A Glossary for IWGS (Auto-Generated)

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December 16, 2021

Preface

This document contains an English glossary for the course *Informatische Werkzeuge in den Geistes- und Sozialwissenschaften* at FAU Erlangen-Nürnberg (IWGS). It is automatically generated from the sources of the IWGS course notes and should be up-to-date with the course progress.

The glossary contains definitions for all technical terms used in the course, both the ones defined in the course, as well as the ones presupposed. The latter should be relatively few, since IWGS is intended as a beginner's course.

1 Glossary for IWGS

To make the role of arguments extremely clear, we write functions in λ-notation. For $f = \{(x, E) \mid x \in X\}$, where E is an expression, we write $\lambda x \in X.E$.

n-dim Cartesian space n-dim Cartesian space: $A^n := \{\langle a_1, \ldots, a_n\rangle \mid 1 \leq i \leq n \Rightarrow a_i \in A\}$, call $\langle a_1, \ldots, a_n\rangle$ a vector

sional Cartesian space An n-dimensional Cartesian product $A_1 \times \ldots \times A_n$ is called a n-dimensional Cartesian space over A (and denoted A^n) iff $A_i = A$ for some set A for all i. We call $\langle a_1, \ldots, a_n\rangle \in A^n$ a vector.

old Cartesian product Let $A := \{A_i \mid 1 \leq i \leq n\}$ be a collection of sets, then the n-fold Cartesian product $A_1 \times \ldots \times A_n$ is $\{\langle a_1, \ldots, a_n\rangle \mid a_i \in A_i \text{ for all } 1 \leq i \leq n\}$, we call $\langle a_1, \ldots, a_n\rangle \in A_1 \times \ldots \times A_n$ an n-tuple. n is called the dimension of $A_1 \times \ldots \times A_n$.

old Cartesian product n-fold Cartesian product: $A_1 \times \ldots \times A_n := \{\langle a_1, \ldots, a_n\rangle \mid \forall i.1 \leq i \leq n \Rightarrow a_i \in A_i\}$, call $\langle a_1, \ldots, a_n\rangle$ an n-tuple

n-fold composition We write the n-fold composition of the relation R as R^n and define it by $R^1 := R$ and $R^{i+1} := \{S \circ R \mid S \in R^i\}$

n-tuple Defined along with n-fold Cartesian product

n-tuple Defined along with n-fold Cartesian product

p-closure Let p be a properties and $R \subseteq A \times B$ a relation, then we call the smallest (in terms of the $\subseteq$) relation $R' \supseteq R$ that has property p the p-closure of R.

p-closure Let p be one of the properties above and R be a relation, then we call the smallest relation $\supseteq R'R$ (in terms of the $\subseteq$) that has property p the p-closure of R.

ADT See abstract data type

AI See Artificial Intelligence

AI Defined along with Artificial Intelligence

AI See Artificial Intelligence

ALU Defined along with central processing unit

API See application programming interface

formation Interchange The American Standard Code for Information Interchange (ASCII) is a character code that assigns characters to numbers 0-127

Code	⋯0	⋯1	⋯2	⋯3	⋯4	⋯5	⋯6	⋯7	⋯8	⋯9	⋯A	⋯B	⋯C	⋯D	⋯E	⋯F
0⋯	NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	BS	HT	LF	VT	FF	CR	SO	SI
1⋯	DLE	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS	RS	US
2⋯		!	"	#	$	%	&	’	(	)	*	+	,	-	.	/
3⋯	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4⋯	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5⋯	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
6⋯	‘	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7⋯	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	DEL

Artificial Intelligence Artificial Intelligence (AI) is intelligence exhibited by machines

Artificial Intelligence Artificial Intelligence (AI) is a sub-field of Computer Science that is concerned with the automation of intelligent behavior.

Artificial Intelligence Artificial Intelligence (AI) studies how we can make the computer do things that humans can still do better at the moment.

Boolean Defined along with integer

CLI See command-line interface

CPU See central processing unit

CS See computer science

Cartesian product The Cartesian product of an arbitrary (possibly infinite) indexed family of sets is defined as $\prod_{i \in I} X_i := \{f \colon I \to \bigcup_{i \in I} X_i \mid f(i) \in X_i\}$.

Cartesian product Cartesian product: $A \times B := \{(a, b) \mid a \in A \wedge b \in B\}$, call (a, b) pair.

Content MathML Defined along with Mathematics Markup Language

DAG We will sometimes use the abbreviation DAG for "directed acyclic graph".

DAG Defined along with cyclic

DELETE Defined along with method

DOM See document object model

DTM Defined along with nondeterministic Turing machine

ble Markup Language See XML

FLOSS See Free/Libre/Open-Source Software

Open-Source Software Free/Libre/Open-Source Software (FLOSS or just open source) is software that is and licensed via licenses that ensure that its source code is available.

GET Defined along with method

Gregorian calendar The Gregorian calendar is a solar calendar that takes the birth of Christ is taken as the year 1 and has a complicated rule for leap years: Every year that is exactly divisible by four is a leap year, except for years that are exactly divisible by 100; the centurial years that are exactly divisible by 400 are still leap years.

HTML See HyperText Markup Labnguage

HTML5 See HyperText Markup Language

HTTP See Hypertext Transfer Protocol

HTTP request Defined along with user agent

xt Markup Labnguage The HyperText Markup Labnguage (HTML), is a representation format for web pages [Hic+14].

ext Markup Language The HyperText Markup Language (HTML5), is believed to be the next generation of HTML. It is defined by the W3C and the WhatWG.

ext Transfer Protocol The Hypertext Transfer Protocol (HTTP) is an application layer protocol for distributed, collaborative, hypermedia information systems.

IDE See integrated development environment

ISO-Latin 16 Extensions of ASCII to 8-bit (256 characters) ISO-Latin 1 ≙ "Western European", ISO-Latin 6 ≙ "Arabic",ISO-Latin 7 ≙ "Greek"...

tional System of Units The International System of Units (SI) is the modern form of the metric system and is generally a system of units of measurement devised around seven base units and corresponding dimensions.

Internet The Internet is a worldwide computer network that connects hundreds of thousands of smaller networks. (The mother of all networks)

Kleene closure The operation of passing from an alphabet A to A^* is called Kleene closure, Kleene operation, or Kleene star. The operation $\cdot^+$ is called Kleene plus.

Kleene operation See Kleene closure

Kleene plus See Kleene closure

Kleene star See Kleene closure

Landau set The three Landau sets $\mathcal{O}(g), \Omega(g), \Theta(g)$ are defined as

- $\mathcal{O}(g) = \{f \mid \exists k{>}0. f \leq_a k \cdot g\}$
- $\Omega(g) = \{f \mid \exists k{>}0. f \leq_a k \cdot g\}$
- $\Theta(g) = \mathcal{O}(g) \cap \Omega(g)$

Landau set Let $g\colon \mathbb{N} \to \mathbb{N}$, then we define the three Landau sets $\mathcal{O}(g)$,$\Omega(g)$,$\Theta(g)$ as

- $\mathcal{O}(g) := \{g\colon \mathbb{N} \to \mathbb{N} \mid \exists k{>}0. f \leq_a k \cdot g\}$
- $\Omega(g) := \{g\colon \mathbb{N} \to \mathbb{N} \mid \exists k{>}0. f \geq_a k \cdot g\}$
- $\Theta(g) := \mathcal{O}(g) \cap \Omega(g)$

If $G \in \{\mathcal{O}(g), \Omega(g), \Theta(g)\}$, we often say that $f\colon \mathbb{N} \to \mathbb{N}$ is (of complexity) G, iff $f \in G$, accordingly we often write $f = G$ by a certain abuse of notation.

Given a particular function, e.g. $g\colon \mathbb{N} \to \mathbb{N}; n \mapsto n^3$, we often write $\mathcal{O}(g)$ as $\mathcal{O}(n^3)$, and analogously for $\Omega(g)$ and $\Theta(g)$.

MathTalk Abbreviations for Mathematical statements in MathTalk

- $\wedge$ and $\vee$ are common notations for *and* and *or*
- *not* is in mathematical statements often denoted with $\neg$
- $\forall x. P$ ($\forall x \in S. P$) stands for *condition P holds for all x (in S)*
- $\exists x. P$ ($\exists x \in S. P$) stands for *there exists an x (in S) such that proposition P holds*
- $\nexists x. P$ ($\nexists x \in S. P$) stands for *there exists no x (in S) such that proposition P holds*
- $\exists^1 x. P$ ($\exists^1 x \in S. P$) stands for *there exists one and only one x (in S) such that proposition P holds*
- iff as abbreviation for *if and only if*, symbolized by $\Leftrightarrow$
- the symbol $\Rightarrow$ is used a as shortcut for *implies*

tics Markup Language The Mathematics Markup Language (MathML) is an integrated framework for content and presentation in web-based mathematics.

Presentation MathML covers the basic font, box, grouping primitives for presenting the two-dimensional layout of mathematical formulae

Content MathML provides the an infrastructure for marking up the functional/logical structure of formulae as applications, variables, constants, and binding expressions.

NTM See nondeterministic Turing machine

ODF Defined along with Office Open XML

OOP See object-oriented programming

OOXML See Office Open XML

OS See operating system

Office Open XML Popular word processors include

- `MS Word`, an elaborated word processor for `Windows`, whose native format is Office Open XML (OOXML; file extension .`docx`).
- `OpenOffice` and `LibreOffice` are similar word processors using the ODF format (Open Office Format; file extension .`odf`) natively, but can also import other formats..
- `Pages`, a word processors for `Mac OS X` it uses a proprietary format.
- `Office Online` and `GoogleDocs` are browser-based real-time collaborative word processors.

Open Office Format Defined along with Office Open XML

PDF See Protable document format

PGS work Defined along with copyrightable work

POST Defined along with method

PUT Defined along with method

Peano axioms The following set of axioms are called the Peano axioms (Giuseppe Peano ∗1858, †1932)

Presentation MathML Defined along with Mathematics Markup Language

able document format Protable document format (PDF) is a document format that mixes text and graphics with a variety of content including logical structuring elements, interactive elements such as annotations and form-fields, layers, rich media (including video content), and three-dimensional objects using U3D or PRC, and various other data formats. The PDF specification also provides for encryption and digital signatures, file attachments, and metadata to enable workflows requiring these features.

REPL See read–eval–print loop

RTFM RTFM (≙ "read those fine manuals")

RTFM RTFM (≙ "read the fine manuals")

SI See International System of Units

SVG See Scalable Vector Graphics

lable Vector Graphics Scalable Vector Graphics (SVG) is an XML-based markup format for vector graphics.

Turing complete An information processing system is said to be Turing complete or computationally universal if it can be used to simulate any Turing machine.

Turing machine A Turing machine consists of

- An tape with infinitely many cells, each of which contains a symbol from a finite alphabet $\mathcal{A}$ with $\#(\mathcal{A}) \geq 2$.
- A head that can read/write symbols on the tape and move left/right.
- A state register that stores the state of the Turing machine. The set of states is finite, the state register is initialized with a special start state.
- An action table (or program]) that – given the symbol it has just read from the tape and the state it is currently in – specifies the next action, i.e. what symbol to write, how to move the head and the next state. If no entry applicable the machine halts.

UCS See universal character set

UI See user interface

URI See uniform resource identifier

URL A uniform resource locator (URL) is a URI that that gives access to a web resource, by specifying an access method or location. All other URIs are called uniform resource names (URN).

URL See uniform resource locator

URN Defined along with uniform resource locator

UTF-8 The UTF-8 encoding encodes each character in one to four octets (8-bit bytes):

1. One byte is needed to encode the 128 US-ASCII characters (Unicode range U+0000 to U+007F).
2. Two bytes are needed for Latin letters with diacritics and for characters from Greek, Cyrillic, Armenian, Hebrew, Arabic, Syriac and Thaana alphabets (Unicode range U+0080 to U+07FF).
3. Three bytes are needed for the rest of the Basic Multilingual Plane (which contains virtually all characters in common use).
4. Four bytes are needed for characters in the other planes of Unicode, which are rarely used in practice.

WFH See work made for hire

WWW See World Wide Web

WWWeb See World Wide Web

World Wide Web The World Wide Web (WWW or WWWeb) is an open source information space where documents and other web resources are identified by URLs, interlinked by hypertext links, and can be accessed via the Internet.

XHTML XHTML is the XML version of HTML. (just make it valid XML)

XML XML (short for Extensible Markup Language) is a framework for markup formats for electronic documents and structured data.

XML document tree The XML document tree is made up of element nodes, attribute nodes, text nodes (and namespace declarations, comments,...)

XML literal We call any string that is well-formed XML an XML literal.

XML namespace An XML namespace is a string that identifies an XML vocabulary. Every element and attribute name in XML consists of a local name and a namespace.

XML path language The XML path language (XPath) is a language framework for specifying fragments of XML trees.

