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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

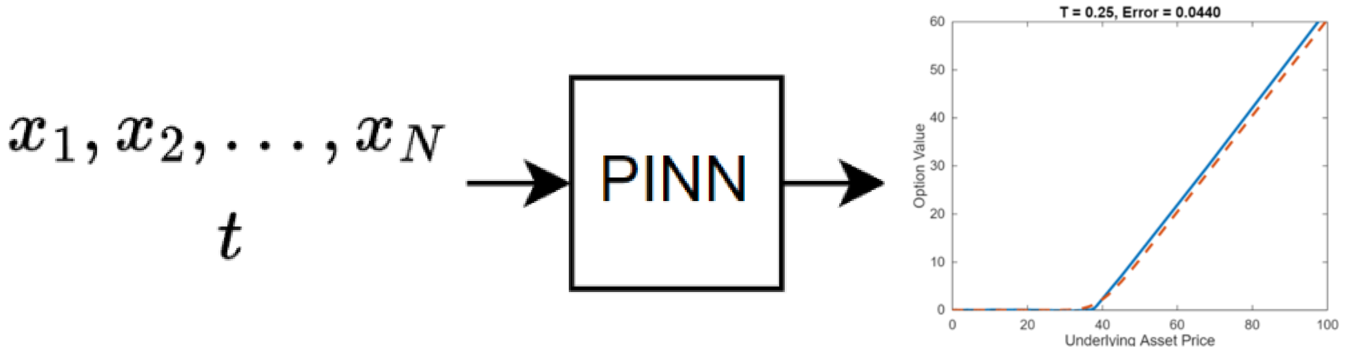
Why Physics-Informed Neural Networks?

- 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.



