Programmierkurs 2

Aufgaben für die Vorbereitung auf die Klausur im Wintersemester 2016/17

**Disclaimer:**

Die Aufgaben in diesem Dokument sind so konzipiert, dass sie ohne Hilfsmittel zu lösen sind und beruhen auf Wissen, welches in der Vorlesung „Programmierkurs 2“ im Wintersemester 2016/17 vermittelt wurde.

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Gegebenenfalls werde ich abgeschätzte Bearbeitungszeiten an die Aufgaben schreiben und den Schwierigkeitsgrad, damit ihr evaluieren könnt wie sicher ihr in den Themengebieten seid.

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# Versionshistorie

* 0.2.0
  + Added „C++ > Klassen und Vererbung“
  + Added „C++ > Klassen und Vererbung 2, Polymorphie und virtuelle Funktionen“
  + Added „C++ > Klassen und Vererbung 3, Mehrfachvererbung“
  + Added Footer
* 0.1.12
  + Renamed „C > Types & Sizes“ to „C > Datentypen und ihre Größen“
  + Split „C > Datentypen und ihre Größen“ into two paragraphs
  + Renamed „C > Libraries“ to „C > Abhängigkeitsbibliotheken“
  + Renamed „C > Zeigerarithmetik & Arrays“ to „C > Zeigerarithmetik und Arrays“
* 0.1.11
  + Added Disclaimer
* 0.1.10
  + Added „C > Types & Sizes“
* 0.1.9
  + Added „C > Funktionszeiger“
  + Added „C > Funktionszeiger 2“
* 0.1.8
  + Polished some code designs
* 0.1.7
  + Added „C > Malloc & free“
* 0.1.6
  + Added „C > Libraries“
* 0.1.5
  + Added „C > Zeigerarithmetik & Arrays“
  + Added „C > Zeigerarithmetik & Arrays 2“
  + Added „C > Zeigerarithmetik & Arrays 3“
* 0.1.4
  + Added TODOs
* 0.1.3
  + Design overhaul
* 0.1.2
  + Added „C > Struts and Unions“
  + Added „C > Struts and Unions 2“
* 0.1.1
  + Added „C > Startpunkt“
  + Added „C > Makefile“
* 0.1.0
  + Added „GNU Free Documentation License“
* 0.0.1
  + First document design

# C

## Startpunkt

Was hiervon sind valide Deklarationen der Main Methode? (ankreuzen)

|  |  |
| --- | --- |
| int main(int argc, char \*argv[]) { return 0; } | □ |
| int main(){ return 0; } | □ |
| float main(){ return 0; } | □ |
| void main() { return 0; } | □ |
| int main(int argc, char \*\*argv) { return 0; } | □ |
| int main(void) { return 0; } | □ |
| char\* main() { return 0; } | □ |

## Makefile

Situation: Zwei Quelldateien main.c und summe.c sowie die Headerdatei summe.h, die main.c ruft die Methode int make\_sum(int a, int b).  
Schreiben Sie ein makefile, welches die Dateien kompiliert und eine ausführbare Datei „main“ erstellt. Beachten Sie dabei, dass die Anweisungen die Abhängigkeiten der Quelldateien beachten(Bonus wenn beim Kompilieren der richtige C-Standard angegeben wird)

main.c

#include <stdio.h>

#include "summe.h"

int main**(**void**)**

**{**

printf**(**"Summe von 9 und 21 ist %d\n"**,** make\_sum**(**9**,**21**));**

**}**

summe.c

int make\_sum**(**int a**,** int b**)**

**{**

**return** a**+**b**;**

**}**

summe.h

int make\_sum**(**int a**,** int b**);**

makefile

## Structs und Unions

#include <stdio.h>

struct teststruct **{**

int a**;**

char b**;**

**};**

union testunion **{**

int a**;**

char b**;**

**};**

int main**()**

**{**

/\* Auszug aus der ASCII Tabelle

65 = A

66 = B \*/

struct teststruct s**;**

s**.**a **=** 65**;**

s**.**b **=** 66**;**

printf**(**"s.a = %d\n"**,** s**.**a**);**

printf**(**"s.b = %c\n"**,** s**.**b**);**

union testunion u**;**

u**.**a **=** 65**;**

u**.**b **=** 66**;**

printf**(**"u.a = %d\n"**,** u**.**a**);**

printf**(**"u.b = %c\n"**,** u**.**b**);**

**return** 0**;**

**}**

Sie sehen das Programm auf der rechten Seite, es ist laut C11 Standard valide und kompiliert ohne Fehler.  
Wie sieht die Ausgabe des Programms aus?

s.a =

s.b =

u.a =

u.b =

## Structs und Unions 2

Welche der drei unteren Aussagen trifft zu?