XPath See XML path language

absolute value The absolute value $|r|$ of an integer r is defined as $\begin{cases} r & \text{if } r \geq 0 \\ -(r) & \text{else} \end{cases}$.

absolute value The absolute value $|r|$ of an rational number $\frac{a}{b}$ is defined as $\frac{|a|}{|b|}$.

absolute value The absolute value $|r|$ of a number r is defined as $\begin{cases} r & \text{if } r \geq 0 \\ -(r) & \text{else} \end{cases}$.

absolute value Real absolute value, addition, subtraction, multiplication, division, and exponentiation, square roots, r-th roots, and the ordering relations are extended to the real numbers, so that they respect limits.

abstract data type An abstract data type (ADT) is a mathematical model for a data types, which specifies a container by its behavior from the point of view of a user of the data, specifically in terms of possible value, possible operations on data of this type, and the behavior of these operations.

accepted unit Some units that have important contemporary application worldwide, or are otherwise commonly encountered worldwide and can be expressed as scalar multiples of derived units. They have been given the status of accepted units in the SI system.

accepting state Defined along with nondeterministic Turing machine

action Defined along with Turing machine

action table Defined along with Turing machine

acyclic Defined along with cyclic

acyclic Defined along with cyclic

addition Addition is extended to the integers by defining the sum as

$$a + b := \begin{cases} |a| + |b| & \text{if } a, b \in \mathbb{N} \\ (-(|a| + |b|)) & \text{if } a, b \in \mathbb{Z}^- \\ |a| + (-(|b|)) & \text{if } (a \geq b) \\ |b| + (-(|a|)) & \text{if } (a < b) \end{cases}$$

addition We define addition on the rational numbers: the sum $\frac{a}{b} + \frac{c}{d}$ is $\frac{a \cdot d + b \cdot c}{b \cdot d}$.

addition Addition + computes the sum of $a + b$ of natural numbers a and b. It defined by the equations $x + 0 = x$ and $x + s(y) = s(x + y)$, where s is the successor function.

addition Addition + computes the sum of $a + b$ of numbers a and b.

addition Defined along with absolute value

addition operation We "define" the addition operation $\oplus$ procedurally (by an algorithm)

- adding zero to a number does not change it.
  written as an equation: $n \oplus o = n$
- adding m to the successor of n yields the successor of $m \oplus n$.
  written as an equation: $m \oplus s(n) = s(m \oplus n)$

algorithm An algorithm is a formal or informal specification for solving a problem by executing a finite sequence of instructions (concrete or imaginary/abstract) information processing systems.

alphabet Defined along with formal language

alphabet An alphabet A is a finite set; we call each element $a \in A$ a character, and an n-tuple of $s \in A^n$ a word (or string) of over A. We will often write a string $\langle c_1, \ldots, c_n \rangle$ as "$c_1 \ldots c_n$" or even as $c_1 \ldots c_n$. We write the empty word (empty string) in A^0 with ϵ.

alphabet Defined along with nondeterministic Turing machine

amount Defined along with length

ancestor The ancestor and descendant relations are the transitive closures of the parent and child relations respectively.

anonymous function python also allows to make anonymous functions via the lambda constructor for function objects:

```
lambda (p1,...,pn): ⟪expr⟫
```

anti-reflexive Defined along with reflexive

antisymmetric Defined along with symmetric

antisymmetric Defined along with reflexive

application Defined along with partial function

application layer The application layer of the internet protocol suite contains all protocols and methods that fall into the realm of process-to-process communications via an Internet Protocol (IP) network using the Transport Layer protocols to establish underlying host-to-host connections.

programming interface An application programming interface (API) is an interface that defines interactions between multiple software intermediaries. It defines the kinds of calls or requests that can be made, how to make them, the data formats that should be used, the conventions to follow, etc.

arbitrary Defined along with variable

arc Defined along with graph

architectural work Defined along with copyrightable work

argument Defined along with subroutine

argument Defined along with partial function

arithmetic/logic unit Defined along with central processing unit

arity A python function is defined by a code snippet of the form

```
def f (p1,...,pn):
    """docstring, what does this function do on parameters
          :param pi: document arguments}
    """
    ⟪body⟫ # it can contain p1,...,pn, and even f
    return ⟪value⟫ # value of the function call (e.g text or number)
⟪more code⟫
```

- the indented part is called the body of f, (⚠: whitespace matters in python)
- the p_i are called parameters, and n the arity of f.

A function f can be called on arguments $a_1, \ldots, a_n$ by writing the expression $f(a_1, ..., a_n)$. This executes the body of f where the (formal) parameters p_i are replaced by the arguments a_i.

arity Defined along with subroutine

assign Defined along with variable assignment

associative array See dictionary

asymmetric Defined along with symmetric

asymmetric Defined along with reflexive

ymptotically bounded Let $f, g\colon \mathbb{N} \to \mathbb{N}$, we say that f is asymptotically bounded by g, written as $f \leq_a g$, iff there is an $n_0 \in \mathbb{N}$, such that $f(n) \leq g(n)$ for all $n > n_0$.

ymptotically bounded Let $f, g\colon \mathbb{N} \to \mathbb{N}$, we say that f is asymptotically bounded by g (write $f \leq_a g$), iff there is an $n_0 \in \mathbb{N}$, such that $f(n) \leq g(n)$ for all $n > n_0$.

atto Defined along with prefixes

attribute Defined along with opening tag

attribute Defined along with object-oriented programming

attribute node Defined along with XML document tree

audiovisual work Defined along with copyrightable work

aural markup Defined along with visual markup

authority Defined along with uniform resource identifier

auxiliary storage See secondary storage

axiom An axiom (or postulate) is a statement about mathematical objects that we assume to be true.

base Defined along with positional number system

base Defined along with positional number system

base Defined along with exponentiation

base Defined along with positional number system

base Defined along with exponentiation

base Defined along with exponentiation

base Defined along with exponentiation

base equation **Error: The defi does not appear to be inside a definition environment. line 75:3**

base name Defined along with file system

base set We call a structure $\langle S, \leq \rangle$ of a set S (the base set) equipped with a preorder r an preordered set or proset.

base unit Defined along with International System of Units

asic multilingual plane Most (non-Chinese) characters have code points in $[1, 65536]$ (the basic multilingual plane).

begin tag Defined along with tag

bijection Defined along with bijective

bijective Defined along with injective

bijective A function $f\colon S \to T$ is called bijective (or a bijection or a one-to-one correspondence), iff f is injective and surjective.

binary Defined along with source

binary Defined along with unary

binary A code is a called binary iff $B = \{0, 1\}$.

binary file Defined along with text file

binary unit prefix The following binary unit prefix es are used for units of information because they are similar to the SI unit prefixes.

prefix	symbol	2^n	decimal	~SI prefix	Symbol
kibi	Ki	2^{10}	1024	kilo	k
mebi	Mi	2^{20}	1048576	mega	M
gibi	Gi	2^{30}	1.074×10^9	giga	G
tebi	Ti	2^{40}	1.1×10^{12}	tera	T
pebi	Pi	2^{50}	1.125×10^{15}	peta	P
exbi	Ei	2^{60}	1.153×10^{18}	exa	E
zebi	Zi	2^{70}	1.181×10^{21}	zetta	Z
yobi	Yi	2^{80}	1.209×10^{24}	yotta	Y

bit A bit (a contraction of "binary digit") is the basic unit of capacity of a data storage device or communication channel. The capacity of a system which can exist in only two states, is one bit (written as 1 b)

blank symbol Defined along with nondeterministic Turing machine

body Defined along with loop

body Defined along with function definition

body Defined along with subroutine

bound An occurrence of a variable v is called bound in an expression E, iff it is in a variable binding that binds v. Variables that are not bound in an expression E are called free in E.

We often write an expression E in which variables $x_1, \ldots, x_n$ occur freely, as $E[x_1, \ldots, x_n]$.

branch A path in a tree that starts with the root is called a branch.

branch Defined along with graph

branches Defined along with conditional execution

branching factor Defined along with in-degree

browsing Defined along with hypertext

byte The byte is a derived unit for information capacity: $1\,\mathrm{B} = 8\,\mathrm{b}$.

calendar A calendar is a system of organizing dates. This is done by giving names to periods of time, typically days, weeks, month and years. A date is the designation of a single, specific day within such a system.

called Defined along with subroutine

canonical projection Defined along with equivalence class

canonical surjection Defined along with equivalence class

cardinality Defined along with finite

cell Jupyter notebooks consist of cells which come in three forms

- a raw cell shows text as is
- a markdown cell interprets the contents as markdown text (later more)
- a code cell interprets the contents as (e.g. python) code

cell Defined along with Turing machine

centi Defined along with prefixes

central processing unit A central processing unit (CPU), also called a central processor or main processor, is the electronic circuitry within a computer that carries out the instructions of a program by performing the basic arithmetic, logic, controlling, and input/output (I/O) operations specified by the instructions.

A CPU that consists of a

- control unit that interprets the program and controls the flow of machine instructions and
- a arithmetic/logic unit (ALU) that does the actual computations internally.

central processor See central processing unit

character Defined along with universal character set

character Defined along with alphabet

character code Let A and B be alphabets, then we call an injective function $c\colon A \to B^+$ a character code. A string $c(w) \in \{c(a) \mid a \in A\}$ is called a codeword.

character encoding A character encoding is a mapping from bit strings to UCS code points.

character name Defined along with code point

character properties Defined along with code point

characteristic Defined along with floating point number

child Defined along with tree

child Defined along with tree

choreographic work Defined along with copyrightable work

civil law tradition Legal systems in the civil law tradition are usually based on explicitly codified laws (civil codes).

class In object-oriented programming, a class is a program construct for creating objects as well as providing the fields with initial values and the methods with implementations.

client A client is a piece of computer hardware or software that accesses a service made available by a server.

ent-server architecture In the client-server architecture a single overall computation is distributed across multiple processes or computers.

A single server can serve multiple clients, and a single client can use multiple servers. A client may run on the same computer or may connect over a network to a server on a different computer.

closed Defined along with opened

closed An expression is called closed or ground, iff it does not contain free variables.

closing tag Defined along with opening tag

cloud IDE See web IDE

code See computer code

code A code is a system of rules to convert information – such as a letter, word, sound, image, or gesture – into another form, sometimes shortened or secret, for communication via a communication medium or storage in a storage medium.

The process of encoding applies a code for communication or storage, whereas the process of decoding applies it in reverse to restore the original information

code cell Defined along with cell

code point Each UCS character is identified by an unambiguous name and an integer number called its code point.

code point For each character UniCode defines a code point (a number written in hexadecimal as U+$ABCD$), a character name, and a set of character properties.

codeword Defined along with character code

coding The implementation of an algorithm in a chosen programming language is called coding.

codomain Defined along with domain

codomain Defined along with partial function

coefficient Defined along with floating point number

coefficient Defined along with scientific notation

collection See container

command Defined along with command-line interface

command line Defined along with command-line interface

ommand-line interface A command-line interface (CLI) is a means of interacting with a computer program where the user (or client) issues instructions (called commands in a CLI) to the program in the form of successive lines of text (command line). The program which handles this user interface is called a command-line interpreter or command-line processor.

mand-line interpreter Defined along with command-line interface

mmand-line processor Defined along with command-line interface

common law tradition Legal systems in the common law tradition are usually based on case law, they are often derived from the British system.

athematical language Defined along with formulae

communication Communication is the act of conveying information from one group of subjects to another.

mmunication medium A communication medium is a channel or system of communication – the means by which information (the message) is transmitted between a speaker or writer (the sender) and an audience (the receiver).

compile Defined along with compiler

compiler A compiler is a program that translates (compiles)code written in one programming language (the source language) into another language (the target language).

complement See set difference

complex numbers The set $\mathbb{C}$ of complex numbers contains expressions of the form $c = (a + bi)$, where $a, b \in \mathbb{R}$. $\mathrm{Re}(c) := a$ is called the real part and $\mathrm{Im}(c) := b$ the imaginary part of c; we call i the imaginary unit.

complexes Defined along with integer

component Defined along with uniform resource identifier

component Defined along with mathematical structure

composable We call two relations $R \subseteq A \times B$ and $S \subseteq C \times D$ composable, iff $B = C$

compose Defined along with composition principle

composition The composition of two relations $R \subseteq A \times B$ and $S \subseteq B \times C$ is defined as

$$S \circ R := \{(a, c) \in A \times C \mid \text{there is a } b \in B \text{ with } (a, b) \in R \text{ and } (b, c) \in S\}$$

composition The composition of $R \subseteq A \times B$ and $S \subseteq B \times C$ is defined as $S \circ R := \{(a, c) \in A \times C \mid \exists b \in B . (a, b) \in R \wedge (b, c) \in S\}$

composition principle All programming languages provide composition principles that allow to compose smaller program fragments into larger ones in such a way, that the semantics of the larger is determined by the semantics of the smaller ones and that of the composition principle employed.

putationally universal See Turing complete

computer See computing device

computer code We call any well-formed fragments of a program computer code or program code, or just code.

omputer programming Computer programming (or just programming) is the process of designing and building a program for accomplishing a specific computing task.

It involves sub-processes, such as: analysis, generating algorithms, profiling algorithms' resource consumption, proving algorithm properties, coding, and program verification.

computer science Computer science (or short CS) is the study of algorithms and information processing system in theory and practice. A CS professional is called a computer scientist.

computer scientist Defined along with computer science

computing device A computing device or simply a computer is an physical (usually electrical or electronic) information processing system that can automatically execute a sequence of machine instructions i.e. arithmetic or logical operations that change state of the system.

A computer consists of physical parts (its hardware) and a set of programs and data, its software.

concatenation The concatenation $\mathrm{conc}(L_1, L_2)$ of two languages L_1 and L_2 over the same alphabet is defined as $\mathrm{conc}(L_1, L_2) := \{s_1 s_2 \mid s_1 \in L_1 \wedge s_2 \in L_2\}$.

concatenation The concatenation $\mathrm{conc}(s, t)$ of two strings $s{=}\langle s_1, \ldots, s_n\rangle{\in}A^n$ and $t{=}\langle t_1, \ldots, t_m\rangle{\in}A^m$ is defined as $\langle s_1, \ldots, s_n, t_1, \ldots, t_m\rangle \in A^{(n+m)}$.

