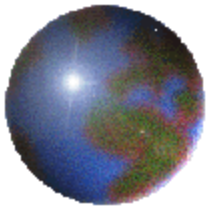
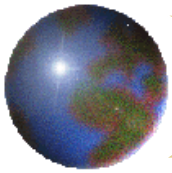


Options

Options - Definitions

- A call is an option to buy an asset at a given price
- A put is an option to sell an asset at a given price
- A European option can be exercised only at the end of its life
- An American option can be exercised at any time



Outline

- The mechanics of options and their trading. Types of options by:
  - Exercise optionality
  - Underlying asset (equity, index, futures)
- Option properties:
  - Risks
  - Put-call parity
  - Dividends

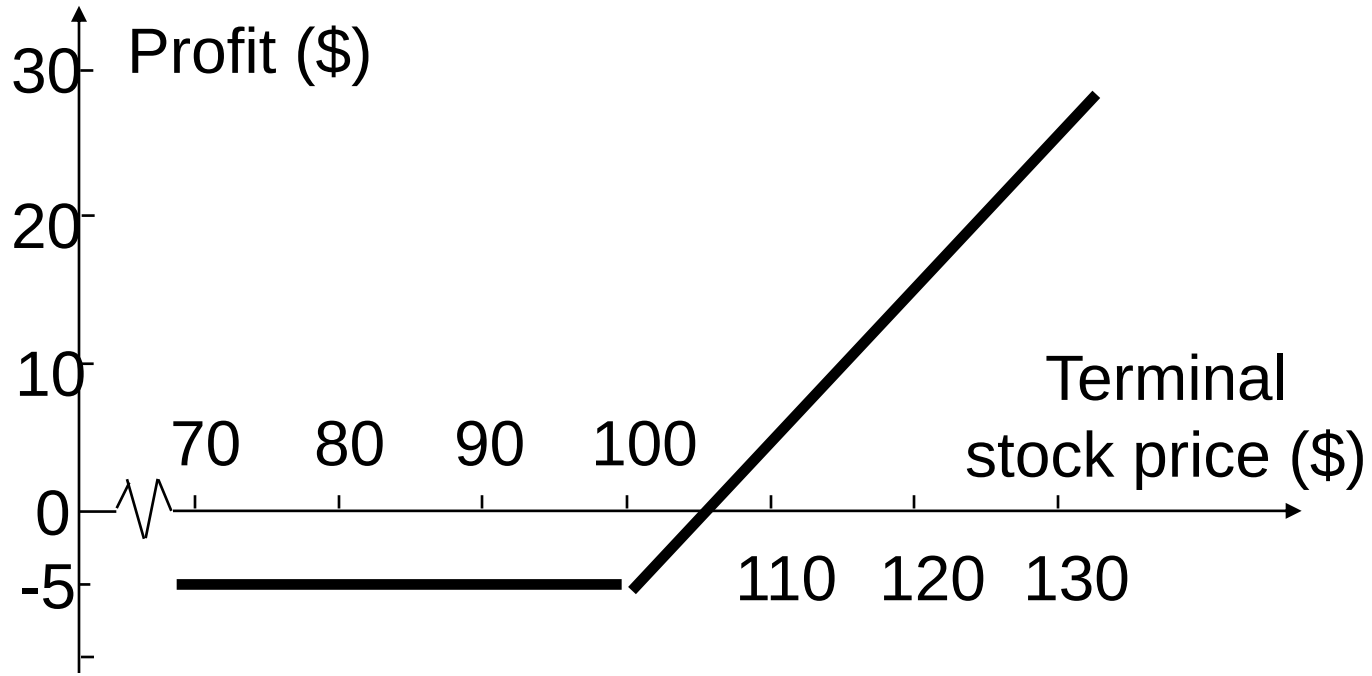
Option Positions

There are two sides to each option: the option writer and the option holder (buyer)

- Long call – bought a call option
- Long put – bought a put option
- Short call – wrote a call option
- Short put – wrote a put option

