

Probabilistic Programming and Bayesian Computing with PyMC

Duration: 03 days (24 hours)

Day 1: Introduction and Foundations

Module 1: Introduction to Probabilistic Programming

- What is Probabilistic Programming?
- Applications and Importance
- Overview of PyMC and its Ecosystem

Module 2: Bayesian Statistics Fundamentals

- Understanding Probability and Uncertainty
- Bayes' Theorem: Concepts and Applications
- Priors, Likelihood, and Posterior Distributions

Module 3: Getting Started with PyMC

- Installation and Setup
- Overview of PyMC Syntax and Workflow
- Simple Bayesian Model in PyMC: Coin Flip Example

Module 4: Modeling with PyMC: Basics

- Defining Random Variables and Distributions
- Constructing Simple Models
- Visualizing Priors and Likelihoods

Module 5: Hands-On Session: Building Your First Bayesian Model

- Building and Running Basic Models
 - Exploring Posterior Distributions
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Day 2: Intermediate Modelling and Inference Techniques

Module 6: Markov Chain Monte Carlo (MCMC) Methods

- Introduction to MCMC

- The Role of Sampling in Bayesian Inference
- Overview of Sampling Algorithms: Metropolis-Hastings, NUTS

Module 7: Hierarchical Modelling

- Understanding Hierarchical Models
- Applications in Real-World Scenarios
- Building Hierarchical Models in PyMC

Module 8: Model Diagnostics and Convergence

- Analysing MCMC Convergence
- Effective Sample Size and Autocorrelation
- Posterior Predictive Checks

Module 9: Hands-On Session: Complex Models in PyMC

- Implementing a Hierarchical Model
- Model Validation and Diagnostics

Module 10: Advanced PyMC Features

- Custom Distributions and Models
 - Using PyMC3 Extensions (e.g., Theano, Aesara Integration)
 - Introduction to PyMC4 and Future Directions
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Day 3: Advanced Topics and Applications

Module 11. Variational Inference

- Introduction to Variational Inference
- Comparison with MCMC
- Implementing Variational Inference in PyMC

Module 12: Time Series Modelling

- Bayesian Time Series Analysis
- Building Time Series Models in PyMC
- Case Study: Financial Forecasting

Module 13: Bayesian A/B Testing

- Designing A/B Tests with Bayesian Methods
- Implementing A/B Tests in PyMC
- Analyzing and Interpreting Results

Module 14: Decision Making Under Uncertainty

- Bayesian Decision Theory
- Utility Functions and Loss Functions
- Making Decisions with PyMC Models

Module 15: Hands-On Session: End-to-End Project

- Choose a Real-World Problem (e.g., Marketing, Healthcare, Finance)
- Model Building, Inference, and Decision Making
- Presenting and Interpreting Results