F03 - iteration, loopar

Programmeringsteknik med C och Matlab, 7,5 hp

Niclas Börlin
niclas.borlin@cs.umu.se

Datavetenskap, Umeå universitet

2023-10-02 Mån

Påminnelse

- Fönstret för att anmäla sig till tentamen har öppnat
- Är öppet till och med 10 okt
- Instruktioner finns på https://www.umu.se/student/mina-studier/tentamen/digital-salstentamen/

Iteration

- För att ett programmeringsspråk ska vara användbart måste man kunna uttrycka
  - sekvenser av satser
  - uttrycka val
  - upprepa satser (iterationer)
- Språket C innehåller följande iterationssatser:
  - `for`
  - `while`
  - `do-while`

Blank

`while`

`while`-satsen

- `while`-satsen upprepar något så länge ett test är sant
  - Det motsvarar ungefär:
    - *Så länge det finns disk kvar i diskmaskinen, plocka ut en sak*
    - *While the are dishes left in the dishwasher, pick one item*

while-satsen, syntax

- C-syntaxen för en `while`-sats är

```
while ( TEST )
    STATEMENT
```

eller hellre

```
while ( TEST ) {
    STATEMENT1
    STATEMENT2
    ...
}
```

- Så länge `TEST` är sant utförs `satsen/blocket` efter slutparantesen
- `TEST` beräknas innan satsen/blocket körs första gången

while-exempel

- Vad gör följande exempel?

```c
#include <stdio.h>

int main(void)
{
    int i = 0;

    while (i < 3) {
        printf("%d ", i);
        i = i + 1;
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

Simulering `while`-exempel

```c
#include <stdio.h>

int main(void)
{
    int i = 0;

    while (i < 3) {
        printf("%d ", i);
        i = i + 1;
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

X

Simulering `while`-exempel

```c
#include <stdio.h>

int main(void)
{
    int i = 0;

    while (i < 3) {
        printf("%d ", i);
        i = i + 1;
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

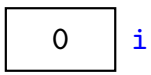
X

Simulering `while`-exempel

```
1  #include <stdio.h>
2
3  int main(void)
4  {
5      int i = 0;
6
7      while (i < 3) {
8          printf("%d ", i);
9          i = i + 1;
10     }
11
12     printf("\nNormal exit.\n");
13     return 0;
14 }
```

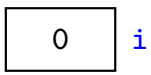
Simulering `while`-exempel

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i = 0;
6
7       while (i < 3) {
8           printf("%d ", i);
9           i = i + 1;
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```



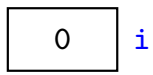
Simulering `while`-exempel

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i = 0;
6
7       while (i < 3) {
8           printf("%d ", i);
9           i = i + 1;
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```



Simulering `while`-exempel

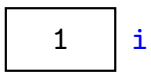
```
1  #include <stdio.h>
2
3  int main(void)
4  {
5      int i = 0;
6
7      while (i < 3) {
8          printf("%d ", i);
9          i = i + 1;
10     }
11
12     printf("\nNormal exit.\n");
13     return 0;
14 }
```




```
0
```

Simulering `while`-exempel

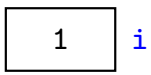
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i = 0;
6
7       while (i < 3) {
8           printf("%d ", i);
9           i = i + 1;
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```




```
0
```

Simulering `while`-exempel

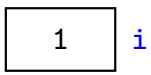
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i = 0;
6
7       while (i < 3) {
8           printf("%d ", i);
9           i = i + 1;
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```




```
0
```

Simulering `while`-exempel

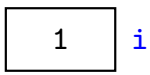
```
1  #include <stdio.h>
2
3  int main(void)
4  {
5      int i = 0;
6
7      while (i < 3) {
8          printf("%d ", i);
9          i = i + 1;
10     }
11
12     printf("\nNormal exit.\n");
13     return 0;
14 }
```




```
0
```

Simulering `while`-exempel

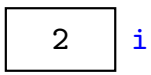
```
1  #include <stdio.h>
2
3  int main(void)
4  {
5      int i = 0;
6
7      while (i < 3) {
8          printf("%d ", i);
9          i = i + 1;
10     }
11
12     printf("\nNormal exit.\n");
13     return 0;
14 }
```




```
0 1
```

Simulering `while`-exempel

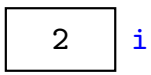
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i = 0;
6
7       while (i < 3) {
8           printf("%d ", i);
9           i = i + 1;
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```




```
0 1
```

Simulering `while`-exempel

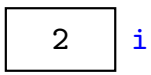
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i = 0;
6
7       while (i < 3) {
8           printf("%d ", i);
9           i = i + 1;
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```




```
0 1
```

Simulering `while`-exempel

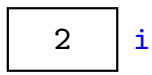
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i = 0;
6
7       while (i < 3) {
8           printf("%d ", i);
9           i = i + 1;
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```




```
0 1
```

Simulering `while`-exempel

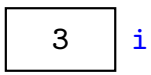
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i = 0;
6
7       while (i < 3) {
8           printf("%d ", i);
9           i = i + 1;
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```




```
0 1 2
```

Simulering `while`-exempel

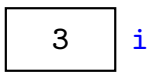
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i = 0;
6
7       while (i < 3) {
8           printf("%d ", i);
9           i = i + 1;
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```




```
0 1 2
```

Simulering `while`-exempel

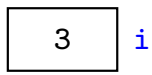
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i = 0;
6
7       while (i < 3) {
8           printf("%d ", i);
9           i = i + 1;
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```




```
0 1 2
```

Simulering `while`-exempel

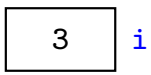
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i = 0;
6
7       while (i < 3) {
8           printf("%d ", i);
9           i = i + 1;
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```




```
0 1 2
```

Simulering `while`-exempel

```c
#include <stdio.h>

int main(void)
{
    int i = 0;

    while (i < 3) {
        printf("%d ", i);
        i = i + 1;
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
0 1 2

Normal exit.
```

Simulering `while`-exempel

```c
#include <stdio.h>

int main(void)
{
    int i = 0;

    while (i < 3) {
        printf("%d ", i);
        i = i + 1;
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

3

```
0 1 2

Normal exit.
```

Simulering `while`-exempel

```c
#include <stdio.h>

int main(void)
{
    int i = 0;

    while (i < 3) {
        printf("%d ", i);
        i = i + 1;
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

3

```
0 1 2

Normal exit.
```

Hur många varv? (1)

- Studera följande kodsnutt:

```
1  i = 0;
2
3  while (i < n) {
4      printf("%d ", i);
5      i = i + 1;
6  }
```

- Antag att `n == 5`
  - Hur många gånger kommer satsen `printf(...)` på rad 4 att utföras?
  - Hur många gånger kommer uppräkningen `i = i + 1` på rad 5 att utföras?
  - Hur många gånger kommer testet `i < n` på rad 3 att utföras?

Hur många varv? (1)

- Studera följande kodsnutt:

```
1  i = 0;
2
3  while (i < n) {
4      printf("%d ", i);
5      i = i + 1;
6  }
```

- Antag att `n == 5`
  - Hur många gånger kommer satsen `printf(...)` på rad 4 att utföras?
    - 5
  - Hur många gånger kommer uppräkningen `i = i + 1` på rad 5 att utföras?
  - Hur många gånger kommer testet `i < n` på rad 3 att utföras?

Hur många varv? (1)

- Studera följande kodsnutt:

```
1  i = 0;
2
3  while (i < n) {
4      printf("%d ", i);
5      i = i + 1;
6  }
```

- Antag att `n == 5`
  - Hur många gånger kommer satsen `printf(...)` på rad 4 att utföras?
    - 5
  - Hur många gånger kommer uppräkningen `i = i + 1` på rad 5 att utföras?
    - 5
  - Hur många gånger kommer testet `i < n` på rad 3 att utföras?

Hur många varv? (1)

- Studera följande kodsnutt:

```
1  i = 0;
2
3  while (i < n) {
4      printf("%d ", i);
5      i = i + 1;
6  }
```

- Antag att `n == 5`
  - Hur många gånger kommer satsen `printf(...)` på rad 4 att utföras?
    - 5
  - Hur många gånger kommer uppräkningen `i = i + 1` på rad 5 att utföras?
    - 5
  - Hur många gånger kommer testet `i < n` på rad 3 att utföras?
    - 6

Hur många varv? (2)

- Samma kodsnutt:

```
1  i = 0;
2
3  while (i < n) {
4      printf("%d ", i);
5      i = i + 1;
6  }
```

- Vad händer om `n == 0`?

Hur många varv? (2)

- Samma kodsnutt:

```
1  i = 0;
2
3  while (i < n) {
4      printf("%d ", i);
5      i = i + 1;
6  }
```

- Vad händer om `n == 0`?
  - Testet körs `1` gång (och returnerar `false`)

Hur många varv? (2)

- Samma kodsnutt:

```
1  i = 0;
2
3  while (i < n) {
4      printf("%d ", i);
5      i = i + 1;
6  }
```

- Vad händer om `n == 0`?
  - Testet körs 1 gång (och returnerar `false`)
  - Loopen körs 0 gånger

Hur många varv? (2)

- Samma kodsnutt:

```
1  i = 0;
2
3  while (i < n) {
4      printf("%d ", i);
5      i = i + 1;
6  }
```

- Vad händer om `n == 0`?
  - Testet körs 1 gång (och returnerar `false`)
  - Loopen körs 0 gånger
- Vad gäller i det generella fallet?
  - Hur många gånger körs respektive del, som funktion av `n`?

Hur många varv? (2)

- Samma kodsnutt:

```
1  i = 0;
2
3  while (i < n) {
4      printf("%d ", i);
5      i = i + 1;
6  }
```

- Vad händer om `n == 0`?
  - Testet körs 1 gång (och returnerar `false`)
  - Loopen körs 0 gånger
- Vad gäller i det generella fallet?
  - Hur många gånger körs respektive del, som funktion av `n`?
    - Testet körs `n + 1` gånger (`n` ggr `true`, en gång `false`)

Hur många varv? (2)

- Samma kodsnutt:

```
1  i = 0;
2
3  while (i < n) {
4      printf("%d ", i);
5      i = i + 1;
6  }
```

- Vad händer om `n == 0`?
  - Testet körs 1 gång (och returnerar `false`)
  - Loopen körs 0 gånger
- Vad gäller i det generella fallet?
  - Hur många gånger körs respektive del, som funktion av `n`?
    - Testet körs `n + 1` gånger (`n` ggr `true`, en gång `false`)
    - Loopen körs `n` gånger

Uppräkning

- Operationen `i = i + 1` i slutet av `while`-loopen kallas för en uppräkning
- Det ligger vanligen sist i loopen
- Uppräkningen `i = i + 1` är så vanlig i C att den fått sin egen operator `i++`
- På samma sätt finns motsvarande operator `i--` för nedräkning
- Några vanliga uppräkningsoperatorer är:

Operator	Gör samma som
`i++`	`i = i + 1`
`i--`	`i = i - 1`
`i += 2`	`i = i + 2`
`i -= 2`	`i = i - 2`

while-satsen — problem

- Vad är problemet med följande kod?

```
1  int i = 0;
2
3  while (i < 5) {
4      printf("%d ", i);
5  }
```

while-satsen — problem

- Vad är problemet med följande kod?

```
1  int i = 0;
2
3  while (i < 5) {
4      printf("%d ", i);
5  }
```

  - i uppdateras aldrig, så loopen kommer aldrig att terminera!

while-satsen — problem

- Vad är problemet med följande kod?

```
1  int i = 0;
2
3  while (i < 5) {
4      printf("%d ", i);
5  }
```

  - `i` uppdateras aldrig, så loopen kommer aldrig att terminera!
- Kom ihåg att uppdatera loop-variabeln!

Förtida avbrott

- Det går att avbryta en `while`-loop (och `for` och `do-while`) "inifrån" loopen med `break`

```
1  while (i < n) {
2      ...
3      if (user_pressed_quit_button) {
4          break;
5      }
6      ...
7      i++;
8  }
```

- Det gör det möjligt att använda "oändliga" loopar:

```
1  while (true) {
2      ...
3      if (user_pressed_quit_button) {
4          break;
5      }
6      ...
7      if (computation_is_done) {
8          break;
9      }
10     ...
11 }
```

Blank

Blank

`for`

En typisk `while`-loop

- Studera följande kodsnutt:

```
1  i = 0;
2
3  while (i < n) {
4      printf("%d ", i);
5      i++;
6  }
```

- Vad händer?
  - Intieringen `i = 0` körs först
  - Sen körs testet `i < n`
    - Om testet är `true` så körs innehållet i loopen
    - Det sista som körs inuti loopen är uppräkningen `i++`
- Vi kan skriva en sån här loop på ett kompaktare sätt: `for`

for-satsen

- C-syntaxen för en `for`-loop ser ut så här:

```
for ( [INIT] ; [TEST] ; [UPDATE] )
    STATEMENT
```

eller hellre

```
for ( [INIT] ; [TEST] ; [UPDATE] ) {
    STATEMENT1
    STATEMENT2
    ...
}
```

- Koden `[INIT]` utförs en gång när `for`-satsen startas
- Varje varv påbörjas med att `[TEST]` evalueras
  - Om `[TEST]` returnerar `true` kommer den `blå` koden i huvudsatsen att köras
  - Sist i varje varv körs koden i `[UPDATE]`

while kontra for

- C-koden:

```
1  i = 0;
2
3  while (i < n) {
4      printf("%d ", i);
5      i++;
6  }
```

är semantiskt identisk med följande C-kod:

```
1  for ( i = 0 ; i < n ; i++ ) {
2      printf("%d ", i);
3  }
```

Simulering av `for`-loop

- Ordningen för delarna i **`for`**-loopen är densamma som för **`while`**-loopen:
  - Init-test-(loop-update-test)-(loop-update-test)-...

```
1  #include <stdio.h>
2
3  int main(void)
4  {
5      int i;
6
7      for (i = 0; i < 3; i++) {
8          printf("%d ", i);
9      }
10
11     printf("\nNormal exit.\n");
12     return 0;
13 }
```

```
X
```

Simulering av `for`-loop

- Ordningen för delarna i **`for`**-loopen är densamma som för **`while`**-loopen:
  - Init-test-(loop-update-test)-(loop-update-test)-...

```
1  #include <stdio.h>
2
3  int main(void)
4  {
5      int i;
6
7      for (i = 0; i < 3; i++) {
8          printf("%d ", i);
9      }
10
11     printf("\nNormal exit.\n");
12     return 0;
13 }
```

Simulering av `for`-loop

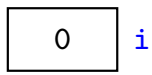
- Ordningen för delarna i **`for`**-loopen är densamma som för **`while`**-loopen:
  - Init-test-(loop-update-test)-(loop-update-test)-...

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i;
6
7       for (i = 0; i < 3; i++) {
8           printf("%d ", i);
9       }
10
11      printf("\nNormal exit.\n");
12      return 0;
13  }
```

Simulering av `for`-loop

- Ordningen för delarna i **`for`**-loopen är densamma som för **`while`**-loopen:
  - Init-test-(loop-update-test)-(loop-update-test)-...

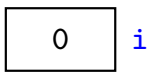
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i;
6
7       for (i = 0; i < 3; i++) {
8           printf("%d ", i);
9       }
10
11      printf("\nNormal exit.\n");
12      return 0;
13  }
```



Simulering av `for`-loop

- Ordningen för delarna i **`for`**-loopen är densamma som för **`while`**-loopen:
  - Init-test-(loop-update-test)-(loop-update-test)-...

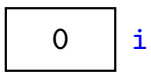
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i;
6
7       for (i = 0; i < 3; i++) {
8           printf("%d ", i);
9       }
10
11      printf("\nNormal exit.\n");
12      return 0;
13  }
```



Simulering av `for`-loop

- Ordningen för delarna i **`for`**-loopen är densamma som för **`while`**-loopen:
  - Init-test-(loop-update-test)-(loop-update-test)-...

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i;
6
7       for (i = 0; i < 3; i++) {
8           printf("%d ", i);
9       }
10
11      printf("\nNormal exit.\n");
12      return 0;
13  }
```

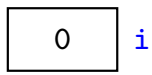



```
0
```

Simulering av `for`-loop

- Ordningen för delarna i **`for`**-loopen är densamma som för **`while`**-loopen:
  - Init-test-(loop-update-test)-(loop-update-test)-...

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i;
6
7       for (i = 0; i < 3; i++) {
8           printf("%d ", i);
9       }
10
11      printf("\nNormal exit.\n");
12      return 0;
13  }
```

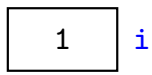



```
0
```

Simulering av `for`-loop

- Ordningen för delarna i **`for`**-loopen är densamma som för **`while`**-loopen:
  - Init-test-(loop-update-test)-(loop-update-test)-...