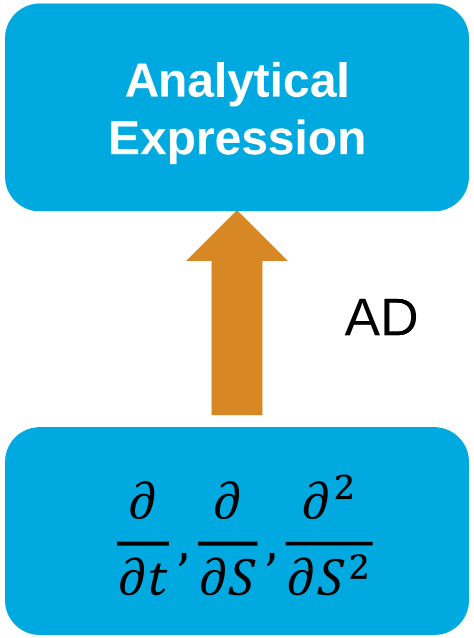
PINNs for Option Pricing

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

  $$V(T,S) = K(S)$$

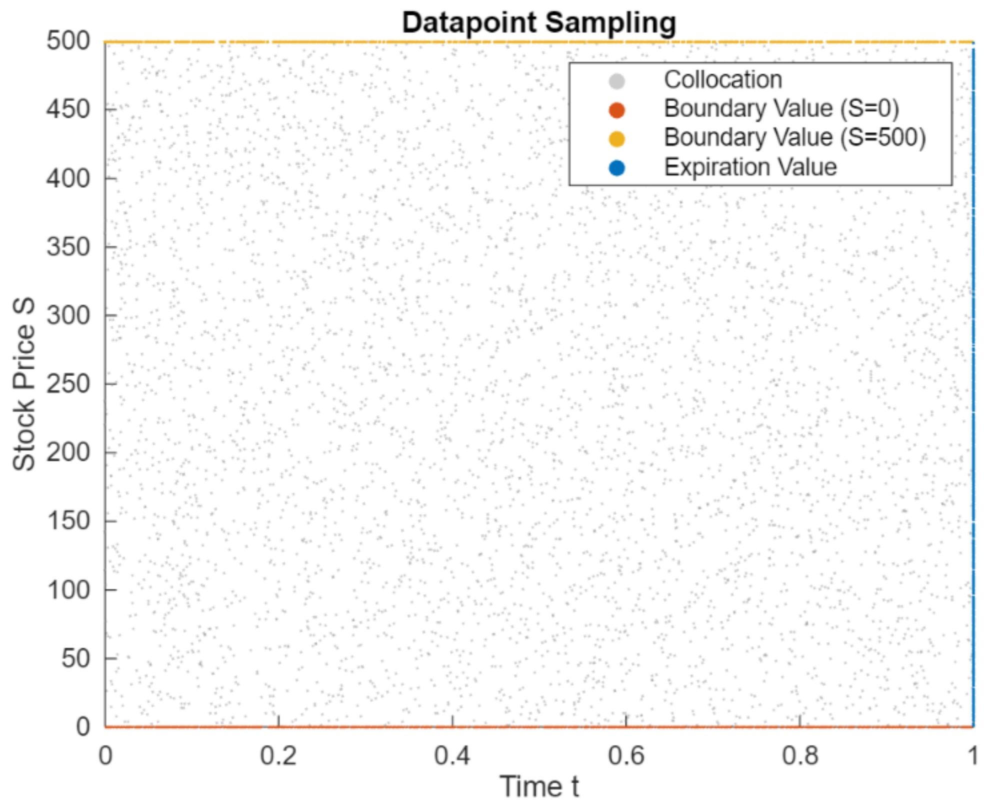
- The Customized Loss function:
  - $(t,s) \xrightarrow{Neural\ Networks} V(t,s)$ fulfills the Black Scholes Equation
  - The boundary conditions
  - The initial conditions

- Auto-Differentiation In Deep Learning Toolbox
  - Compute gradients for custom training loops



