Options Part 1 - Basics

Introduction to Basic Options

Options are financial derivatives that provide the holder with the right, but not the obligation, to buy or sell an underlying asset at a predetermined price (the **strike price**) on or before a specific expiration date.

Options are powerful tools in finance, used for hedging, speculation, and risk management. Understanding the basic types of options, their payoffs, and common strategies involving calls and puts forms the foundation of options trading.

Key Terminology

1. **Underlying Asset**: The asset on which the option is based (e.g., stock, index, currency).
2. **Strike Price (K)**: The price at which the option holder can buy or sell the underlying asset.
3. **Expiration Date**: The date when the option expires.
4. **Premium**: The price paid to acquire the option.

Types of Options

There are two primary types of options:

1. **Call Option**: Grants the right to buy the underlying asset at the strike price.
2. **Put Option**: Grants the right to sell the underlying asset at the strike price.

In this section, we will explore the payoffs for both types of options from the perspectives of the buyer (long) and the seller (short).

Call and Put Options: Long and Short Positions

Understanding the payoffs for both long and short positions in calls and puts is essential for grasping how options function in different market scenarios.

Call Option

A **call option** gives the holder the right to **buy** the underlying asset at the strike price.

- **Long Call**: When you buy a call option, you profit if the price of the underlying asset rises above the strike price.
- **Short Call**: When you sell a call option, you receive the premium but risk losses if the asset price rises above the strike price.

Put Option

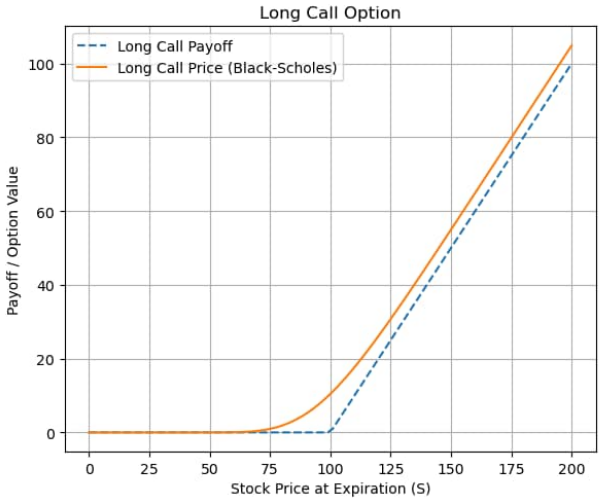
A **put option** gives the holder the right to **sell** the underlying asset at the strike price.

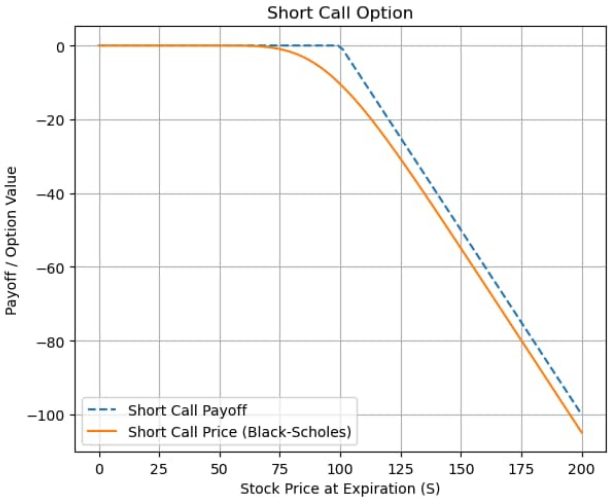
- **Long Put**: When you buy a put option, you profit if the price of the underlying asset falls below the strike price.
- **Short Put**: When you sell a put option, you collect the premium but risk losses if the asset price falls below the strike price.

Below, we visualize the payoff structures for each of these positions, including a Black-Scholes valuation to illustrate expected option values under different conditions.

