



Pricing Exotic Options Using the Binomial Model

AMERICAN BARRIER OPTION

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Contenidos

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Introduction

What Are Exotic Options?

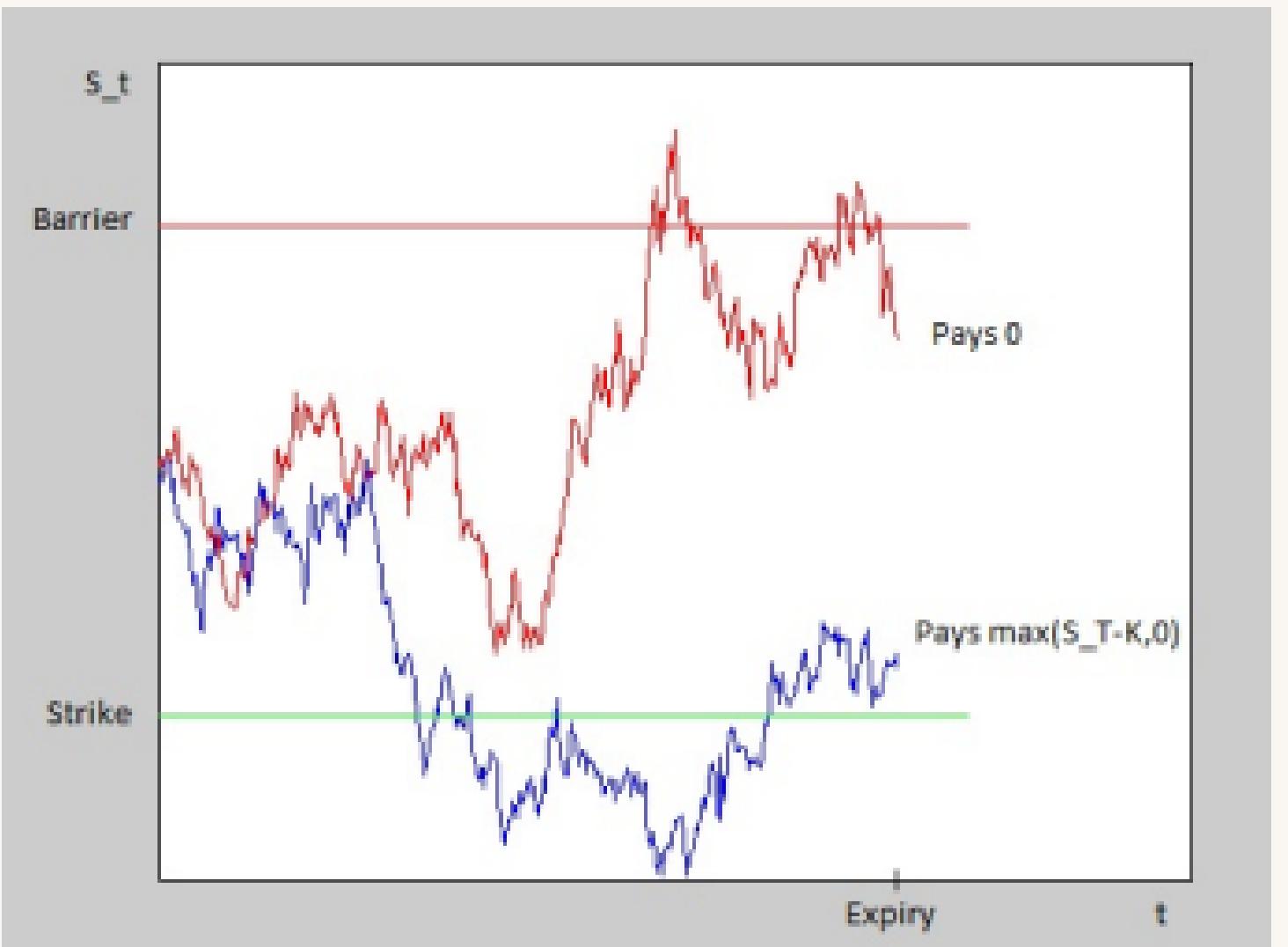
- Exotic options have complex features beyond standard options (e.g., barriers, multiple strike prices).
- Widely used in risk management, hedging, and speculative strategies.



Introduction

Barrier Option

- A barrier option's payoff depends on whether the underlying asset crosses a specific price level.



American Barrier Options

Combines features of **American options** (early exercise allowed) and **barrier options** (price dependency on a threshold).