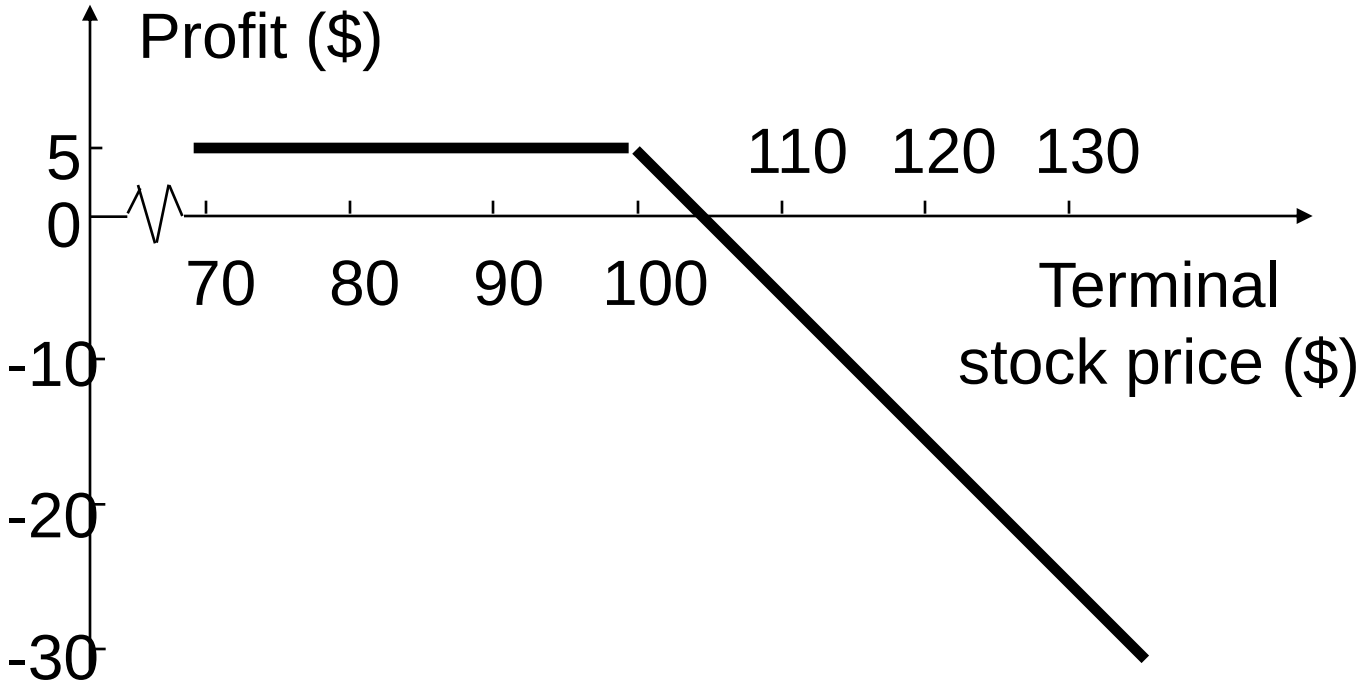
Long Call *(Figure 10.1, Page 210)*

Profit from buying one European call option: option price = $5, strike price = $100, option life = 2 months



