Functions

SET07106 Mathematics for Software Engineering

School of Computing
Edinburgh Napier University
Module Leader: Uta Priss

2010

Outline

Functions

Real functions

Python functions

Programming with functions

A relation between two sets: a binary relation
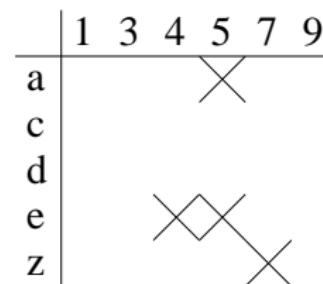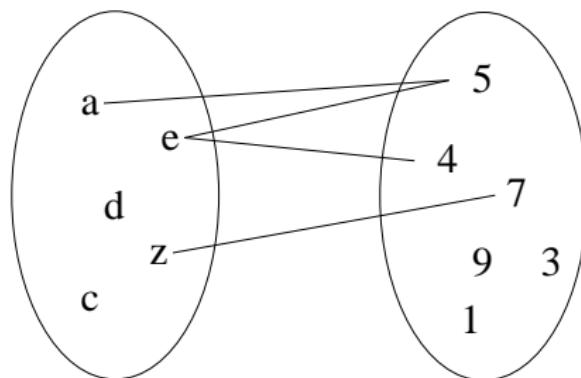
$$\{ (a,5), (e,5), (e,4), (z,7) \}$$

## A function: mapping from one set into another set
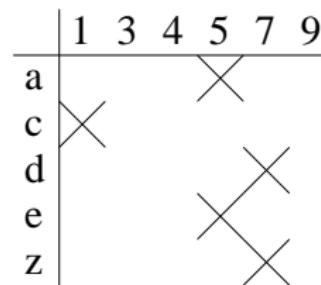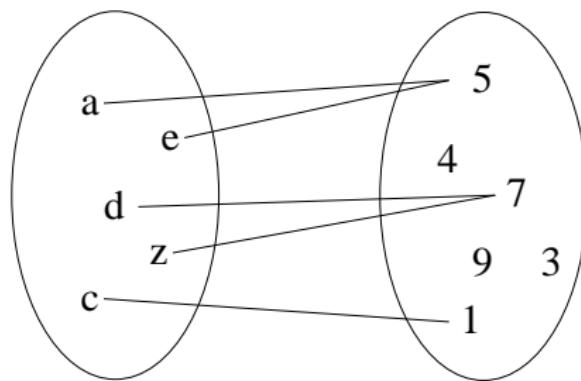
$$\{ (a,5), (e,5), (d,7), (c,1), (z,7) \}$$

A one-to-one function: a bijection

$\{ (a,5), (e,3), (d,7), (c,1), (z,4) \}$

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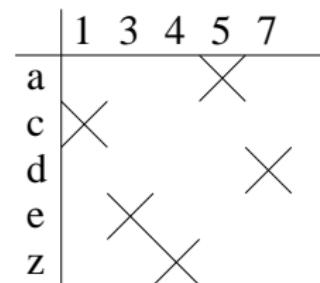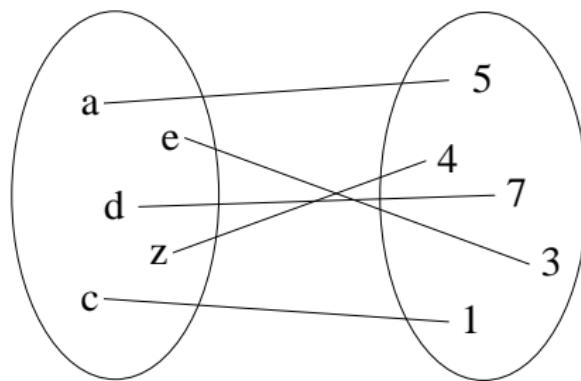
A function: mapping from one set into another set
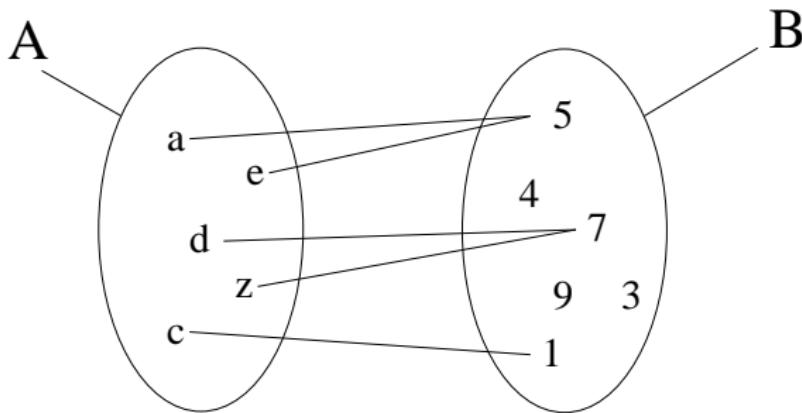
$f : A \rightarrow B$