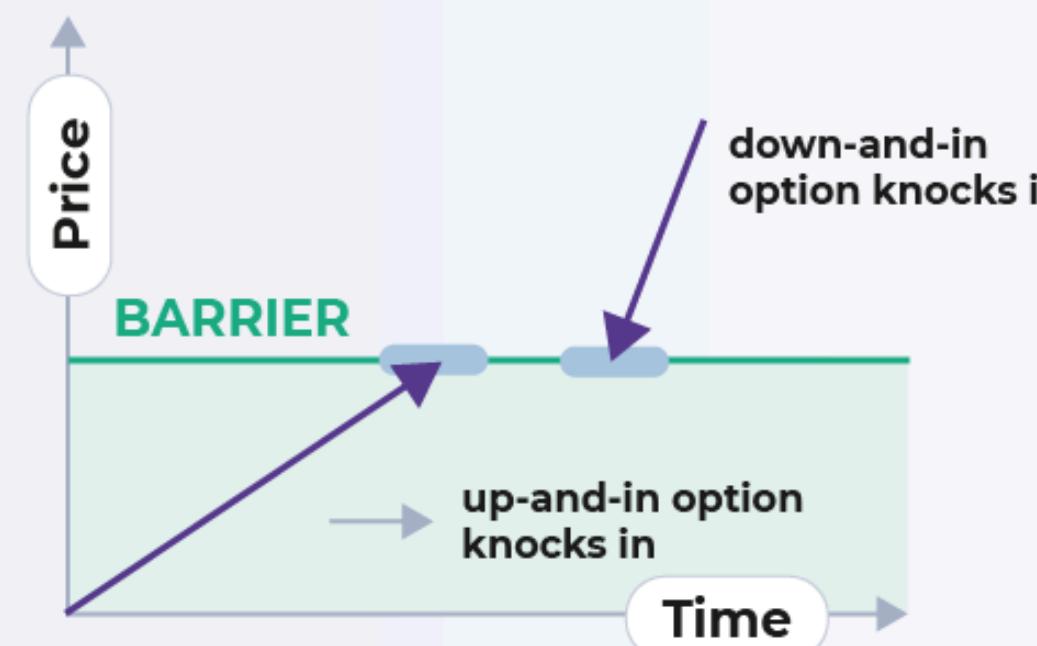
Types:

- *Up-and-out*: Deactivated if the stock price goes above the barrier.
- *Down-and-out*: Deactivated if the stock price goes below the barrier.

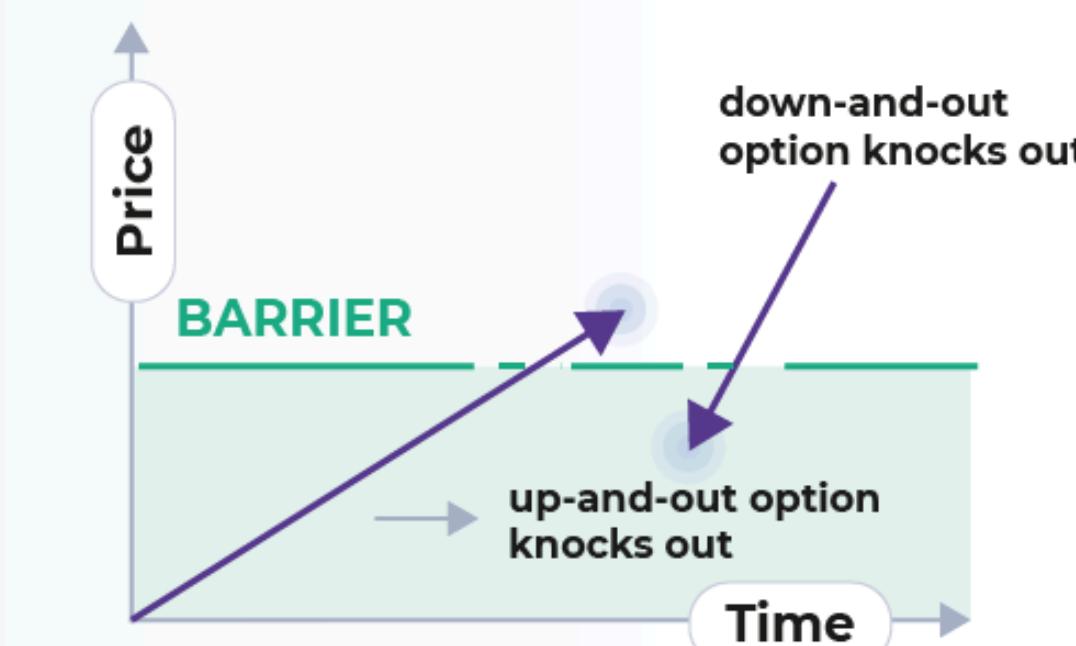
Pricing is computationally challenging due to these combined features.