We will often write $\mathrm{conc}(s, t)$ as $s + t$ or simply st.

condition A condition is a Boolean expression in a control structure.

conditional execution Conditional execution allows to execute (or not to execute) certain parts of a program (the branches) depending on a condition. We call a code block that enables conditional execution a conditional statement.

conditional statement Defined along with conditional execution

conjecture **Error: The defi does not appear to be inside a definition environment. line 43:51**

connective Defined along with formulae

constant A constant is a memory location which contains a value that cannot be altered by the program during normal execution. It is referenced by an identifier – the constant name.

constant name Defined along with constant

container A container or collection is a grouping of some variable number (possibly zero) of data items – the elements of the container – that need to be operated upon together in some controlled fashion.

control flow The control flow of a program is the sequence of execution of the program instructions. It is specified via special program instructions called control structures.

control structure Defined along with control flow

control unit Defined along with central processing unit

control word Defined along with document markup

converse $R^{-1} := \{(y, x) \mid (x, y) \in R\}$ is the converse relation of R.

converse relation $R^{-1} := \{(y, x) \mid (x, y) \in R\}$ is the converse relation of $R \subseteq A \times B$.

copyright Defined along with intellectual property

copyright holder The copyright holder is the legal entity that owns the copyright to a copyrighted work.

opyright infringement The use of a copyrighted material, by anyone other than the owner of the copyright, amounts to copyright infringement only when the use is such that it conflicts with any one or more of the exclusive rights conferred to the owner of the copyright.

copyrightable work A copyrightable work is any artefact of human labor that fits into one of the following eight categories:

- Literary works: Any work expressed in letters, numbers, or symbols, regardless of medium. (Computer source code is also considered to be a literary work.)
- Musical works: Original musical compositions.
- Sound recordings of musical works. (different licensing)
- Dramatic works: literary works that direct a performance through written instructions.
- Choreographic works must be "fixed," either through notation or video recording.
- Pictorial, graphic and sculptural work (PGS works): Any two-dimensional or three-dimensional art work
- Audiovisual works: work that combines audio and visual components. (e.g. films, television programs)
- Architectural works. (copyright only extends to aesthetics)

copyrighted Defined along with public domain

corollary **Error: The defi does not appear to be inside a definition environment. line 49:3**

countable We say that a set A is countable (otherwise uncountable), iff there is an bijective function $f\colon A \to N$ with $N \subseteq \mathbb{N}$.

countably infinite We say that a set A is countably infinite, iff there is a bijective function $f\colon A \to \mathbb{N}$.

current Defined along with length

cycle Defined along with cyclic

cycle Defined along with cyclic

cyclic Given a graph $G = \langle V, E\rangle$, then

- a path p is called cyclic (or a cycle) iff $\text{start}(p) = \text{end}(p)$.
- a cycle $\langle v_0, \ldots, v_n\rangle$ is called simple, iff $v_i \neq v_j$ for $1 \leq i, j \leq n$ with $i \neq j$.
- graph G is called acyclic iff there is no cyclic path in G.

cyclic Given a directed graph $G := \langle V, E\rangle$,

- a path p is called cyclic (or a cycle) iff $\mathrm{start}(p) = \mathrm{end}(p)$.
- a cycle $\langle v_0, \ldots, v_n \rangle$ is called simple, iff $v_i \neq v_j$ for $1 \leq i, j \leq n$ with $i \neq j$.
- G is called acyclic (or a DAG: directed acyclic graph) iff there is no cycle in G.

dashboard A dashboard is a user interface that organizes and presents system information give an overview over the state of a complex system and its services.

data Data is information that is used to represent objects by giving values to their relevant attributes and stating their relationships.

data language A data language is a formal language for specifying data in an information processing system. data languages are not Turing complete.

data structure A data structure is a data organization, management, and storage format that enables efficient access and modification.

data type A data type or simply type is an programming language attribute of data which tells the compiler or interpreter how the programmer intends to use the data.

A type constrains the values a variable or function can might take and defines the operators that can be applied to it.

date Defined along with calendar

day Defined along with minute

deca Defined along with prefixes

deci Defined along with prefixes

decimal Defined along with unary

decimal point Defined along with floating point number

decoding Defined along with code

namespace declaration Defined along with namespace declaration

default value Defined along with keyword argument

defined at We call a partial function $f \colon X \rightharpoonup Y$

- defined at $x \in X$, iff $(x, y) \in f$ for some $y \in Y$ and
- undefined at $x \in X$ (write $f(x) = \bot$), iff $(x, y) \notin f$ for all $y \in Y$.

defined piecewise A function m is defined piecewise, we write

$$m(x) = \begin{cases} a_1 & \text{if } A_1 \\ \vdots & \vdots \\ a_n & \text{if } A_n \\ o & \text{else} \end{cases}$$

where A_i are conditions involving x, if $m(x) = a_i$ for all x with A_i and o otherwise.

definiendum **Error: The defi does not appear to be inside a definition environment. line 22:26**

definiendum Defined along with definitional equation

definiens **Error: The defi does not appear to be inside a definition environment. line 23:3**

definiens Defined along with definitional equation

definite integral Given a function $f\colon \mathbb{R} \to \mathbb{R}$ and an interval $[a, b] \subset \mathbb{R}$, then the definite integral $\int_b^a f(x)dx$ is defined to be the signed area of the region in the plane bounded by the graph of f, the x-axis, and the vertical lines $x = a$ and $x = b$, such that area above the x-axis adds to the total, and that below the x-axis subtracts from the total.

finition by description **Error: The defi does not appear to be inside a definition environment. line 58:16**

definitional equation If a does not occur in A, we call a pair $a := A$ a definitional equation and $a :\Leftrightarrow A$ a definitional equivalence with definiendum a and definiens A.

efinitional equivalence Defined along with definitional equation

denominator Defined along with rational number

depth The depth of a node n in a tree t is the length of the path that links n with the root of t.

dereferencing Defined along with reference

derivation Defined along with inference

derived unit A derived unit is formed as a product of integer powers of base units.

descendant Defined along with tree

descendant Defined along with ancestor

inistic Turing machine Defined along with nondeterministic Turing machine

diagonal See identity function

dictionary A dictionary (also called associative array, map, symbol table) is an abstract data type composed of a set of key/value pairs, such that each possible key appears at most once in the container.

difference Defined along with subtraction

difference Defined along with subtraction

difference Defined along with subtraction

difference Defined along with subtraction

digit Defined along with positional number system

digit Defined along with positional number system

digit Defined along with positional number system

digital text An electronic document that contains a digital encoding of textual material that can be read by the end user by simply presenting the encoded characters is called digital text.

digraph Defined along with graph

digraph Defined along with directed graph

dimension Defined along with n-fold Cartesian product

dimension Defined along with International System of Units

directed acyclic graph Defined along with cyclic

directed edge Defined along with directed graph

directed graph Defined along with graph

directed graph A directed graph (also called digraph) is a pair $\langle V, E \rangle$ such that

- V is a set of vertices
- $E \subseteq V \times V$ is the set of its directed edges

division The division operator computes the quotient $a \,/\, b$ of $a \in \mathbb{Q}$ and $b \in \mathbb{Q}$. On $\mathbb{Q}$ we define $\frac{a}{b} \,/\, \frac{c}{d} := \frac{a \cdot c}{b \cdot d}$.

division Division computes the modulus $n\mathrm{div}m$ of two natural numbers n and m. $n\mathrm{div}m$ is defined as that $q \in \mathbb{N}$, such that $n = m \cdot q + r$ for some $r \leq 0 < m$. The number r is called the remainder and is written as $n\mathrm{mod}m$.

division Division computes the quotient $a \,/\, b$ of a and b. It is defined as is that c – if it exists, such that $a\ c = b$.

division Defined along with absolute value

document format A document format is a file format for electronic documents.

document markup Document markup (or just markup) is the process of adding control words (special character sequences also called markup codes) to a plain text to control the structure, formatting, or the relationship among its parts, making it a formatted text. All characters of a formatted text that are not control words constitute its textual content.

ocument object model The document object model (DOM) is a data structure for storing marked-up electronic documents as trees together with a standardized set of access methods for manipulating them.

document renderer Defined along with electronic document

document root As a document is a tree, the XML specification mandates that there must be a unique document root.

document type Defined along with markup format

domain call X the domain (write $\mathbf{dom}(f)$), and Y the codomain ($\mathbf{codom}(f)$) (come with f)

domain Defined along with partial function

dot notation Defined along with object

double star operator The double star operator unpacks a dictionary into a sequence of keyword arguments.

dramatic work Defined along with copyrightable work

edge Defined along with graph

electronic document An electronic document is any electronic media content that is intended to be used via a document renderer, i.e. a program or computing device that transforms it into a form that can be directy perceived by the end user.

element Defined along with set

element Defined along with set

element Defined along with container

element node Defined along with XML document tree

elementhood Defined along with set

embedded system An embedded system is a computing device with a dedicated function within a larger mechanical or electrical system.

empty Defined along with empty set

empty element tag Defined along with opening tag

empty set the empty set: $\forall x . x \notin \emptyset$

empty set The empty set $\emptyset$ (also written as $\{\}$) is the set without elements. A set is called empty, iff it is $\emptyset$, and non-empty or (inhabited) otherwise.

empty string Defined along with alphabet

empty tag Defined along with tag

empty word Defined along with alphabet

encoding Defined along with code

encoding scheme UniCode defines various encoding schemes for characters, the most important is UTF-8.

end Defined along with path

end Defined along with path

end tag Defined along with tag

end user An end user is a person who ultimately uses or is intended to ultimately use a computation device or program.

user license agreement Software vendors usually license software under extensive end-user license agreement (EULA) entered into upon the installation of that software on a computer. The license authorizes the user to install the software on a limited number of computers.

equal Two sets A and B are equal (written $A \equiv B$), iff they have the same elements.

equal We call two mathematical objects a and b equal, (written $a = b$), iff there are no properties that discern them.

equivalence class Let S be a set and R be an equivalence relation on S, then for any we call $x \in S$ we call the set $[x]_R := \{y \in S \mid R(x, y)\}$ the equivalence class of x (under R), and the set $S/R := \{[x]_R \mid x \in S\}$ the quotient space of S (under R).

equivalence class Let S be a set and R be an equivalence relation on S, then for any we call $x \in S$ we call the set $[x]_R := \{y \in S \mid R(x, y)\}$ the equivalence class of x (under R), and the set $S/R := \{[x]_R \mid x \in S\}$ the quotient space or quotient set of S (under R), it is often read as S "modulo R". The element x is called the representative of $[x]_R \in S/R$.

The mapping $\pi_R \colon S \to S/R; x \mapsto [x]_R$ is called the canonical projection or canonical surjection of S to S/R.

equivalence relation Defined along with reflexive

equivalence relation A relation $R \subseteq A \times A$ is an equivalence relation on A, iff R is reflexive, symmetric, and transitive.

escape character Defined along with string literal

escape sequence Defined along with string literal

evaluation Defined along with expression

exa Defined along with prefixes

exbi Defined along with binary unit prefix

execute Defined along with interpreter

execute Defined along with computing device

exploitation rights Defined along with personal rights

exponent Defined along with floating point number

exponent Defined along with exponentiation

exponent Defined along with exponentiation

exponent Defined along with exponentiation

exponent Defined along with exponentiation

exponentiation The exponentiation operation raises a number a (the base) to the power n (the exponent). We define it as

$$a^n := \begin{cases} b^n & \text{if } a \in \mathbb{Z}^- \text{ and } (n = 2 \cdot k) \\ -(b^n) & \text{if } a \in \mathbb{Z}^- \text{ and } (n = 2 \cdot k + 1) \end{cases}$$

exponentiation Exponentiation raises a number $a \in \mathbb{Q}$ (the base) to the power $n \in \mathbb{Q}$ (the exponent). We define

$$\frac{a}{b}^{\frac{n}{m}} := \frac{\sqrt[m]{a^n}}{\sqrt[m]{b^n}}$$

exponentiation Exponentiation raises a natural number a (the base) to the n-th power a^n ($n \in \mathbb{N}$ is called the exponent). We define $a^0 := 1$ and $a^{s(n)} := aa^n$.

exponentiation Exponentiation raises a number a (the base) to the n-th power a^n (n is called the exponent).

exponentiation Defined along with absolute value

expression An expression in a programming language is a combination of one or more constants, variables, operators, and functions that the programming language computes to produce a value. This process is called evaluation.

expression An expression is a finite construction composed of variables and names of mathematical objects/concepts composed by operator application and variable binding according to rules that depend of the (mathematical) context.

extension The extension of a code (on characters) $c\colon A \to B^+$ to a function $c'\colon A^* \to B^*$ is defined as $c'(\langle a_1, \ldots, a_n \rangle = \langle c(a_1), \ldots, c(a_n) \rangle)$.

extension Defined along with file system

external memory See secondary storage

f-string See formatted string literal

f-string See formatted string literal

fair use doctrine Case law in common law traditions has established a fair use doctrine, which allows e.g.

- making safety copies of software and audiovisual data,
- lending of books in public libraries,
- citing for scientific and educational purposes, or
- excerpts in search engine.

Fair use is established in court on a case-by-case taking into account the purpose (commercial/educational), the nature of the work the amount of the excerpt, the effect on the marketability of the work.

false Defined along with truth value

falsum Defined along with truth value

femto Defined along with prefixes

field Defined along with object-oriented programming

file A file is a resource for recording data in a storage device.

file format A file format is a standard way that information is encoded for storage in a computer file. It specifies how bits are used to encode information in a storage device.

file object python uses file objects to encapsulate all file input/output functionality.

file system A file system is a program that organizes space on a storage device and makes it acessible as files. A file name usually consists of a base name and an extension separated by a dot.

final state Defined along with nondeterministic Turing machine

finite We say that a set A is finite and has cardinality (or size) $\#(A) \in \mathbb{N}$, iff there is a bijective function $f\colon A \to \{n \in \mathbb{N} \,|\, n<\#(A)\}$.

The cardinality of a set A is also written as $|A|$, $\mathrm{card}(A)$, $n(A)$, or $\overline{\overline{A}}$.

finite sequence Defined along with sequence

first component Let $p := (a, b)$ be a pair, then we call $p^1 := a$ the first component and $p^2 := b$ the second component of p.

float Defined along with integer

float See floating point number

floating point number A floating point number (or short a float) is a quintuple $n := \langle \sigma, s_1, s_2, b, e \rangle$, where

1. the sign σ is unit sequence $-$ or the empty sequence, and the s_i are sequence of digits of base b. Together, (i.e. concatenated with a decimal point between s_1 and s_2) σ, s_1, and s_2 make up the significand s (also called the mantissa or coefficient.
2. an exponent $e \in \mathbb{Z}$ (also referred to as the characteristic, or scale), which modifies the magnitude of the number n.

The number $\langle \sigma, s_1, s_2, b, e \rangle$ represents the rational number $\frac{s}{b^{p-1}} \cdot b^e$.