Notations and terminology for functions
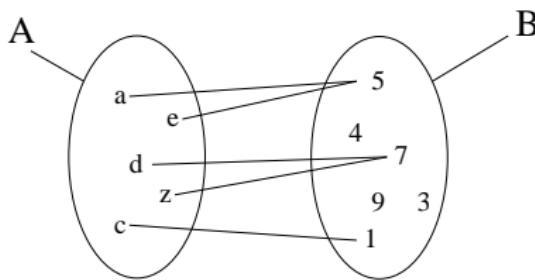
- $f : A \to B$
- $f(a) = 5$; $f(e) = 5$; $f(d) = 7 = f(z)$; $f(c) = 1$
- A is called **domain**
- B is called **co-domain**

Definition

A function is a relation where **each** element in the domain is associated with **exactly one** element in the co-domain.

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Which of these are functions, bijections, relations?

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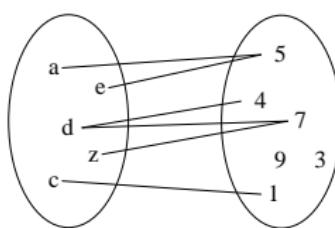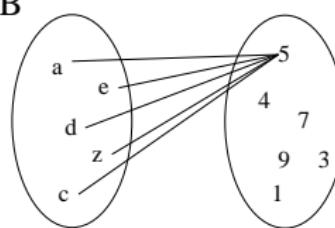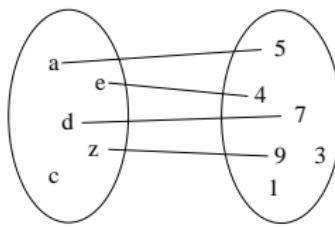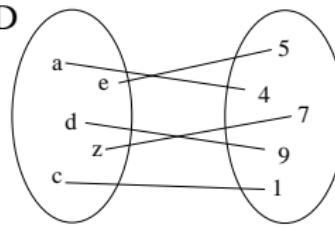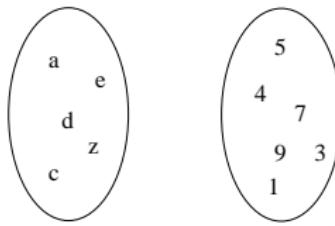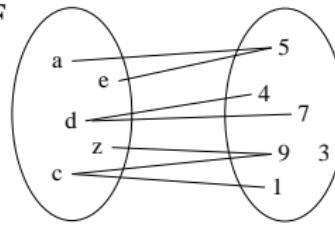
Examples: $f(x) = x^2$