In [1]:
```
# Import necessary libraries
import numpy as np
import matplotlib.pyplot as plt
from scipy.stats import norm

# Parameters
S = np.linspace(0, 200, 100)  # Stock price range
K = 100  # Strike price
T = 1  # Time to expiration
r = 0.05  # Risk-free rate
sigma = 0.2  # Volatility

# Black-Scholes Formula
def black_scholes(S, K, T, r, sigma, option_type="call"):
    S = np.maximum(S, 1e-6)  # Avoid divide-by-zero issues
    d1 = (np.log(S / K) + (r + 0.5 * sigma ** 2) * T) / (sigma * np.sqrt(T))
    d2 = d1 - sigma * np.sqrt(T)
    if option_type == "call":
        return S * norm.cdf(d1) - K * np.exp(-r * T) * norm.cdf(d2)
    elif option_type == "put":
        return K * np.exp(-r * T) * norm.cdf(-d2) - S * norm.cdf(-d1)

# Calculate payoffs and Black-Scholes values for each scenario
long_call_payoff = np.maximum(S - K, 0)
short_call_payoff = -long_call_payoff
long_put_payoff = np.maximum(K - S, 0)
short_put_payoff = -long_put_payoff

long_call_price = [black_scholes(s, K, T, r, sigma, "call") for s in S]
short_call_price = [-price for price in long_call_price]
long_put_price = [black_scholes(s, K, T, r, sigma, "put") for s in S]
short_put_price = [-price for price in long_put_price]

# Plotting in a 2x2 grid with Black-Scholes values
fig, axs = plt.subplots(2, 2, figsize=(12, 10))

# Long Call
axs[0, 0].plot(S, long_call_payoff, label="Long Call Payoff", linestyle="--")
axs[0, 0].plot(S, long_call_price, label="Long Call Price (Black-Scholes)")
axs[0, 0].set_title("Long Call Option")
axs[0, 0].set_xlabel("Stock Price at Expiration (S)")
```

```
axs[0, 0].set_ylabel("Payoff / Option Value")
axs[0, 0].legend()
axs[0, 0].grid(True)

# Short Call
axs[0, 1].plot(S, short_call_payoff, label="Short Call Payoff", linestyle="--")
axs[0, 1].plot(S, short_call_price, label="Short Call Price (Black-Scholes)")
axs[0, 1].set_title("Short Call Option")
axs[0, 1].set_xlabel("Stock Price at Expiration (S)")
axs[0, 1].set_ylabel("Payoff / Option Value")
axs[0, 1].legend()
axs[0, 1].grid(True)

# Long Put
axs[1, 0].plot(S, long_put_payoff, label="Long Put Payoff", linestyle="--")
axs[1, 0].plot(S, long_put_price, label="Long Put Price (Black-Scholes)")
axs[1, 0].set_title("Long Put Option")
axs[1, 0].set_xlabel("Stock Price at Expiration (S)")
axs[1, 0].set_ylabel("Payoff / Option Value")
axs[1, 0].legend()
axs[1, 0].grid(True)

# Short Put
axs[1, 1].plot(S, short_put_payoff, label="Short Put Payoff", linestyle="--")
axs[1, 1].plot(S, short_put_price, label="Short Put Price (Black-Scholes)")
axs[1, 1].set_title("Short Put Option")
axs[1, 1].set_xlabel("Stock Price at Expiration (S)")
axs[1, 1].set_ylabel("Payoff / Option Value")
axs[1, 1].legend()
axs[1, 1].grid(True)

plt.tight_layout()
plt.show()
```


Long Call Option
Long Call Payoff
Long Call Price (Black-Scholes)
Payoff / Option Value
Stock Price at Expiration (S)


Short Call Option
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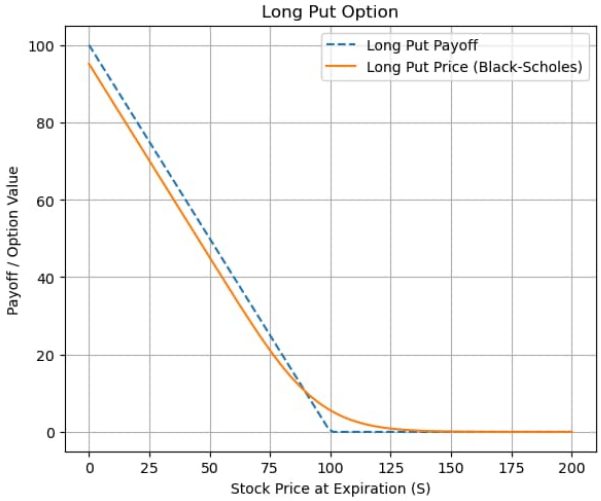
Long Put Option
Long Put Payoff
Long Put Price (Black-Scholes)
Payoff / Option Value
Stock Price at Expiration (S)


Short Put Option
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