Die Struktur s ist…

|  |  |
| --- | --- |
| kleiner als das Union u | □ |
| gleich groß wie das Union u | □ |
| größer als das Union u | □ |

#include <stdio.h>

struct point\_s **{**

int x**;**

char y**;**

**};**

//hier kommt die Typdefinition hin:

int main**()**

**{**

struct point\_s p1 **=** **{** 5**,** 7 **};**

point p2 **=** **{** 3**,** 2 **};**

printf**(**"p1.x = %d, p1.y = %d\n"**,** p1**.**x**,** p1**.**y**);**

printf**(**"p2.x = %d, p2.y = %d\n"**,** p2**.**x**,** p2**.**y**);**

**return** 0**;**

**}**

## Typedef

Ergänzen Sie den nebenstehenden Programmcode so, dass ein neuer Typ definiert wird mit Namen point, der auf die Struktur point\_s zeigt, sodass der untere Code nach C11 Standard valide ist und kompiliert.

## Zeigerarithmetik und Arrays

Was sind laut C11 Standard valide Deklaration für ein Array aus Integer Werten? Wie groß ist das Array(nichts angeben, falls es sich um eine nicht valide Deklaration handelt)

|  |  |  |
| --- | --- | --- |
| **Deklaration** | **valide?** | **Maximale Anzahl der enthaltenen Elemente?** |
| int arr1[] = { 2 }; | □ |  |
| int arr2[]; | □ |  |
| int arr3[1]; | □ |  |
| int arr4[2] = { 6 }; | □ |  |

## Zeigerarithmetik und Arrays 2

Ergänzen Sie den unteren Programmcode so, dass die Methode void uppercase(?) einen Zeiger erwartet, dessen Wert überprüft wie im Programmcode angegeben und ihn ggf. auf einen neuen Wert setzt. Beim Aufruf der Methode void uppercase(?) soll ein Zeiger auf den char c1 übergeben werden, nicht c1 selber.

#include <stdio.h>

void uppercase**(** **)**

**{**

char tmp **=** **;**//Wert von Übergabeparameter der Variable tmp zuweisen

//Prüfe ob der Wert im lowercase Bereich liegt

**if(**tmp **>=** 'a' **&&** tmp **<=** 'z'**)**

**{**

tmp **=** tmp **-** 'a' **+** 'A'**;**

**=** tmp**;** //Weise dem Speicher, auf den der Zeiger zeigt, den Wert von tmp zu

**}**

**}**

int main**()**

**{**

char c1 **=** 'a'**;**

printf**(**"c1 = '%c'\n"**,** c1**);**

printf**(**"making c1 uppercase..\n"**);**

uppercase**(** **);**

printf**(**"c1 = '%c'\n"**,** c1**);**

**return** 0**;**

**}**

Die Ausgabe des korrekt vervollständigten Programms würde dann so aussehen

c1 = 'a'

making c1 uppercase..

c1 = 'A'

## Zeigerarithmetik und Arrays 3

*In C gibt es von Haus aus nicht den Datentyp String, stattdessen wird dieser Datentyp über ein Chararray simuliert, dessen letztes Element ein ‘\0‘ ist, sodass man nicht die Länge des Arrays angeben muss. Dieser simulierte String lässt sich einmal über die ganz normale Arraydeklaration definieren, wobei das letzte Element ein ‘\0‘ ist(in der Aufgabe Variable str1). Der Nullterminator muss nicht am Ende des eigentlichen Arrays stehen, aber dies hat zur Folge, dass Methoden wie z.B. printf() alle Elemente nach dem Nullterminator ignorieren – gleichbedeutend ist das Verhalten undefiniert wenn ein so simulierter String keinen Nullterminator enthält. Weiterhin kann man ein nullterminiertes Chararray auch durch die Deklaration mit doppelten Anführungszeichen erzeugen(in der Aufgabe Variable str1), was deutlich einfacher und natürlicher ist, aber komplett gleichbedeutend mit der Arraynotation ist.*