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i;
6
7       for (i = 0; i < 3; i++) {
8           printf("%d ", i);
9       }
10
11      printf("\nNormal exit.\n");
12      return 0;
13  }
```

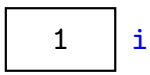



```
0
```

Simulering av `for`-loop

- Ordningen för delarna i **`for`**-loopen är densamma som för **`while`**-loopen:
  - Init-test-(loop-update-test)-(loop-update-test)-...

```
1  #include <stdio.h>
2
3  int main(void)
4  {
5      int i;
6
7      for (i = 0; i < 3; i++) {
8          printf("%d ", i);
9      }
10
11     printf("\nNormal exit.\n");
12     return 0;
13 }
```

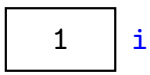



```
0
```

Simulering av `for`-loop

- Ordningen för delarna i **`for`**-loopen är densamma som för **`while`**-loopen:
  - Init-test-(loop-update-test)-(loop-update-test)-...

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i;
6
7       for (i = 0; i < 3; i++) {
8           printf("%d ", i);
9       }
10
11      printf("\nNormal exit.\n");
12      return 0;
13  }
```

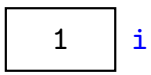



```
0 1
```

Simulering av `for`-loop

- Ordningen för delarna i **`for`**-loopen är densamma som för **`while`**-loopen:
  - Init-test-(loop-update-test)-(loop-update-test)-...

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i;
6
7       for (i = 0; i < 3; i++) {
8           printf("%d ", i);
9       }
10
11      printf("\nNormal exit.\n");
12      return 0;
13  }
```




```
0 1
```

Simulering av `for`-loop

- Ordningen för delarna i **`for`**-loopen är densamma som för **`while`**-loopen:
  - Init-test-(loop-update-test)-(loop-update-test)-...

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i;
6
7       for (i = 0; i < 3; i++) {
8           printf("%d ", i);
9       }
10
11      printf("\nNormal exit.\n");
12      return 0;
13  }
```

2	i

```
0 1
```

Simulering av `for`-loop

- Ordningen för delarna i **`for`**-loopen är densamma som för **`while`**-loopen:
  - Init-test-(loop-update-test)-(loop-update-test)-...

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i;
6
7       for (i = 0; i < 3; i++) {
8           printf("%d ", i);
9       }
10
11      printf("\nNormal exit.\n");
12      return 0;
13  }
```

2	i

```
0 1
```

Simulering av `for`-loop

- Ordningen för delarna i **`for`**-loopen är densamma som för **`while`**-loopen:
  - Init-test-(loop-update-test)-(loop-update-test)-...

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i;
6
7       for (i = 0; i < 3; i++) {
8           printf("%d ", i);
9       }
10
11      printf("\nNormal exit.\n");
12      return 0;
13  }
```

2	i

```
0 1 2
```

Simulering av `for`-loop

- Ordningen för delarna i **`for`**-loopen är densamma som för **`while`**-loopen:
  - Init-test-(loop-update-test)-(loop-update-test)-...

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i;
6
7       for (i = 0; i < 3; i++) {
8           printf("%d ", i);
9       }
10
11      printf("\nNormal exit.\n");
12      return 0;
13  }
```

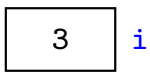
2	i

```
0 1 2
```

Simulering av `for`-loop

- Ordningen för delarna i **`for`**-loopen är densamma som för **`while`**-loopen:
  - Init-test-(loop-update-test)-(loop-update-test)-...

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i;
6
7       for (i = 0; i < 3; i++) {
8           printf("%d ", i);
9       }
10
11      printf("\nNormal exit.\n");
12      return 0;
13  }
```




```
0 1 2
```

Simulering av `for`-loop

- Ordningen för delarna i **`for`**-loopen är densamma som för **`while`**-loopen:
  - Init-test-(loop-update-test)-(loop-update-test)-...

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i;
6
7       for (i = 0; i < 3; i++) {
8           printf("%d ", i);
9       }
10
11      printf("\nNormal exit.\n");
12      return 0;
13  }
```

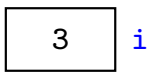
3	i

```
0 1 2
```

Simulering av `for`-loop

- Ordningen för delarna i **`for`**-loopen är densamma som för **`while`**-loopen:
  - Init-test-(loop-update-test)-(loop-update-test)-...

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int i;
6
7       for (i = 0; i < 3; i++) {
8           printf("%d ", i);
9       }
10
11      printf("\nNormal exit.\n");
12      return 0;
13  }
```




```
0 1 2

Normal exit.
```

Simulering av `for`-loop

- Ordningen för delarna i **`for`**-loopen är densamma som för **`while`**-loopen:
  - Init-test-(loop-update-test)-(loop-update-test)-...

```
1  #include <stdio.h>
2
3  int main(void)
4  {
5      int i;
6
7      for (i = 0; i < 3; i++) {
8          printf("%d ", i);
9      }
10
11     printf("\nNormal exit.\n");
12     return 0;
13 }
```

3

```
0 1 2

Normal exit.
```

Simulering av `for`-loop

- Ordningen för delarna i **`for`**-loopen är densamma som för **`while`**-loopen:
  - Init-test-(loop-update-test)-(loop-update-test)-...

```
1  #include <stdio.h>
2
3  int main(void)
4  {
5      int i;
6
7      for (i = 0; i < 3; i++) {
8          printf("%d ", i);
9      }
10
11     printf("\nNormal exit.\n");
12     return 0;
13 }
```

3

```
0 1 2

Normal exit.
```

Behövs `for`-satsen?

- Nej! (inte i C)
- En vanlig presentation är att den ungefär motsvarar den språkliga konstruktionen
  - *för varje tal i=0, 1, . . . , 5*
- I praktiken är `for`-satsen lämplig om vi vet hur många gånger vi vill upprepa något

```c
#include <stdio.h>

int main(void)
{
    int i;

    for (i = 0; i < 3; i++) {
        printf("%d ", i);
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

- Koden blir lättare att läsa (om man förstår hur `for`-loopen fungerar)

`for`-satsen - loop-variabel (1)

- I `for`-satsen använder vi oftast en loop-variabel för att ha kontroll på antalet varv
- Om variabeln bara ska användas i loopen kan vi flytta in deklarationen inuti `for`-satsen:

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for ( int i = 0 ; i < 3 ; i++ ) {
6           printf("%d ", i);
7       }
8
9       printf("\nNormal exit.\n");
10      return 0;
11  }
```

- Fördelen med denna konstruktion är
  - Loop-konstruktionen blir ännu kompaktare
  - Loop-variabeln är bara synlig inuti loopen
  - Loop-variabeln skräpar inte ner resten av koden

for-satsen - loop-variabel (2)

- Om vi försöker använda loop-variabeln efter loopen kommer vi att få ett kompileringsfel

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0; i < 3; i++) {
6           printf("%d ", i);
7       }
8
9       printf("%d ", i);
10
11      printf("\nNormal exit.\n");
12      return 0;
13  }
```

`for`-satsen – nedräkning

- Det går utmärkt att skriva en `for`-loop som räknar ner
- Vad skriver följande kod ut?

```c
#include <stdio.h>

int main(void)
{
    for (int i = 4; i > 0; i--) {
        printf("%d ", i);
    }

    return 0;
}
```

`for`-satsen – nedräkning

- Det går utmärkt att skriva en `for`-loop som räknar ner
- Vad skriver följande kod ut?

```c
#include <stdio.h>

int main(void)
{
    for (int i = 4; i > 0; i--) {
        printf("%d ", i);
    }

    return 0;
}
```

- Utskrift: `4 3 2 1`

`for`-satsen — val av tester

- Det är viktigt att ha koll på vilket test man använder:
  - < eller <= vid uppräkning?
  - > eller >= vid nedräkning?
- Vilket är det första och sista värdet `i` kommer att ha inuti loopen och hur många varv kommer att köras?

```
for (i = 0; i < 12; i++) {
    ...
}
```

```
for (i = 12; i > 0; i--) {
    ...
}
```

```
for (i = 0; i <= 12; i++) {
    ...
}
```

```
for (i = 12; i >= 0; i--) {
    ...
}
```

`for`-satsen — val av tester

- Det är viktigt att ha koll på vilket test man använder:
  - < eller <= vid uppräkning?
  - > eller >= vid nedräkning?
- Vilket är det första och sista värdet `i` kommer att ha inuti loopen och hur många varv kommer att köras?