The length $p := \text{len}(s_1) + \text{len}(s_2)$ of the significand determines the precision to which numbers can be represented.

for loop A for loop iterates a program fragment over a sequence; we call the process iteration. python uses the following general syntax

```
for ⟪var⟫ in ⟪range⟫:
    ⟪body⟫
⟪other code⟫
```

form action Defined along with input element

form data The HTML form element groups the layout and input elements:

- <form action="⟪URI⟫"method="⟪req⟫"> specifies the form action in terms of a HTTP request ⟪req⟫ to the URI ⟪URI⟫.
- The form data consists of a string ⟪data⟫ of the form n_1=v_1&$\cdots$&n_k=v_k, where
  - n_i are the values of the name attributes of the input fields
  - and v_i are their values at the time of submission.
- <**input type**="submit".../> triggers the form action: it composes a HTTP request
  - If ⟪req⟫ is get (the default), then the browser issues a GET request ⟪URI⟫?⟪data⟫.
  - If ⟪req⟫ is post, then the browser issues a POST request to ⟪URI⟫ with document content ⟪data⟫.

formal language A set $L \subseteq A^*$ is called a formal language in A.

formal language A formal language (or simply language) over an alphabet $\mathcal{A}$ is a set $\mathcal{L} \subseteq \mathcal{A}^*$ of words over $\mathcal{A}$.

ormatted string literal Formatted string literals (aka. f-strings) are string literals can contain python expressions that will be replaced with their values at runtime.

F-strings are prefixed by a prefix f or F, the expressions are delimited by curly braces, and the characters { and } themselves are represented by {{ and }}.

formatted text Defined along with plain text

formulae Mathematicians use a stylized language that

- uses formulae to represent mathematical objects, e.g. $\int_1^0 x^{3/2} dx$
- uses math idioms for special situations (e.g. *iff*, *hence*, *let... be...*, *then...*)
- classifies statements by role (e.g. Definition, Lemma, Theorem, Proof, Example)

We call this language mathematical vernacular or common mathematical language.

For the use in formulae we use abbreviations (special symbols) for many of the connectives:

- $\wedge$ and $\vee$ and $\neg$ are common notations for *and* and *or*
- *not* is in mathematical statements often denoted with $\neg$
- iff as abbreviation for *if and only if*, symbolized by $\Leftrightarrow$
- the symbol $\Rightarrow$ is used a as shortcut for *implies* or *if..., then ...*.

and quantifiers:

- $\forall x.P$ ($\forall x \in S.P$) stands for *P holds for all x (in S)*
- $\exists x.P$ ($\exists x \in S.P$) stands for *there exists an x (in S) such that P holds*
- $\nexists x.P$ ($\nexists x \in S.P$) stands for *there exists no x (in S) such that P holds*
- $\exists^1 x.P$ ($\exists^1 x \in S.P$) stands for *there exists one and only one x (in S) such that P holds*

fraction Defined along with rational number

fragment identifier Defined along with uniform resource identifier

free Defined along with bound

function Defined along with subroutine

function If we do not want to specify whether a partial function is total, then we simply speak of a function.

function definition The function definition $f(a_1, \ldots, a_n) := B[a_1, \ldots, a_n]$ defines a n-ary function f by its behavior on the (formal) arguments $a_1, \ldots, a_n$. Here we call $f(a_1, \ldots, a_n)$ the function pattern and $B[a_1, \ldots, a_n]$ the body– an expression that can contain the arguments $a_1, \ldots, a_n$ as free variables.

A relation p is defined analogously via definitional equivalence $p(a_1, \ldots, a_n) :\Leftrightarrow B[a_1, \ldots, a_n]$.

function object Defined along with anonymous function

function pattern Defined along with function definition

function space Given sets A and B We will call the set $A \to B$ ($A \rightharpoonup B$) of all (partial) functions from A to B the (partial) function space from A to B.

function space Defined along with partial function space

eral-purpose computer A general-purpose computer is one that, given the appropriate Software and the required time, should be able to perform arbitrary computing tasks.

gibi Defined along with binary unit prefix

giga Defined along with prefixes

graph A graph is a pair $G := \langle V, E \rangle$ such that V is a set and $E \subseteq V \times V$ is a relation on V. We call V the vertices (or nodes, points, junctions) and E the edges (or lines, branches, arcs) of G.

If E is symmetric, we call G an undirected graph, else a directed graph or digraph. In the former we consider the pairs $(a, b), (b, a) \in E$ together as an unordered pair $\{a, b\}$.

raphical user interface A graphical user interface is a user interface that includes graphical elements, such as windows, icons, and buttons.

greater than Defined along with less than

ground See closed

halt Defined along with Turing machine

handle See identifier

hardware Defined along with computing device

head Defined along with Turing machine

hecto Defined along with prefixes

height The height of a node n in a tree t is the length of the longest path that links n to a leaf of t. The height of t is the height of its root.

height Defined along with height

hexadecimal Defined along with unary

higher-order function We call a function a higher-order function, iff it takes a function as argument.

hour Defined along with minute

hyperlink A hyperlink is a reference to data that can immediately be followed by the user or that is followed automatically by a user agent.

hypertext A collection text documents with hyperlinks that point to text fragments within the collection is called a hypertext. The action of following hyperlinks in a hypertext is called browsing or navigating the hypertext.

idempotent We call a HTTP request idempotent, iff executing it twice has the same effect as executing it once.

identifier An identifier (also called handle) is reference to a resource.

identity function The identity function on a set A is defined as $\mathrm{Id}_A := \{(a, a) \mid a \in A\}$.

identity function For a set A, the identity function $\mathrm{Id}_A \colon A \to A$ on A maps any $a \in A$ to itself. If we think of Id_A as a relation on A, then we call it the identity relation or diagonal on A and write it as Δ_A.

identity relation See identity function

iff Defined along with MathTalk

iff Defined along with formulae

image Let $f \colon A \to B$ be a function, $A' \subseteq A$, and $B' \subseteq B$, then we call

- $f(A') := \{b \in B \mid (a, b) \in f \text{ for some } a \in A'\}$ the image of A' under f,
- $\mathbf{Im}(f) := f(A)$ the image of f, and
- $f^{-1}(B') := \{a \in A \mid (a, b) \in f \text{ for some } b \in B'\}$ the pre-image of B' under f.

image Defined along with image

imaginary part Defined along with complex numbers

imaginary unit Defined along with complex numbers

immutable Defined along with mutable

implicit definition **Error: The defi does not appear to be inside a definition environment. line 57:56**

in-degree Given a graph $G = \langle V, E \rangle$. The in-degree $\mathrm{indeg}(v)$ and the out-degree $\mathrm{outdeg}(v)$ (or branching factor) of a vertex $v \in V$ are defined as

- $\text{indeg}(v) = \#(\{w \mid (w, v) \in E\})$
- $\text{outdeg}(v) = \#(\{w \mid (v, w) \in E\})$

indegree Let $G := \langle V, E \rangle$ be a directed graph and $v \in V$ a node in G, then we define

- indegree $\text{indeg}(v)$ of v as $\#(\{w \mid (w, v) \in E\})$
- outdegree $\text{outdeg}(v)$ of v as $\#(\{w \mid (v, w) \in E\})$

uced undirected graph Let $G := \langle V, E \rangle$ be a graph, and E' the symmetric closure of E, then we call $\langle V, E' \rangle$ the induced undirected graph of G.

industrial design right Defined along with intellectual property

inference We call a sequence of inferences a derivation or a proof (of the last statement).

infinite A set that is not finite is called infinite.

infinite sequence Defined along with sequence

infinity Infinity (written ∞) is an abstract concept describing something without any limit. In mathematics is is usually treated like a number.

information Information consists of a sequence of symbols or states.

ion processing system An information processing system (or information processor) is a stateful system (be it electrical, mechanical or biological) which takes information in one form and transforms it into another form.

An information processing system S is made up of four subsystems:

1. the input subsystem channels information into S,
2. the processor executes the transformation in a sequence of operations called instructions on the processor state,
3. the storage subsystem stores information, and
4. the output subsystem channels the transformed information out of S.

information processor See information processing system

inhabited Defined along with empty set

initial Let $G := \langle V, E \rangle$ be a directed graph, then we call a node $v \in V$

- initial (or a source) in G, iff there is no $w \in V$ such that $(w, v) \in E$.
- terminal (or a sink) in G, iff there is no $w \in V$ such that $(v, w) \in E$.

initial Let $G = \langle V, E \rangle$ be a directed graph, then we call a node $v \in V$

- initial, iff there is no $w \in V$ such that $(w, v) \in E$. (no predecessor)
- terminal, iff there is no $w \in V$ such that $(v, w) \in E$. (no successor)

In a graph G, node v is also called a source (sink) of G, iff it is initial (terminal) in G.

initial state Defined along with nondeterministic Turing machine

injection Given a tuple $v \in A_1 \times \ldots \times A_{(i-1)} \times A_{(i+1)} \times \ldots \times A_n$ we call the function $\iota_v^i \colon A_i \to A_1 \times \ldots \times A_n; a_i \mapsto \langle a_1, \ldots, a_n \rangle$ the (i^{th}) injection induced by v.

injective A function $f\colon S \to T$ is called

- injective iff $\forall\, x, y \in S \,.\, f(x) = f(y) \Rightarrow x = y$.
- surjective iff $\forall\, y \in T \,.\, \exists\, x \in S \,.\, f(x) = y$.
- bijective iff f is injective and surjective.

injective A function $f\colon S \to T$ is called injective or one-to-one, iff $f(x) = f(y)$ entails $x = y$ for all $x, y \in S$.

inner node Defined along with path

input element The HTML form element groups the layout and input elements:

- **<form action="⟪URI⟫"...>** specifies the form action (as a web page address).
- **<input type="submit".../>** triggers the form action: it sends the form data to web page specified there.

input subsystem Defined along with information processing system

input symbol Defined along with nondeterministic Turing machine

instruction Defined along with information processing system

integer python has the following five basic data types

Data type	Keyword	contains	Examples
integers	int	bounded integers	1, −5, 0, ...
floats	float	floating point numbers	1.2, .125, −1.0, ...
strings	str	strings	"Hello", 'Hello', "123", 'a', ...
Booleans	bool	truth values	True, False
complexess	complex	complex numbers	2+3j,...

integer See integer number

integer division Integer division computes the integer quotient (or modulus) n div m of two integers. n div m is defined as that $q \in \mathbb{Z}$, such that $nm \cdot q + r$ for some $0 \leq r < m$. The number r is called the remainder and is written as n mod m.

integer interval We define the integer interval as a set of consecutive integers: $[a, b] := \{x \in \mathbb{Z} \,|\, x \leq a \leq b\}$

integer number The set $\mathbb{Z}$ of integer numbers (or integers) is defined as $\mathbb{Z} := \mathbb{N} \cup \{-n \,|\, n \in \mathbb{N}^+\}$.

integer quotient Defined along with integer division

elopment environment An integrated development environment (IDE) is a program that provides comprehensive facilities to computer programmers for software development. An IDE normally consists of at least a source code editor, build automation tools, and a debugger.

intellectual property The concept of intellectual property motivates a set of laws that regulate property rights rights on intangible objects, in particular

- Patents grant exploitation rights on original ideas.
- Copyrights grant personal and exploitation rights on expressions of ideas.
- Industrial design rights protect the visual design of objects beyond their function.
- Trademarks protect the signs that identify a legal entity or its products to establish brand recognition.

interactive toplevel See read–eval–print loop

interface See user interface

interpreter An interpreter is a program that directly executes instructions written in a programming language, without requiring them previously to have been compiled into a machine language program.

intersection intersection: $A \cap B := \{x \mid x \in A \wedge x \in B\}$

intersection Let A and B be sets, then the intersection $A \cap B$ of A and B is $\{x \mid x \in A \text{ and } x \in B\}$.

intersection Let I be a set and S_i a family of sets indexed by I, then the intersection $\bigcap_{i \in I} S_i$ over I is $\{x \mid x \in S_i \text{ for all } i \in I\}$.

ction over a collection intersection over a collection: Let I be a set and S_i a family of sets indexed by I, then $\bigcap_{i \in I} S_i := \{x \mid \forall\, i \in I \mathbf{.} x \in S_i\}$.

interval We define four kinds of intervals as subsets of the real numbers:

- $[a, b] := \{x \in \mathbb{R} \mid (a \leq x) \text{ and } (x \leq b)\}$
- $[a, b) := \{x \in \mathbb{R} \mid (a \leq x) \text{ and } (x < b)\}$
- $(a, b] := \{x \in \mathbb{R} \mid (a < x) \text{ and } (x \leq b)\}$
- $(a, b) := \{x \in \mathbb{R} \mid (a < x) \text{ and } (x < b)\}$

intransitive Defined along with transitive

inverse function If f is bijective, call the converse relation inverse function, we (also) write it as f^{-1}.

inverse function If $f \colon A \to B$ is injective, then the converse relation is a partial function $f^{-1} \colon B \rightharpoonup A$, we call it the inverse function of f. If f is bijective total function, then f^{-1} is a total function.

invoke Defined along with subroutine

invoker Defined along with subroutine

irreflexive Defined along with reflexive

irreflexive Defined along with reflexive

is (of complexity) Defined along with Landau set

iterate Defined along with for loop

iteration Defined along with for loop

junction Defined along with graph

key Defined along with dictionary

keyword argument The last $k \leq n$ of n parameters of a function can be keyword arguments of the form $p_i = \langle\!\langle \mathsf{val} \rangle\!\rangle_i$: If no argument a_i is given in the function call, the default value $\langle\!\langle \mathsf{val} \rangle\!\rangle_i$ is taken.

keyword argument python functions can take keyword arguments:
if k is a sequence of key/value pairs then def $f(p_1, \ldots, p_n, **k)$, binds the keys to values in the body of f.

kibi Defined along with binary unit prefix

kilo Defined along with prefixes

language See formal language

language shell See read–eval–print loop

leaf Defined along with tree

leaf Defined along with tree

leap year Defined along with year

lemma **Error: The defi does not appear to be inside a definition environment. line 47:67**

length Defined along with sequence

length Defined along with path

length The length $|s|$ of a word $s \in A^n$ is n.

length Defined along with path

length The seven dimensions of SI base units are length (L), mass (M), time (T), current (I), temperature (Θ), luminous intensity (J), and amount (N).

less than We define the order relation $<_{\mathbb{Z}}$ (n is less than m also written as $<$) by

$$<_{\mathbb{Z}} := <_{\mathbb{N}} \cup \{(n, m) \,|\, n \in \mathbb{Z}^- \text{ and } m \in \mathbb{N}\} \cup \{(-(n), -(m)) \,|\, n, m \in \mathbb{N}^+ \text{ and } m <_{\mathbb{N}} n\}$$

We define the relation $>_{\mathbb{Z}}$ (greater than) via $(n>m) :\Leftrightarrow (m<n)$ and the relations $\leq_{\mathbb{Z}}$ and $\leq_{\mathbb{Z}}$ as the reflexive extensions.

less than The $<$ relation is the transitive closure of the relation $\{(n, s(n)) \,|\, n \in \mathbb{N}\}$, and $\leq$ its transitive-reflexive closure. $>$ and $\leq$ are the corresponding converse relations.