Vervollständigen Sie die Methode void uppercase\_string(char \* str) so, dass alle Elemente eines übergebenen nullterminierten Chararrays uppercase sind

#include <stdio.h>

int work**(**char**\*** str**);**

void uppercase\_string**(**char**\*** str**)**;

int main**()**

**{**

char str1**[]** **=** **{** 'h'**,** 'e'**,** 'l'**,** 'l'**,** 'o'**,** '\0' **};**

char str2**[]** **=** "world"**;**

work**(**str1**);**

work**(**str2**);**

**return** 0**;**

**}**

int work**(**char**\*** str**)**

**{**

printf**(**"str = '%s'\n"**,** str**);**

printf**(**"making str uppercase..\n"**);**

uppercase\_string**(**str**);**

printf**(**"str = '%s'\n"**,** str**);**

**}**

void uppercase\_string**(**char**\*** str**)**

**{**

int i**;**

**for(**i**=**0**;** **!=** '\0'**;** i**++)**

**{**

**if((** **>=** 'a'**)** **&& (** **<=** 'z'**))**

**{**

**=** **-** 'a' **+** 'A'**;**

**}**

**}**

**}**

Die Ausgabe des korrekt vervollständigten Programms würde dann so aussehen

str = 'hello'

making str uppercase..

str = 'HELLO'

str = 'world'

making str uppercase..

str = 'WORLD'

## Funktionszeiger

Vervollständigen Sie das untere Programm so, dass die Funktion int work(int a, ?) einen int und einen Funktionszeiger, welcher als Parameter sowie als Rückgabe einen int hat, erwartet. Die Funktion int work(int a, ?) ruft den Funktionszeiger auf und gibt den Wert zurück.

Weiterhin soll die int main() Funktion zwei Funktionszeiger erstellen, mit denen nachher die Funktion int work(int a, ?) aufgerufen wird. Der erste Funktionszeiger fp1 soll auf die Funktion int add\_two(int a) verweisen, der zweite fp2 auf die Funktion int add\_multiply\_by\_three(int a).

#include <stdio.h>

int add\_two**(**int a**)**

**{**

**return** a**+**2**;**

**}**

int multiply\_by\_three**(**int a**)**

**{**

**return** a**\***3**;**

**}**

int work**(**int a**,** **)**

**{**

**return** **;**

**}**

int main**()**

**{**

int a **=** 7**;**

printf**(**"work(a, fp1) = %d\n"**,** work**(**a**,** fp1**));**

printf**(**"work(a, fp2) = %d\n"**,** work**(**a**,** fp2**));**

**return** 0**;**

**}**

Die Ausgabe des korrekt vervollständigten Programms würde dann so aussehen

work(a, fp1) = 9

work(a, fp2) = 21

## Funktionszeiger 2

Was gibt das untere Programm bei Ausführung aus?

#include <stdio.h>

int add**(**int a**,** int b**)**

**{**

**return** a**+**b**;**

**}**

int subtract**(**int a**,** int b**)**

**{**

**return** a**-**b**;**

**}**

int multiply**(**int a**,** int b**)**

**{**

**return** a**\***b**;**

**}**

int divide**(**int a**,** int b**)**

**{**

**return** a**/**b**;**

**}**

int main**()**

**{**

int **(\*** fp1**)** **(**int**,** int**)** **=** add**;**

int **(\*** fp2**)** **(**int**,** int**)** **=** **&**subtract**;**

int **(\*** fp3**)** **(**int**,** int**)** **=** **\***multiply**;**

int **(\*** fp4**)** **(**int**,** int**)** **=** **\*\***divide**;**

int a **=** 7**;**

int b **=** 3**;**

printf**(**"fp1 = %d\n"**,** **(\***fp1**)** **(**a**,** b**));**

printf**(**"fp2 = %d\n"**,** fp2**(**a**,** b**));**

printf**(**"fp3 = %d\n"**,** **(\***fp3**)** **(**a**,** b**));**

printf**(**"fp4 = %d\n"**,** fp4**(**a**,** b**));**

printf**(**"etwas Action reinbringen..\n"**);**

fp2 **=** fp1**;**

fp1 **=** fp3**;**

printf**(**"fp1 = %d\n"**,** **(\***fp1**)** **(**a**,** b**));**

printf**(**"fp2 = %d\n"**,** fp2**(**a**,** b**));**

printf**(**"fp3 = %d\n"**,** **(\***fp3**)** **(**a**,** b**));**

printf**(**"fp4 = %d\n"**,** fp4**(**a**,** b**));**

**return** 0**;**

**}**

Ausgabe:

fp1 =

fp2 =

fp3 =

fp4 =

etwas Action reinbringen..

