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Physics-Informed Neural Networks for Option Pricing

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Agenda

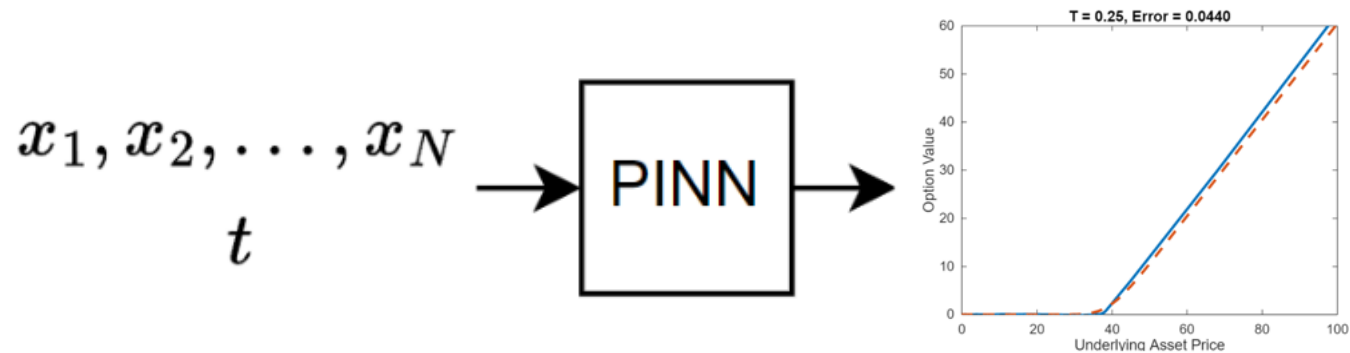
- Physics-Informed Neural Networks (PINNs)
- Example: PINNs for Option Pricing

Why Physics-Informed Neural Networks?

- Monte Carlo Simulations are time consuming.
- Provide an alternative approach to price an option
- Find the values of more complicated options

Physics-Informed Neural Networks (PINNs)

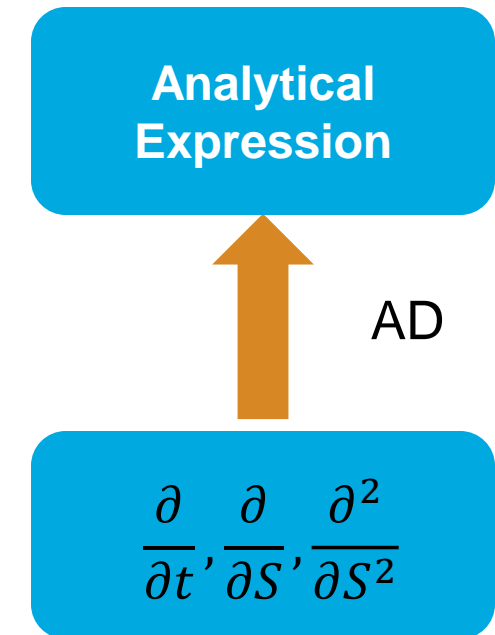
- A physics-informed neural network (PINN) is a neural network that incorporates physical laws into its structure and training process.
- For example, you can train a neural network that outputs the solution of a Partial Differential Equation (PDE) that defines a physical system.



PINNs for Option Pricing

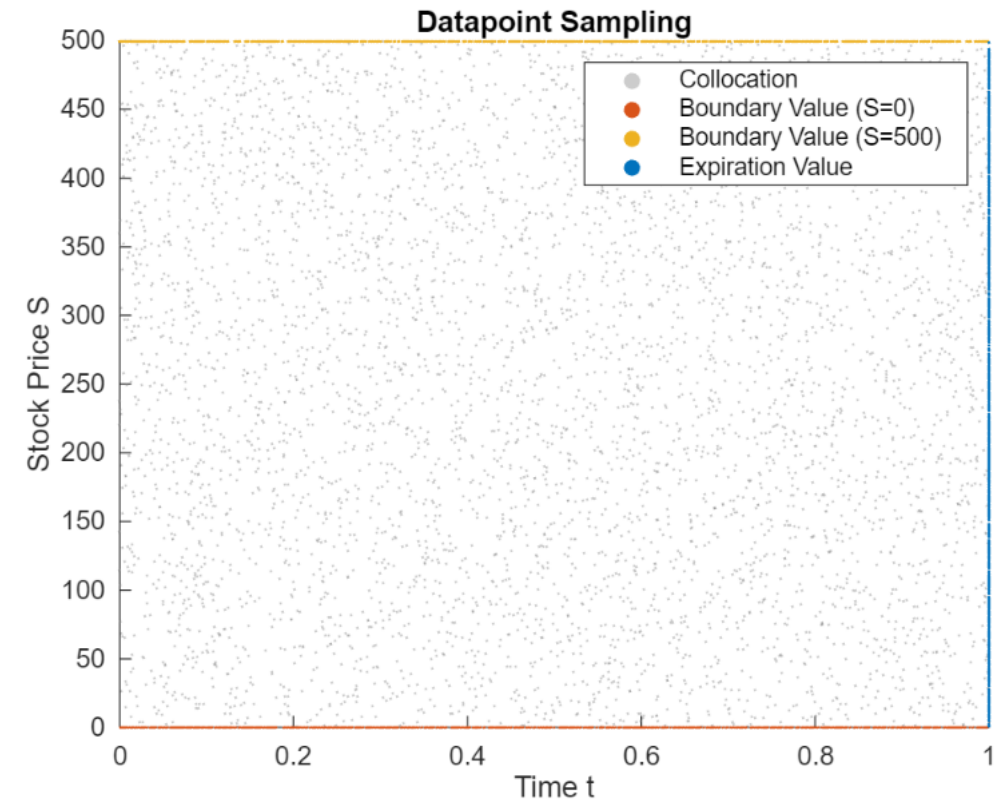
- Black Scholes PDE:
$$\frac{\partial V}{\partial t} + \frac{1}{2}\sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} + rS \frac{\partial V}{\partial S} - rV = 0$$

$$V(T, S) = K(S)$$
- The Customized Loss function:
 - $(t, s) \xrightarrow{\text{Neural Networks}} V(t, s)$ fulfills the Black Scholes Equation
 - The boundary conditions
 - The initial conditions
- Auto-Differentiation In Deep Learning Toolbox
 - Compute gradients for custom training loops



