Übungen zu Systemnahe Programmierung in C (SPiC) – Wintersemester 2019/2020

Übung 4

Benedict Herzog
Bernhard Heinloth
Tim Rheinfels

Lehrstuhl für Informatik 4
Friedrich-Alexander-Universität Erlangen-Nürnberg

Lehrstuhl für Verteilte Systeme und Betriebssysteme

FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG
TECHNISCHE FAKULTÄT

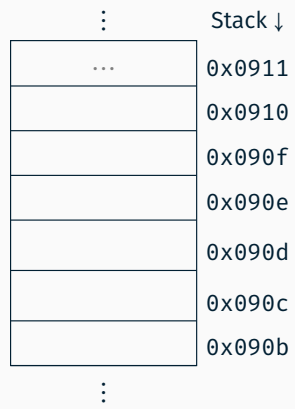
Vorstellung Aufgabe 2

Zeiger & Felder

Vertiefung: Zeiger

- Variable: `uint8_t x`
- Zeiger: `uint8_t *y`
- Adressoperator: `&x`
- Verweisoperator: `*y`

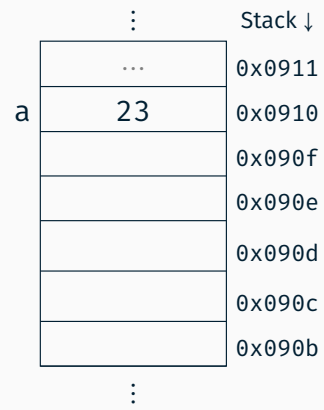
```
01 uint8_t a = 23;
02 uint8_t b = 42;
03 uint8_t * p = &a;
04 *p = 66;
05 p = &b;
06 *p -= 40;
07 uint8_t c = *p;
```



Vertiefung: Zeiger

- Variable: `uint8_t x`
- Zeiger: `uint8_t *y`
- Adressoperator: `&x`
- Verweisoperator: `*y`

```
01 uint8_t a = 23;
02 uint8_t b = 42;
03 uint8_t * p = &a;
04 *p = 66;
05 p = &b;
06 *p -= 40;
07 uint8_t c = *p;
```

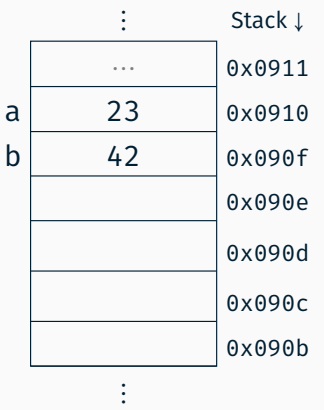


Achtung: Die genaue Anordnung der Variablen auf dem Stack ist abhängig vom Übersetzer und den gewählten Optimierungen!

Vertiefung: Zeiger

- Variable: `uint8_t x`
- Zeiger: `uint8_t *y`
- Adressoperator: `&x`
- Verweisoperator: `*y`

```
01 uint8_t a = 23;
02 uint8_t b = 42;
03 uint8_t * p = &a;
04 *p = 66;
05 p = &b;
06 *p -= 40;
07 uint8_t c = *p;
```

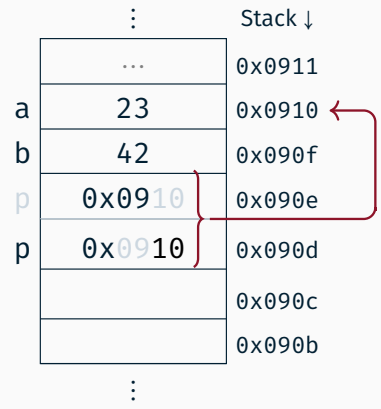


Achtung: Die genaue Anordnung der Variablen auf dem Stack ist abhängig vom Übersetzer und den gewählten Optimierungen!