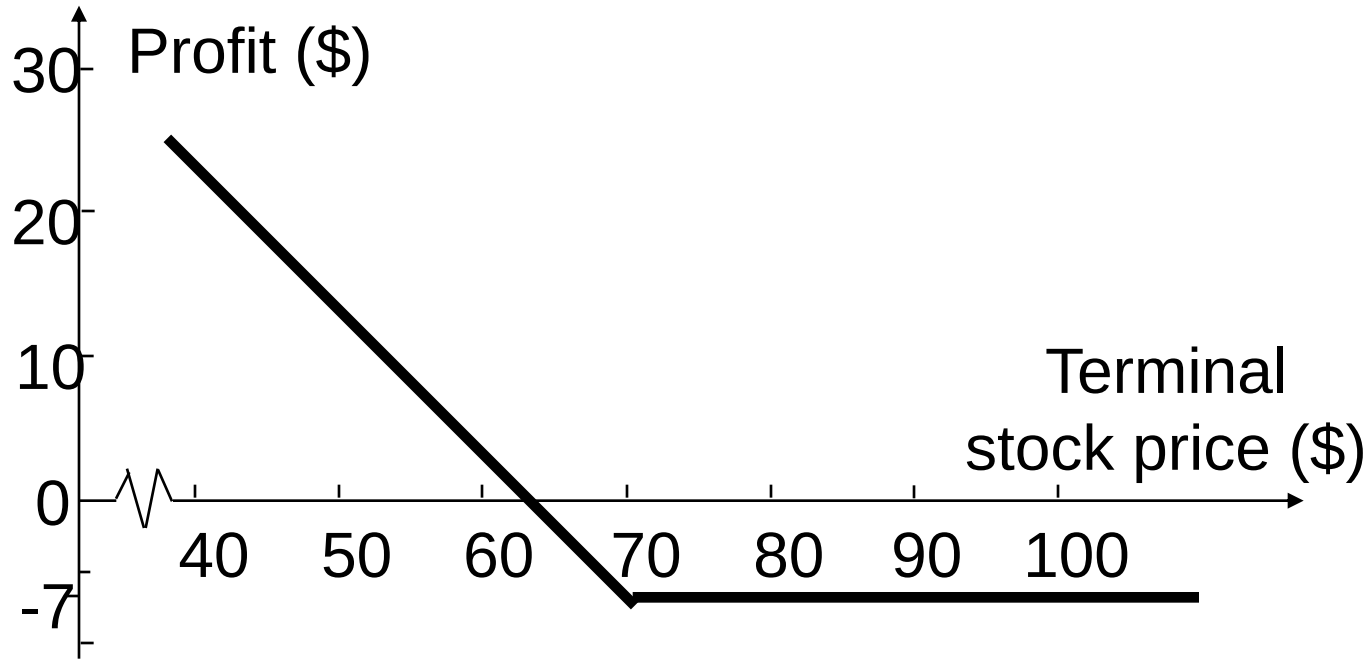
Short Call *(Figure 10.3, page 212)*

Profit from writing one European call option: option price = $5, strike price = $100