For $a<b$ we say that a is less than b. [1] EdN:1

library A python library is a python file with a collection of functions, classes, and methods. It can be loaded via the import command.

license A license is an authorization (by the licensor) to use the licensed material (by the licensee).

licensee Defined along with license

licensor Defined along with license

line See text line

line Defined along with graph

line feed character Defined along with text line

line number Defined along with text line

linear ordering We call a partial ordering R a linear ordering (or simple ordering or total ordering), iff $a \leq b$ or $b \leq a$ for all $a, b \in A$.

linearly ordered set We call a structure $\langle S, \leq \rangle$ of a set S and a total ordering $\leq$ a linearly or totally ordered set.

[1] EdNote: continue for the others

linked Defined along with path

list A list or sequence is an abstract data type that represents a finite number of ordered elements, where the same value may occur more than once.

list See sequence

list constructor We call [⟪seq⟫] the list constructor.

literary work Defined along with copyrightable work

local name Defined along with XML namespace

logical reasoning **Error: The defi does not appear to be inside a definition environment. line 42:54**

logical system **Error: The defi does not appear to be inside a definition environment. line 51:5**

loop A loop is a control structure that allows to execute certain parts of a program (the body) multiple times depending on conditions.

lower bound Defined along with summation

luminous intensity Defined along with length

machine instruction Defined along with computing device

main processor See central processing unit

mantissa Defined along with floating point number

mantissa Defined along with scientific notation

map See dictionary

markdown cell Defined along with cell

markup See document markup

markup code Defined along with document markup

markup format The control words and composition rules for a particular kind of markup system determine a markup format. The markup format used in an electronic document is called its document type.

mass Defined along with length

math idiom Mathematicians use a stylized language that

- uses formulae to represent mathematical objects, e.g. $\int_1^0 x^{3/2} dx$
- uses math idioms for special situations (e.g. *iff*, *hence*, *let... be...*, *then...*)
- classifies statements by role (e.g. Definition, Lemma, Theorem, Proof, Example)

We call this language mathematical vernacular.

math idiom Defined along with formulae

athematical structure A mathematical structure combines multiple mathematical objects (the components) into a new object. Structures are usually given as finite enumerations, where the components have names by which they can be referenced.

thematical vernacular Defined along with math idiom

thematical vernacular Defined along with formulae

maximum Defined along with minimum

maximum Defined along with minimum

mebi Defined along with binary unit prefix

media See medium

media content Defined along with medium

medium A medium (plural media) is a communication medium or storage medium. The information conveyed or stored is called the media content.

mega Defined along with prefixes

member Defined along with set

membership Defined along with set

memory The memory (also primary storage) is a storage subsystem in a computer that stores information for immediate use by its CPU.

message Defined along with communication medium

metasyntactic variable Defined along with pseudocode

method Most important HTTP request methods. (5 more less prominent)

GET	Requests a representation of the specified resource.	safe
PUT	Uploads a representation of the specified resource.	idempotent
DELETE	Deletes the specified resource.	idempotent
POST	Submits data to be processed (e.g., from a web form) to the identified resource.	

method Defined along with object-oriented programming

micro Defined along with prefixes

milli Defined along with prefixes

minimum The minimum $\min S$ (maximum $\max S$) of an ordered set S is that element m (if it exists), such that all other members of S are smaller (larger) than m. We write $\min(a_1, \ldots, a_n)$ for $\min\{a_1, \ldots, a_n\}$ and $\max(a_1, \ldots, a_n)$ for $\max\{a_1, \ldots, a_n\}$.

If e is an expression and φ a condition (in a variable x), we write $\max_{\varphi}(e)$ for $\max\{e \mid \varphi\}$ and call it the maximum for e over φ. Analogously, we write $\min_{\varphi}(e)$ for $\min\{\varphi \mid e\}$ and call it the minimum for e over φ

minimum Defined along with minimum

minute A minute is 60 seconds, an hour is 60 minutes, a day is 24 hours, and a week is seven days.

modulo Defined along with equivalence class

modulus Defined along with integer division

modulus Defined along with division

month A month is between 27 and 31 day, depending on which month of the calendar and year it is.

lti-relation expression A multi-relation expression is built up from binary relations via conjunction: $aRbSc\ldots$ holds, iff $R(a,b)$ holds and also $bSc\ldots$.

multiplication Multiplication is extended to $\mathbb{Z}$ by defining the product by cases:

$$a \cdot b := \begin{cases} |a| \cdot |b| & \text{if } a,b \in \mathbb{N} \text{ or } a,b \in \mathbb{Z}^- \\ (-(|a| \cdot |b|)) & \text{else} \end{cases}$$

multiplication We define multiplication on $\mathbb{Q}$: The product $\frac{a}{b} \cdot \frac{c}{d}$ is $\frac{a \cdot c}{b \cdot d}$.

multiplication Multiplication $\cdot$ computes the product $a \cdot b$ (also written as ab or $a \times b$) of natural numbers a and b. It is defined by the equations $x \cdot 0 = 0$ and $x + s(y) = x + x \cdot y$.

multiplication Multiplication computes the product $a\ b$ of numbers a and b.

multiplication Defined along with absolute value

musical work Defined along with copyrightable work

mutable The last two items touch a somewhat delicate subject in programming. Mutable an immutable data structures: the former can be changed in-place – as we have above with the .set method, and the latter cannot. Both have their justification and respective advantages. Immutable data structures are "safe" in the sense that they cannot be changed unexpectedly by another part of the program, they have the disadvantage that every time we want to have a variant, we have to copy the whole object. Mutable ones do not – we can change in place – but we have to be very careful about who accesses them when.

This is also the reason why we spoke of "dictionary-like interface" to XML trees in lxml: dictionaries are immutable, while XML trees are not.

mutually recursive Defined along with recursive

name Defined along with subroutine

namepsace prefix Defined along with namespace declaration

namespace declaration Defined along with XML document tree

namespace declaration namespace declaration is an attribute xmlns:⟨prefix⟩|=| whose value is an XML namespace n on an XML element e. The first associates the namepsace prefix ⟨prefix⟩ with the namespace n in e: Then, any XML element in e with a prefixed name ⟨prefix⟩:⟨name⟩ has namespace n and local name ⟨name⟩.

A default namespace declaration xmlns=d on an element e gives all elements in e whose name is not prefixed, the namepsace d.

Namespace declarations on subtrees shadow the ones on supertrees.

nano Defined along with prefixes

natural number The set $\mathbb{N}$ of natural numbers is the set $\{0,1,2,\ldots\}$. They are constructed by iteration of the successor function over zero.

navigating Defined along with hypertext

negative integer Defined along with non-negative integer

ative rational number Defined along with positive rational number

negative real number Defined along with positive real number

node Defined along with graph

node Defined along with undirected graph

non-empty Defined along with empty set

non-negative integer We use $\mathbb{Z}_0^+ := \mathbb{N}$ and $\mathbb{Z}_0^- := \{x \in \mathbb{Z} \mid x = (-y) \text{ for some } y \in \mathbb{N}\}$ and call them the non-negative integers and non-positive integers respectively. Analogously, we use $\mathbb{Z}^+ := \{x \in \mathbb{Z}_0^+ \mid x \neq 0\}$ and $\mathbb{Z}^- := \{x \in \mathbb{Z}_0^- \mid x \neq 0\}$ for the positive integers and negative integers.

ative rational number Defined along with positive rational number

-negative real number Defined along with positive real number

non-positive integer Defined along with non-negative integer

sitive rational number Defined along with positive rational number

n-positive real number Defined along with positive real number

inistic Turing machine A nondeterministic Turing machine (NTM) is a septuple $\mathcal{M} := \langle \mathcal{A}, \mathcal{S}, b, \Sigma, s_0, \mathcal{F}, \mathcal{R} \rangle$, where

- $\mathcal{A}$ is a set called the alphabet,
- $\mathcal{S}$ is a set of states,
- $b \in \mathcal{A}$ the blank symbol.
- $\Sigma \subseteq \mathcal{A}$ the input symbols
- $s_0 \in \mathcal{S}$ is the initial state,
- $\mathcal{F} \subseteq \mathcal{S}$ is the set of accepting or final states,
- and $\mathcal{R} \subseteq ((\mathcal{S} \backslash \mathcal{F}) \times \mathcal{A}) \times (\mathcal{S} \times \mathcal{A} \times \{R, L\})$; it is called the transition relation.

$\mathcal{M}$ is called a deterministic Turing machine (DTM) if $\mathcal{R}$ is a function $\mathcal{R} \colon (\mathcal{S} \backslash \mathcal{F}) \times \mathcal{A} \to \mathcal{S} \times \mathcal{A} \times \{R, L\}$, then it is called the transition function.

If it is irrelevant – or clear from the context – whether $\mathcal{M}$ is deterministic or not, we often just speak of Turing machines without a qualifier.

nonempty string Let A be an alphabet, then we define the sets $A^+ := \bigcup_{i \in \mathbb{N}^+} A^i$ of nonempty strings and $A^* := A^+ \cup \{\epsilon\}$ of strings.

nonempty word Let A be an alphabet, then we define the sets $A^+ := \bigcup_{i \in \mathbb{N}^+} A^i$ of nonempty words (nonempty strings) and $A^* := A^+ \cup \{\epsilon\}$ of words (strings).

normalized Defined along with scientific notation

not fully specified Defined along with variable

number A number is a mathematical object used to count or measure other objects.

number system A number system is simply a set of numbers.

numeral The representation of a number in a numeral system is called a numeral.

numeral system A numeral system (or system of numeration) is a writing system for expressing numbers, that is, a mathematical notation for representing numbers of a given set, using symbols in a consistent manner.

numerator Defined along with rational number

object In python all values belong to a class, which provide special functions we call methods. Values are also called objects, to emphasise class aspects. Method application is written with dot notation: ⟪obj⟫.⟪meth⟫(⟪args⟫) corresponds to ⟪meth⟫(⟪obj⟫,⟪args⟫).

object Defined along with object-oriented programming

oriented programming Object-oriented programming (OOP) is a programming paradigm based on the concept of an objects. Objects can contain data, in the form of fields (often known as attribute or properties) to represent object properties. Object behavior is specified via procedures (called methods in OOP).

octal Defined along with unary

on Defined along with path

one Defined along with zero

one-to-one See injective

to-one correspondence See bijective

onto See surjective

open source See Free/Libre/Open-Source Software

opened Once a file has been opened, the CPU can write to it and read from it. After use a file should be closed to protect it from accidental reads and writes.

opening tag For communication this tree is serialized into a balanced bracketing structure, where

- an inner element node is represented by the brackets <el> (called the opening tag) and </el> (called the closing tag),
- the leaves of the XML tree are represented by empty element tags (serialized as <el></el>, which can be abbreviated as <el/>,
- and text nodes (serialized as a sequence of UniCode characters).
- An element node can be annotated by further information using attribute nodes — serialized as an attribute in its opening tag.

operating system An operating system (OS) is a system program that manages computer hardware, software resources, and provides common services for computer programs.

operator An operator is a function that differs syntactically (e.g. by using infix notation) or semantically (in evaluation strategy or argument passing mode) from usual functions.

operator application Defined along with expression

out-degree Defined along with in-degree

outdegree Defined along with indegree

output subsystem Defined along with information processing system

owner There are various legal entities (e.g. persons, states, companies, associations, ...) that can have ownership over a property p. We call them the owners of p.

ownership Ownership is the state or fact of exclusive rights and control over property, which may be a physical object, land/real estate or intangible object.

pair Defined along with Cartesian product

pair Defined along with set of pairs

pair set See unordered pair

parameter Defined along with subroutine

parent Defined along with tree

parent Defined along with tree

partial function $f \subseteq X \times Y$, is called a partial function, iff for all $x \in X$ there is at most one $y \in Y$ with $(x, y) \in f$.

partial function A relation $f \subseteq X \times Y$, is called a partial function with domain X (write $\mathbf{dom}(f)$) and codomain Y (write $\mathbf{codom}(f)$), iff for all $x \in X$ there is at most one $y \in Y$ with $(x, y) \in f$.

We write $f\colon X \rightharpoonup Y; x \mapsto y$ and $f(x) = y$ instead of $(x, y) \in f$. We say that $f(x)$ is the application of f to x and call x the argument of f.

partial function space Given sets A and B we will call the set $A \to B$ ($A \rightharpoonup B$) of all (partial) functions from A to B the (partial) function space from A to B.

partial order See partial ordering

partial ordering We call a preorder $\leq \subseteq A \times A$ on A a partial ordering (or partial order), iff it is antisymmetric. We associate with $\leq$ a strict ordering $< := \{(a, b) \in \leq \mid a \neq b\}$.

