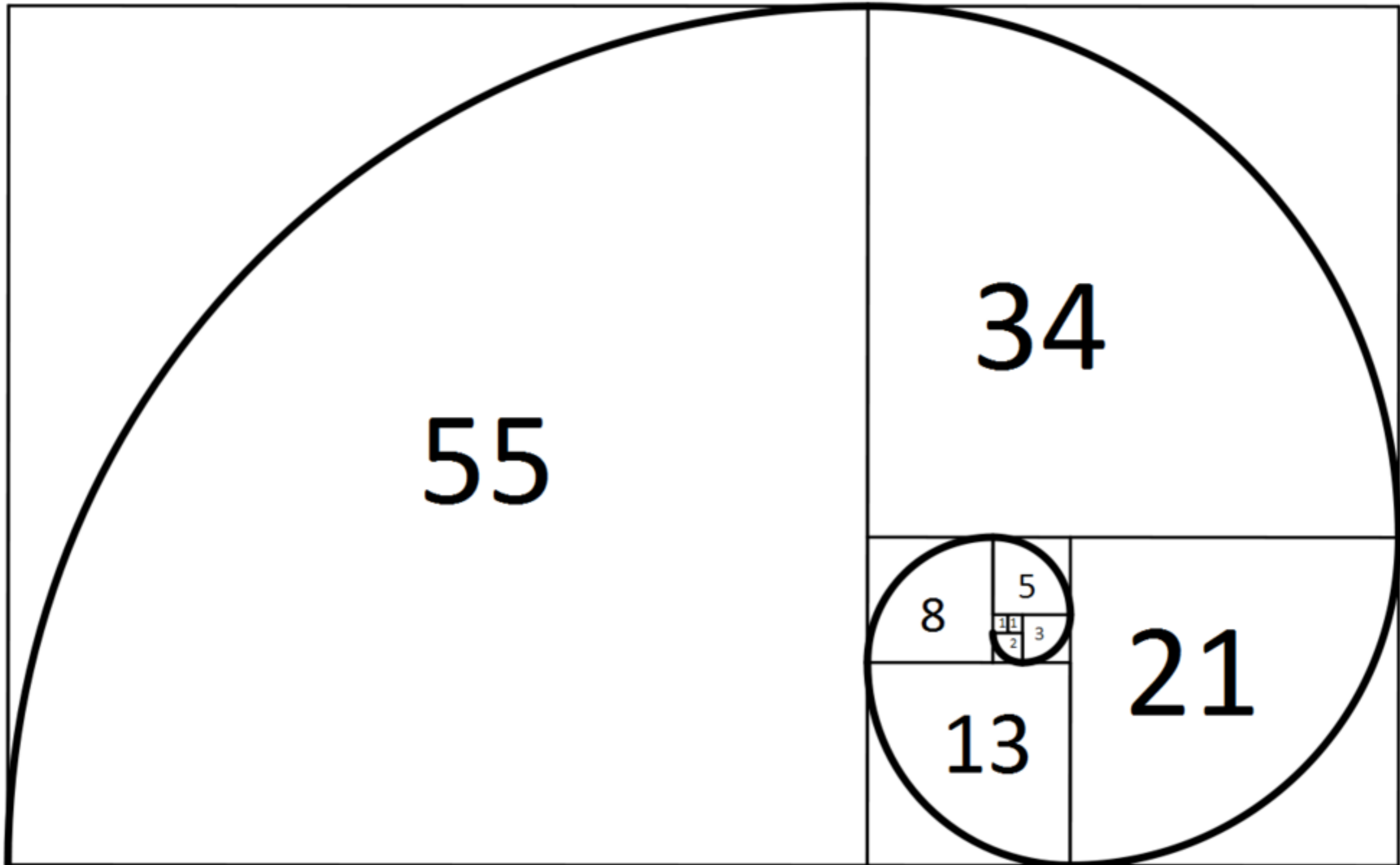


Iteration, aka For and While



Iteration is a key element in much of technical computation. Examples involving the Golden Ratio introduce the MATLAB assignment statement, `for` and `while` loops, and the `plot` function.