Vertiefung: Zeiger

- Variable: `uint8_t x`
- Zeiger: `uint8_t *y`
- Adressoperator: `&x`
- Verweisoperator: `*y`

```
01 uint8_t a = 23;
02 uint8_t b = 42;
03 uint8_t * p = &a;
04 *p = 66;
05 p = &b;
06 *p -= 40;
07 uint8_t c = *p;
```

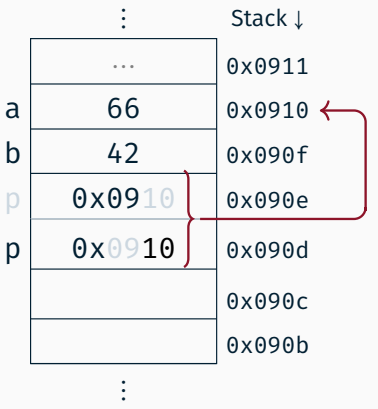


Achtung: ATmega328PB hat 8-bit Register und 16-bit Adressen

Vertiefung: Zeiger

- Variable: `uint8_t x`
- Zeiger: `uint8_t *y`
- Adressoperator: `&x`
- Verweisoperator: `*y`

```
01 uint8_t a = 23;
02 uint8_t b = 42;
03 uint8_t * p = &a;
04 *p = 66;
05 p = &b;
06 *p -= 40;
07 uint8_t c = *p;
```

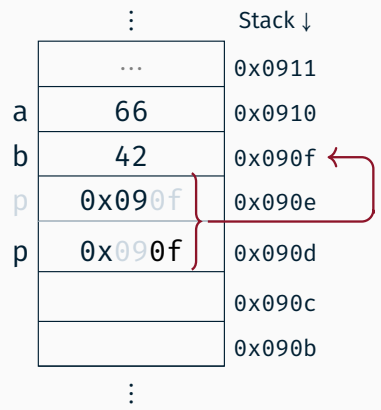


Achtung: ATmega328PB hat 8-bit Register und 16-bit Adressen

Vertiefung: Zeiger

- Variable: `uint8_t x`
- Zeiger: `uint8_t *y`
- Adressoperator: `&x`
- Verweisoperator: `*y`

```
01 uint8_t a = 23;
02 uint8_t b = 42;
03 uint8_t * p = &a;
04 *p = 66;
05 p = &b;
06 *p -= 40;
07 uint8_t c = *p;
```

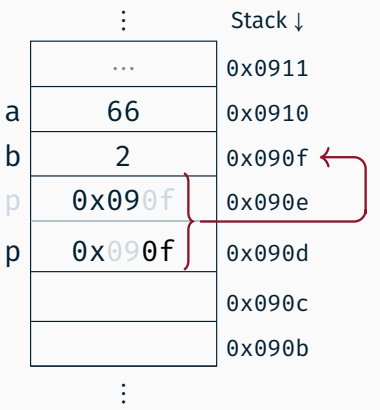


Achtung: ATmega328PB hat 8-bit Register und 16-bit Adressen

Vertiefung: Zeiger

- Variable: `uint8_t x`
- Zeiger: `uint8_t *y`
- Adressoperator: `&x`
- Verweisoperator: `*y`

```
01 uint8_t a = 23;
02 uint8_t b = 42;
03 uint8_t * p = &a;
04 *p = 66;
05 p = &b;
06 *p -= 40;
07 uint8_t c = *p;
```

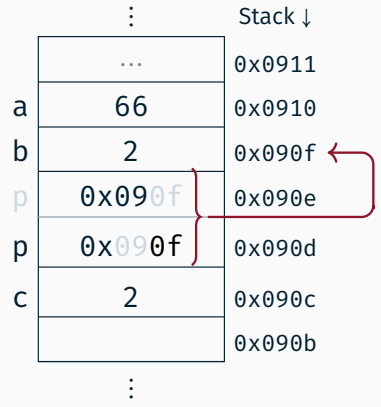


Achtung: ATmega328PB hat 8-bit Register und 16-bit Adressen

Vertiefung: Zeiger

- Variable: `uint8_t x`
- Zeiger: `uint8_t *y`
- Adressoperator: `&x`
- Verweisoperator: `*y`

```
01 uint8_t a = 23;
02 uint8_t b = 42;
03 uint8_t * p = &a;
04 *p = 66;
05 p = &b;
06 *p -= 40;
07 uint8_t c = *p;
```