Numbers and their squares
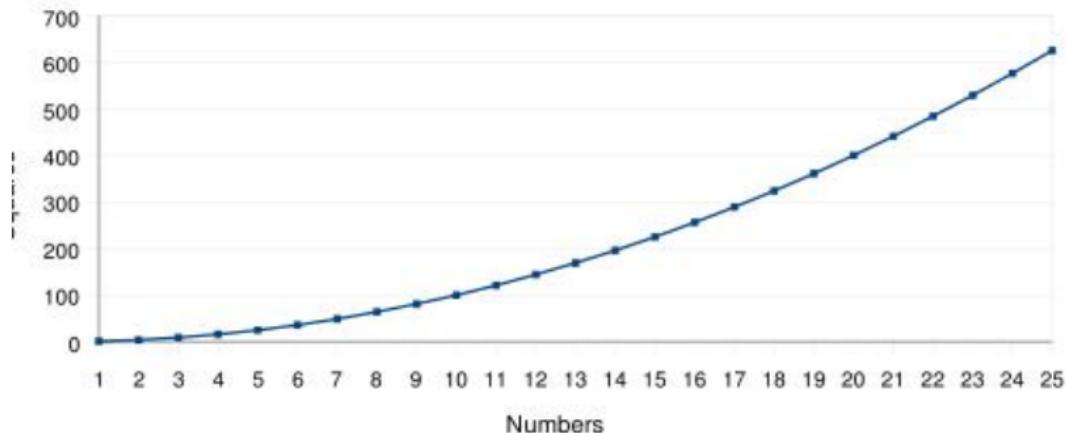
Examples: $f(x) = \sqrt{x}$
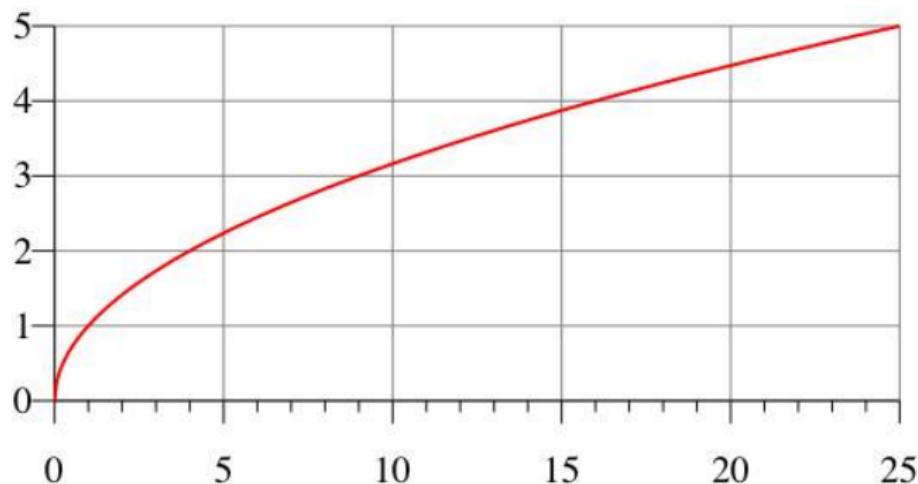
Examples: sign function

$$f(x) = \begin{cases} -1 & \text{if} \quad x < 0 \\ 0 & \text{if} \quad x = 0 \\ 1 & \text{if} \quad x > 0 \end{cases}$$

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Examples: $f(x) = \sin(x)$, $f(x) = \cos(x)$