We often also use the converse relations $\geq$ and $>$.

partially ordered set We call a structure $\langle S, \leq \rangle$ of a set S and a partial ordering $\leq$ an partially ordered set or poset.

patent Defined along with intellectual property

path Given a directed graph $G = \langle V, E \rangle$, then we call a vector $p = \langle v_0, \ldots, v_n \rangle \in V^{n+1}$ a path in G iff $(v_{i-1}, v_i) \in E$ for all $1 \leq i \leq n$, $n > 0$.

- v_0 is called the start of p (write start(p))
- v_n is called the end of p (write end(p))
- n is called the length of p (write len(p))

path Given a directed graph $G := \langle V, E \rangle a$ we call a $n+1$-tuple $p = \langle v_0, \ldots, v_n \rangle \in V^{n+1}$ a path in G iff $(v_{i-1}, v_i) \in E$ for all $1 \leq i \leq n$ and $n > 0$.

- We say that the v_i are nodes on p and that v_0 and v_n are linked by p.
- v_0 and v_n are called the start and end of p (write start(p) and end(p)), the other v_i are called inner nodes of p.
- n is called the length of p (write len(p)).
- We denote the set of paths in G with $\Pi(G)$

path Defined along with uniform resource identifier

pebi Defined along with binary unit prefix

personal rights The copyright is a collection of rights on a copyrighted work;

- Personal rights: the owner of the copyright may
  - determine whether and how the work is published (right to publish)
  - determine whether and how her authorship is acknowledged. (right of attribution)
  - to object to any distortion, mutilation or other modification of the work, which would be prejudicial to his honor or reputation. (droit de respect)
- Exploitation rights: the owner of a copyright has the exclusive right to do, or authorize to do any of the following:
  - to reproduce the copyrighted work in copies (or phonorecords);
  - to prepare derivative works based upon the copyrighted work;
  - to distribute copies of the work to the public by sale, rental, lease, or lending;
  - to perform the copyrighted work publicly;
  - to display the copyrighted work publicly; and
  - to perform the copyrighted work publicly by means of a digital-audio transmission.

peta Defined along with prefixes

physical quantity A physical quantity is a physical property of a phenomenon, body, or substance, that can be quantified by measurement.

pico Defined along with prefixes

ic and sculptural work Defined along with copyrightable work

pixel Defined along with raster

place-value notation Defined along with positional number system

plain text Digital text is subdivided into plain text, where all characters carry the textual information and formatted text, which also contains instructions to the document renderer.

point Defined along with graph

poset See partially ordered set

positional notation Defined along with positional number system

itional number system A positional number system $\mathcal{N}$ is a pair $\mathcal{N} = \langle D_b, \varphi_b \rangle$ with

- D_b is a finite alphabet of b digits. b is called the base or radix of $\mathcal{N}$
- assign each digit $d \in D_b$ a number $\varphi_b(d)$ between 0 and $b-1$.
- Extend φ_b to sequences of digits by $\varphi_b(\langle n_k, \dots, n_1 \rangle) := \sum_{i=1}^{k} \varphi_b(n_i) \cdot b^{i-1}$

itional number system A positional number system $\mathcal{N}$ is a triple $\mathcal{N} = \langle D_b, \varphi_b, \psi_b \rangle$ with

- D_b is a finite alphabet of b digits. ($b := \#(D_b)$ base or radix of $\mathcal{N}$)
- $\varphi_b \colon D_b \to \{\epsilon, /, \dots, /^{[b-1]}\}$ is bijective (first b unary numbers)
- $\psi_b \colon {D_b}^+ \to \{/\}^*; \langle n_k, \dots, n_1 \rangle \mapsto \bigoplus_{i=1}^{k} \varphi_b(n_i) \odot \exp(/^{[b]}, /^{[i-1]})$ (extends φ_b to string code)

itional number system A positional number system is a numeral system that uses positional notation (also called place-value notation) to encode a number by a sequence of digits.

A positional number system for a number system N is given as a pair $P := \langle D, \varphi \rangle$, where D is a finite set D of digits (we call $b := \#(D)$ the base or radix of P) and a injective mapping from D to N.

Positional Notation extends φ to a bijective mapping from finite sequences over D to N using the arithmetics of N by interpreting a finite sequence $a_0, \ldots, a_n$ as a sum of successive powers b^i multiplied by $\varphi(a_i)$. Details vary with N.

positive integer Defined along with non-negative integer

ositive natural number The set $\mathbb{N}^+$ of positive natural numbers is the set $\{1, 2, 3, \ldots\}$.

sitive rational number We use $\mathbb{Q}^+ := \{\frac{p}{q} \in \mathbb{Q} \,|\, p{>}0\}$ and $\mathbb{Q}^- := \{\frac{p}{q} \in \mathbb{Q} \,|\, p{<}0\}$ sets of positive rational numbers and negative rational numbers and $\mathbb{Q}_0^- := \{\frac{p}{q} \in \mathbb{Q} \,|\, p{\leq}0\}$ and $\mathbb{Q}_0^- := \{\frac{p}{q} \in \mathbb{Q} \,|\, p{\geq}0\}$ sets of non-positive rational numbers and non-negative rational numbers.

positive real number We use $\mathbb{R}^+$ and $\mathbb{R}^-$ sets of positive real numbers and negative real numbers and $\mathbb{R}_0^-$ and $\mathbb{R}_0^+$ sets of non-positive real numbers and non-negative real numbers. Here a real number is called positive/negative, iff all rational numbers that approximate it are.

postulate See axiom

power Defined along with exponentiation

power Defined along with exponentiation

power Defined along with exponentiation

power Defined along with exponentiation

power set the power set: $\mathcal{P}(A) := \{S \,|\, S \subseteq A\}$

power set Let A be a set, then the power set $\mathcal{P}(A)$ of A is $\{S \,|\, S \subseteq A\}$.

pre-image Defined along with image

precision Defined along with floating point number

predecessor Defined along with successor

prefix A string p is a called a prefix of s (write $p \trianglelefteq s$), iff there is a string t, such that $s = \mathrm{conc}(p, t)$. p is a proper prefix of s (write $p \triangleleft s$), iff $t \neq \epsilon$.

prefix Defined along with subword

prefix code A (character) code $c\colon A \to B^+$ is a prefix code iff none of the codewords is a proper prefix to an other codeword, i.e.,

$$\forall\, x, y \in A \,.\, x \neq y \Rightarrow (c(x) \not\triangleleft c(y) \wedge c(y) \not\triangleleft c(x))$$

prefixed name Defined along with namespace declaration

prefixed unit Defined along with prefixes

prefixes The SI system defines a set of 19 prefixes, which transform a unit into a prefixed unit by multiplying it with a power of 10.

Prefix	Symbol	10^n
yotta	Y	10^{24}
zetta	Z	10^{21}
exa	E	10^{18}
peta	P	10^{15}
tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
hecto	h	10^{2}
deca	da	10^{1}
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}
atto	a	10^{-18}
zepto	z	10^{-21}
yocto	y	10^{-24}

preorder We call a binary relation $\leq \subseteq A \times A$ on A a preorder (or quasiorder), iff it is reflexive and transitive.

preordered set Defined along with base set

presentation MathML Defined along with Mathematics Markup Language

primary storage See memory

primitive In a programming language, a primitive is a "basic unit of processing", i.e. the simplest element that can be given a procedural meaning (its semantics) of its own.

procedure Defined along with subroutine

process A process is an instance of a program that is being executed.

processor Defined along with information processing system

product Defined along with multiplication

product Defined along with multiplication

product Defined along with multiplication

product Defined along with multiplication

program Defined along with programming language

program Defined along with Turing machine

program code See computer code

programmer A person involved in programming is called a programmer.

programming See computer programming

programming language A programming language L is a formal language for specifying sequences information processing system instructions. A word in L is called a program of L.

programming paradigm Programming paradigms are a way to classify programming languages based on their features. Languages can be classified into multiple paradigms.

projection We call the function $\pi_i \colon A_1 \times \ldots \times A_n \to A_i; \langle a_1, \ldots, a_n \rangle \mapsto a_i$ the (i^{th}) projection.

proof Defined along with inference

proper prefix Defined along with prefix

proper prefix Defined along with subword

proper subgraph Defined along with subgraph

proper subset A set A is a proper subset of a set B (written $A \subset B$), iff $A \subseteq B$ but $A \not\equiv B$.

proper substring Defined along with subword

proper subword Defined along with subword

proper suffix Defined along with subword

proper superset A set A is a proper superset of a set B (written $A \supset B$), iff $B \subset A$.

property Defined along with object-oriented programming

property Defined along with ownership

property right Ownership involves multiple rights (the property rights), which may be separated and held by different parties.

proset Defined along with base set

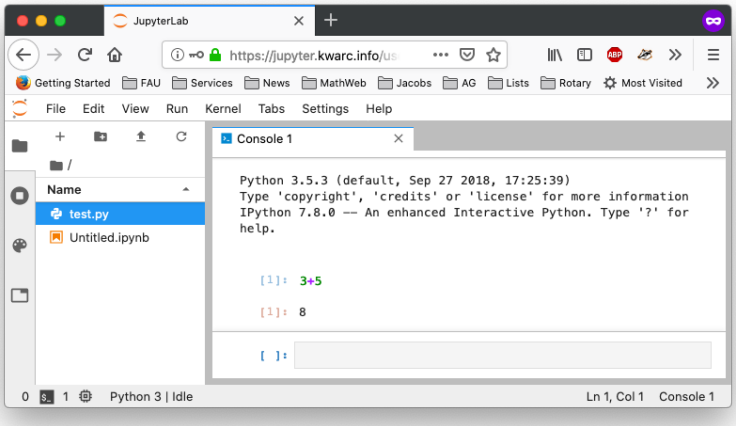
pseudocode Pseudocode is a plain language description of the steps in an algorithm or another system. Pseudocode often uses structural conventions of a normal programming language, but is intended for human reading rather than machine reading.

In pseudocode we often use metasyntactic variables, i.e. is a specific word or set of words identified as a placeholder that is intended to be modified or substituted before real-world usage.

public domain A work is said to be in the public domain, if no copyright applies, otherwise it is called copyrighted.

punch card A punch card is a piece of stiff paper that contains digital information represented by the presence or absence of holes in predefined positions.

python console The JupyterLab python console, i.e. a python interpreter in your browser. (use this for python interaction and testing.)



quantifier Defined along with formulae

quasiorder See preorder

query Defined along with uniform resource identifier

quotient Defined along with division

quotient Defined along with division

quotient Defined along with rational number

quotient set Defined along with equivalence class

quotient space Defined along with equivalence class

quotient space Defined along with equivalence class

radix Defined along with positional number system

radix Defined along with positional number system

radix Defined along with positional number system

range A range is a finite sequence of numbers it can conveniently be constructed by the range function: range(⟨start⟩,⟨stop⟩,⟨step⟩) construts a range from ⟨start⟩ to ⟨stop⟩ with step size ⟨step⟩.

range Defined along with variable

raster We call the grid raster and each entry in it pixel (from "picture element").

rational number The set $\mathbb{Q}$ of rational numbers is defined as $(\mathbb{Z} \times \mathbb{N}^+)/\sim$, where $((p_1, q_1) \sim (p_2, q_3))$, iff $p_1\ q_2 = q_2\ q_1$. We call $\frac{n}{m} := (n, m)$ a fraction or quotient; it denotes the rational number $[(n, m)]_\sim$. In a fraction $\frac{n}{d}$, n is called the numerator and d the denominator.

raw cell Defined along with cell

raw string literal Defined along with string literal

read Defined along with opened

read–eval–print loop A read–eval–print loop (REPL), also termed an interactive toplevel or language shell, is a simple, interactive user interface that takes single user inputs (i.e., single expressions or instructions), evaluates or executes) them, and returns the result to the user.

real number The set $\mathbb{R}$ of real numbers is defined as the completion of $\mathbb{Q}$.

real part Defined along with complex numbers

receiver Defined along with communication medium

recursion Defined along with recursive

recursive We call a problem recursive, if its solution depends on solutions to smaller instances of the same problem.

Recursion solves recursive problems by (mutually) recursive functions or types.

We call a set $F = \{f_1, \ldots, f_n\}$ of functions or types mutually recursive if they call each other in their bodies.

We call a functions or types f recursive, iff $\{f\}$ is mutually recursive.

recursive Defined along with recursive

refer Defined along with reference

reference A reference is a value that enables a program to indirectly access a particular datum in the computer's memory or in some other storage device. The reference is said to refer to the datum, and accessing the datum is called dereferencing the reference.

reflexive A relation $R \subseteq A \times A$ is called

- reflexive on A, iff $(a, a) \in R$ for all $a \in A$, and
- irreflexive (or anti-reflexive) on A, iff $(a, a) \notin R$ for all $a \in A$.

reflexive A relation $R \subseteq A \times A$ is called

- reflexive on A, iff $\forall a \in A . (a, a) \in R$
- irreflexive on A, iff $\forall a \in A . (a, a) \notin R$
- symmetric on A, iff $\forall a, b \in A . (a, b) \in R \Rightarrow (b, a) \in R$
- asymmetric on A, iff $\forall a, b \in A . (a, b) \in R \Rightarrow (b, a) \notin R$
- antisymmetric on A, iff $\forall a, b \in A . ((a, b) \in R \wedge (b, a) \in R) \Rightarrow a = b$
- transitive on A, iff $\forall a, b, c \in A . ((a, b) \in R \wedge (b, c) \in R) \Rightarrow (a, c) \in R$
- equivalence relation on A, iff R is reflexive, symmetric, and transitive.

reflexive extension A relation R on A is reflexive, iff $\mathrm{Id}_A \subseteq R$, so we call $R \cup \mathrm{Id}_A$ the reflexive extension of R.

regexp See regular expression

regular expression A regular expression (also called regexp) is a formal expression that specifies a set of strings.

relation $R \subseteq A \times B$ is a (binary) relation between A and B.