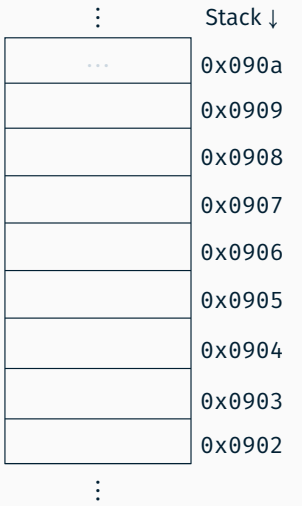


Achtung: ATmega328PB hat 8-bit Register und 16-bit Adressen

Vertiefung: Felder

- Konstanter Zeiger: `uint8_t a[]`
- Variabler Zeiger: `uint8_t *b`
- Aktuelles Element: `*b`
- x-te Element: `b[x]`
- x-te Element: `*(b+x)`

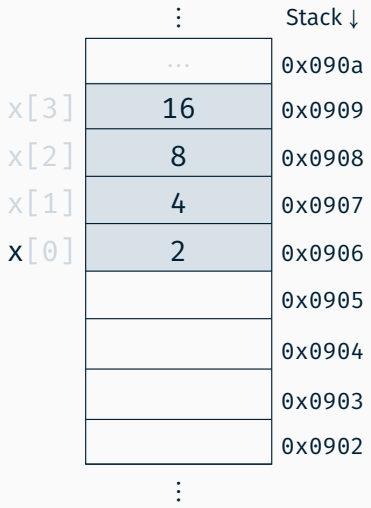
```
08 uint8_t x[] = {2,4,8,16};
09 uint8_t *y = x;
10 uint8_t z = x[1];
11 z = *y;
12 y = y+2;
13 z = *y;
14 z = x[7];
```



Vertiefung: Felder

- Konstanter Zeiger: `uint8_t a[]`
- Variabler Zeiger: `uint8_t *b`
- Aktuelles Element: `*b`
- x-te Element: `b[x]`
- x-te Element: `*(b+x)`

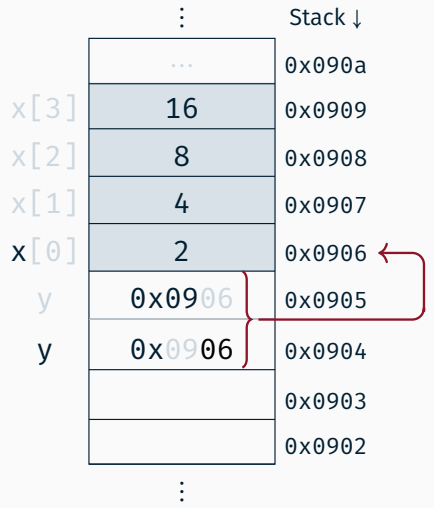
```
08 uint8_t x[] = {2,4,8,16};
09 uint8_t *y = x;
10 uint8_t z = x[1];
11 z = *y;
12 y = y+2;
13 z = *y;
14 z = x[7];
```



Vertiefung: Felder

- Konstanter Zeiger: `uint8_t a[]`
- Variabler Zeiger: `uint8_t *b`
- Aktuelles Element: `*b`
- x-te Element: `b[x]`
- x-te Element: `*(b+x)`

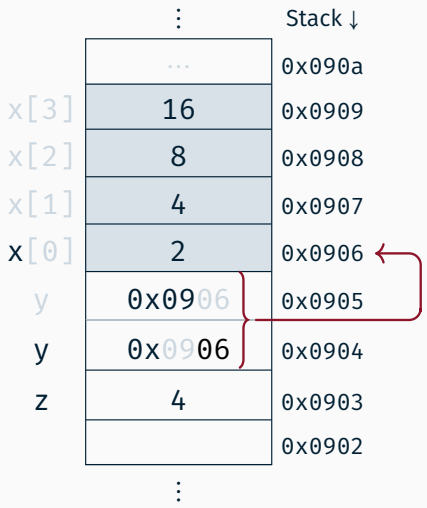
```
08 uint8_t x[] = {2,4,8,16};
09 uint8_t *y = x;
10 uint8_t z = x[1];
11 z = *y;
12 y = y+2;
13 z = *y;
14 z = x[7];
```



Vertiefung: Felder

- Konstanter Zeiger: `uint8_t a[]`
- Variabler Zeiger: `uint8_t *b`
- Aktuelles Element: `*b`
- x-te Element: `b[x]`
- x-te Element: `*(b+x)`

