clustering	Both
	Principal Component Analysis (PCA)	Both
	t-SNE, MAP, Other Dimensionality Reduction Methods	Practice
	DBSCAN Clustering	Practice
	Hierarchical Clustering	Practice
Evaluation	Model Evaluation Metrics (Accuracy, Precision, Recall, F1-Score, etc.)	Both
	Underfitting, Overfitting	Theory
	Hyperparameter Tuning	Practice
	Cross-Validation	Practice
	Confusion Matrix and ROC Curve	Both

Section 2: Neural Networks & Deep Learning

Topic	Subtopic	Category
Neural Networks	Perceptron Basics	Both
	Gradient Descent	Both
	Backpropagation	Both
	Activation Functions (ReLU, Sigmoid, Tanh)	Both
	Cost Functions (MSE, MAE, Cross Entropy, etc.)	Both
Deep Learning	Multi-Layer Perceptrons (MLP)	Both
	Stochastic Gradient Descent (SGD), Mini-Batch Gradient Descent	Both
	Momentum Methods (Adam, AdamW)	Practice
	Adaptive Learning Rates	Practice
	Convergence and Learning Rates	Both
	Weight Regularization	Practice
	Early Stopping	Practice
	Dropout, Gaussian Noise	Practice
	Weight Initialization	Practice
	Batch Normalization	Practice
	Autoencoders and Sparse Encoders	Practice

Section 3: Computer Vision

Computer Vision	Fundamentals of Convolutional Layers	Both
	Pooling Techniques (Max, Average)	Both
	Basic Image Classification	Both
	Object Detection Basics (YOLO, SSD)	Practice
	Image Segmentation Basics (U-Net)	Practice
	Transfer Learning for Image Classification (e.g., ResNet, MobileNet)	Practice
	Image Augmentation Techniques	Practice
	Feature Extraction Using Pre-Trained Models	Practice
	Introduction to GANs (Generating Images)	Practice
	Introduction to Self-Supervised Learning for Vision	Practice
	Vision Transformers (ViT) Basics	Practice
	CLIP and Multimodal Learning	Practice
	Generative Models such as Stable Diffusion, DALL.E	Practice

Section 4: Natural Language Processing

Natural Language Processing (NLP)	Word Embeddings (Word2Vec, GloVe)	Practice
	Transformers Basics (Attention Mechanism)	Both
	Text Classification	Practice
	Introduction to Pre-trained NLP Models (e.g., BERT, GPT)	Practice
	Question Answering with Pre-trained Models	Practice
	Introduction to Large Language Models (LLMs) (e.g., GPT-4)	Practice
	Building Simple Chatbots Using NLP	Practice
	Model Fine-Tuning: Methods and Limitations (LoRA, Adapters, etc.)	Practice
	LLM Agents Basics	Practice