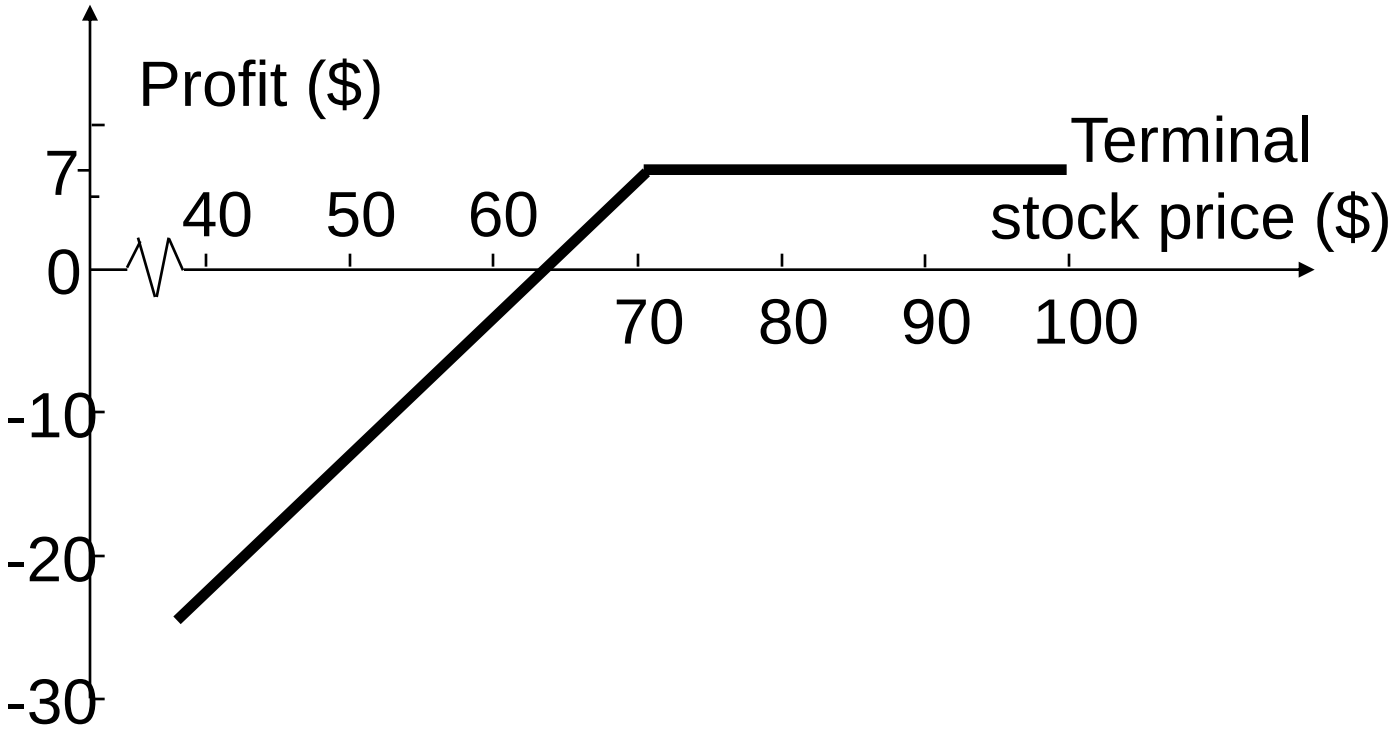
Long Put *(Figure 10.2, page 211)*

Profit from buying a European put option: option price = $7, strike price = $70



Short Put *(Figure 10.4, page 212)*

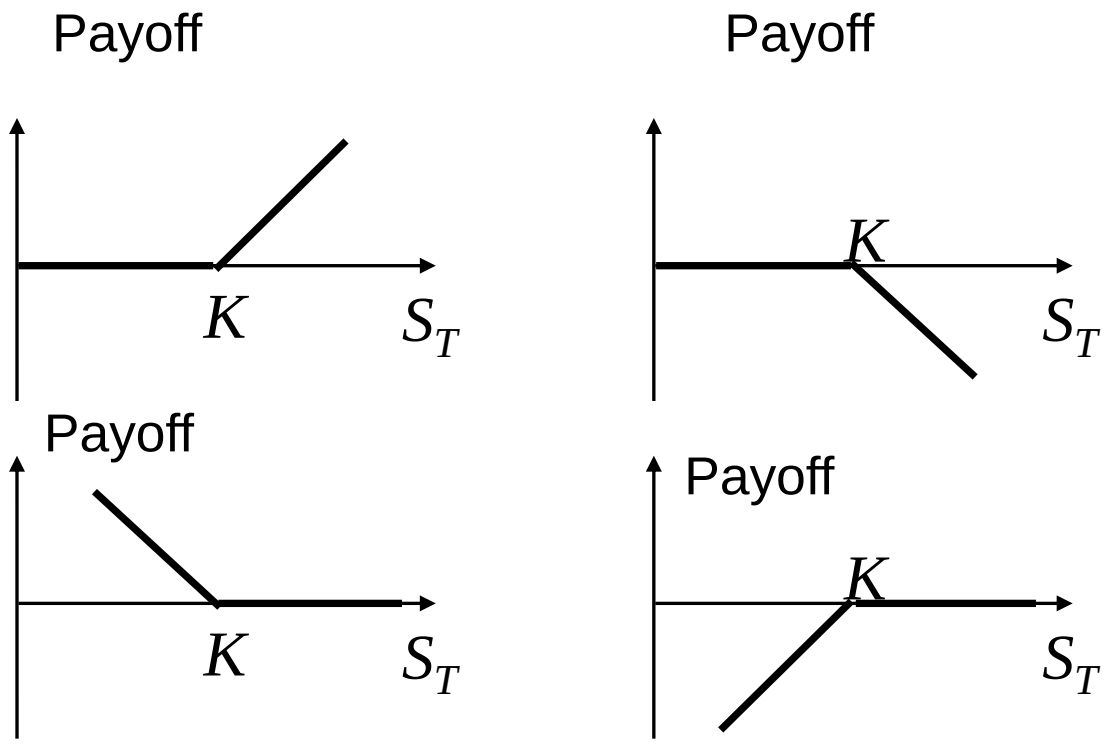
Profit from writing a European put option: option price = $7, strike price = $70



Payoffs from Options

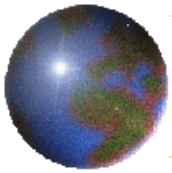
What is the Option Position in Each Case?

K = Strike price, S_T = Price of asset at maturity



Assets Underlying Options

- Stocks
- Exchange Traded Funds (ETFs), e.g. SPY
- Foreign Currency
- Stock Indices
- Futures



Option parameters

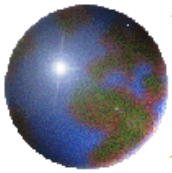
- Expiration date
- Strike price
- European or American
- Call or Put (option class)

Terminology

Moneyness :

- At-the-money option
- In-the-money option
- Out-of-the-money option

Q: What are the strikes of ITM call options?