American Barrier Options

Knock-in option



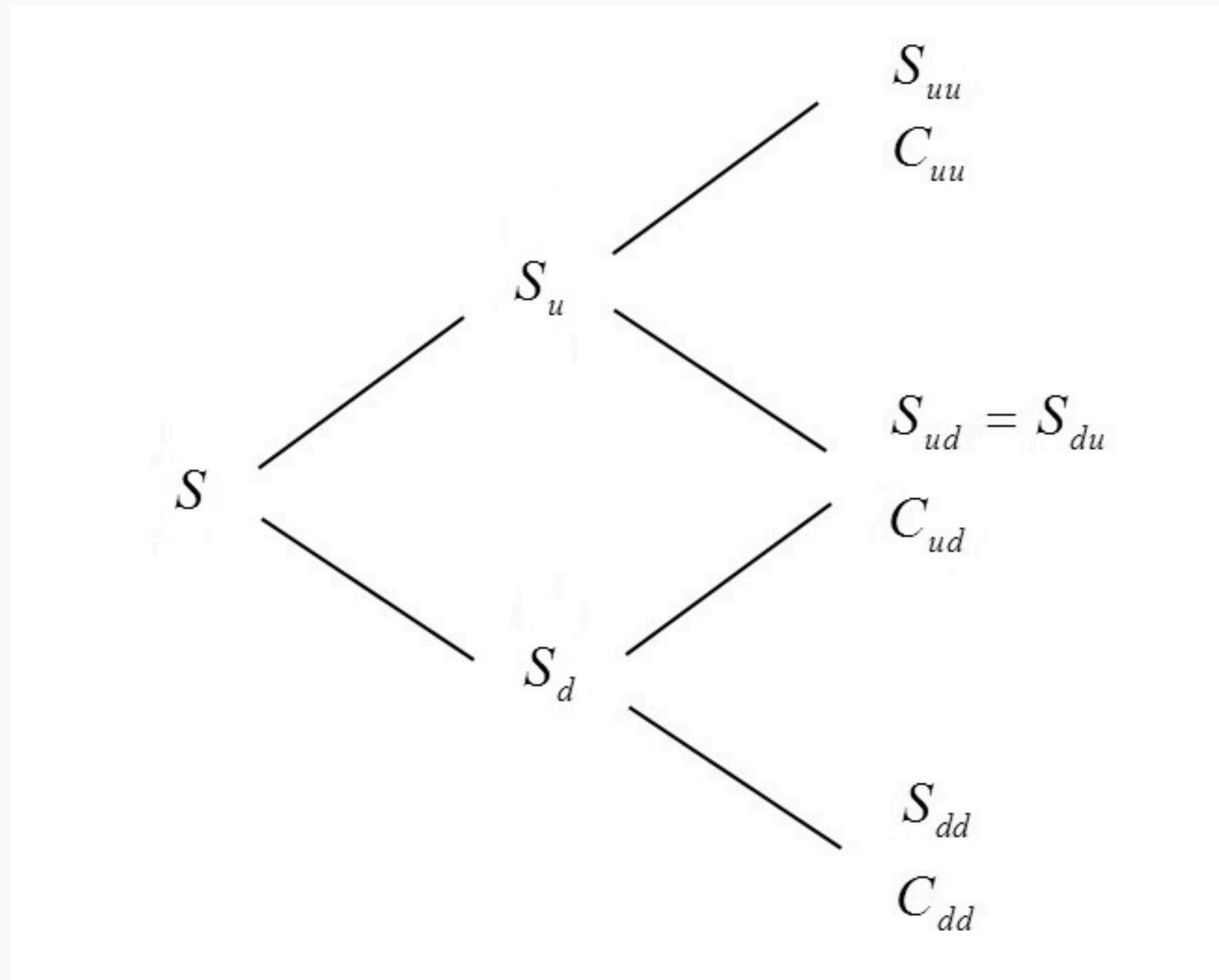
Knock-out option



The Binomial Model

- A tree-based method to model stock prices in discrete time steps.
- Stock prices evolve as up or down per step.
- Factors:
 - Risk-neutral probability (p):** Assumes no arbitrage.
 - Discount factor:** Accounts for the time value of money.
- Capable of handling early exercise and complex barriers.