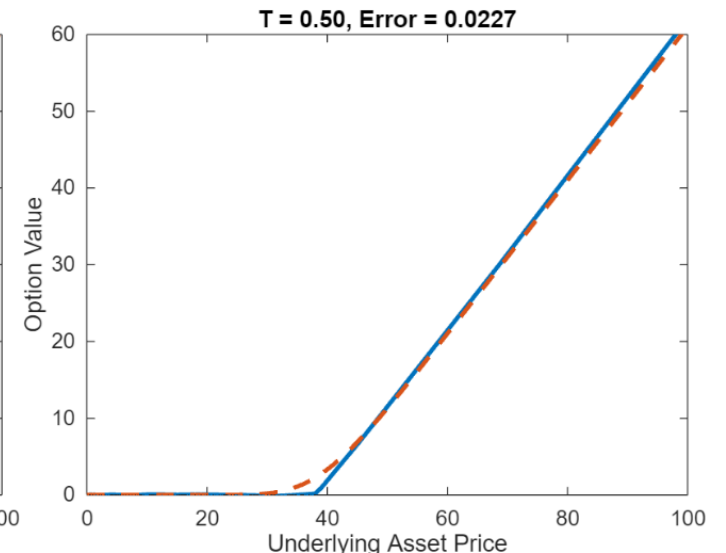
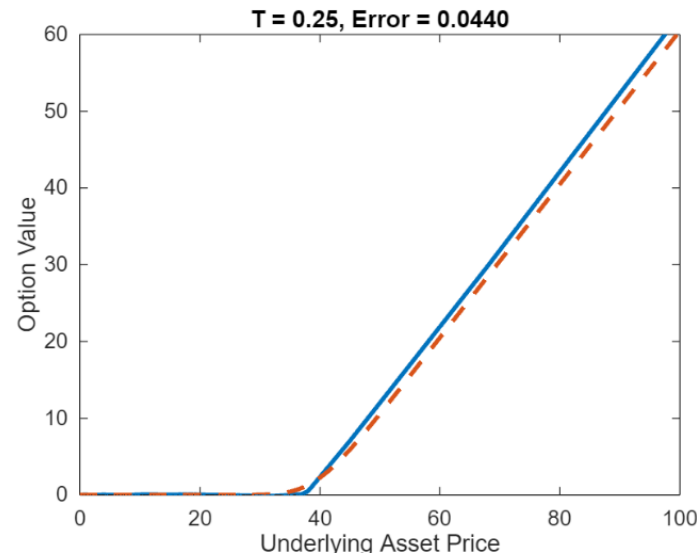
Demo: PINNs for option pricing

- Key steps:
 - Generate Training Data
 - Define Neural Network Architecture
 - Customize the Model Loss Function
 - Train the Neural Network
 - Evaluate Model Accuracy



Demo: PINNs for option pricing

- Key steps:
 - Generate Training Data
 - Uniformly sampling data points in the domain
 - Define Neural Network Architecture
 - Interactive Tools to visualize the neural networks
 - Customize the Model Loss Function
 - Auto-Differentiation in Deep Learning Toolbox
 - Train the Neural Network
 - Monitor Training Progress
 - Evaluate Model Accuracy



Key Takeaways

- Building Neural Networks
 - Auto-Differentiation Tools in Deep Learning Toolbox
 - Pre-defined and Custom Deep Learning Layers
- Training Neural Networks
 - Customize the loss functions
 - Monitor Training Progress
- Option Pricing
 - Physics Informed Neural Networks

More AI-related Examples:

- Transformer model for Time Series Analysis
- Reinforcement Learning for Portfolio managers
- FOMC minutes Text Analytics
- More examples: <https://www.mathworks.com/help/deeplearning/computational-finance.html>

mathworks.com/help/deeplearning/computational-finance.html

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Featured Examples

Compare Deep Learning Networks for Credit Default Prediction

Create, train, and compare three deep learning networks for predicting credit default probability.

Interpret and Stress-Test Deep Learning Networks for Probability of Default

Train a credit risk for probability of default (PD) prediction using a deep neural network. The example also shows how to use the locally

Hedge Options Using Reinforcement Learning Toolbox™

Outperform the traditional BSM approach using an optimal option hedging policy.

Use Deep Learning to Approximate Barrier Option Prices with Heston Model

Use Deep Learning Toolbox™ to train a network and obtain predictions on barrier option prices with a Heston model.

Backtest Strategies Using Deep Learning

Construct trading strategies using a deep learning model and then backtest the strategies using the Financial Toolbox™ backtesting

Deep Reinforcement Learning for Optimal Trade Execution

Use the Reinforcement Learning Toolbox™ and Deep Learning Toolbox™ to design agents for optimal trade execution.

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Thank you