If $A = B$ then R is called a relation on A.

relation $R \subseteq A \times B$ is a (binary) relation between A and B.

relation on Defined along with relation

relation on If $A = B$ then R is called a relation on A.

relative complement See set difference

remainder Defined along with integer division

remainder Defined along with division

renewal provision Defined along with term provision

representative Defined along with equivalence class

resource See system resource

return Defined along with subroutine

return value Defined along with subroutine

root Defined along with tree

root For $b \in \mathbb{Z}$, $r \in \mathbb{Z}$ is a b-th root of $a \in \mathbb{Z}$ (we write $\sqrt[b]{a}$), if $r^b = a$. The square root $\sqrt[2]{a}$ is written as $\sqrt{a}$.

root Defined along with tree

root For $b \in \mathbb{Q}$, $r \in \mathbb{Q}$ is a b-th root of $a \in \mathbb{Q}$ (we write $\sqrt[b]{a}$), if $r^b = a$. The square root $\sqrt[2]{a}$ is written as $\sqrt{a}$.

root The n-th root $\sqrt[n]{a}$ of a number $a \in \mathbb{N}$ is the $r \in \mathbb{N}$ – if it exists, such that $r^n = a$. The square root $\sqrt[2]{a}$ is written as $\sqrt{a}$.

root The n-th root $\sqrt[n]{a}$ of a number a is that r – if it exists, such that $r^n = a$. The second root is also called the square root and is written as $\sqrt{a}$.

root Defined along with absolute value

routine See subroutine

safe We call a HTTP request safe, iff it does not change the state in the web server.(except for server logs, counters,...; no side effects)

scalar fraction Defined along with scalar multiple

scalar multiple For a quantity $q \in Q$ and a scalar r we define the scalar multiple $r \cdot q$ of r and q to be $r \cdot q := r, su$, if $q = su$ for some $u \in U$.

Similarly, we define the scalar fraction q/q' of two quantities q and q' to be that $(r \,/\, r') \in \mathbb{R}$, such that if $q = ru$ and $q' = r'u$ for some $u \in U$. Note that both operations are well-defined by the axioms above.

scale Defined along with floating point number

scheme Defined along with uniform resource identifier

scientific notation In scientific notation all numbers are written in the form of $a \times 10^b$, ($a \in \mathbb{R}$ times 10 raised to the power of $b \in \mathbb{Z}$), a is called the significand, mantissa, or coefficient.

$a \times 10^b$ is called normalized, iff $1 \leq |a| < 10$

second Since 1967, the second has been defined as exactly the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium-133 atom (at a temperature of 0°K).

second component Defined along with first component

secondary storage Secondary storage (also known as external memory or auxiliary storage), refers to any form of storage device and media that it is not directly accessible by the CPU.

semantics Defined along with primitive

sender Defined along with communication medium

sequence python has more types that behave just like lists, they are called sequence types.

sequence See list

sequence A sequence (also called a list), $(a_n)_{n\in S}$, is a function whose domain is a countable, totally ordered set S (e.g. $\mathbb{N}$, then we often write (a_i)). If S is infinite, we call any sequence $(a_i)_{i\in S}$ on S an infinite sequence, and finite sequence otherwise. Then the cardinality of S is called the length of $(a_i)_{i\in S}$.

Sequences are writen as

- $1, 2, 3, 4$ for a concrete finite sequence,
- $1, 2, 3, 4, \dots, 10$ for a finite sequence with ellipsis,
- $x^1, \dots, x^n$ and $x_1, \dots, x_n$ for a sequence of upper/lower-indexed variables of length n,
- $1, 2, 3, 4, \dots$ for an infinite sequence,
- $x^1, x^2, \dots$ and $x_1, x_2, \dots$ for a sequence of upper/lower-indexed variables of length n,

Given a sequence $a\colon S \to T$, and $a \in S$ we write the i^{th} element of a as S_i.

server A server is a program or a computer that provides functionality – called a service– for other programs or computers, called clients.

service Defined along with server

set A set is a collection of elements. We can represent sets by

1. listing the elements (also called member) within curly brackets: e.g. $\{a, b, c\}$
2. describing the elements via selection from another set S using a property P: $\{x \in S \mid x \text{ has property } P\}$. We use $\{x \mid x \text{ has property } P\}$ as a shorthand, if the set to be selected from is obvious from the context.
3. stating elementhood (also called membership; written $a \in S$) or not ($b \notin S$) outright.

set comprehension Indeed it is very difficult to define something as foundational as a set. We want sets to be collections of objects, and we want to be as unconstrained as possible as to what their elements can be. But what then to say about them? Cantor's intuition is one attempt to do this, but of course this is not how we want to define concepts in math.

$$\begin{matrix} & a \\ AA & b \\ & b \end{matrix}$$

So instead of defining sets, we will directly work with representations of sets. For that we only have to agree on how we can write down sets. Note that with this practice, we introduce a hidden assumption: called set comprehension, i.e. that every set we can write down actually exists. We will see below that we cannot hold this assumption.

set difference set difference: $A \backslash B := \{x \mid x \in A \wedge x \notin B\}$

set difference Let A and B be sets, then the set difference $A\backslash B$ of A and B is $\{x \mid x \in A \text{ and } x \notin B\}$. We also call $A\backslash B$ the relative complement or simply complement of B in A. If A is clear from the context, we write $\overline{B}$ for the complement of B in A.

set inclusion Defined along with subset

et of nonempty strings See nonempty word

set of pairs Let A and B be sets, then the set of pairs $A \times B$ of A and B is defined as $\{(a, b) \mid a \in A, b \in B\}$, we call $(a, b) \in A \times B$ a pair. $(a, b) = (c, d)$, iff $a = c$ and $b = d$.

set of str ings Defined along with nonempty word

set of words Defined along with nonempty word

shell A shell is a command-line interface for accessing the services of a computer's operating system.

sign Defined along with floating point number

significand Defined along with floating point number

significand Defined along with scientific notation

simple Defined along with cyclic

simple Defined along with cyclic

simple definition **Error: The defi does not appear to be inside a definition environment. line 21:49**

simple ordering See linear ordering

sink Defined along with initial

sink Defined along with initial

size Defined along with finite

size The size $\#(A)$ of a set A is the number of elements in A.

software Defined along with computing device

solar A solar or tropical year is the time between successive spring or autumn equinoxes, or winter or summer solstices, roughly 365 days, 5 hours, 48 minutes, and 46 seconds.

solar calendar A solar calendar assigns a day to each solar day and often aligns years with the solar years.

solar day A solar day is the length of time which elapses between the sun reaching its highest point in the sky two consecutive times. The solar day on Earth is roghly 86400s.

sound recording Defined along with copyrightable work

source Compiler: translates a program (the source) into another program (the binary) in a much simpler programming language for optimized execution on hardware directly.

source See initial

source Defined along with initial

source language Defined along with compiler

square root Defined along with root

square root Defined along with root

square root Defined along with root

square root Defined along with root

square root Defined along with absolute value

star operator The star operator unpacks a list into an argument sequence.

start Defined along with path

start Defined along with path

state Defined along with nondeterministic Turing machine

state Defined along with stateful

state register Defined along with Turing machine

stateful A system S is described as stateful if it is designed to remember preceding events. The totality of remembered events is called the state of S.

step equation **Error: The defi does not appear to be inside a definition environment. line 75:48**

storage device A storage device is any type of hardware that stores (i.e. records with the purpose of later returning) data in a (fixed or removable) storage medium.

storage medium A storage medium is a physical material that holds (stores) information.

storage subsystem Defined along with information processing system

store Defined along with storage device

store Defined along with storage medium

stream Many operating systems use files as a primary computational metaphor, also treating other resources like files. This leads to an abstraction of files called streams, which encompass files as well as e.g. keyboards, printers, and the screen, which are seen as objects that can be read from (keyboards) and written to (e.g. screens). This practice allows flexible use of programs, e.g. re-directing a the (screen) output of a program to a file by simply changing the output stream.

strict ordering Defined along with partial ordering

string Defined along with integer

string python strings are sequences of UniCode characters.

string Defined along with nonempty string

string Defined along with alphabet

string literal python uses string literals, i.e character sequences surrounded by one, two, or three sets of matched single or double quotes for string input. The content can contain escape sequences, i.e. the escape character backslash followed by a code character for problematic characters:

Seq	Meaning	Seq	Meaning
\\	Backslash (\)	\'	Single quote (')
\"	Double quote (")	\a	Bell (BEL)
\b	Backspace (BS)	\f	Form-feed (FF)
\n	Linefeed (LF)	\r	Carriage Return (CR)
\t	Horizontal Tab (TAB)	\v	Vertical Tab (VT)

In triple-quoted string literals, unescaped newlines and quotes are honored, except that three unescaped quotes in a row terminate the literal.

Prefixing a string literal with a r or R turns it into a raw string literal, in which backslashes have no special meaning.

subgraph Let $G := \langle V, E \rangle$ and $G' := \langle V', E' \rangle$ be two graphs. If $V' \subseteq V$ and $E' \subseteq E$, then G' is a subgraph of G, written $G' \subseteq G$. If $G' \subseteq G$ and $G' \neq G$, then G' is a proper subgraph of G; we write $G' \subset G$.

subprogram See subroutine

subroutine A subroutine (also called routine or subprogram) is a program fragment in a program P that performs a specific task, packaged as a unit in so that it can be executed (called, or invoked) by P.

A subroutine p consists of an identifier (its name), a sequence $xx_1, \ldots, x_n$ of local identifiers called parameters, and a program fragment (called the body of p). The length n of x is called the arity of p.

When P (the invoker) calls p, then it supplies a list of values (called arguments) to p: the parameters are replaced by the arguments, and the body is executed in the context where it is called. p may or may not return values v to P, the return values. If it does, it is called a function otherwise a procedure.

subset A set A is a subset of a set B (written $A \subseteq B$), iff all $x \in A$ are members of B. The relation $\subseteq$ is called set inclusion.

substring Let A be an alphabet, then we say that a string $s \in A^*$ is a substring of a string $t \in A^*$ (written $s \subseteq t$), iff there are strings $v, w \in A^*$, such that $t = vsw$.

substring See subword

subsystem An entity S' in a system S that is a system itself is called a subsystem of S.

subtraction Subtraction computes the difference $a - b$ of a and b which is defined as $a + (-(b))$.

subtraction The subtraction operator computes the difference $a - b$ of $a \in \mathbb{Q}$ and $\frac{b}{c} \in \mathbb{Q}$ which is defined as $a + \frac{(-(b))}{c}$.

subtraction Subtraction $-$ computes the difference ab of natural numbers a and b. It is defined as is that natural number c – if it exists, such that $a + c = b$.

subtraction Subtraction $-$ computes the difference ab of a and b. It is defined as is that number c – if it exists, such that $a + c = b$.

subtraction Defined along with absolute value

subtree A subgraph of a tree that is itself a tree is called a subtree.

subword Let A be an alphabet, then we say that a word $s \in A^*$ is a subword (substring) of a word $t \in A^*$ (written $s \subseteq t$), iff there are words $v, w \in A^*$, such that $t = vsw$. If $v \neq \epsilon$ or $w \neq \epsilon$, then we call s a proper subword (proper substring) of t and write $s \subset t$.

If $v = \epsilon$, then we call s a prefix of t and write $s \trianglelefteq t$, if additionally $w \neq \epsilon$ we call s a proper prefix of t and write $s \triangleleft t$. Similarly, if $w \neq \epsilon$, then we call s a suffix of t, if additionally $v \neq \epsilon$ a proper suffix of t.

successor We call a unary natural number the successor (predecessor) of another, if it can be constructing by adding (removing) a slash. (successors are created by the s-rule)

successor function Defined along with natural number

suffix Defined along with subword

sum Defined along with addition

sum Defined along with summation

sum Defined along with addition

sum Defined along with addition

sum Defined along with addition

summation Summation is iterated addition, we define the sum over a sequnce a_i by

$$\sum_{i=n}^{m} a_i := \begin{cases} 0 & \text{if } (n \leq m) \\ a_n + (\sum_{i=(n+1)}^{m} a_i) & \text{else} \end{cases}$$

The variable i is called the summation index and n and m the lower bound and upper bound of the sum respectively, together the specify the range of summation.

There are variant summation operators $\sum_{\varphi} a_i$ and $\sum_{i \in S} a_i$. The first one specifies the range of the summation via a formula φ in i and the second one directly by giving a set S.

summation index Defined along with summation

summation range Defined along with summation

supergraph If G is a subgraph of G', then we call G' a supergraph of G.

superset A set A is a superset of a set B (written $A \supseteq B$), iff $B \subseteq A$.

supertree If T is a subtree of T', then we call T' a supertree of T.

surjective Defined along with injective

surjective A function $f\colon S \to T$ is called surjective or onto, iff for all $y \in T$ there is a $x \in S$ with $f(x) = y$.

symbol A symbol is a mark, sign or word that indicates, signifies, or is understood as representing an idea, object, or relationship.

symbol table See dictionary

symmetric A relation $R \subseteq A \times A$ is called

- symmetric on A, iff $(b, a) \in R$ for all $a, b \in A$ with $(a, b) \in R$.