fp1 =

fp2 =

fp3 =

fp4 =

## Datentypen und ihre Größen

Wie groß ist ein int laut C11 Standard? (nur eine Lösung ist korrekt)

|  |  |
| --- | --- |
| 8 bit | □ |
| 16 bit | □ |
| 32 bit | □ |
| 64 bit | □ |
| Bitte ein Bit | □ |
| 128 bit | □ |
| abhängig vom Betriebssystem | □ |

Wie groß ist ein char laut C11 Standard? (nur eine Lösung ist korrekt)

|  |  |
| --- | --- |
| genau 8 bit | □ |
| mindestens 8 bit | □ |
| genau 16 bit | □ |
| mindestens 16 bit | □ |

## Datentypen und ihre Größen 2

Wir haben folgenden Programmcode

#include <stdio.h>

#include <stdlib.h>

int main**()**

**{**

int arr1**[**5**]** **=** **{** 1**,** 2**,** 3 **};**

int arr2**[]** **=** **{** 1**,** 2**,** 3 **};**

int**\*** arr3 **=** **(**int**\*)** malloc**(sizeof(**int**)** **\*** 5**);**

printf**(**"sizeof(int) = %d\n"**,** **sizeof(**int**));**

printf**(**"sizeof(int\*) = %d\n"**,** **sizeof(**int**\*));**

printf**(**"sizeof(arr1) = %d\n"**,** **sizeof(**arr1**));**

printf**(**"sizeof(arr2) = %d\n"**,** **sizeof(**arr2**));**

printf**(**"sizeof(arr3) = %d\n"**,** **sizeof(**arr3**));**

**return** 0**;**

**}**

Wie sieht die Ausgabe aus? (kreise die richtige Ausgabe ein)

(INFO: die Rückgabe von sizeof(int) und sizeof(int\*) wurde mit einer Variable realisiert, da der Rückgabewert abhängig vom System ist)

sizeof(int) = x

sizeof(int\*) = y

sizeof(arr1) = x\*5

sizeof(arr2) = x\*3

sizeof(arr3) = x\*5

a)

sizeof(int) = x

sizeof(int\*) = y

sizeof(arr1) = x\*5

sizeof(arr2) = x\*3

sizeof(arr3) = y

b)

sizeof(int) = x

sizeof(int\*) = y

sizeof(arr1) = x\*3

sizeof(arr2) = x\*3

sizeof(arr3) = y

c)

## Abhängigkeitsbibliotheken

Sie haben die Quelldateien auto.c, fahrrad.c die zu einer Library fahrzeug.a hinzugefügt werden sollen via den Anweisungen im makefile und dem Konsolentool „ar“

auto.c

#include <stdio.h>

#include "fahrzeug.h"

Auto new\_auto**(**char**\*** bezeichnung**,** int ps**,** double preis**)**

**{**

Auto a **=** **{** bezeichnung**,** ps**,** preis **};**

**return** a**;**

**}**

void print\_auto**(**Auto a**)**

**{**

printf**(**"bezeichnung = %s, ps = %d, preis = %.2f"**,** a**.**bezeichnung**,** a**.**ps**,** a**.**preis**);**

**}**

fahrrad.c

#include <stdio.h>

#include "fahrzeug.h"

Fahrrad new\_fahrrad**(**char**\*** bezeichnung**,** double preis**)**

**{**

Fahrrad f **=** **{** bezeichnung**,** preis **};**

**return** f**;**

**}**

void print\_fahrrad**(**Fahrrad f**)**

**{**

printf**(**"bezeichnung = %s, preis = %.2f"**,** f**.**bezeichnung**,** f**.**preis**);**