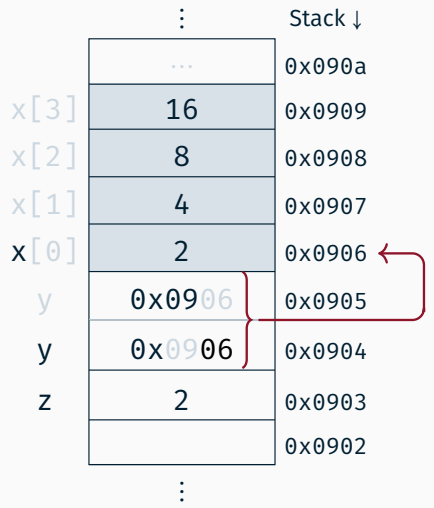
```
08 uint8_t x[] = {2,4,8,16};
09 uint8_t *y = x;
10 uint8_t z = x[1];
11 z = *y;
12 y = y+2;
13 z = *y;
14 z = x[7];
```



Vertiefung: Felder

- Konstanter Zeiger: `uint8_t a[]`
- Variabler Zeiger: `uint8_t *b`
- Aktuelles Element: `*b`
- x-te Element: `b[x]`
- x-te Element: `*(b+x)`

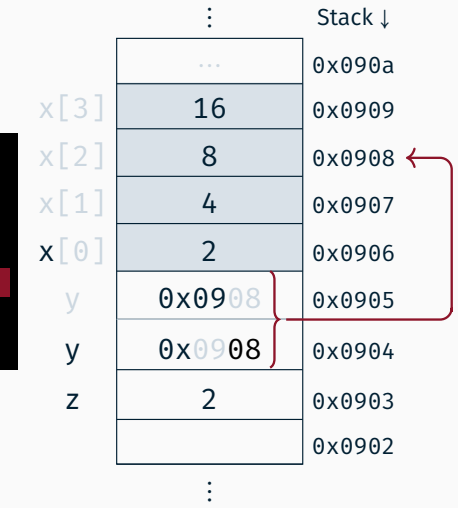
```
08 uint8_t x[] = {2,4,8,16};
09 uint8_t *y = x;
10 uint8_t z = x[1];
11 z = *y;
12 y = y+2;
13 z = *y;
14 z = x[7];
```



Vertiefung: Felder

- Konstanter Zeiger: `uint8_t a[]`
- Variabler Zeiger: `uint8_t *b`
- Aktuelles Element: `*b`
- x-te Element: `b[x]`
- x-te Element: `*(b+x)`

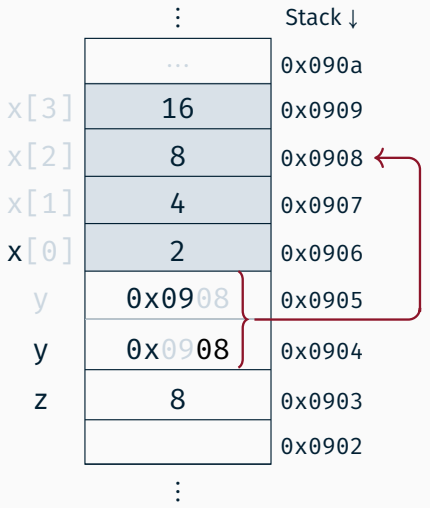
```
08 uint8_t x[] = {2,4,8,16};
09 uint8_t *y = x;
10 uint8_t z = x[1];
11 z = *y;
12 y = y+2;
13 z = *y;
14 z = x[7];
```



Vertiefung: Felder

- Konstanter Zeiger: `uint8_t a[]`
- Variabler Zeiger: `uint8_t *b`
- Aktuelles Element: `*b`
- x-te Element: `b[x]`
- x-te Element: `*(b+x)`