```
for (i = 0; i < 12; i++) {
    ...
}
```

```
for (i = 12; i > 0; i--) {
    ...
}
```

- 0, 1, . . . , 11 (12 varv)

```
for (i = 0; i <= 12; i++) {
    ...
}
```

```
for (i = 12; i >= 0; i--) {
    ...
}
```

for-satsen — val av tester

- Det är viktigt att ha koll på vilket test man använder:
  - < eller <= vid uppräkning?
  - > eller >= vid nedräkning?
- Vilket är det första och sista värdet `i` kommer att ha inuti loopen och hur många varv kommer att köras?

```
for (i = 0; i < 12; i++) {
    ...
}
```

```
for (i = 12; i > 0; i--) {
    ...
}
```

- 0, 1, . . . , 11 (12 varv)

```
for (i = 0; i <= 12; i++) {
    ...
}
```

```
for (i = 12; i >= 0; i--) {
    ...
}
```

- 0, 1, . . . , 12 (13 varv)

for-satsen — val av tester

- Det är viktigt att ha koll på vilket test man använder:
  - < eller <= vid uppräkning?
  - > eller >= vid nedräkning?
- Vilket är det första och sista värdet i kommer att ha inuti loopen och hur många varv kommer att köras?

```
for (i = 0; i < 12; i++) {
    ...
}
```

- 0, 1, . . . , 11 (12 varv)

```
for (i = 12; i > 0; i--) {
    ...
}
```

- 12, . . . , 1 (12 varv)

```
for (i = 0; i <= 12; i++) {
    ...
}
```

- 0, 1, . . . , 12 (13 varv)

```
for (i = 12; i >= 0; i--) {
    ...
}
```

for-satsen — val av tester

- Det är viktigt att ha koll på vilket test man använder:
  - < eller <= vid uppräkning?
  - > eller >= vid nedräkning?
- Vilket är det första och sista värdet i kommer att ha inuti loopen och hur många varv kommer att köras?

```
for (i = 0; i < 12; i++) {
    ...
}
```

- 0, 1, . . . , 11 (12 varv)

```
for (i = 12; i > 0; i--) {
    ...
}
```

- 12, . . . , 1 (12 varv)

```
for (i = 0; i <= 12; i++) {
    ...
}
```

- 0, 1, . . . , 12 (13 varv)

```
for (i = 12; i >= 0; i--) {
    ...
}
```

- 12, . . . , 0 (13 varv)

for-satsen - block

- Den sammansatta loop-satsen kan förstås innehålla flera satser:

```
1  #include <stdio.h>
2
3  int main(void)
4  {
5      for ( int i = 0, sum = 0 ; i < 5 ; i++) {
6          sum += i;
7          printf("%d ", sum);
8      }
9
10     printf("\nNormal exit.\n");
11     return 0;
12 }
```

for-satsen - block

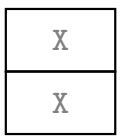
- Den sammansatta loop-satsen kan förstås innehålla flera satser:

```c
#include <stdio.h>

int main(void)
{
    for ( int i = 0, sum = 0 ; i < 5 ; i++) {
        sum += i;
        printf("%d ", sum);
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

- Notera att vi kan deklarera och initiera flera variabler i `for`-satsen

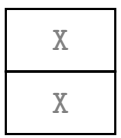
Simulering

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0, sum = 0 ; i < 5 ; i++) {
6           sum += i;
7           printf("%d ", sum);
8       }
9
10      printf("\nNormal exit.\n");
11      return 0;
12  }
```



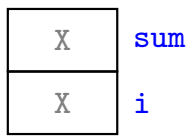
Simulering

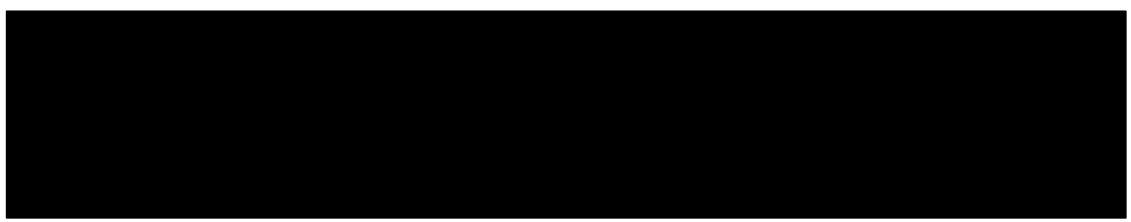
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0, sum = 0 ; i < 5 ; i++) {
6           sum += i;
7           printf("%d ", sum);
8       }
9
10      printf("\nNormal exit.\n");
11      return 0;
12  }
```



Simulering

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0, sum = 0 ; i < 5 ; i++) {
6           sum += i;
7           printf("%d ", sum);
8       }
9
10      printf("\nNormal exit.\n");
11      return 0;
12  }
```





Simulering

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0, sum = 0 ; i < 5 ; i++) {
6           sum += i;
7           printf("%d ", sum);
8       }
9
10      printf("\nNormal exit.\n");
11      return 0;
12  }
```

0	sum
0	i

Simulering

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0, sum = 0 ; i < 5 ; i++) {
6           sum += i;
7           printf("%d ", sum);
8       }
9
10      printf("\nNormal exit.\n");
11      return 0;
12  }
```

0	sum
0	i

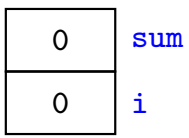
Simulering

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0, sum = 0 ; i < 5 ; i++) {
6           sum += i;
7           printf("%d ", sum);
8       }
9
10      printf("\nNormal exit.\n");
11      return 0;
12  }
```

0	sum
0	i

Simulering

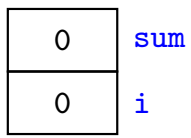
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0, sum = 0 ; i < 5 ; i++) {
6           sum += i;
7           printf("%d ", sum);
8       }
9
10      printf("\nNormal exit.\n");
11      return 0;
12  }
```




```
0
```

Simulering

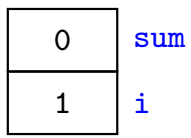
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0, sum = 0 ; i < 5 ; i++) {
        sum += i;
        printf("%d ", sum);
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
0
```

Simulering

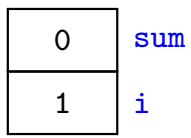
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0, sum = 0 ; i < 5 ; i++) {
        sum += i;
        printf("%d ", sum);
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
0
```

Simulering

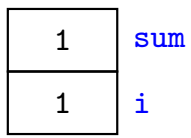
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0, sum = 0 ; i < 5 ; i++) {
6           sum += i;
7           printf("%d ", sum);
8       }
9
10      printf("\nNormal exit.\n");
11      return 0;
12  }
```




```
0
```

Simulering

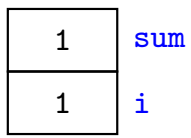
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0, sum = 0 ; i < 5 ; i++) {
6           sum += i;
7           printf("%d ", sum);
8       }
9
10      printf("\nNormal exit.\n");
11      return 0;
12  }
```




```
0
```

Simulering

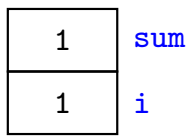
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0, sum = 0 ; i < 5 ; i++) {
6           sum += i;
7           printf("%d ", sum);
8       }
9
10      printf("\nNormal exit.\n");
11      return 0;
12  }
```




```
0 1
```

Simulering

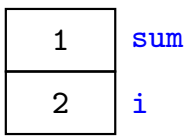
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0, sum = 0 ; i < 5 ; i++) {
6           sum += i;
7           printf("%d ", sum);
8       }
9
10      printf("\nNormal exit.\n");
11      return 0;
12  }
```




```
0 1
```

Simulering

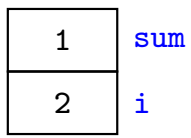
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0, sum = 0 ; i < 5 ; i++) {
        sum += i;
        printf("%d ", sum);
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
0 1
```

Simulering

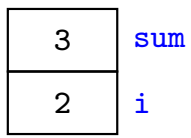
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0, sum = 0 ; i < 5 ; i++) {
6           sum += i;
7           printf("%d ", sum);
8       }
9
10      printf("\nNormal exit.\n");
11      return 0;
12  }
```




```
0 1
```

Simulering

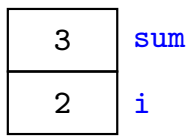
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0, sum = 0 ; i < 5 ; i++) {
6           sum += i;
7           printf("%d ", sum);
8       }
9
10      printf("\nNormal exit.\n");
11      return 0;
12  }
```




```
0 1
```

Simulering

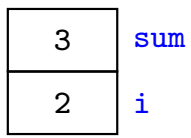
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0, sum = 0 ; i < 5 ; i++) {
6           sum += i;
7           printf("%d ", sum);
8       }
9
10      printf("\nNormal exit.\n");
11      return 0;
12  }
```