**}**

fahrzeug.h

#ifndef FAHRZEUG\_H\_

#define FAHRZEUG\_H\_

**typedef** struct **{**

char**\*** bezeichnung**;**

int ps**;**

double preis**;**

**}** Auto**;**

Auto new\_auto**(**char**\*** bezeichnung**,** int ps**,** double preis**);**

void print\_auto**(**Auto a**);**

**typedef** struct **{**

char**\*** bezeichnung**;**

double preis**;**

**}** Fahrrad**;**

Fahrrad new\_fahrrad**(**char**\*** bezeichnung**,** double preis**);**

void print\_fahrrad**(**Fahrrad f**);**

#endif

main.c

#include <stdio.h>

#include "fahrzeug.h"

int main**()**

**{**

Auto a **=** new\_auto**(**"Ford Fiesta"**,** 42**,** 1337.0**);**

Fahrrad f **=** new\_fahrrad**(**"Hollandrad"**,** 420.0**);**

printf**(**"Auto a: "**);**

print\_auto**(**a**);**

printf**(**"\n"**);**

printf**(**"Fahrrad f: "**);**

print\_fahrrad**(**f**);**

printf**(**"\n"**);**

**return** 0**;**

**}**

makefile

Bonus:

Warum sind in der Headerdatei fahrzeug.h diese Compileranweisungen enthalten?

#ifndef FAHRZEUG\_H\_

#define FAHRZEUG\_H\_

[…]

#endif

## malloc & free

Vervollständigen Sie das Programm so, dass die Funktion char\* create\_string(int length, char init) ein Chararray dynamisch mittels der Library stdlib.h erzeugt mit length Elementen, die den Wert von init haben. Zudem soll das Chararray nullterminiert sein.

Weiterhin soll die Methode void delete\_string(char\* str) ein dynamisch erzeugtes Chararray übergeben bekommen und dieses mittels der Library stdlib.h löschen

#include <stdio.h>

#include <stdlib.h>

char**\*** create\_string**(**int length**,** char init**)**

**{**

char**\*** str **= ;**

int i**;**

**for(**i**=**0**;** **;** i**++)**

**{**

str**[**i**]** **=** init**;**

**}**

**return** str**;**

**}**

void delete\_string**(**char**\*** str**)**

**{**

**}**

int main**()**

**{**

char**\*** str1 **=** create\_string**(**5**,** 'a'**);**

char**\*** str2 **=** create\_string**(**9**,** 'B'**);**

printf**(**"str1 = %s\n"**,** str1**);**

printf**(**"str2 = %s\n"**,** str2**);**

delete\_string**(**str1**);**

delete\_string**(**str2**);**

**return** 0**;**

**}**

Die Ausgabe des korrekt vervollständigten Programms würde dann so aussehen

str1 = aaaaa

str2 = BBBBBBBBB

# C++

## Klassen und Vererbung

Erstellen Sie eine Klasse Auto mit den folgenden Eigenschaften:

* Sie hat zwei (private) Attribute
  + Einen std::string namens „name“
  + Einen int namens „baujahr“
* Einem öffentlichen Konstruktor der einen std::string und einen int übergeben bekommt und die oben genannten Attribute initialisiert. Diesen bitte in der Headerdatei Auto.h implementieren
* Einen öffentlichen Destruktor der vollständigkeit halber, der jedoch nichts macht, da die Klasse Auto nur Werteobjekte enthält dessen Destruktor implizit aufgerufen wird. Diesen bitte in der Headerdatei Auto.h implementieren
* Eine öffentliche Methode std::string getBeschreibung(). Diese bitte in der Headerdatei Auto.h angeben und in der Auto.cpp implementieren

Benutzen Sie die dabei vorgegebenen Textboxen in denen Teile bereits implementiert sind.

makefile

main**:** main.cpp Auto.h Auto.o

g++ main.cpp -o main Auto.o -std=c++11

Auto.o**:** Auto.cpp Auto.h

g++ Auto.cpp -c -std=c++11

clean**:**

rm Auto.o main

main.cpp

#include <iostream>

#include "Auto.h"

int main**()**

**{**

Auto**\*** a1 **=** **new** Auto**(**"Trabant 601"**,** 1976**);**

Auto**\*** a2 **=** **new** Auto**(**"Porsche 911"**,** 1963**);**

std**::**cout **<<** a1**->**getBeschreibung**()** **<<** std**::**endl**;**

std**::**cout **<<** a2**->**getBeschreibung**()** **<<** std**::**endl**;**

**return** 0**;**

**}**

Die Ausgabe des korrekt vervollständigten Programms würde dann so aussehen

Auto: name='Trabant 601', baujahr=1976

Auto: name='Porsche 911', baujahr=1963

Auto.h

#ifndef AUTO\_H

#define AUTO\_H

#include <string>

#endif

Auto.cpp

#include "Auto.h"

// hier "std::string getBeschreibung()" implementieren

**{**

std**::**string out **=** "Auto: name='" **+** name **+** "', baujahr=" **+** std**::**to\_string**(**baujahr**);**

**return** out**;**

**}**

## Klassen und Vererbung 2, Polymorphie und virtuelle Funktionen

In der folgenden Aufgabe haben wir die zwei Klassen Dreirad und Panzer, die von der abstrakten Klasse Fahrzeug ableiten.