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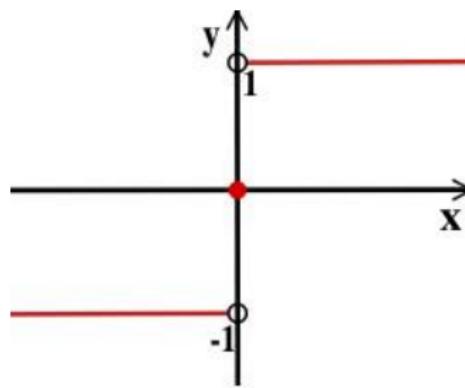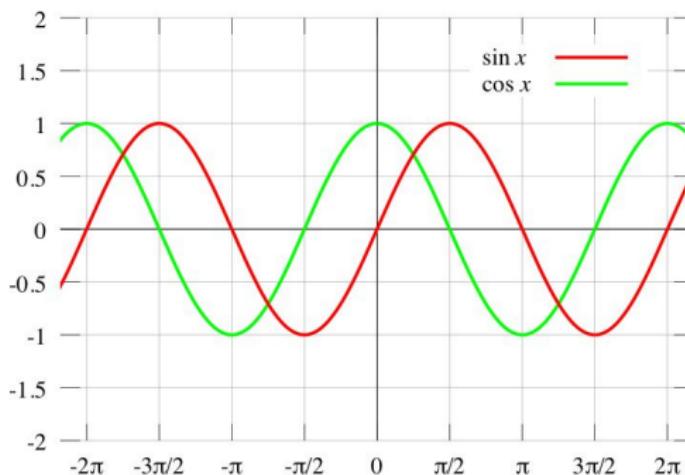
Which of these are functions, bijections, relations?
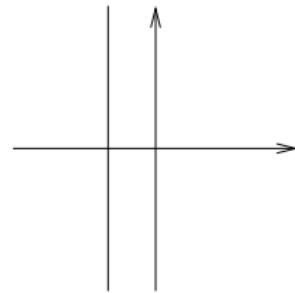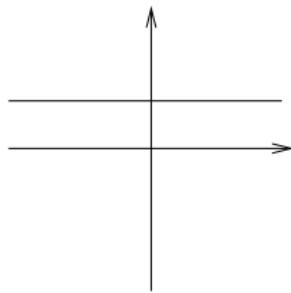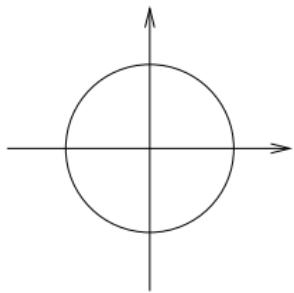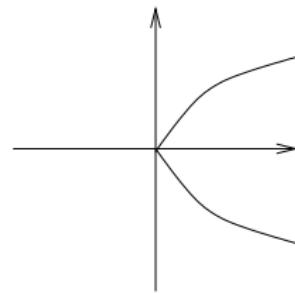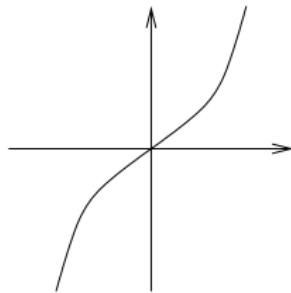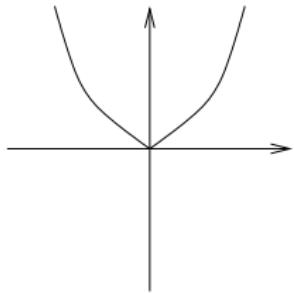
Python functions

$\star$ What are the domains, codomains of these functions?
$\star$ What are the results?

```
a = "abc"
len(a)
bool(a)
max(a)
min(a)
```

Methods are (often) just functions

$\star$ In Python:

```
a = "abc"
a.capitalize()
```

$\star$ In mathematical notation:

$f("abc") = "Abc"$

Some Python methods for strings

⋆ What are the domains, codomains of these functions?
⋆ What are the results?

```
a = "abc"
a.capitalize()
a.endswith("c")
a.find("b")
a.isalpha()
a.isdigit()
```

… and many more.

SymPy's mathematical functions

```
sqrt(4)
sign(-1)
factorial(7)
factorial(7) == 1 * 2 * 3 * 4 * 5 * 6 * 7
N(sin(1))
```

... and many more.

Defining a function in Python

$$f(x) = \begin{cases} -1 & \text{if} \quad x < 0 \\ 0 & \text{if} \quad x = 0 \\ 1 & \text{if} \quad x > 0 \end{cases}$$

```python
def sign_function(x):
    if x < 0:
        return -1
    elif x == 0:
        return 0
    else:
        return 1

sign_function(8)
```

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Defining a recursive function

Reminder: factorial(7) == 1 * 2 * 3 * 4 * 5 * 6 * 7

```
def fact(n):
    if n == 0 or n == 1:
        return 1
    else:
        return (n * fact(n-1))

fact(7)
```

A dictionary definition:

Recursion

    See Recursion

A Google joke:

Google   Recursion

Web   ⊞ Show options...
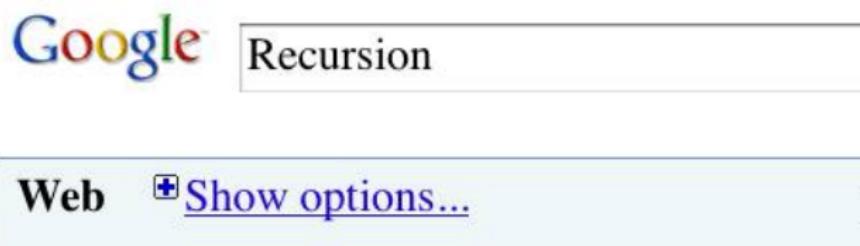
Did you mean: *Recursion*

Recursion - Wikipedia, the free encyclopedia
A visual form of **recursion** known as the Dros