The Binomial Model



Methodology – Build the Stock Price Tree

- Tree structure evolves from the initial stock price (**S₀**).
- Stock prices at each node are calculated:

Up: S^*u

Down: S^*d

- Barrier applied at each node:

If stock crosses the barrier, the node becomes invalid.

Methodology – Option Value Calculation

Option values are computed backward:

- Maturity nodes: $\text{Intrinsic value} = \max(S - K, 0)$.
- Earlier nodes: $\max(\text{Continuation Value}, \text{Intrinsic Value})$.

If a node violates the barrier, the option value at that node is set to 0.

Implementation

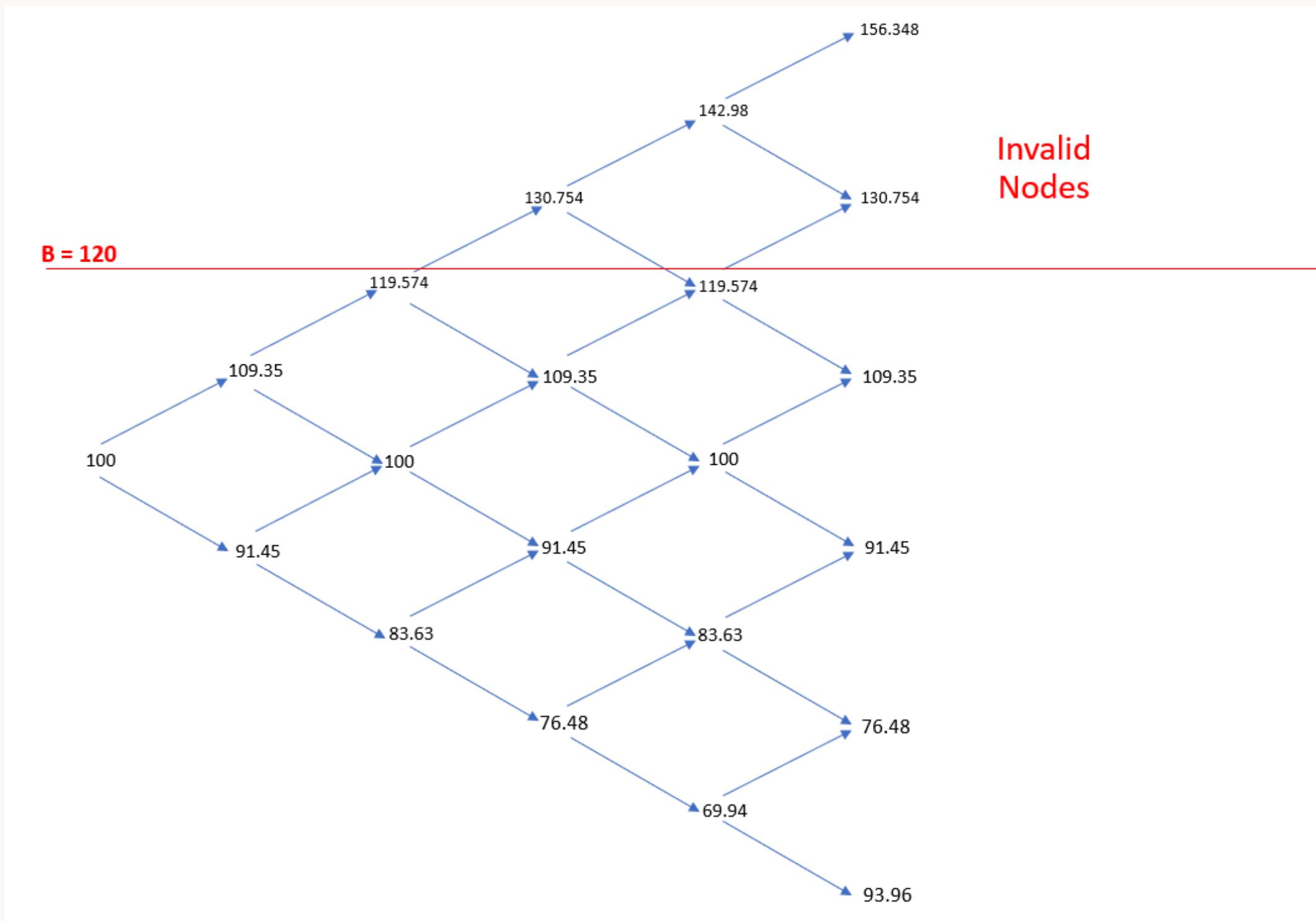


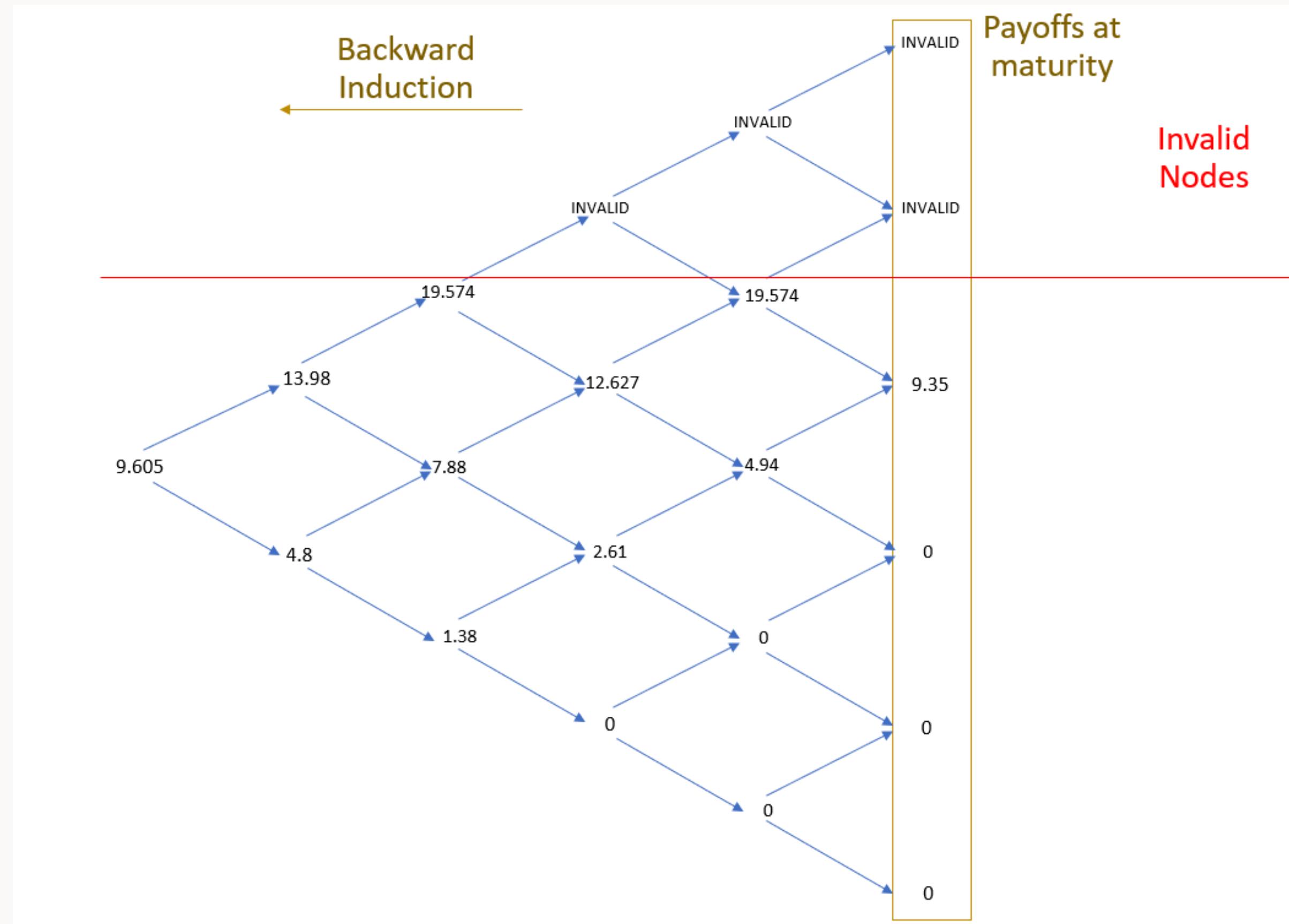
The code was implemented in **Python**, utilizing libraries for numerical computations.

Testing & Validation:

- Case 1: Standard call option, validating early exercise payoff calculation.
 - Case 2: Up-and-Out Barrier Option, incorporating invalidation if the price exceeded
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Results





*The value of the option at the root node is the price of the American barrier option and is equal to **9.605**.*

Conclusion

- Successfully priced an American barrier option using the binomial model.
- The barrier condition adds complexity but can be modeled effectively.
- The binomial model is robust and provides a good foundation for further refinement.

Future Work

- Use finer grids for increased accuracy (higher N).
 - Apply other numerical techniques (e.g., Monte Carlo, finite difference).
 - Explore exotic options with multiple barriers or other complexities.
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Thank you for
your attention!