More Terminology

- Option class (call or put)
- Option series
- Intrinsic value
- Time value
- Naked vs covered options

How to get stock price and options data

- Yahoo finance has freely available data but no historical option prices

https://finance.yahoo.com

- Options on futures are listed on the CME Group website
- Bloomberg has historical option price data

Example: options on SPY

NYSEArca - Nasdaq Real Time Price • USD

SPDR S&P 500 ETF Trust (SPY) ☆ Follow

577.14 +3.97 (+0.69%) **576.77** -0.37 (-0.06%)

At close: 4:00 PM EDT After hours: 4:56 PM EDT

1D 5D 3M 6M YTD 1Y 5Y All Key Events Mountain Advanced Chart

Previous Close	573.17	Day's Range	572.55 - 577.71	Net Assets	591.49B	YTD Daily Total Return	21.73%
Open	573.16	52 Week Range	409.21 - 577.71	NAV	573.09	Beta (5Y Monthly)	1.00
Bid	576.71 x 1000	Volume	34,648,991	PE Ratio (TTM)	29.07	Expense Ratio (net)	0.09%
Ask	576.51 x 1200	Avg. Volume	52,177,696	Yield	1.22%		

NYSEArca - Nasdaq Real Time Price • USD

SPDR S&P 500 ETF Trust (SPY)

☆ Follow

577.14 +3.97 (+0.69%) **576.79** -0.35 (-0.06%)

At close: 4:00 PM EDT After hours: 4:59 PM EDT

Oct 11, 2024 | All Strike Prices | Straddle

Calls

Last Price	Change	% Change	Volume	Open Interest	Strike
4.64	+1.53	+49.20%	9,900	4,941	574.00
3.96	+1.32	+50.00%	15,535	7,439	575.00
3.29	+1.12	+51.61%	17,775	3,621	576.00
2.74	+1.01	+58.38%	17,843	6,505	577.00
2.20	+0.86	+64.18%	12,265	4,890	578.00
1.73	+0.68	+64.76%	10,984	3,502	579.00
1.31	+0.52	+65.82%	30,072	9,228	580.00
0.98	+0.42	+75.00%	8,617	5,067	581.00

Puts

Last Price	Change	% Change	Volume	Open Interest
1.72	-1.99	-53.64%	19,811	1,828
2.03	-2.12	-51.08%	33,236	2,282
2.41	-2.34	-49.26%	17,352	760
2.84	-2.58	-47.60%	13,775	1,027
3.29	-2.89	-46.76%	4,212	323
3.88	-2.96	-43.27%	2,472	493
4.47	-3.02	-40.32%	1,884	913
5.09	-4.23	-45.39%	506	245

Dividends & Stock Splits

(Page 217-218)

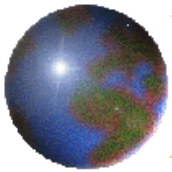
Suppose you own N options with strike price K :

- No adjustments are made to the option terms for cash dividends
- When there is an n-for-m stock split,
  - the strike price is reduced to mK/n
  - the no. of options is increased to nN/m
- Stock dividends are handled similarly to stock splits

Dividends & Stock Splits

(continued)

- Consider a call option to buy 100 shares for $20/share
- How should terms be adjusted:
  - for a 2-for-1 stock split?
  - for a 5% stock dividend?



Option Properties

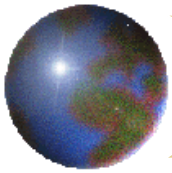
(Chapter 11)

Notation

c:	European call option price
p:	European put option price
S_0:	Stock price today
K:	Strike price
T:	Life of option
σ:	Volatility of stock price
C:	American call option price
P:	American put option price
S_T:	Stock price at option maturity
D:	PV of dividends paid during life of option
r	Risk-free rate for maturity T with cont. comp.

Effect of Variables on Option Pricing *(Table 11.1, page 232)*

	European		American	
Variable	c	p	C	P
S_0	+	−	+	−
K	−	+	−	+
T	?	?	+	+
σ	+	+	+	+
r	+	−	+	−
D	−	+	−	+



American vs European Options

An American option is worth at least as much as the corresponding European option

$$C \geq c$$

$$P \geq p$$

Calls: An Arbitrage Opportunity?

- Suppose that

$c = 3$ $\quad S_0 = 20$

$T = 1$ $\quad r = 10\%$

$K = 18$ $\quad D = 0$

- Is there an arbitrage opportunity?

Lower Bound for European Call Option Prices; No Dividends

(Equation 11.4, page 237)

$$c \geq \max(S_0 - Ke^{-rT}, 0)$$

Puts: An Arbitrage Opportunity?

- Suppose that

$p = 1$ $\quad S_0 = 37$

$T = 0.5$ $\quad r = 5\%$

$K = 40$ $\quad D = 0$

- Is there an arbitrage opportunity?