```
0 1 3
```

Simulering

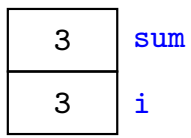
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0, sum = 0 ; i < 5 ; i++) {
        sum += i;
        printf("%d ", sum);
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
0 1 3
```

Simulering

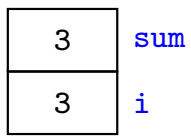
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0, sum = 0 ; i < 5 ; i++) {
        sum += i;
        printf("%d ", sum);
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
0 1 3
```

Simulering

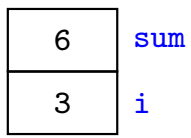
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0, sum = 0 ; i < 5 ; i++) {
6           sum += i;
7           printf("%d ", sum);
8       }
9
10      printf("\nNormal exit.\n");
11      return 0;
12  }
```




```
0 1 3
```

Simulering

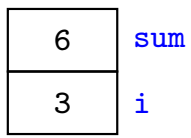
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0, sum = 0 ; i < 5 ; i++) {
6           sum += i;
7           printf("%d ", sum);
8       }
9
10      printf("\nNormal exit.\n");
11      return 0;
12  }
```




```
0 1 3
```

Simulering

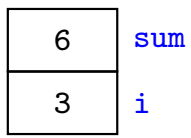
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0, sum = 0 ; i < 5 ; i++) {
        sum += i;
        printf("%d ", sum);
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
0 1 3 6
```

Simulering

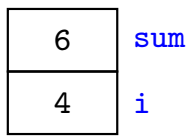
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0, sum = 0 ; i < 5 ; i++) {
        sum += i;
        printf("%d ", sum);
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
0 1 3 6
```

Simulering

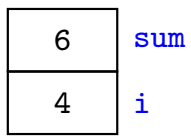
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0, sum = 0 ; i < 5 ; i++) {
        sum += i;
        printf("%d ", sum);
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
0 1 3 6
```

Simulering

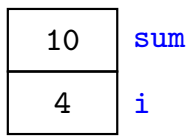
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0, sum = 0 ; i < 5 ; i++) {
6           sum += i;
7           printf("%d ", sum);
8       }
9
10      printf("\nNormal exit.\n");
11      return 0;
12  }
```




```
0 1 3 6
```

Simulering

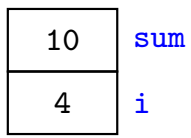
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0, sum = 0 ; i < 5 ; i++) {
6           sum += i;
7           printf("%d ", sum);
8       }
9
10      printf("\nNormal exit.\n");
11      return 0;
12  }
```




```
0 1 3 6
```

Simulering

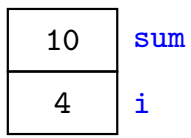
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0, sum = 0 ; i < 5 ; i++) {
6           sum += i;
7           printf("%d ", sum);
8       }
9
10      printf("\nNormal exit.\n");
11      return 0;
12  }
```




```
0 1 3 6 10
```

Simulering

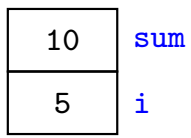
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0, sum = 0 ; i < 5 ; i++) {
        sum += i;
        printf("%d ", sum);
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
0 1 3 6 10
```

Simulering

```c
#include <stdio.h>

int main(void)
{
    for (int i = 0, sum = 0 ; i < 5 ; i++) {
        sum += i;
        printf("%d ", sum);
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
0 1 3 6 10
```

Simulering

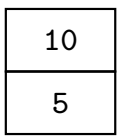
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0, sum = 0 ; i < 5 ; i++) {
6           sum += i;
7           printf("%d ", sum);
8       }
9
10      printf("\nNormal exit.\n");
11      return 0;
12  }
```

10
5

```
0 1 3 6 10
```

Simulering

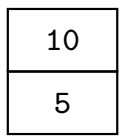
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0, sum = 0 ; i < 5 ; i++) {
6           sum += i;
7           printf("%d ", sum);
8       }
9
10      printf("\nNormal exit.\n");
11      return 0;
12  }
```




```
0 1 3 6 10

Normal exit.
```

Simulering

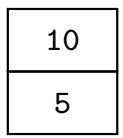
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0, sum = 0 ; i < 5 ; i++) {
        sum += i;
        printf("%d ", sum);
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
0 1 3 6 10

Normal exit.
```

Simulering

```c
#include <stdio.h>

int main(void)
{
    for (int i = 0, sum = 0 ; i < 5 ; i++) {
        sum += i;
        printf("%d ", sum);
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
0 1 3 6 10

Normal exit.
```

for-satsen – uppdatering

- Uppdateringen av loop-variabeln kan vara vad som helst

```c
#include <stdio.h>

int main(void)
{
    printf("Feet Meters\n");
    printf("-----------\n");

    for (int feet = 20 ; feet > 0 ; feet -= 5 ) {
        double meters = 0.3048 * feet;
        printf("%4d %6.2f\n", feet, meters);
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

for-satsen – uppdatering

- Uppdateringen av loop-variabeln kan vara vad som helst

```c
#include <stdio.h>

int main(void)
{
    printf("Feet Meters\n");
    printf("-----------\n");

    for (int feet = 20 ; feet > 0 ; feet -= 5 ) {
        double meters = 0.3048 * feet;
        printf("%4d %6.2f\n", feet, meters);
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

- Utskrift:

```
Feet Meters
-----------
  20   6.10
  15   4.57
  10   3.05
   5   1.52

Normal exit.
```

`for`-satsen – slutvärde

- Sista värdet för loop-variabeln behöver inte vara nära ”stopp”-värdet

```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 20; i+=8) {
        printf("%d ", i);
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

for-satsen – slutvärde

- Sista värdet för loop-variabeln behöver inte vara nära ”stopp”-värdet

```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 20; i+=8) {
        printf("%d ", i);
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

- Utskrift:

```
0 8 16

Normal exit.
```

`for`-satsen – icke-heltal som loop-variabel

- Loop-variabeln behöver inte vara ett heltal

```
1  for (double s = 1 ; s < 10 ; s *= 1.7) {
2      printf("%6.5f\n", s);
3  }
```

`for`-satsen – icke-heltal som loop-variabel

- Loop-variabeln behöver inte vara ett heltal

```
1  for (double s = 1 ; s < 10 ; s *= 1.7) {
2      printf("%6.5f\n", s);
3  }
```

- Utskrift:

```
1.00000
1.70000
2.89000
4.91300
8.35210
```

`for`-satsen – varning för flyttal

- Se upp med flyttal i villkor (ska 1.0 skrivas ut?):

```c
#include <stdio.h>

int main(void)
{
    for (double x = 0.0 ; x < 1.0 ; x += 0.1 ) {
        printf("%3.1f\n", x);
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

for-satsen – varning för flyttal

- Se upp med flyttal i villkor (ska 1.0 skrivas ut?):

```c
#include <stdio.h>

int main(void)
{
    for (double x = 0.0 ; x < 1.0 ; x += 0.1 ) {
        printf("%3.1f\n", x);
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

- Utskrift:

```
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

Normal exit.
```

Tips

- Det är oftast vettigt att ha med en utskrift av loop-variabeln vid debugging!

Blank

do-while

do-while-satsen

- Ibland är det önskvärt att utföra något innan villkoret beräknas
- Ett typfall är att kontrollera indata från användaren
- Då kan `do-while`-satsen vara användbar!
- C-syntaxen för en `do-while`-loop ser ut så här:

```
do {
    STATEMENT1
    STATEMENT2
    ...
} while ( TEST ) ;
```

- Först körs den blå sammansatta satsen
- Sen evalueras `TEST`
  - Om testet är `true` så körs loopen ett varv till

do-while-satsen

- Ibland är det önskvärt att utföra något innan villkoret beräknas
- Ett typfall är att kontrollera indata från användaren
- Då kan `do-while`-satsen vara användbar!
- C-syntaxen för en `do-while`-loop ser ut så här:

```
do {
    STATEMENT1
    STATEMENT2
    ...
} while ( TEST ) ;
```

- Först körs den blå sammansatta satsen
- Sen evalueras `TEST`
  - Om testet är `true` så körs loopen ett varv till
- Notera det avslutande semikolonet!

do-while-satsen — exempel

- Exempel:

```
1  int n;
2  do {
3      printf("Enter an integer in the range 0-100: ");
4      scanf("%d", &n);
5  } while ( ! (n >= 0 && n <= 100) );
6  printf("n = %d\n", n);
```

- Exempelkörning:

```
Enter an integer in the range 0-100: -5
Enter an integer in the range 0-100: 345
Enter an integer in the range 0-100: 34
n = 34
```

Ackumulera en summa — do-while