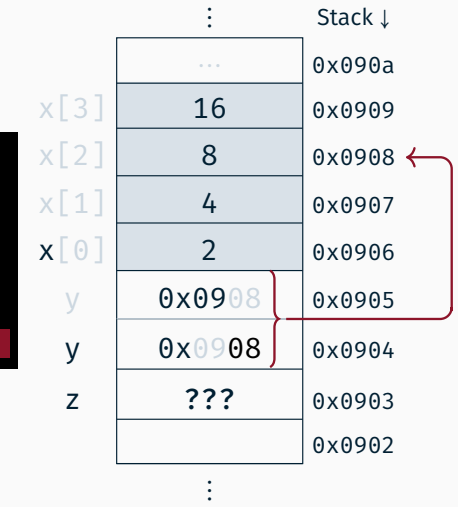
```
08 uint8_t x[] = {2,4,8,16};
09 uint8_t *y = x;
10 uint8_t z = x[1];
11 z = *y;
12 y = y+2;
13 z = *y;
14 z = x[7];
```



Vertiefung: Felder

- Konstanter Zeiger: `uint8_t a[]`
- Variabler Zeiger: `uint8_t *b`
- Aktuelles Element: `*b`
- x-te Element: `b[x]`
- x-te Element: `*(b+x)`

```
08 uint8_t x[] = {2,4,8,16};
09 uint8_t *y = x;
10 uint8_t z = x[1];
11 z = *y;
12 y = y+2;
13 z = *y;
14 z = x[7]; // ϟϟϟ
```



Hands-on: Zeiger

Hands-on: Strukturen, Felder & Zeiger

- Call-by-Value vs. Call-by-Reference
- Zeiger und Felder
- Zeigerarithmetik
- `struct` für GPS-Koordinaten
- Feld von GPS-Koordinaten
- Funktionszeiger

Kompilierbar für das SPiCboard (serielle Konsole) oder Linux

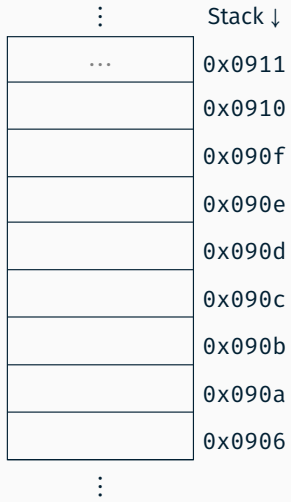
Quellcode:
`https://www4.cs.fau.de/Lehre/WS19/V_SPIC/Uebungen/material/pointer.c`

Hands-on: Laufschrift

Vertiefung: Strings

- `char`: Einzelnes Zeichen (z.B. `'a'`)
- String: Array von `char`s (z.B. `"Hello"`)
- In C: Letztes Zeichen eines Strings: `'\0'`
  ⇒ Speicherbedarf: strlen(s) + 1

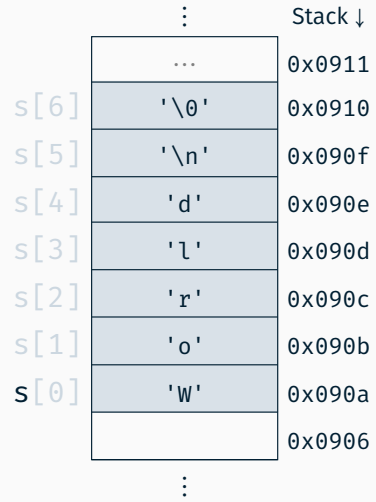
```
01 char *s = "World\n";
```



Vertiefung: Strings

- `char`: Einzelnes Zeichen (z.B. `'a'`)
- String: Array von `char`s (z.B. `"Hello"`)
- In C: Letztes Zeichen eines Strings: `'\0'`
  ⇒ Speicherbedarf: strlen(s) + 1

```
01 char *s = "World\n";
```



Hands-on: Laufschrift

- Funktionsweise:
  Schrittweises Anzeigen eines Textes auf der 7-Segment-Anzeige
- Lernziele:
  - Alarme & Schlafenlegen
  - Zeiger & Zeigerarithmetik
  - Zeichenfolgen in C
- Vorgehen:
  - Aktivieren eines wiederkehrenden Alarms (`sb_timer_setAlarm()`)
  - Optional: Manuelles Konfigurieren des Timers
  - Zusammensetzen des aktuellen Teilstrings
  - Ausgabe über 7-Segment-Anzeige
  - In Wartephasen Mikrocontroller in den Energiesparmodus versetzen