Datentypen, die den Definitionsbereich genau abbilden

Adrian Imboden

adi@thingdust.com
adrian.imboden@komaxgroup.com

`https://github.com/adrianimboden/cppusergroup-datatypes-with-domain`

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Inhalt

Inhalt

Intro

- Wir haben genug Zeit
- Der Hauptteil wird Hands-On sein
- Diskussionen sind explizit erwünscht

Inhalt

Motivation

```
my_list = [1, 2, 3]
do_something(my_list)
assert (my_list == [1, 2, 3])
```

Motivation

```
secret_global = None


def do_something(value):
    global secret_global
    value.append('new fancy value')  # no const
    secret_global = value  # everything is shared


my_list = [1, 2, 3]
do_something(my_list)
assert (my_list == [1, 2, 3])
```

Motivation

```java
import java.util.ArrayList;

public class HelloWorld
{
  static ArrayList<Integer> cache;
  static void doSomething(ArrayList<Integer> list) { // null?
    list.add(5);  // no language-level const
    cache = list; // (almost) everything is always shared
  }

  public static void main(String[] args)
  {
    final ArrayList<Integer> my_list = new ArrayList<>();
    my_list.add(1);
    doSomething(my_list);
    doSomething(null);
  }
}
```

Motivation

```
using System;
using System.Collections.Generic;

public class HelloWorld
{
  public static List<int> cache;
  public static void doSomething(List<int> list) { //null?
    list.Add(5);  // no language-level const
    cache = list; // shareability is a type-design decision
  }

  public static void main(String[] args)
  {
    List<int> my_list = new List<int>();
    my_list.Add(1);
    doSomething(my_list);
    doSomething(null);
  }
}
```

Inhalt

Value Type

Alles was sich wie ein “int” verhält:

- Kopierbar
- Kein (sichtbares) sharing
- Keine Werte ausserhalb vom Wertebereich (nicht nullable)
- const ist transitiv

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Konkret:

- int
- std::string
- std::vector
- std::optional
- std::variant

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Konkret:

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- std::vector
- std::optional
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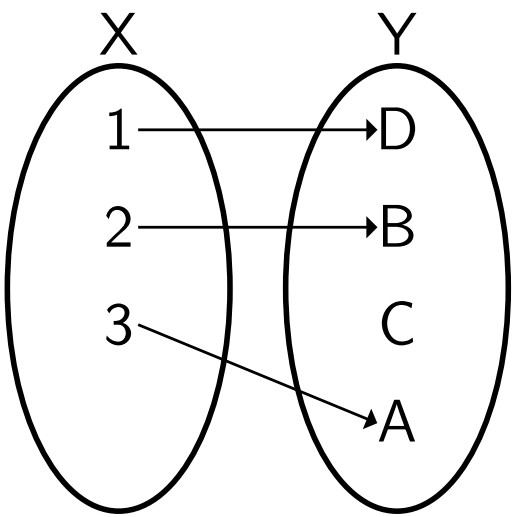
Kurz: fast alle Typen in der Standardlibrary

Definitionsmenge

In der Mathematik versteht man unter Definitionsmenge oder Definitionsbereich die Menge mit genau den Elementen, unter denen die Funktion definiert bzw. die Aussage erfüllbar ist.



Quelle: wikipedia.org

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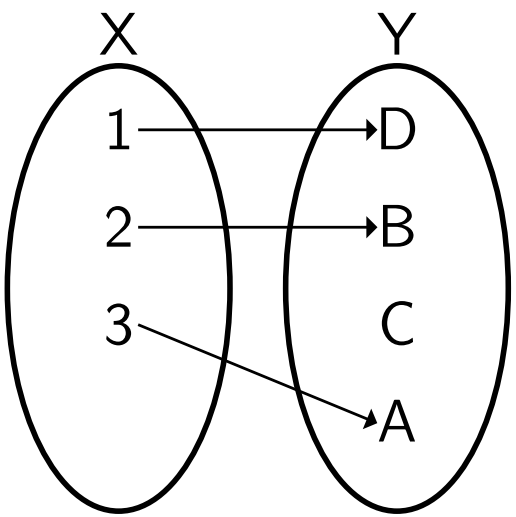