```c
#include <stdio.h>

int main(void)
{
    int n, sum = 0; // Initialize sum

    printf("Enter a positive integer to accumulate.\n");
    printf("Enter -1 to quit.\n\n");

    do {
        printf("Enter number: ");
        scanf("%d", &n);
        if (n > 0) {
            sum += n;
        }
    } while (n > 0);

    printf("\nThe sum is %d.\n", sum);

    printf("Normal exit.\n");
    return 0;
}
```

Ackumulera en summa — `while`

```c
#include <stdio.h>

int main(void)
{
    int n, sum;

    printf("Enter a positive integer to accumulate.\n");
    printf("Enter -1 to quit.\n\n");

    sum = 0; // Initialize sum
    n = 1; // To enter the loop
    while (n > 0) {
        printf("Enter number: ");
        scanf("%d", &n);
        if (n > 0) {
            sum += n;
        }
    }
    printf("\nThe sum is %d.\n", sum);

    printf("Normal exit.\n");
    return 0;
}
```

Ackumulera en summa — `for`

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       int sum = 0; // Initialize sum
6
7       printf("Enter a positive integer to accumulate.\n");
8       printf("Enter -1 to quit.\n\n");
9
10      for (int n = 1; n > 0;      ) {
11          printf("Enter number: ");
12          scanf("%d", &n);
13          if (n > 0) {
14              sum += n;
15          }
16      }
17      printf("\nThe sum is %d.\n", sum);
18
19      printf("Normal exit.\n");
20      return 0;
21  }
```

- Notera den tomma satsen i [UPDATE]-delen av `for`-satsen på rad 10

Vanliga fel (1)

- Glömma måsvingar {}

```
for (int i = 1, sum = 0 ; i <= 5 ; i++)
    int j = i*i;
    sum += j;
printf("sum=%d\n",sum);
```

Vanliga fel (1)

- Glömma måsvingar {}

```
for (int i = 1, sum = 0 ; i <= 5 ; i++)
    int j = i*i;
    sum += j;
printf("sum=%d\n",sum);
```

- Glömma semikolon i `for`-satsen

```
for (int i = 1, i <= n, i++)
```

Vanliga fel (1)

- Glömma måsvingar {}

```
for (int i = 1, sum = 0 ; i <= 5 ; i++)
    int j = i*i;
    sum += j;
printf("sum=%d\n",sum);
```

- Glömma semikolon i `for`-satsen

```
for (int i = 1, i <= n, i++)
```

Vanliga fel (1)

- Glömma måsvingar {}

```
for (int i = 1, sum = 0 ; i <= 5 ; i++)
    int j = i*i;
    sum += j;
printf("sum=%d\n",sum);
```

- Glömma semikolon i `for`-satsen

```
for (int i = 1, i <= n, i++)
```

- Semikolon efter slutparantesen för `for` och `while`

```
for (int i = 1, sum = 0 ; i <= 5 ; i++); {
    sum += i*i;
}
printf("sum=%d\n",sum);
```

Vanliga fel (1)

- Glömma måsvingar {}

```
for (int i = 1, sum = 0 ; i <= 5 ; i++)
    int j = i*i;
    sum += j;
printf("sum=%d\n",sum);
```

- Glömma semikolon i `for`-satsen

```
for (int i = 1, i <= n, i++)
```

- Semikolon efter slutparantesen för `for` och `while`

```
for (int i = 1, sum = 0 ; i <= 5 ; i++); {
    sum += i*i;
}
printf("sum=%d\n",sum);
```

Vanliga fel (2)

- Tilldelning = i stället för likhetstest == i `while`-testet

```
while (i = 0) {
    ...
}
```

- Se upp med flyttal!

```
for (double x = 0.0; x < 1.0; x += 0.1) {
    printf("%3.1f\n", x);
}
```

Blank

Blank

Nästlade loopar

Nästlade loopar

- Det är vanligt att man skriver en loop inuti en annan

```
1  for (int i = 0 ; i < 2 ; i++) {
2      for (int j = 0 ; j < 3 ; j++) {
3          printf("(%d,%d) ", i, j);
4      }
5      printf("\n");
6  }
```

- Det kallas att looparna är nästlade

Nästlade loopar, delar

- Delarna av den yttre `for`-satsen ser ut så här:

```
1  for ( int i = 0 ; i < 2 ; i++ ) {
2      for ( int j = 0 ; j < 3 ; j++ ) {
3          printf("(%d,%d) ", i, j);
4      }
5      printf("\n");
6  }
```

dvs. hela den inre `for`-loopen och rad 5 ligger inuti

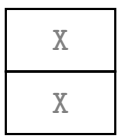
- Delarna av den inre `for`-satsen ser ut så här:

```
1  for ( int i = 0 ; i < 2 ; i++ ) {
2      for ( int j = 0 ; j < 3 ; j++ ) {
3          printf("(%d,%d) ", i, j);
4      }
5      printf("\n");
6  }
```

dvs. endast `printf`-anropet på rad 3 ligger inuti

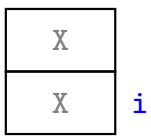
Simulering nästlad `for`-loop (1)

```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```



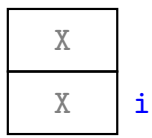
Simulering nästlad `for`-loop (1)

```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```



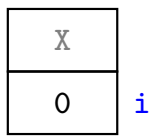
Simulering nästlad `for`-loop (1)

```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```



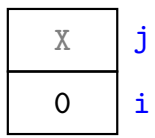
Simulering nästlad `for`-loop (1)

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0; i < 2; i++) {
6           for (int j = 0; j < 3; j++) {
7               printf("(%d,%d) ", i, j);
8           }
9           printf("\n");
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```



Simulering nästlad `for`-loop (1)

```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```



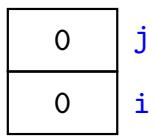
Simulering nästlad `for`-loop (1)

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0; i < 2; i++) {
6           for (int j = 0; j < 3; j++) {
7               printf("(%d,%d) ", i, j);
8           }
9           printf("\n");
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```

0	j
0	i

Simulering nästlad `for`-loop (1)

```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```



Simulering nästlad `for`-loop (1)

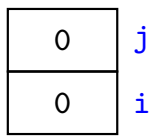
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0; i < 2; i++) {
6           for (int j = 0; j < 3; j++) {
7               printf("(%d,%d) ", i, j);
8           }
9           printf("\n");
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```

0	j
0	i

```
(0,0) |
```

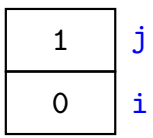
Simulering nästlad `for`-loop (1)

```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```



Simulering nästlad `for`-loop (1)

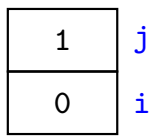
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) |
```

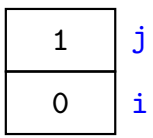
Simulering nästlad `for`-loop (1)

```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```



Simulering nästlad `for`-loop (1)

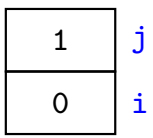
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) (0,1) |
```

Simulering nästlad `for`-loop (1)

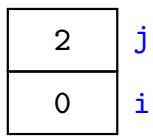
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) (0,1) |
```

Simulering nästlad `for`-loop (1)

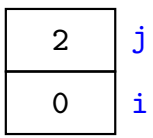
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) (0,1) |
```

Simulering nästlad `for`-loop (1)

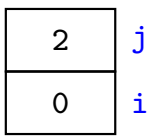
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0; i < 2; i++) {
6           for (int j = 0; j < 3; j++) {
7               printf("(%d,%d) ", i, j);
8           }
9           printf("\n");
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```




```
(0,0) (0,1) |
```

Simulering nästlad `for`-loop (1)

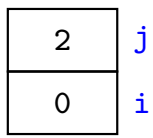
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) (0,1) (0,2) |
```

Simulering nästlad `for`-loop (1)

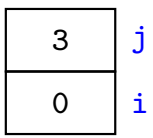
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) (0,1) (0,2) |
```

Simulering nästlad `for`-loop (1)

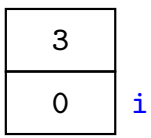
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) (0,1) (0,2) |
```

Simulering nästlad `for`-loop (1)

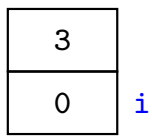
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) (0,1) (0,2) |
```

Simulering nästlad `for`-loop (1)

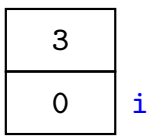
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) (0,1) (0,2)
```

Simulering nästlad `for`-loop (1)

