Course: ENCM 369
Lab Section: B03
Lab 1
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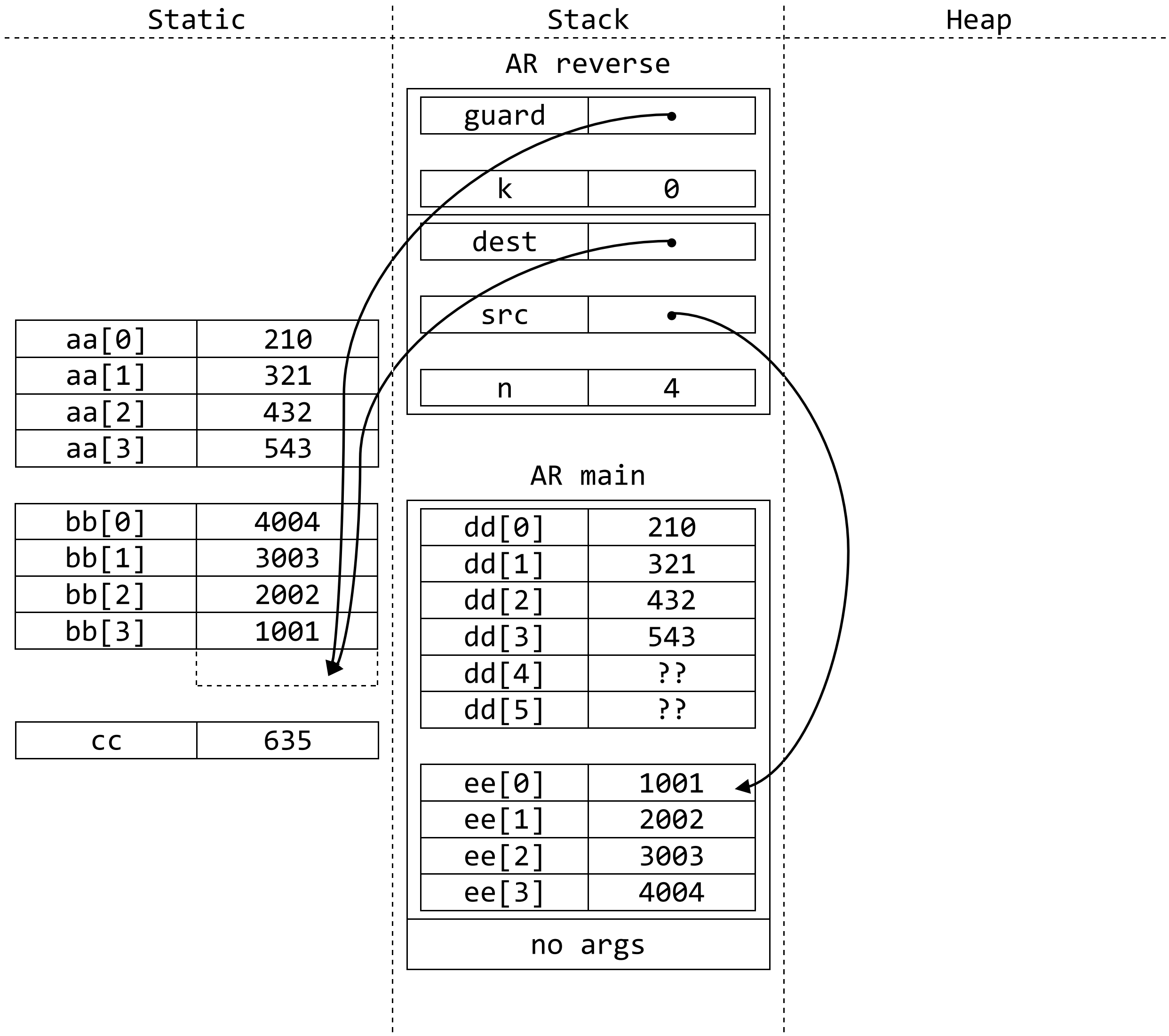
Exercise 5.2

Point Three



instant in time	dest	src	guard
point two, first time	0x10003C	0x7FFE60	0x10004C
point two, second time	0x100040	0x7FFE60	0x10004C
point two, third time	0x100044	0x7FFE60	0x10004C
point two, fourth time	0x100048	0x7FFE60	0x10004C