Wie lautet die Ausgabe(ganz unten)?

makefile

main**:** main.cpp Fahrzeug.h Fahrzeug.o Dreirad.h Dreirad.o Panzer.h Panzer.o

g++ main.cpp -o main Fahrzeug.o Dreirad.o Panzer.o -std=c++11

Dreirad.o**:** Dreirad.cpp Dreirad.h Fahrzeug.o

g++ Dreirad.cpp -c Fahrzeug.o -std=c++11

Panzer.o**:** Panzer.cpp Panzer.h Fahrzeug.o

g++ Panzer.cpp -c Fahrzeug.o -std=c++11

Fahrzeug.o**:** Fahrzeug.cpp Fahrzeug.h

g++ Fahrzeug.cpp -c -std=c++11

clean**:**

rm Fahrzeug.o Panzer.o Dreirad.o main

Fahrzeug.h

#ifndef FAHRZEUG\_H

#define FAHRZEUG\_H

#include <string>

class Fahrzeug

**{**

private**:**

int baujahr**;**

public**:**

Fahrzeug**(**int \_baujahr**)** **:** baujahr**(**\_baujahr**)** **{};**

**~**Fahrzeug**()** **{};**

int inline getBaujahr**()** **{** **return** baujahr**;** **};**

std**::**string virtual getBeschreibung**()** **=** 0**;**

std**::**string getTyp**();**

**};**

#endif

Fahrzeug.cpp

#include "Fahrzeug.h"

std**::**string Fahrzeug**::**getTyp**()**

**{**

**return** "Fahrzeug"**;**

**}**

Panzer.h

#ifndef PANZER\_H

#define PANZER\_H

#include <string>

#include "Fahrzeug.h"

class Panzer **:** Fahrzeug

**{**

private**:**

std**::**string name**;**

public**:**

Panzer**(**std**::**string \_name**,** int \_baujahr**)** **:** name**(**\_name**),** Fahrzeug**(**\_baujahr**)** **{};**

**~**Panzer**()** **{};**

std**::**string getBeschreibung**();**

std**::**string getTyp**();**

**};**

#endif

Panzer.cpp

#include "Panzer.h"

std**::**string Panzer**::**getBeschreibung**()**

**{**

std**::**string out **=** "Panzer: name='" **+** name **+** "', baujahr=" **+** std**::**to\_string**(**getBaujahr**());**

**return** out**;**

**}**

std**::**string Panzer**::**getTyp**()**

**{**

**return** "Panzer"**;**

**}**

Dreirad.h

#ifndef DREIRAD\_H

#define DREIRAD\_H

#include <string>

#include "Fahrzeug.h"

class Dreirad **:** Fahrzeug

**{**

private**:**

double preis**;**

public**:**

Dreirad**(**double \_preis**,** int \_baujahr**)** **:** preis**(**\_preis**),** Fahrzeug**(**\_baujahr**)** **{};**

**~**Dreirad**()** **{};**

std**::**string getBeschreibung**();**

std**::**string getTyp**();**

**};**

#endif

Dreirad.cpp

#include "Dreirad.h"

std**::**string Dreirad**::**getBeschreibung**()**

**{**

std**::**string out **=** "Dreirad: preis=" **+** std**::**to\_string**(**preis**)** **+** "$, baujahr=" **+** std**::**to\_string**(**getBaujahr**());**

**return** out**;**

**}**

std**::**string Dreirad**::**getTyp**()**

**{**

**return** "Dreirad"**;**

**}**

main.cpp

#include <iostream>

#include "Fahrzeug.h"

#include "Dreirad.h"

#include "Panzer.h"

int main**()**

**{**

Panzer**\*** p **=** **new** Panzer**(**"Leopard 2"**,** 1979**);**

Dreirad**\*** d **=** **new** Dreirad**(**59.99**,** 2011**);**

std**::**cout **<<** "Beschreibung: " **<<** p**->**getBeschreibung**()** **<<** ", Typ: " **<<** p**->**getTyp**()** **<<** std**::**endl**;**

std**::**cout **<<** "Beschreibung: " **<<** d**->**getBeschreibung**()** **<<** ", Typ: " **<<** d**->**getTyp**()** **<<** std**::**endl**;**