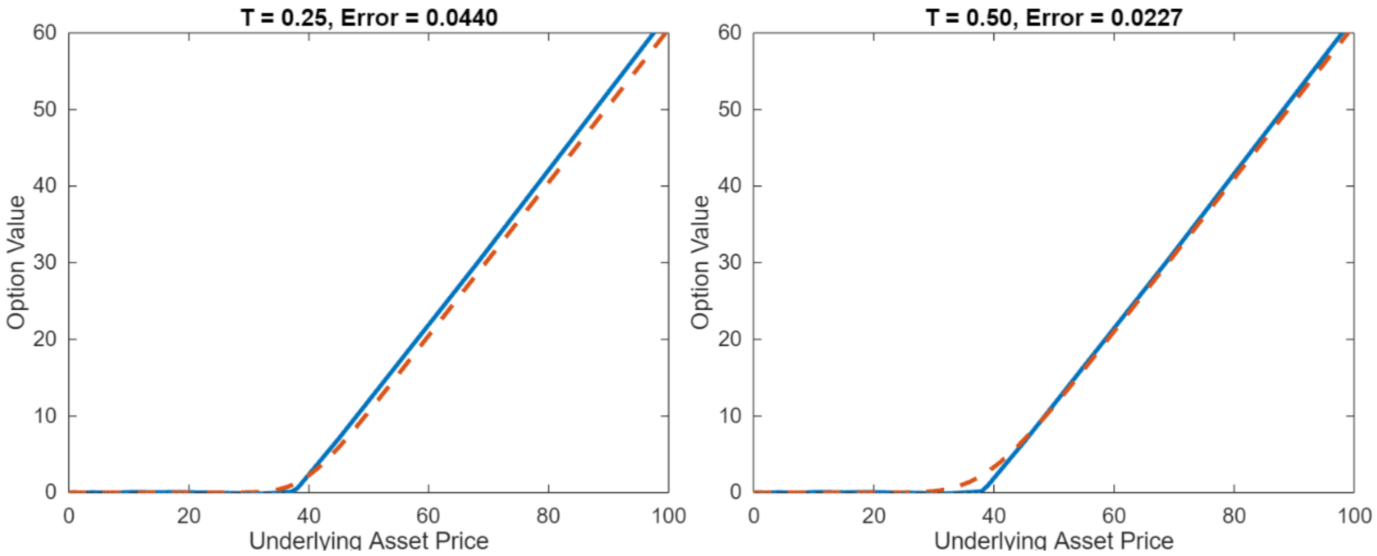
Demo: PINNs for option pricing

- 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

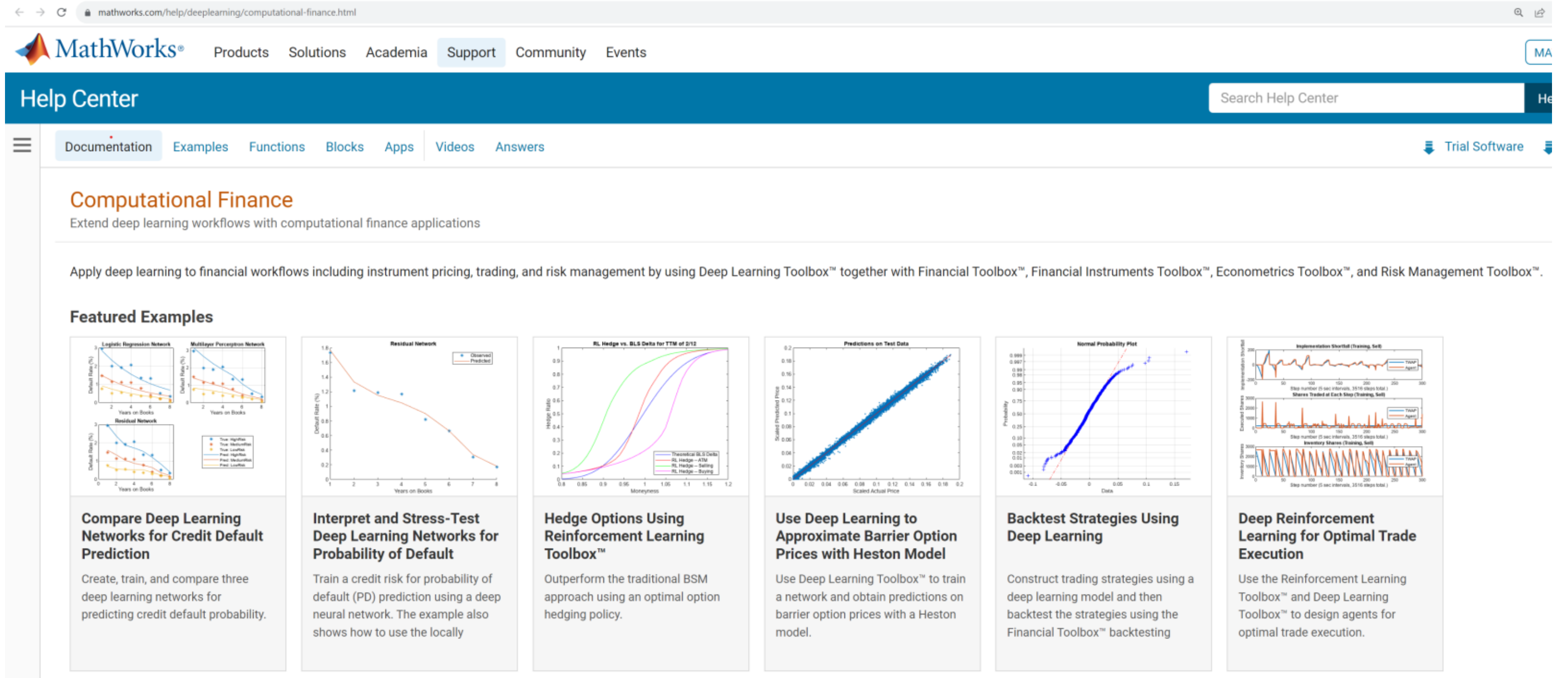


Key Takeaways

- 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



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Thank you

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