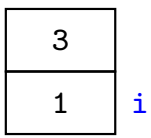
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0; i < 2; i++) {
6           for (int j = 0; j < 3; j++) {
7               printf("(%d,%d) ", i, j);
8           }
9           printf("\n");
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```




```
(0,0) (0,1) (0,2)
```

Simulering nästlad `for`-loop (1)

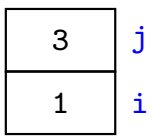
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) (0,1) (0,2)
(1,0) (1,1) (1,2)

Normal exit.
```

Simulering nästlad `for`-loop (1)

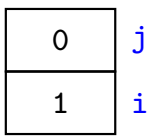
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) (0,1) (0,2)
```

Simulering nästlad `for`-loop (1)

```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) (0,1) (0,2)
```

Simulering nästlad `for`-loop (1)

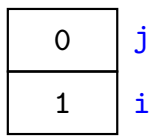
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

0	j
1	i

```
(0,0) (0,1) (0,2)
```

Simulering nästlad `for`-loop (1)

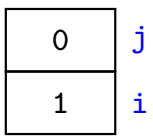
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) (0,1) (0,2)
(1,0) |
```

Simulering nästlad `for`-loop (1)

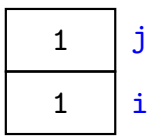
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) (0,1) (0,2)
(1,0) |
```

Simulering nästlad `for`-loop (1)

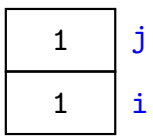
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) (0,1) (0,2)
(1,0) |
```

Simulering nästlad `for`-loop (1)

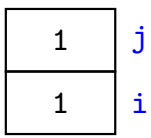
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) (0,1) (0,2)
(1,0) |
```

Simulering nästlad `for`-loop (1)

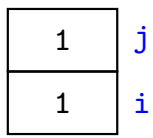
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0; i < 2; i++) {
6           for (int j = 0; j < 3; j++) {
7               printf("(%d,%d) ", i, j);
8           }
9           printf("\n");
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```




```
(0,0) (0,1) (0,2)
(1,0) (1,1) |
```

Simulering nästlad `for`-loop (1)

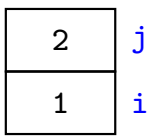
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) (0,1) (0,2)
(1,0) (1,1) |
```

Simulering nästlad `for`-loop (1)

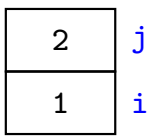
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) (0,1) (0,2)
(1,0) (1,1) |
```

Simulering nästlad `for`-loop (1)

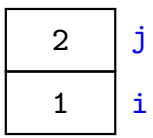
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0; i < 2; i++) {
6           for (int j = 0; j < 3; j++) {
7               printf("(%d,%d) ", i, j);
8           }
9           printf("\n");
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```




```
(0,0) (0,1) (0,2)
(1,0) (1,1) |
```

Simulering nästlad `for`-loop (1)

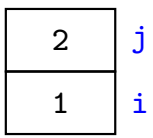
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) (0,1) (0,2)
(1,0) (1,1) (1,2)
```

Simulering nästlad `for`-loop (1)

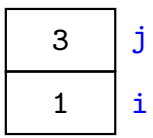
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) (0,1) (0,2)
(1,0) (1,1) (1,2)
```

Simulering nästlad `for`-loop (1)

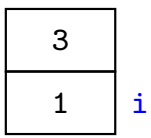
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) (0,1) (0,2)
(1,0) (1,1) (1,2)
```

Simulering nästlad `for`-loop (1)

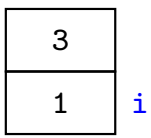
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0; i < 2; i++) {
6           for (int j = 0; j < 3; j++) {
7               printf("(%d,%d) ", i, j);
8           }
9           printf("\n");
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```




```
(0,0) (0,1) (0,2)
(1,0) (1,1) (1,2)
```

Simulering nästlad `for`-loop (1)

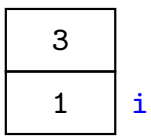
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0; i < 2; i++) {
6           for (int j = 0; j < 3; j++) {
7               printf("(%d,%d) ", i, j);
8           }
9           printf("\n");
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```




```
(0,0) (0,1) (0,2)
(1,0) (1,1) (1,2)
```

Simulering nästlad `for`-loop (1)

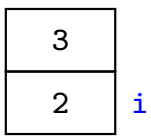
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) (0,1) (0,2)
(1,0) (1,1) (1,2)
```

Simulering nästlad `for`-loop (1)

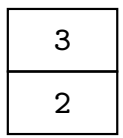
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) (0,1) (0,2)
(1,0) (1,1) (1,2)
```

Simulering nästlad `for`-loop (1)

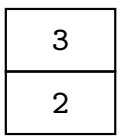
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) (0,1) (0,2)
(1,0) (1,1) (1,2)
```

Simulering nästlad `for`-loop (1)

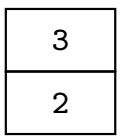
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0; i < 2; i++) {
6           for (int j = 0; j < 3; j++) {
7               printf("(%d,%d) ", i, j);
8           }
9           printf("\n");
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```




```
(0,0) (0,1) (0,2)
(1,0) (1,1) (1,2)

Normal exit.
```

Simulering nästlad `for`-loop (1)

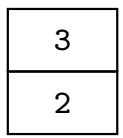
```c
#include <stdio.h>

int main(void)
{
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("(%d,%d) ", i, j);
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
(0,0) (0,1) (0,2)
(1,0) (1,1) (1,2)

Normal exit.
```

Simulering nästlad `for`-loop (1)

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int i = 0; i < 2; i++) {
6           for (int j = 0; j < 3; j++) {
7               printf("(%d,%d) ", i, j);
8           }
9           printf("\n");
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```




```
(0,0) (0,1) (0,2)
(1,0) (1,1) (1,2)

Normal exit.
```

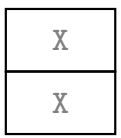
Initiering av inre nästad loop

- Loop-variabeln i den yttre loopen kan användas för att styra antalet varv i den inre

```
for ( int outer = 0 ; outer < 3 ; outer++ ) {
    for ( int inner = outer ; inner < 3 ; inner++ ) {
        printf("*");
    }
    printf("\n");
}
```

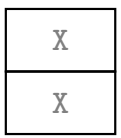
Simulering nästlad `for`-loop (2)

```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```



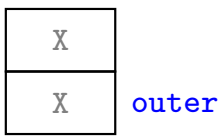
Simulering nästlad `for`-loop (2)

```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```



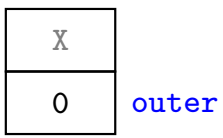
Simulering nästlad `for`-loop (2)

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int outer = 0; outer < 3; outer++) {
6           for (int inner = outer; inner < 3; inner++) {
7               printf("*");
8           }
9           printf("\n");
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```



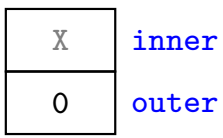
Simulering nästlad `for`-loop (2)

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int outer = 0; outer < 3; outer++) {
6           for (int inner = outer; inner < 3; inner++) {
7               printf("*");
8           }
9           printf("\n");
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```



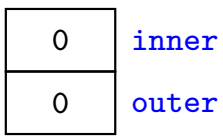
Simulering nästlad `for`-loop (2)

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int outer = 0; outer < 3; outer++) {
6           for (int inner = outer; inner < 3; inner++) {
7               printf("*");
8           }
9           printf("\n");
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```



Simulering nästlad `for`-loop (2)

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int outer = 0; outer < 3; outer++) {
6           for (int inner = outer; inner < 3; inner++) {
7               printf("*");
8           }
9           printf("\n");
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```



Simulering nästlad `for`-loop (2)

```
1  #include <stdio.h>
2
3  int main(void)
4  {
5      for (int outer = 0; outer < 3; outer++) {
6          for (int inner = outer; inner < 3; inner++) {
7              printf("*");
8          }
9          printf("\n");
10     }
11
12     printf("\nNormal exit.\n");
13     return 0;
14 }
```

0	inner
0	outer

Simulering nästlad `for`-loop (2)

```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

0	inner
0	outer

```
*
```

Simulering nästlad `for`-loop (2)

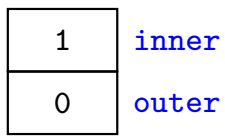
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int outer = 0; outer < 3; outer++) {
6           for (int inner = outer; inner < 3; inner++) {
7               printf("*");
8           }
9           printf("\n");
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```

0	inner
0	outer

```
*
```

Simulering nästlad `for`-loop (2)