Fahrzeug**\*** f1 **=** **(**Fahrzeug**\*)** p**;**

Fahrzeug**\*** f2 **=** **(**Fahrzeug**\*)** d**;**

std**::**cout **<<** "Beschreibung: " **<<** f1**->**getBeschreibung**()** **<<** ", Typ: " **<<** f1**->**getTyp**()** **<<** std**::**endl**;**

std**::**cout **<<** "Beschreibung: " **<<** f2**->**getBeschreibung**()** **<<** ", Typ: " **<<** f2**->**getTyp**()** **<<** std**::**endl**;**

**return** 0**;**

**}**

Ausgabe:

Beschreibung: , Typ:

Beschreibung: , Typ:

Beschreibung: , Typ:

Beschreibung: , Typ:

Bonus:  
Was bedeutet, dass die Klasse Fahrzeug abstrakt ist?

Bonus2:  
Warum ist die Klasse Fahrzeug abstrakt?

Bonus3:  
Was bedeutet das inline bei der Funktion int inline getBaujahr() in der Klasse Fahrzeug? Vor- und Nachteile nennen sowie die Funktionsweise.

## Klassen und Vererbung 3, Mehrfachvererbung

Wieso ist Mehrfachvererbung mit Vorsicht zu benutzen?

Wieso kann der g++ Compiler die folgende Ergänzung zur Klassenhierarchie von „Klassen und Vererbung 2“ nicht kompilieren?(Beim Compilieren von Panzerdreirad.o meckert er)

Panzerdreirad.h

#ifndef PANZERDREIRAD\_H

#define PANZERDREIRAD\_H

#include <string>

#include "Panzer.h"

#include "Dreirad.h"

class Panzerdreirad **:** Panzer**,** Dreirad

**{**

private**:**

public**:**

Panzerdreirad**(**std**::**string \_name**,** double \_preis**,** int \_baujahr**)** **:** Panzer**(**\_name**,** \_baujahr**),** Dreirad**(**\_preis**,** \_baujahr**)** **{};**

**~**Panzerdreirad**()** **{};**

std**::**string getBeschreibung**();**

std**::**string getTyp**();**

**};**

#endif

Panzerdreirad.cpp

#include "Panzerdreirad.h"

std**::**string Panzerdreirad**::**getBeschreibung**()**

**{**

std**::**string out **=** "Panzerdreirad: name='" **+** getName**()** **+** "', preis=" **+** std**::**to\_string**(**getPreis**())** **+** ", baujahr=" **+** std**::**to\_string**(**getBaujahr**());**

**return** out**;**

**}**

std**::**string Panzerdreirad**::**getTyp**()**

**{**

**return** "Panzerdreirad"**;**

**}**

makefile

main**:** main.cpp Panzerdreirad.h Panzerdreirad.o

g++ main.cpp -o main Fahrzeug.o Dreirad.o Panzer.o -std=c++11

Panzerdreirad.o**:** Panzerdreirad.cpp Panzerdreirad.h Dreirad.o Dreirad.h Panzer.o Panzer.h

g++ Panzerdreirad.cpp -c Dreirad.o Panzer.o -std=c++11

Dreirad.o**:** Dreirad.cpp Dreirad.h Fahrzeug.o

g++ Dreirad.cpp -c Fahrzeug.o -std=c++11

Panzer.o**:** Panzer.cpp Panzer.h Fahrzeug.o

g++ Panzer.cpp -c Fahrzeug.o -std=c++11

Fahrzeug.o**:** Fahrzeug.cpp Fahrzeug.h

g++ Fahrzeug.cpp -c -std=c++11

clean**:**

rm Fahrzeug.o Panzer.o Dreirad.o Panzerdreirad.o main

## Namespaces(TODO)

## Input & output / streams(TODO)

## Operatorenüberladung(TODO)

## Exceptions(TODO)

## Templates(TODO)

# C#

## Präamble(TODO)

## Input & output(TODO)

## Klassen und Vererbung(TODO)

## Namespaces(TODO)

## Exceptions(TODO)

## Observer Modell(TODO)

## Delegates(TODO)

## Events(TODO)

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