- asymmetric on A, iff $(b, a) \notin R$ for all $a, b \in A$ with $(a, b) \in R$.
- antisymmetric on A, iff $(a, b) \in R$ and $(b, a) \in R$ imply $a = b$.

symmetric Defined along with reflexive

symmetric difference The symmetric difference $A\Delta B$ of sets A and B is defined as $(A \backslash B) \cup (B \backslash A)$; it is also written as $A \oplus B$ or $A \ominus B$.

syntax Programming language syntax describes the surface form of the program: the admissible character sequences. It is also a composition of the syntax for the primitives.

system A system is a group of interacting or interrelated entities that form a unified whole. A system is delineated by its spatial and temporal boundaries, surrounded and influenced by its environment, described by its structure and purpose and expressed in its functioning.

system of numeration See numeral system

system resource A system resource, or simply resource, is any physical or virtual component of limited availability within a computer system or connected to it.

tag HTML marks up the structure and appearance of text with tags of the form <el> (begin tag), </el> (end tag), and <el/> (empty tag), where el is one of the following

structure	`html`,`head`, `body`	metadata	`title`, `link`, `meta`
headings	`h1`, `h2`, ..., `h6`	paragraphs	`p`, `br`
lists	`ul`, `ol`, `dl`, ..., `li`	hyperlinks	`a`
multimedia	`img`, `video`, `audio`	tables	`table`, `th`, `tr`, `td`, ...
styling	`style`, `div`, `span`	old style	`b`, `u`, `tt`, `i`, ...
interaction	`script`	forms	`form`, `input`, `button`
Math	MathML (formulae)	interactive graphics	vector graphics (SVG) and `canvas` (2D bitmapped)

tape Defined along with Turing machine

tape See tape specification

tape specification A tape specification (also called tape) for a Turing machine $\mathcal{M} := \langle \mathcal{A}, \mathcal{S}, b, \Sigma, s_0, \mathcal{F}, \mathcal{R} \rangle$ is a sequence $t \colon \mathbb{N} \to \mathcal{A}$, such that $t^{-1}(c)$ is finite for all $c \in \mathbf{A}$ except b.

target language Defined along with compiler

tebi Defined along with binary unit prefix

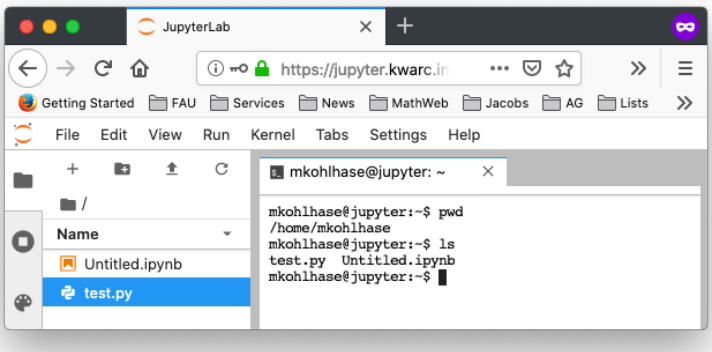
temperature Defined along with length

tera Defined along with prefixes

term provision a license is a regular contract (about intellectual property) that is handled just like any other contract. (it can stipulate anything the licensor and licensees agree on) in particular a license may

- involve term, territory, or renewal provisions,
- require paying a fee and/or proving a capability, or
- require to keep the licensor informed on a type of activity, and to give them the opportunity to set conditions and limitations.

terminal The JupyterLab terminal, i.e. a UNIX shell in your browser. (use this for managing files)



terminal Defined along with initial

terminal Defined along with initial

territory provision Defined along with term provision

text editor A text editor is a program used for rendering and manipulating text files.

text file A text file is a file that is structured as a sequence of encoded characters. Computer files that are not text files are called binary files.

text line In practice, text files are often processed as a sequence of text lines (or just lines), i.e. substrings separated by the line feed character U+000A; LINE FEED (LF). The line number is just the position in the sequence.

text node Defined along with XML document tree

text node The main remaining functionality in XML is the treatment of text. XML treats text as special kinds of node in the tree: text nodes. They can be treated just like any other node in the XML tree in the etree library.

textual content Defined along with document markup

theorem A theorem is a statement about mathematical objects that we know to be true.

time Time can be measured by observing a certain number of repetitions of one or another standard cyclical event. Every such event (e.g. the passage of a free-swinging pendulum) constitutes one standard unit.

time Defined along with length

total A relation $R \subseteq A \times B$ is called total iff for all $x \in A$ there is a $y \in B$, such that $(x, y) \in R$.

total $R \subseteq A \times B$ is called total iff $\forall\, x \in A . \exists\, y \in B . (x, y) \in R$.

total function If $f : X \rightharpoonup Y$ is a total relation, we call f a total function and write $f : X \to Y$. $(\forall\, x \in X . \exists^1\, y \in Y . (x, y) \in f)$

total function If $f : X \rightharpoonup Y$ is a total relation (i.e. for all $x \in X$ there is a unique $y \in Y$ with $(x, y) \in f$), we call f a total function and write $f : X \to Y$.

total ordering See linear ordering

totally ordered set See linearly ordered set

trademark Defined along with intellectual property

transition function Defined along with nondeterministic Turing machine

transition relation Defined along with nondeterministic Turing machine

transitive A relation $R \subseteq A \times A$ is called transitive (else intransitive) on A, iff $(a, c) \in R$ for all $a, b, c \in A$ with $(a, b) \in R$ and $(b, c) \in R$.

transitive Defined along with reflexive

transitive closure Let R be a binary relation, then we call the smallest

- the smallest transitive relation that contains R the transitive closure of R.
- the smallest transitive and reflexive relation that contains R the transitive-reflexive closure of R we denote it with R^*.

sitive-reflexive closure Defined along with transitive closure

sitive-reflexive closure Let R be a binary relation, then we call the smallest transitive relation that contains R the transitive-reflexive closure of R we denote it with R^*.

tree A tree is a DAG $G = \langle V, E \rangle$ such that

- There is exactly one initial node $v_r \in V$ (called the root)
- All nodes but the root have in-degree 1.

We call v the parent of w, iff $(v, w) \in E$ (w is a child of v). We call a node v a leaf of G, iff it is terminal, i.e. if it does not have children.

tree A tree is a directed acyclic graph $G := \langle V, E \rangle$ such that

- there is exactly one initial node $v_r \in V$ (called the root), and
- all nodes but the root have indegree 1.

We call v the parent of w, iff $(v, w) \in E$ (w is a child of v). We call a node v a leaf of G, iff it is terminal, i.e. if it does not have children. An ancestor is an iterated parent, and a descendant an interated child.

tropical year See solar

true Defined along with truth value

truth value There are two truth values: true (also called verum, denoted by T, 1, or $\top$) and false (or untrue, also falsum); written as F, 0, or $\bot$). The set $\{\mathsf{T}, \mathsf{F}\}$ of truth values is denoted with $\mathbb{B}$.

twelve Defined along with zero

two Defined along with zero

type See data type

type Defined along with variable

unary The following positional number systems are in common use.

name	set	base	digits	example
unary	$\mathbb{N}_1$	1	/	$/////_1$
binary	$\mathbb{N}_2$	2	0,1	0101000111_2
octal	$\mathbb{N}_8$	8	0,1,...,7	63027_8
decimal	$\mathbb{N}_{10}$	10	0,1,...,9	162098_{10} or 162098
hexadecimal	$\mathbb{N}_{16}$	16	0,1,...,9,A,...,F	$FF3A12_{16}$

unary exponentiation The unary exponentiation operation can be defined by the equations $\exp(n, o) = s(o)$ and $\exp(n, s(m)) = n \odot \exp(n, m)$.

unary multiplication The unary multiplication operation can be defined by the equations $n \odot o = o$ and $n \odot s(m) = n \oplus n \odot m$.

nary natural numbers We call the representation of natural numbers by slashes on a surface the unary natural numbers

nary natural numbers we call these representations unary natural numbers.

unary product The unary product operation can be defined by the equations $\bigodot_{i=o}^{o} n_i = s(o)$ and $\bigodot_{i=o}^{s(m)} n_i = n_{s(m)} \odot \bigodot_{i=o}^{m} n_i$.

unary summation The unary summation operation can be defined by the equations $\bigoplus_{i=o}^{o} n_i = o$ and $\bigoplus_{i=o}^{s(m)} n_i = n_{s(m)} \oplus \bigoplus_{i=o}^{m} n_i$.

uncountable Defined along with countable

undefined at We call a partial function $f : X \rightharpoonup Y$ undefined at $x \in X$, iff $(x, y) \notin f$ for all $y \in Y$.(write $f(x) = \bot$)

undefined at Defined along with defined at

undirected edge Defined along with undirected graph

undirected graph Defined along with graph

undirected graph An undirected graph is a pair $\langle V, E \rangle$ such that

- V is a set of vertices (or nodes) (draw as circles)
- $E \subseteq \{\{v, v'\} \mid v, v' \in V \wedge (v \neq v')\}$ is the set of its undirected edges (draw as lines)

unicode Standard Defined along with universal character set

unicode standard The unicode standard (UniCode) is an industry standard allowing computers to consistently represent and manipulate text expressed in any of the world's writing systems. (currently about 100.000 characters)

rm resource identifier A uniform resource identifier (URI) is a global identifiers of local or network-retrievable documents, or media files (web resources). URIs adhere a uniform syntax (grammar) defined in RFC-3986 [BLFM05].

A URI is made up of the following components:

- a scheme that specifies the protocol governing the resource
- an authority: the host (authentication there) that provides the resource.
- a path in the hierarchically organized resources on the authority.
- a query in the non-hierarchically organized part of the host data.
- a fragment identifier in the resource.

iform resource locator A uniform resource locator (URL) is a URI that that gives access to a web resource, by specifying an access method or location. All other URIs are called uniform resource names (URN).

niform resource name Defined along with uniform resource locator

union Let A and B be sets, then the union $A \cup B$ of A and B is defined as $\{x \mid x \in A \text{ or } x \in B\}$.

union Let I be a set and $\{S_i \mid i \in I\}$ a family of sets, then the union $\bigcup_{i \in I} S_i$ over the collection S is $\{x \mid x \in S_i \text{ for some } i \in I\}$.

union union: $A \cup B := \{x \mid x \in A \vee x \in B\}$

nion over a collection union over a collection: Let I be a set and S_i a family of sets indexed by I, then $\bigcup_{i \in I} S_i := \{x \mid \exists\, i \in I \,.\, x \in S_i\}$.

unit See unit of measurement

unit of measurement A unit of measurement (or just unit) is a definite magnitude of a physical quantity, defined and adopted by convention and/or by law, that is used as a standard for measurement of the same physical quantity. Any other value of the physical quantity can be expressed as a simple multiple of the unit of measurement.

niversal character set A scalable architecture for representing all the worlds scripts

- The universal character set (UCS) defined by the ISO/IEC 10646 International Standard, is a standard set of characters upon which many character encodings are based.
- The unicode Standard defines a set of standard character encodings, rules for normalization, decomposition, collation, rendering and bidirectional display order

unknown Defined along with variable

unordered pair If A is a set and $x, y \in A$, then the unordered pair or pair set $\{x, y\}$ is the $p \subseteq A$, such that $z \in p$, iff $z = x$ or $z = y$. The set of all pair sets is sometimes denoted with $\left(\!\binom{A}{2}\!\right)$.

untrue Defined along with truth value

upper bound Defined along with summation

user Defined along with user interface

user agent HTTP is used by a client (called user agent) to access web resources (addressed by uniform resource locators (URLs)) via a HTTP request. The web server answers by supplying the resource (and metadata).

user interface A user interface (UI or simply interface), is the means in which a person (the user) controls a software application or hardware device.

value Defined along with dictionary

value Defined along with variable

value A value is the representation of some entity that can be manipulated by a program.

variable A variable is a memory location which contains a value. It is referenced by an identifier – the variable name.

variable A variable is a memory location which contains a value. It is referenced by an identifier – the variable name.

variable A variable is an alphabetic character representing a mathematical object, called the value of the variable, which is either arbitrary (but fixed) or not fully specified or unknown – in this case the variable is called an unknown. The set of objects a variable v can stand for is called the range or type.

variable assignment A variable assignment ⟪var⟫=⟪val⟫ assigns a value.

variable binding Defined along with expression

variable name Defined along with variable

variable name Defined along with variable

vector Defined along with n-dim Cartesian space

vector Defined along with n-dimensional Cartesian space

vector graphics Image representation formats that store shape information instead of individual pixels, are refered to as vector graphics.

vertex Defined along with graph

vertex Defined along with undirected graph

verum Defined along with truth value

visual markup Markup is by no means limited to visual markup for documents intended for printing as **?document-markup.ex?** may suggest. There are aural markup formats that instruct document renderers that transform documents to audio streams of e.g. reading speeds, intonation, and stress.

web IDE A web IDE or cloud IDE, is a browser-based integrated development environment.

web browser A web browser is a software application for retrieving (via HTTP), presenting, and traversing information resources on the WWWeb, enabling users to view web pages and to jump from one page to another.

web page A web page is a document (usually marked up in HTML) on the WWWeb that can include multimedia data and hyperlinks.

web resource Defined along with uniform resource identifier

web server Defined along with user agent

web site A web site is a collection of related web pages usually designed or controlled by the same individual or company.

week Defined along with minute

word Defined along with alphabet

word processor A word processor is a software application, that – apart from being a document renderer – also supports the tasks of composition, editing, formatting, printing of electronic documents.

work made for hire A work made for hire (WFH) is a work created by an employee as part of his or her job, or under the explicit guidance or under the terms of a contract.

write Defined along with opened

year A year is either 364 or 365 day depending whether is is a leap year or not.

yobi Defined along with binary unit prefix

yocto Defined along with prefixes

yotta Defined along with prefixes

zebi Defined along with binary unit prefix

zepto Defined along with prefixes

zero We introduce some abbreviations

- we "abbreviate" o and ' ' by the symbol '0' (called "zero")
- we abbreviate $s(o)$ and / by the symbol '1' (called "one")
- we abbreviate $s(s(o))$ and // by the symbol '2' (called "two")
- ...
- we abbreviate $s(s(s(s(s(s(s(s(s(s(o)))))))))))$ and /////////// by the symbol '12' (called "twelve")
- ...

zero Defined along with natural number

zero **Error: The defi does not appear to be inside a definition environment. line 40:39**

zetta Defined along with prefixes

References

[BLFM05] Tim Berners-Lee, Roy T. Fielding, and Larry Masinter. *Uniform Resource Identifier (URI): Generic Syntax*. RFC 3986. Internet Engineering Task Force (IETF), 2005. URL: `http://www.ietf.org/rfc/rfc3986.txt`.

[Hic+14] Ian Hickson et al. *HTML5. A Vocabulary and Associated APIs for HTML and XHTML*. W3C Recommentation. World Wide Web Consortium (W3C), Oct. 28, 2014. URL: `http://www.w3.org/TR/html5/`.