Quelle: wikipedia.org

```
using X = int;
using Y = char;

Y foo(X input) {
  switch (input) {
  case 1: return 'D';
  case 2: return 'B';
  case 3: return 'A';
  }
  throw std::out_of_range{
    "value out of domain",
  };
}
```

Datentyp für Definitionsmenge

```
class X {
  int value_;

public:
  explicit X(int value) : value_{value} {
    if ((value_ < 1) or (value_ > 3))
      throw std::out_of_range{
        "value not in domain",
      };
  }

  operator int() const { return value_; }
};
```

Vergleich

```
using X = int;
```

```
Y foo(X input) {
  switch (input) {
  case 1: return 'D';
  case 2: return 'B';
  case 3: return 'A';
  }
  throw std::out_of_range{
    "value out of domain",
  };
}

int main() {
  const auto value = X{5};
  foo(value); // throws
}
```

Vergleich

```
using X = int;
```

```
class X {
public:
  explicit X(int value);
  operator int() const;
};
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using X = int;
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  };
}

int main() {
  const auto value = X{5};
  foo(value); // throws
}
```

```
Y foo(X input) {
  switch (input) {
  case 1: return 'D';
  case 2: return 'B';
  case 3: return 'A';
  }
  assert(false); // unreachable
}
```

Vergleich

```
using X = int;
```

```
class X {
public:
  explicit X(int value);
  operator int() const;
};
```

```
Y foo(X input) {
  switch (input) {
  case 1: return 'D';
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  case 3: return 'A';
  }
  throw std::out_of_range{
    "value out of domain",
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}
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int main() {
  const auto value = X{5};
  foo(value); // throws
}
```

```
int main() {
  const auto value = X{5}; // throws
  foo(value);
}
```

Vergleich

```
int roll_dice() {
  //...
  return 8;
}

int yazzee_count(std::array<int, 5> dies) {
  //...
  return 5;
}

int main() { //
  yazzee_count({
    roll_dice(),
    roll_dice(),
    roll_dice(),
    roll_dice(),
    roll_dice(),
  });
}
```

Vergleich

```
class DieRoll {
  int value_;

public:
  explicit DieRoll(int value) : value_{value} {
    if (value < 1 or value > 6)
      throw std::invalid_argument{"invalid roll"};
  }
  operator int() { return value_; }
};
```

```
int roll_dice() {
  //...
  return 8;
}

int yazzee_count(std::array<int, 5> dies) {
  //...
  return 5;
}

int main() { //
  yazzee_count({
    roll_dice(),
    roll_dice(),
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    roll_dice(),
    roll_dice(),
  });
}
```

Vergleich

```cpp
int roll_dice() {
  //...
  return 8;
}

int yazzee_count(std::array<int, 5> dies) {
  //...
  return 5;
}

int main() { //
  yazzee_count({
    roll_dice(),
    roll_dice(),
    roll_dice(),
    roll_dice(),
    roll_dice(),
  });
}
```

```cpp
class DieRoll {
  int value_;

public:
  explicit DieRoll(int value) : value_{value} {
    if (value < 1 or value > 6)
      throw std::invalid_argument{"invalid roll"};
  }
  operator int() { return value_; }
};


DieRoll roll_dice() {
  //...
  return DieRoll{7};
}

int yazzee_count(std::array<DieRoll, 5> dies) {
  //...
  return 5;
}

int main() { //
  yazzee_count({
    roll_dice(),
    roll_dice(),
    roll_dice(),
    roll_dice(),
    roll_dice(),
  });
}
```

Realbeispiele aus der Praxis

- Utf8String
- Message
- Milliesconds
- Configuration

Inhalt

Beispiel Zahlen

```
template <typename T, T from, T to>
class Number {
  T value_;

public:
  static_assert(from <= to);
  explicit Number(T value)
    : value_{value} {
    if (!((value_ >= from) && (value_ <= to))) {
      throw std::out_of_range("value not in domain");
    }
  }

  operator T() const { return value_; }
};

int main() {
  const auto a = Number<int, 2, 5>{3};
  const auto b = Number<int, 1, 2>{2};

  const auto c = Number<int, 4, 5>{a}; //-> runtime error
  const auto d = Number<int, 1, 2>{8}; //-> runtime error
  const auto e = Number<int, 1, 5>{a}; //-> implicit conversion
}
```