Lower Bound for European Put Prices; No Dividends

(Equation 11.5, page 238)

$$p \geq \max(Ke^{-rT} - S_0, 0)$$

Put-Call Parity: No Dividends

- Consider the following 2 portfolios:
  - Portfolio A: European call on a stock + zero-coupon bond that pays K at time T
  - Portfolio C: European put on the stock + the stock

Values of Portfolios

		$S_T > K$	$S_T < K$
Portfolio A	Call option	$S_T - K$	0
	Zero-coupon bond	K	K
	Total	S_T	K
Portfolio C	Put Option	0	$K - S_T$
	Share	S_T	S_T
	Total	S_T	K

The Put-Call Parity Result (Equation 11.6, page 239)

- Both are worth max(S_T , K) at the maturity of the options
- They must therefore be worth the same today. This means that

$$c + Ke^{-rT} = p + S_0$$

Arbitrage Opportunities

- Suppose that

  $c = 3$ $\qquad$ $S_0 = 31$

  $T = 0.25$ $\qquad$ $r = 10\%$

  $K = 30$ $\qquad$ $D = 0$

- What are the arbitrage possibilities when

  $p = 2.25$?

  $p = 1$?

Check put-call parity

$$c + e^{-rT}K \text{ vs } p + S_0$$

Case 1:

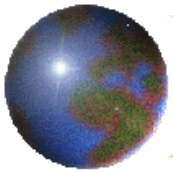
$$32.26 \text{ vs } 33.25$$

Put is overpriced: buy calls, short puts

Case 2:

$$32.25 \text{ vs } 32.00$$

Put is underpriced: buy puts, short calls



American Options: Early Exercise

- Usually there is some chance that an American option will be exercised early
- An exception is an American call on a non-dividend paying stock
- This should never be exercised early

Reasons For Not Exercising an American Call Early (No Dividends)

- No income is sacrificed
- You delay paying the strike price
- Holding the call provides insurance against stock price falling below strike price

However American put options can be exercised early, if the stock price drops below a critical value (exercise boundary)

Extensions of Put-Call Parity

- American options; $D = 0$

  $$S_0 - K < C - P < S_0 - Ke^{-rT}$$

  Equation 11.7 p. 240

- European options; $D > 0$

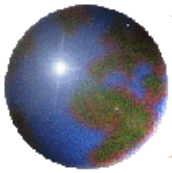
  $$c + D + Ke^{-rT} = p + S_0$$

  Equation 11.10 p. 247

- American options; $D > 0$

  $$S_0 - D - K < C - P < S_0 - Ke^{-rT}$$

  Equation 11.11 p. 247



Exotic options

- Non-standard American options
- Barrier options
- Asian options
- Lookback options

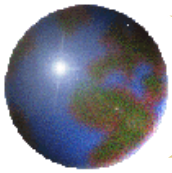
Non-Standard American Options

(page 598)

- Exercisable only on specific dates (Bermudans)
- Early exercise allowed during only part of life (initial “lock out” period)
- Strike price changes over the life (warrants, convertibles)

Barrier Options *(page 602-604)*

- Option comes into existence only if stock price hits barrier before option maturity
  - ‘In’ options
- Option dies if stock price hits barrier before option maturity
  - ‘Out’ options



Barrier Options (continued)

- Stock price must hit barrier from below
  - ‘Up’ options
- Stock price must hit barrier from above
  - ‘Down’ options
- Option may be a put or a call
- Eight possible combinations

Binary Options *(page 604-605)*

- Cash-or-nothing: pays Q if $S_T > K$, otherwise pays nothing.

- Asset-or-nothing: pays S_T if $S_T > K$, otherwise pays nothing.

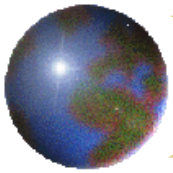
Lookback Options *(page 605-607)*

- Floating lookback call pays $S_T - S_{\min}$ at time T (Allows buyer to buy stock at lowest observed price in some interval of time)
- Floating lookback put pays $S_{\max} - S_T$ at time T

  (Allows buyer to sell stock at highest observed price in some interval of time)
- Fixed lookback call pays $\max(S_{\max} - K, 0)$
- Fixed lookback put pays $\max(K - S_{\min}, 0)$
- Analytic valuation for all types

Asian Options *(page 608-609)*

- Payoff related to average stock price
- Average Price options pay:
  - Call: $\max(S_{\text{ave}} - K, 0)$
  - Put: $\max(K - S_{\text{ave}}, 0)$
- Average Strike options pay:
  - Call: $\max(S_T - S_{\text{ave}}, 0)$
  - Put: $\max(S_{\text{ave}} - S_T, 0)$



Asian Options

- No exact analytic valuation
- Can be approximately valued by assuming that the average stock price is lognormally distributed