

As we see in this example, a conditional statement can be added to a list comprehension. Here it serves as a filter to select out only those elements that are divisible by three.

5.4 Exercises

1. Write a program to calculate the factorial of a positive integer input by the user. Recall that the factorial function is given by $x! = x(x-1)(x-2)\dots(2)(1)$ so that $1! = 1$, $2! = 2$, $3! = 6$, $4! = 24$, $5! = 120$, ...

- (a) Write the factorial function using a Python `while` loop.
- (b) Write the factorial function using a Python `for` loop.

Check your programs to make sure they work for 1, 2, 3, 5, and beyond, but especially for the first 5 integers.

2. The following Python program finds the smallest non-trivial (not 1) prime factor of a positive integer.

```
n = int(input("Input an integer > 1: "))
i = 2
while (n % i) != 0:
    i += 1
print("The smallest factor of {0:d} is {1:d}".format(n, i))
```

- (a) Type this program into your computer and verify that it works as advertised. Then briefly explain how it works and why the `while` loop always terminates.
 - (b) Modify the program so that it tells you if the integer input is a prime number or not. If it is not a prime number, write your program so that it prints out the smallest prime factor. Using your program verify that the following integers are prime numbers: 101, 8191, 94811, 947431.
3. Consider the matrix list `x = [[1, 2, 3], [4, 5, 6], [7, 8, 9]]`. Write a list comprehension to extract the last column of the matrix `[3, 6, 9]`. Write another list comprehension to create a vector of twice the square of the middle column `[8, 50, 128]`.
 4. Write a program that calculates the value of an investment after some number of years specified by the user if

- (a) the principal is compounded annually
- (b) the principle is compounded monthly
- (c) the principle is compounded daily

Your program should ask the user for the initial investment (principal), the interest rate in percent, and the number of years the money will be invested (allow for fractional years). For an initial investment of \$1000 at an interest rate of 6%, after 10 years I get \$1790.85 when compounded annually, \$1819.40 when compounded monthly, and \$1822.03 when compounded daily, assuming 12 months in a year and 365.24 days in a year, where the monthly interest rate is the annual rate divided by 12 and the daily rate is the annual rate divided by 365 (don't worry about leap years).

5. Write a program that determines the day of the week for any given calendar date after January 1, 1900, which was a Monday. Your program will need to take into account leap years, which occur in every year that is divisible by 4, except for years that are divisible by 100 but are not divisible by 400. For example, 1900 was not a leap year, but 2000 was a leap year. Test that your program gives the answers tabulated below.

Date	Weekday
January 1, 1900	Monday
June 28, 1919	Saturday
January 30, 1928	Tuesday
December 5, 1933	Tuesday
February 29, 1948	Sunday
March 1, 1948	Monday
January 15, 1953	Thursday
November 22, 1963	Friday
June 23, 1993	Wednesday
August 28, 2005	Sunday
May 16, 2111	Saturday