Beispiel Zahlen Erweitert

```
int main() {
  const auto a = Number<int, 2, 5>{3};
  const auto b = Number<int, 1, 2>{2};

  static_assert(std::is_same_v<decltype(a + b), Number<int, 3, 7>>);
  static_assert(std::is_same_v<decltype(a - b), Number<int, 0, 4>>);
  static_assert(std::is_same_v<decltype(a * b), Number<int, 2, 10>>);
  static_assert(std::is_same_v<decltype(a / b), Number<int, 1, 5>>);

  constexpr auto c = Number<int, 1, 2>{8}; //-> does not compile

  const auto d = Number<int, 1, 2>{8}; //-> runtime error

  const auto e = Number<int, 4, 5>{a}; //-> static assert

  const auto f = Number<int, 1, 5>{a}; //-> implicit conversion
}
```

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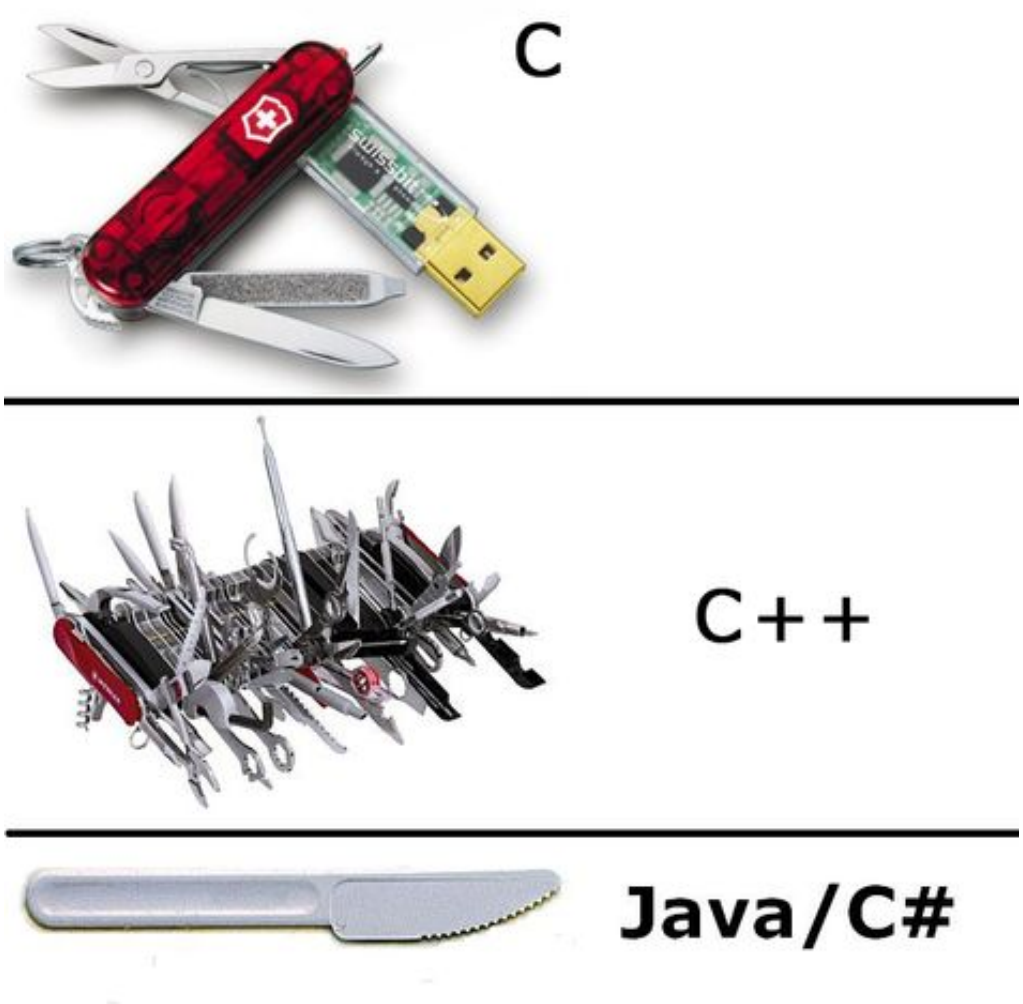
Hands-on



Quelle: https://www.pinterest.com

The End