Algorithmic Journeys

Generic algorithms and performance

Taras Shevhcnkeo

Rails Reactor

Table of contents

Terminology

Terminology

1. Datum
2. Value
3. Value type
4. Object
5. Object type

Datum

Definition

A **datum** is a sequence of bits.

Example

01000001 is an example of a datum.

Value

Definition

A **value is** a **datum** together with its interpretation.

Example

The **datum** 01000001 might have the interpretation of the integer 65, or the character “A”.

Explanation

Every **value** must be associated with a **datum** in memory; there is no way to refer to disembodied **values** in modern programming languages.

Value type

Definition

A **value type** is a set of values sharing a common interpretation.

Object

Definition

An **object** is a collection of bits in memory that contain a **value** of a given **value type**.

Explanation

An **object** is immutable if the value never changes, and mutable otherwise. An object is unrestricted if it can contain any **value** of its **value type**.

Object type

Definition

An **object type** is a uniform method of storing and retrieving **values** of a given **value type** from a particular **object** when given its address.

Programming with concepts

Basic idea

The essence of generic programming lies in the idea of concepts. A concept is a way of describing a family of related object types.

Natural Science	Mathematics	Programming	Programming Examples
genus	theory	concept	Integral, Character
species	model	type or class	uint8_t, char
invidiual	element	instance	01000001(65, 'A')

Notion of Regularity

Operation

1. Copy construction
2. Assignment
3. Equality
4. Destruction

Semantic

$$\forall a\ \forall b\ \forall c : T\ a(b) \implies (b = c \implies a = c)$$

$$\forall a\ \forall b\ \forall c : a \leftarrow b \implies (b = c \implies a = c)$$

$$\forall f \in RegularFunction : a = b \implies f(a) = f(b)$$

More examples of concepts

1. Regular Type
2. Semiegular Type
3. Functional Procedure
4. Homogeneous Function
5. Homogeneous Predicate
6. Semiring
7. Sequence
8. Totally Ordered
9. Input Iterator
10. Forfward Iterator
11. Bidirectional Iterator

Properties

1. Associative
2. Distributive
3. Transitive
4. Semiegular Type
5. Functional Procedure

Techniques

1. Transformation-action duality
2. Operation-accumulation procedure duality
3. Memory adaptivity
4. Reduction to constrained subproblem

Egyptian multiplication

Simple algorithm

3 * 8

x	y
3	8
6	7
9	6
12	5
15	4
18	3
21	2
24	1

8 * 3

x	y
8	3
16	2
24	1

Simple idea

Code

```
def intersect(x, y):
    if len(x) > len(y): x, y = y, x
    for i, v in enumerate(x):
        if v in y: yield v; print(i);

x, y = set([1, 2]), set(range(10**7))
print(set(intersect(x, y)))
```

Output

```
0
1
{1, 2}
```

Typography

```
The theme provides sensible defaults to
\emph{emphasize} text, \alert{accent} parts
or show \textbf{bold} results.
```

becomes

The theme provides sensible defaults to *emphasize* text, accent parts or show **bold** results.

Font feature test

- Regular
- *Italic*
- SmallCaps
- **Bold**
- ***Bold Italic***
- **Bold SmallCaps**
- `Monospace`
- `Monospace Italic`
- **`Monospace Bold`**
- **`Monospace Bold Italic`**

Lists

Items

- Milk
- Eggs
- Potatos

Enumerations

1. First,
2. Second and
3. Last.

Descriptions

PowerPoint Meeh.

Beamer Yeeeha.