$$x = \text{sqrt}(1 + x)$$

```
x = 3
for k = 1:31
    x = sqrt(1 + x)
end
```

```
x = 3
while x ~= sqrt(1+x)
    x = sqrt(1+x)
end
```

```
x = 3
for k = 1:31
    x = sqrt(1 + x)
end
```

```
x = 3
y = 0;
while abs(x-y) > eps(x)
    y = x;
    x = sqrt(1+x)
end
```

$$X = \sqrt{1+X}$$

$$X^2 = 1+X$$

$$X^2 - X - 1 = 0$$

$$X = \frac{1 \pm \sqrt{1+4}}{2}$$

$$\varphi = \frac{1 + \sqrt{5}}{2}$$

Figure 1.2 is our first example of MATLAB graphics. It shows the intersection of the graphs of $y = x$ and $y = \sqrt{1+x}$. The statement

```
x = -1:.02:4;
```

generates a vector x containing the numbers from -1 to 4 in steps of .02. The statements

```
y1 = x;  
y2 = sqrt(1+x);  
plot(x,y1,'-',x,y2,'-',phi,phi,'o')
```

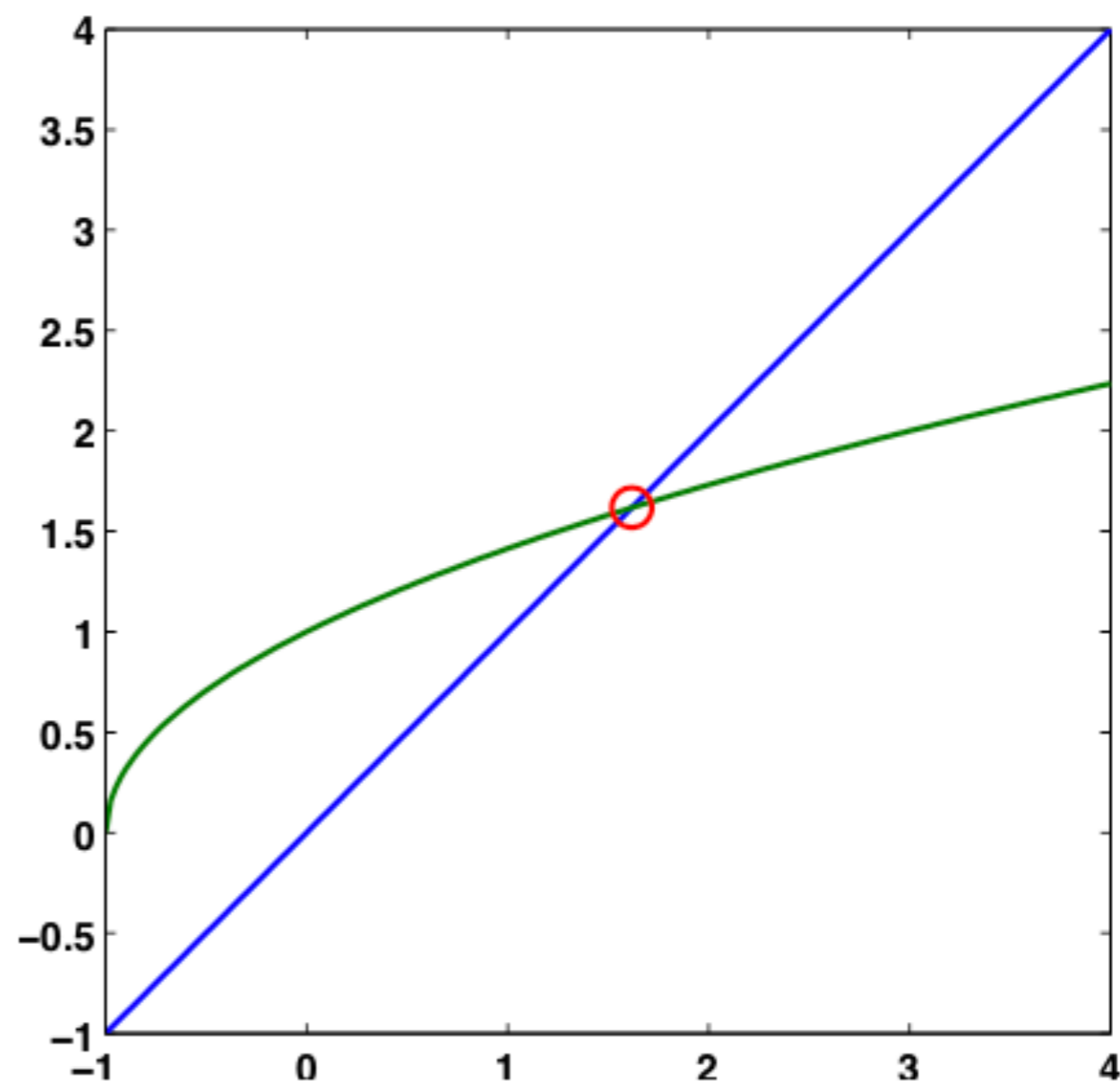


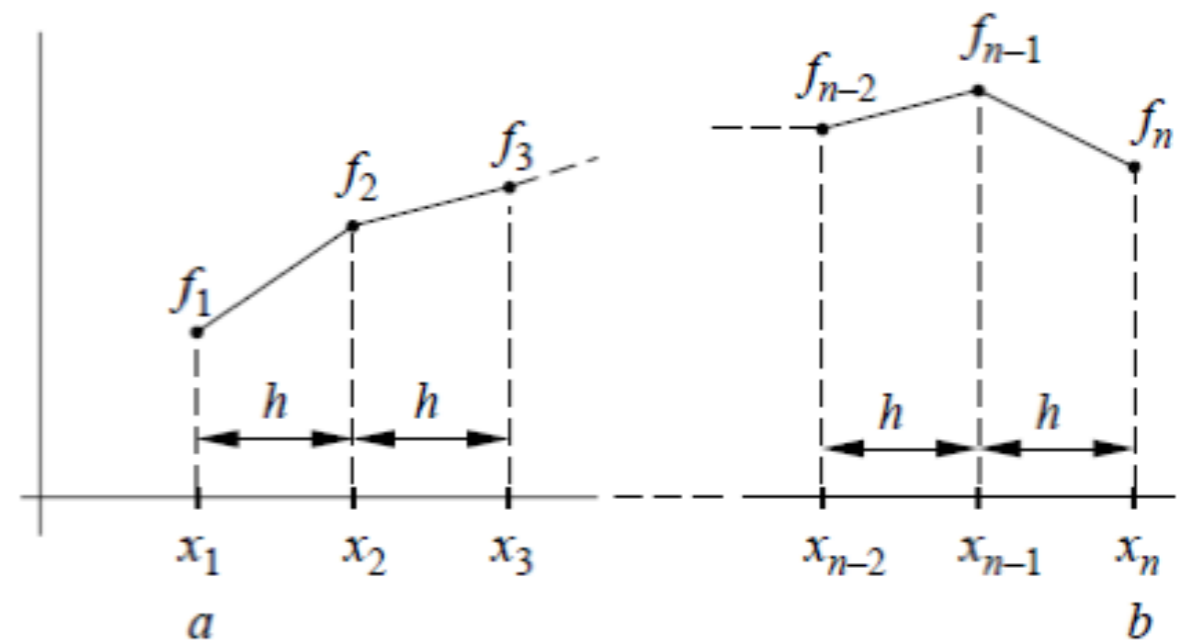
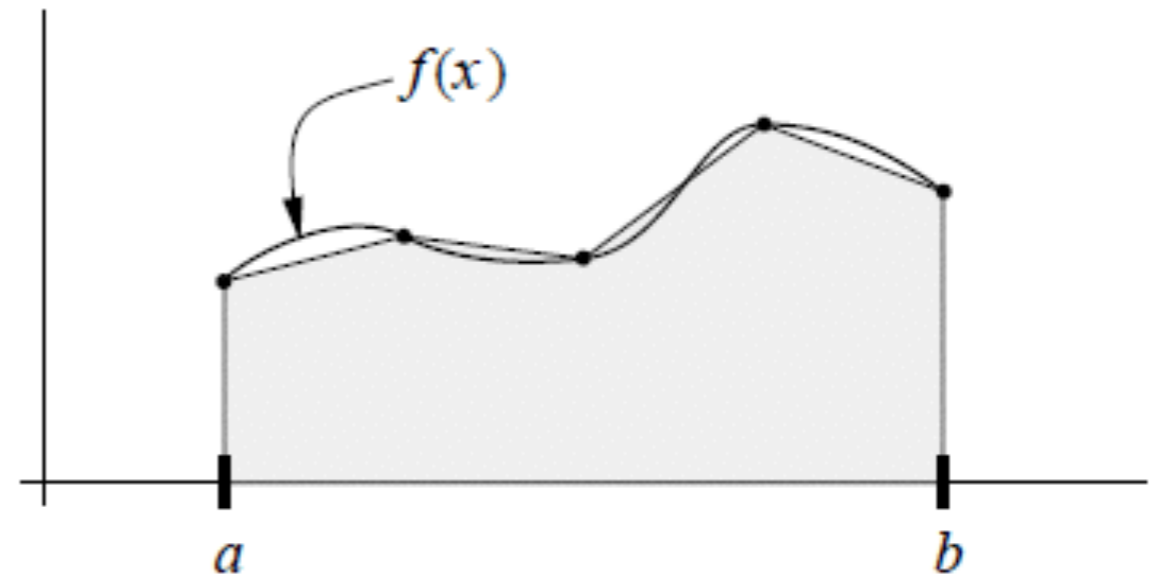
Figure 1.2. A fixed point at $\phi = 1.6180$.