```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
*
```

Simulering nästlad `for`-loop (2)

```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

1	inner
0	outer

```
*
```

Simulering nästlad `for`-loop (2)

```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

1	inner
0	outer

```
**
```

Simulering nästlad `for`-loop (2)

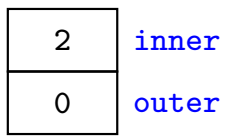
```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

1	inner
0	outer

```
**
```

Simulering nästlad `for`-loop (2)

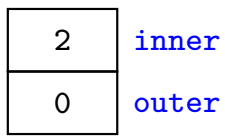
```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
**
```

Simulering nästlad `for`-loop (2)

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int outer = 0; outer < 3; outer++) {
6           for (int inner = outer; inner < 3; inner++) {
7               printf("*");
8           }
9           printf("\n");
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```




```
**
```

Simulering nästlad `for`-loop (2)

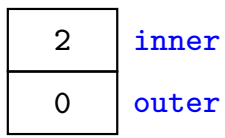
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int outer = 0; outer < 3; outer++) {
6           for (int inner = outer; inner < 3; inner++) {
7               printf("*");
8           }
9           printf("\n");
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```

2	inner
0	outer

```
***
```

Simulering nästlad `for`-loop (2)

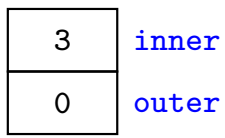
```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
***
```

Simulering nästlad `for`-loop (2)

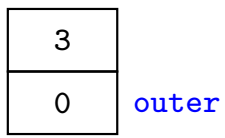
```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
***
```

Simulering nästlad `for`-loop (2)

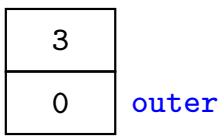
```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
***
```

Simulering nästlad `for`-loop (2)

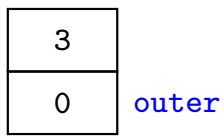
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int outer = 0; outer < 3; outer++) {
6           for (int inner = outer; inner < 3; inner++) {
7               printf("*");
8           }
9           printf("\n");
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```




```
***
```

Simulering nästlad `for`-loop (2)

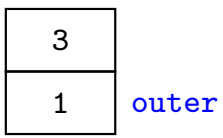
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int outer = 0; outer < 3; outer++) {
6           for (int inner = outer; inner < 3; inner++) {
7               printf("*");
8           }
9           printf("\n");
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```




```
***
```

Simulering nästlad `for`-loop (2)

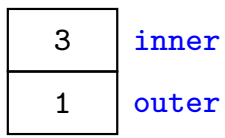
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int outer = 0; outer < 3; outer++) {
6           for (int inner = outer; inner < 3; inner++) {
7               printf("*");
8           }
9           printf("\n");
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```




```
***
```

Simulering nästlad `for`-loop (2)

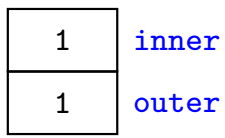
```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
***
```

Simulering nästlad `for`-loop (2)

```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
***
```

Simulering nästlad `for`-loop (2)

```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

1	inner
1	outer

```
***
*
```

Simulering nästlad `for`-loop (2)

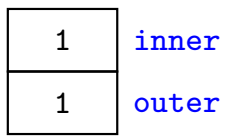
```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

1	inner
1	outer

```
***
*
```

Simulering nästlad `for`-loop (2)

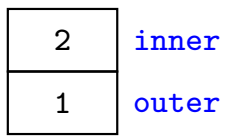
```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
***
*
```

Simulering nästlad `for`-loop (2)

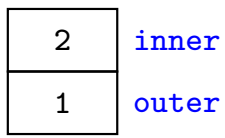
```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
***
*
```

Simulering nästlad `for`-loop (2)

```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
***
*
```

Simulering nästlad `for`-loop (2)

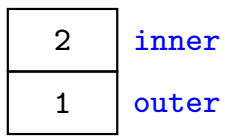
```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

2	inner
1	outer

```
***
**
```

Simulering nästlad `for`-loop (2)

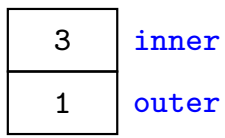
```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
***
**
```

Simulering nästlad `for`-loop (2)

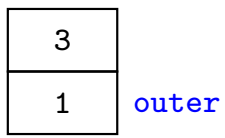
```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
***
**
```

Simulering nästlad `for`-loop (2)

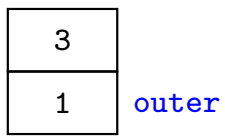
```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
***
**
```

Simulering nästlad `for`-loop (2)

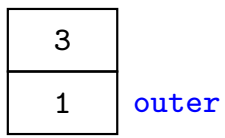
```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
***
**
```

Simulering nästlad `for`-loop (2)

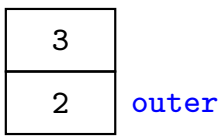
```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
***
**
```

Simulering nästlad `for`-loop (2)

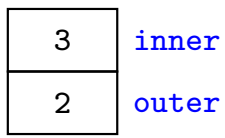
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int outer = 0; outer < 3; outer++) {
6           for (int inner = outer; inner < 3; inner++) {
7               printf("*");
8           }
9           printf("\n");
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```




```
***
**
```

Simulering nästlad `for`-loop (2)

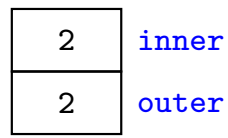
```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
***
**
```

Simulering nästlad `for`-loop (2)

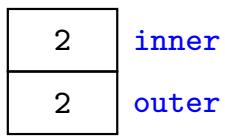
```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
***
**
```

Simulering nästlad `for`-loop (2)

```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
***
**
```

Simulering nästlad `for`-loop (2)

```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

2	inner
2	outer

```
***
**
*
```

Simulering nästlad `for`-loop (2)

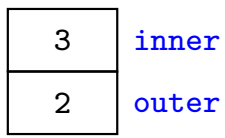
```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

2	inner
2	outer

```
***
**
*
```

Simulering nästlad `for`-loop (2)

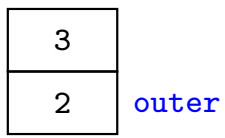
```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
***
**
*
```

Simulering nästlad `for`-loop (2)

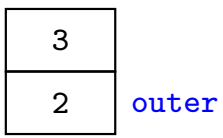
```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
***
**
*
```

Simulering nästlad `for`-loop (2)

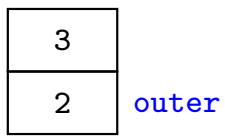
```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int outer = 0; outer < 3; outer++) {
6           for (int inner = outer; inner < 3; inner++) {
7               printf("*");
8           }
9           printf("\n");
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```




```
***
**
*
```

Simulering nästlad `for`-loop (2)

```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```




```
***
**
*
```

Simulering nästlad `for`-loop (2)

```
1   #include <stdio.h>
2
3   int main(void)
4   {
5       for (int outer = 0; outer < 3; outer++) {
6           for (int inner = outer; inner < 3; inner++) {
7               printf("*");
8           }
9           printf("\n");
10      }
11
12      printf("\nNormal exit.\n");
13      return 0;
14  }
```

3
3

outer

```
***
**
*
```

Simulering nästlad `for`-loop (2)

```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

3
3

```
***
**
*
```

Simulering nästlad `for`-loop (2)

```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

3
3

```
***
**
*

Normal exit.
```

Simulering nästlad `for`-loop (2)

```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

3
3

```
***
**
*

Normal exit.
```

Simulering nästlad `for`-loop (2)

```c
#include <stdio.h>

int main(void)
{
    for (int outer = 0; outer < 3; outer++) {
        for (int inner = outer; inner < 3; inner++) {
            printf("*");
        }
        printf("\n");
    }

    printf("\nNormal exit.\n");
    return 0;
}
```

3
3

```
***
**
*

Normal exit.
```

Många loopar blir det...

- Tänk på att det totala antalet loop-varv ökar snabbt med antalet nästlade loopar

```
1   // 10 outermost loops
2   for (int i = 0; i < 10; i++) {
3       // 10*10=100 intermediate loops
4       for (int j = 0; j < 10; j++){
5           // 10*10*10=1000 innermost loops
6           for (int k = 0; k < 10; k++) {
7               printf("Bip: %2d %2d %2d\n", i, j, k);
8           }
9       }
10  }
```

När använder man vilken loop?

- Välj den som är lättast att förklara!
- Tumregler:
  - `for` om man vet antalet varv
  - `while` annars
  - `do-while` om man ska köra minst en gång

Obligatorisk uppgift 1

- Uppgiften
- Strukturerad problemlösning