Animation

- This is important

Animation

- This is important
- Now this

Animation

- This is important
- Now this
- And now this

Animation

- This is really important
- Now this
- And now this

Figures

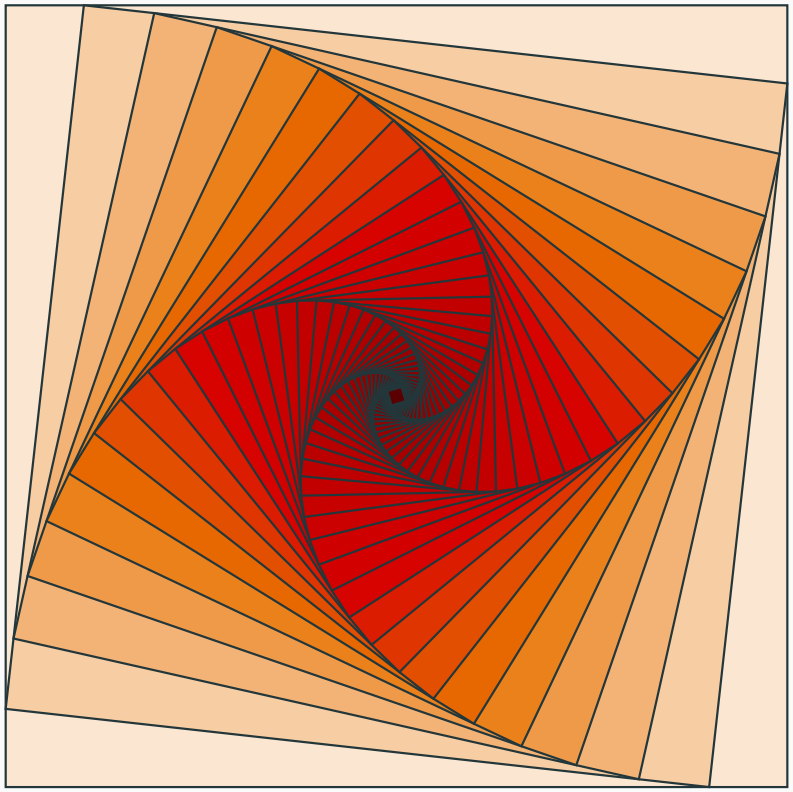


Figure 1: Rotated square from texample.net.

Tables

Table 1: Largest cities in the world (source: Wikipedia)

City	Population
Mexico City	20,116,842
Shanghai	19,210,000
Peking	15,796,450
Istanbul	14,160,467

Blocks

Three different block environments are pre-defined and may be styled with an optional background color.

Default

Block content.

Alert

Block content.

Example

Block content.

Default

Block content.

Alert

Block content.

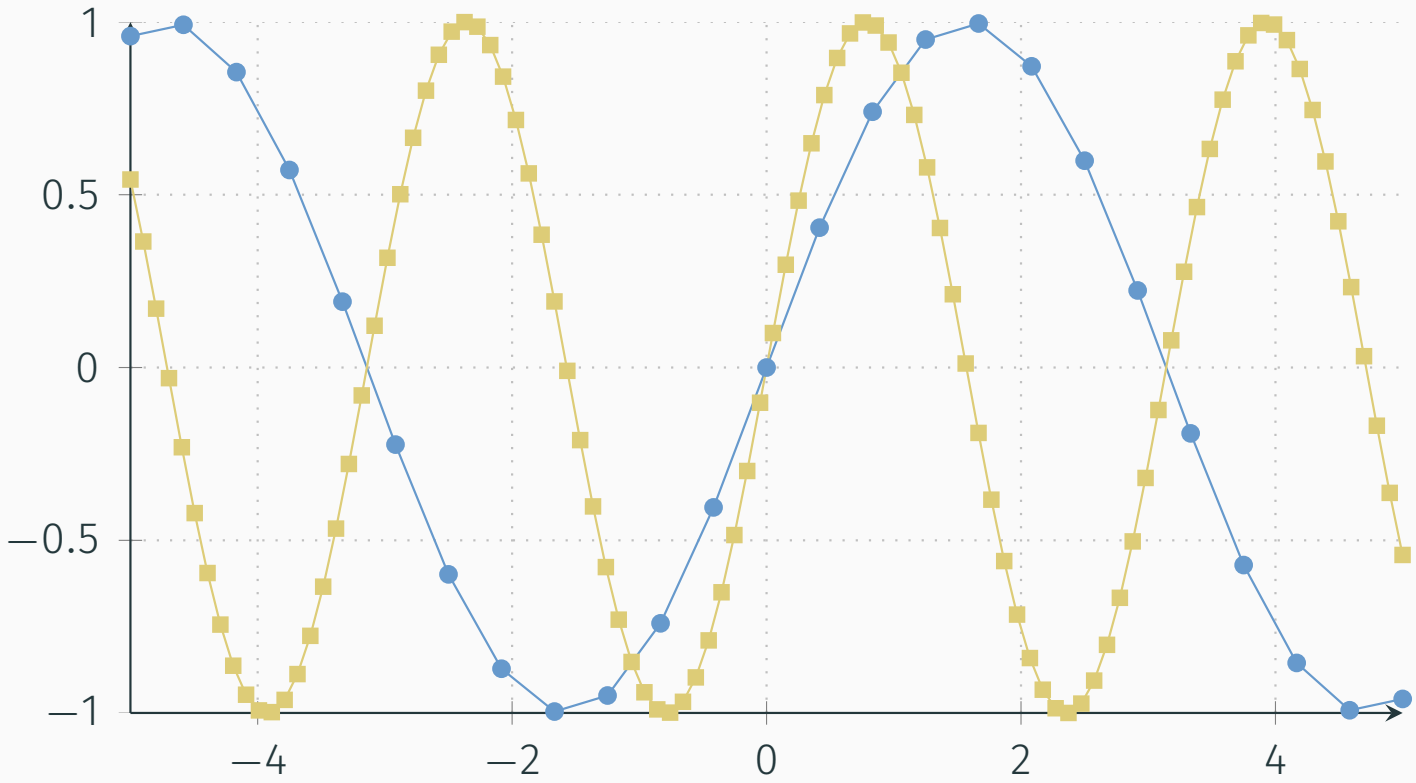
Example

Block content.