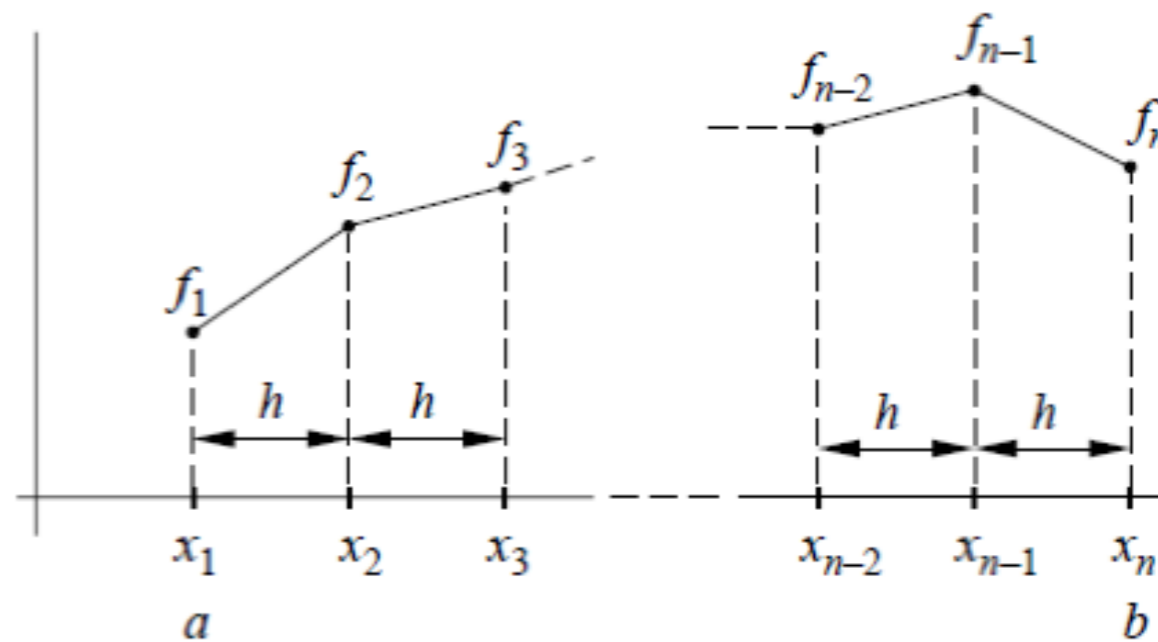
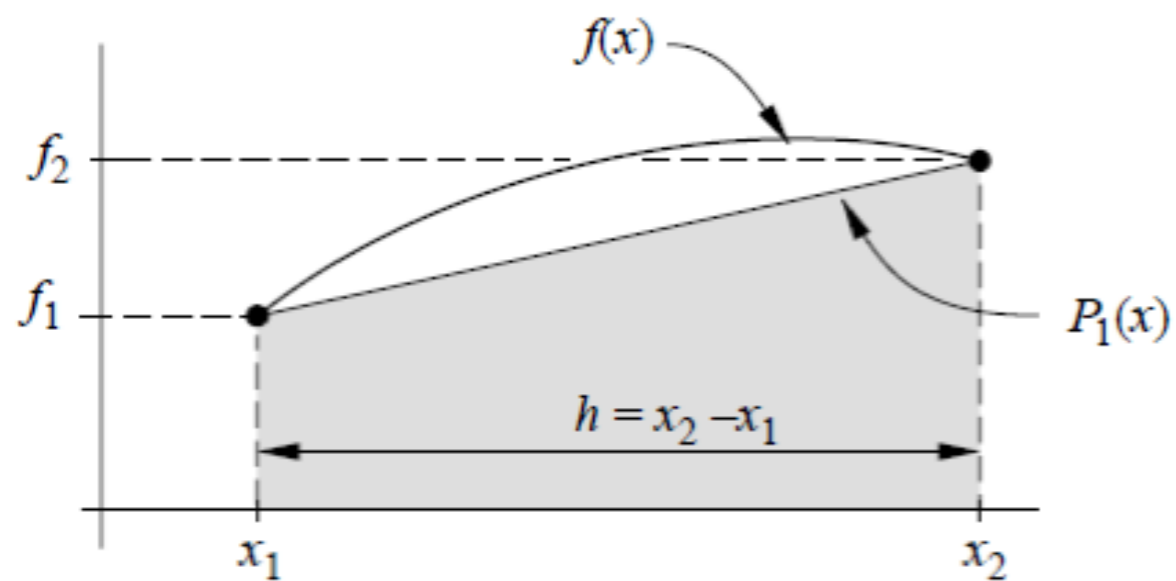
Class Exercise: Numerical Integration

$$\int_a^b f(x) dx$$

Trapezoidal rule

- Divide the integration interval into a number of panels
- Calculate the area below the function for each panel.
- Sum the areas together.