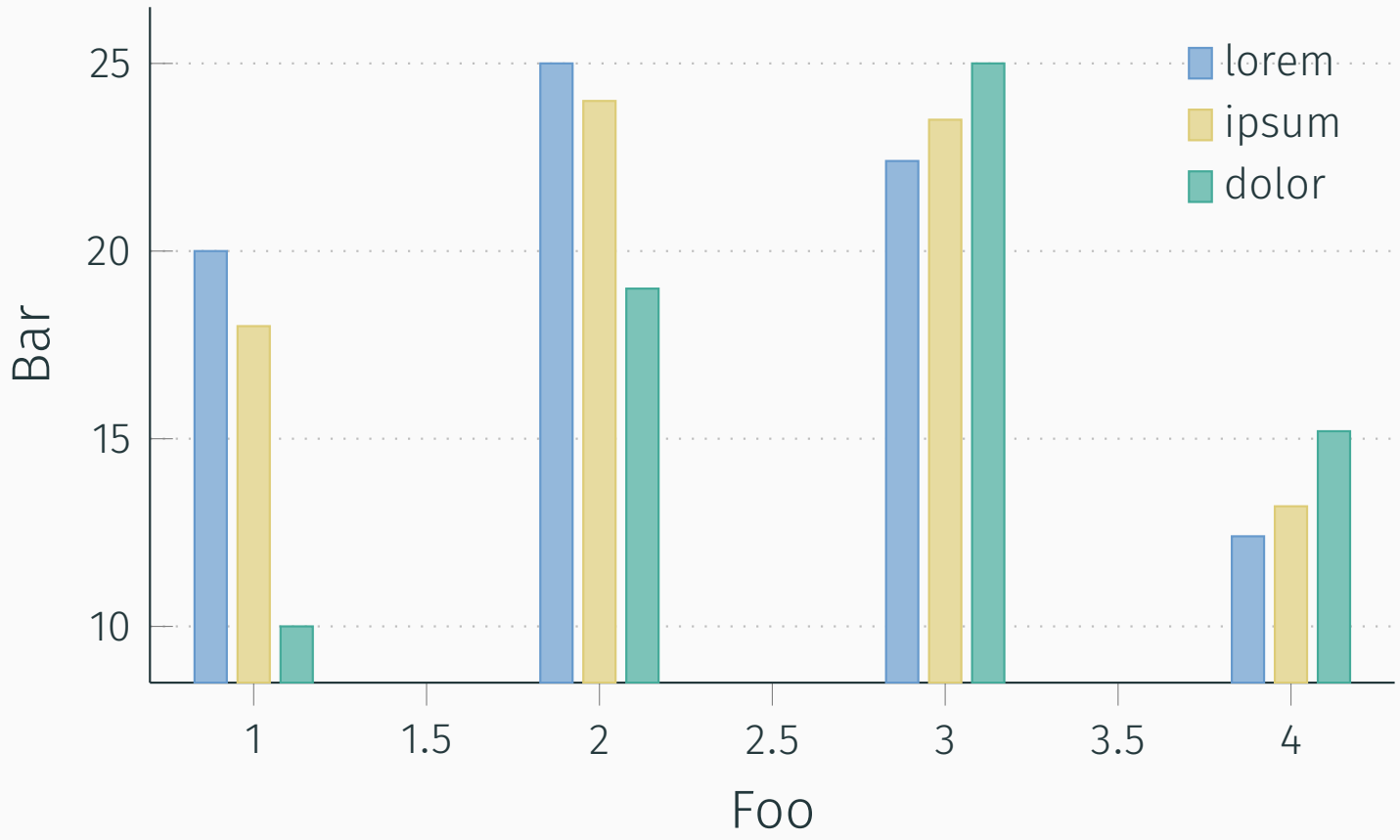
Math

$$e = \lim_{n \to \infty} \left(1 + \frac{1}{n}\right)^n$$

Line plots



Bar charts



Quotes

Veni, Vidi, Vici

Frame footer

METROPOLIS defines a custom beamer template to add a text to the footer. It can be set via

```
\setbeamertemplate{frame footer}{My custom footer}
```

References

Some references to showcase [allowframebreaks] [**?**, **?**, **?**, **?**, **?**]

Conclusion

Summary

1. Concreteness costs
2. Abstracting algorithms to their most general setting without losing efficiency
3. Know your algorithms

Questions?

Backup slides

Sometimes, it is useful to add slides at the end of your presentation to refer to during audience questions.

The best way to do this is to include the `appendixnumberbeamer` package in your preamble and call `\appendix` before your backup slides.

METROPOLIS will automatically turn off slide numbering and progress bars for slides in the appendix.

References I