$$\int_{x_1}^{x_n} f(x) dx \approx h \left[\frac{1}{2} f_1 + f_2 + f_3 + \dots + f_{n-2} + f_{n-1} + \frac{1}{2} f_n \right]$$

$$\int_0^{2\pi} x e^{-x} dx$$

How to specify a function?

>> help function_handle

FUNHANDLE = @FUNCTION_NAME returns a handle to the named function, FUNCTION_NAME. A function handle is a MATLAB value that provides a means of calling a function indirectly. You can pass function handles in calls to other functions (which are often called function functions). You can also store function handles in data structures for later use (for example, as Handle Graphics callbacks). A function handle is one of the standard MATLAB data types. Its class is 'function_handle'.

FUNHANDLE = @(ARGLIST)EXPRESSION constructs an anonymous function and returns a handle to that function. The body of the function, to the right of the parentheses, is a single MATLAB expression. ARGLIST is a comma-separated list of input arguments. Execute the function by calling it by means of the returned function handle, FUNHANDLE. For more information on anonymous functions, see "Types of Functions" in the MATLAB Programming documentation.

To call the function referred to by a function handle value, use ordinary parenthesis notation. That is, specify the function handle variable followed by a comma-separated list of input arguments enclosed in parentheses. For example, HANDLE(ARG1, ARG2, ...). To call a function_handle with no arguments, use empty parenthesis, e.g., HANDLE().

How to specify a function?

Function handles enable you to:

- Pass a function reference to another function.
- Reduce the number of files that define your functions.
- Improve performance in repeated operations.
- Ensure reliability when evaluating functions.

With one exception, function handles can be manipulated and operated on in the same manner as other MATLAB values, including assignment to variables and inclusion in cells and structs. The exception is that you cannot construct a `function_handle` array. The reason is that the parenthesis notation for values of this class is used to call a function, not to index an array. To achieve the effect of an array of function handles, use cells, e.g., write `"A = {@sin, @cos}"` rather than `"A = [@sin, @cos]"`. Of course, you need to index `A` with braces: `"A{i}"`.

matlab file trapz.m

another Exercise

- Write an .m function to evaluate the sum of discrete values of an arbitrary function at n equally spaced points in an interval $a \leq x \leq b$.

$$S = \sum_{i=1}^n f(x_i)$$

$$x_i = a + (i - 1)h$$

$$h = \frac{b - a}{n - 1}$$

Relational and Logical Operators

What are the MATLAB results for the following commands

- $5|4$
- ~ 3
- $y=5+2\&\sim\pi<\text{eps}$
- Given $x=[0\ 5\ 3\ 7]$ and $y=[0\ 2\ 8\ 7]$
 $s=(x>y)\&(x>4)$
 $t=\sim(x|y)$

logical negation and arithmetic

$$y=5+2\&\sim\pi<\text{eps}$$

- If + has higher precedence than ~, $\sim\pi+5$ would give 0, because it is equivalent to $\sim(\pi+5)$. But MATLAB gives 5. This indicates that ~ has higher precedence than +.
- In line with this, running $\sim 0+5$ in MATLAB gives 6.

Operator Precedence

- You can build expressions that use any combination of arithmetic, relational, and logical operators. Precedence levels determine the order in which MATLAB evaluates an expression. Within each precedence level, operators have equal precedence and are evaluated from left to right. The precedence rules for MATLAB operators are shown in this list, ordered from highest precedence level to lowest precedence level:
- Parentheses ()
- Transpose (.'), power (.^), complex conjugate transpose ('), matrix power (^)
- Unary plus (+), unary minus (-), logical negation (~)
- Multiplication (.*), right division (./), left division (.\), matrix multiplication (*), matrix right division (/), matrix left division (\)
- Addition (+), subtraction (-)
- Colon operator (:)
- Less than (<), less than or equal to (<=), greater than (>), greater than or equal to (>=), equal to (==), not equal to (~=)
- Element-wise AND (&)
- Element-wise OR (|)
- Short-circuit AND (&&)
- Short-circuit OR (||)