Exercise 12.1

exG.c

```
// exG.c

// ENCM 369 Winter 2016 Lab 1 Exercise G
```

```
#include <stdio.h>
#include <stdlib.h>
#include <math.h>

#define MAX_ERROR (0.5e-9)
#define POLY_DEGREE 4

double polyval(const double *a, int n, double x);
/* Return a[0] + a[1] * x + ... + a[n] * pow(x, n). */

int main(void)
{
    double f[] = { 1.45, 0.78, -3.03, -1.15, 1.00 };
    double dfdx[POLY_DEGREE];

    double guess;
    int update_max;
    int update_count;
    int n_scanned;
    int i;

    double current_x, current_f, current_dfdx;

    printf("This program demonstrates use of Newton's Method to find\n"
           "approximate roots of the polynomial\nf(x) = ");
    printf("%.2f", f[0]);
    i = 1;
    start_for_b:
        if (i > POLY_DEGREE)
            goto end_for_b;
        if (f[i] >= 0)
            goto if_a;
        goto el_a;
        if_a:
            printf(" + %.2f*pow(x,%d)", f[i], i);
            goto fi_a;
        el_a:
            printf(" - %.2f*pow(x,%d)", -f[i], i);
            goto fi_a;
        fi_a:
            i++;
```

```
        goto start_for_b;
end_for_b:
    ;
printf("\nPlease enter a guess at a root, and a maximum number of\n"
       "updates to do, separated by a space.\n");
n_scanned = scanf("%lf%d", &guess, &update_max);
if (n_scanned != 2)
    goto if_b;
goto el_b;
if_b:
    printf("Sorry, I couldn't understand the input.\n");
    exit(0);
el_b:
    ;
if (update_max < 1)
    goto if_c;
goto el_c;
if_c:
    printf("Sorry, I must be allowed do at least one update.\n");
    exit(0);
el_c:
    ;
printf("Running with initial guess %f.\n", guess);
i = 0;
start_for_c:
    if (i >= POLY_DEGREE)
        goto end_for_c;
    dfdx[i] = (i + 1) * f[i + 1];   // Calculus!
    i++;
    goto start_for_c;
end_for_c:
    ;
current_x = guess;
update_count = 0;
start_while_a:
    current_f = polyval(f, POLY_DEGREE, current_x);
    printf("%d update(s) done; x is %.15f; f(x) is %.15e\n",
           update_count, current_x, current_f);
    if (update_count == update_max)
        goto end_while_a;
    if (fabs(current_f) < MAX_ERROR)
        goto end_while_a;
```

```
        current_dfdx = polyval(dfdx, POLY_DEGREE - 1, current_x);
        current_x -= current_f / current_dfdx;
        update_count++;
        goto start_while_a;
    end_while_a:
        ;
    if (fabs(current_f) <= MAX_ERROR)
        goto if_d;
    goto el_d;
    if_d:
        printf("Stopped with approximate solution of %.10f.\n",
               current_x);
        goto fi_d;
    el_d:
        printf("%d updates performed, solution still not good enough.\n",
               update_count);
        goto fi_d;
    fi_d:
        ;
    return 0;
}

double polyval(const double *a, int n, double x)
{
    double result = 0.0;
    int i = n;
    start_for_a:
        if (i < 1)
            goto end_for_a;
        result += a[i];
        result *= x;
        i--;
        goto start_for_a;
    end_for_a:
        ;
    result += a[0];
    return result;
}
```

Terminal Output:

Before Modification	After Modification
Mitchell@ttys003 21:23 {0} [exG]$ ./test.out	Mitchell@ttys001 22:18 {130} [exG]$ ./test.out
This program demonstrates use of Newton's Method to find	This program demonstrates use of Newton's Method to find
approximate roots of the polynomial	approximate roots of the polynomial
f(x) = 1.45 + 0.78*pow(x,1) - 3.03*pow(x,2) -	f(x) = 1.45 + 0.78*pow(x,1) - 3.03*pow(x,2) -
1.15*pow(x,3) + 1.00*pow(x,4)	1.15*pow(x,3) + 1.00*pow(x,4)
Please enter a guess at a root, and a maximum number of	Please enter a guess at a root, and a maximum number of
updates to do, separated by a space.	updates to do, separated by a space.
1.0 x	1.0 x
Sorry, I couldn't understand the input.	Sorry, I couldn't understand the input.
Mitchell@ttys003 21:23 {0} [exG]$ ./test.out	Mitchell@ttys001 22:18 {0} [exG]$ ./test.out
This program demonstrates use of Newton's Method to find	This program demonstrates use of Newton's Method to find
approximate roots of the polynomial	approximate roots of the polynomial
f(x) = 1.45 + 0.78*pow(x,1) - 3.03*pow(x,2) -	f(x) = 1.45 + 0.78*pow(x,1) - 3.03*pow(x,2) -
1.15*pow(x,3) + 1.00*pow(x,4)	1.15*pow(x,3) + 1.00*pow(x,4)
Please enter a guess at a root, and a maximum number of	Please enter a guess at a root, and a maximum number of
updates to do, separated by a space.	updates to do, separated by a space.
1.0 0	1.0 0
Sorry, I must be allowed do at least one update.	Sorry, I must be allowed do at least one update.
Mitchell@ttys003 21:23 {0} [exG]$ ./test.out	Mitchell@ttys001 22:18 {0} [exG]$ ./test.out
This program demonstrates use of Newton's Method to find	This program demonstrates use of Newton's Method to find
approximate roots of the polynomial	approximate roots of the polynomial
f(x) = 1.45 + 0.78*pow(x,1) - 3.03*pow(x,2) -	f(x) = 1.45 + 0.78*pow(x,1) - 3.03*pow(x,2) -
1.15*pow(x,3) + 1.00*pow(x,4)	1.15*pow(x,3) + 1.00*pow(x,4)
Please enter a guess at a root, and a maximum number of	Please enter a guess at a root, and a maximum number of
updates to do, separated by a space.	updates to do, separated by a space.
1.0 3	1.0 3
Running with initial guess 1.000000.	Running with initial guess 1.000000.
0 update(s) done; x is 1.000000000000000; f(x) is -	0 update(s) done; x is 1.000000000000000; f(x) is -
9.499999999999995e-01	9.499999999999995e-01
1 update(s) done; x is 0.799154334038055; f(x) is -	1 update(s) done; x is 0.799154334038055; f(x) is -
4.082592009647401e-02	4.082592009647401e-02
2 update(s) done; x is 0.789490702493091; f(x) is -	2 update(s) done; x is 0.789490702493091; f(x) is -
1.844257849812347e-04	1.844257849812347e-04
3 update(s) done; x is 0.789446648301911; f(x) is -	3 update(s) done; x is 0.789446648301911; f(x) is -
3.908826595733217e-09	3.908826595733217e-09
3 updates performed, solution still not good enough.	3 updates performed, solution still not good enough.
Mitchell@ttys003 21:23 {0} [exG]$ ./test.out	Mitchell@ttys001 22:18 {0} [exG]$ ./test.out
This program demonstrates use of Newton's Method to find	This program demonstrates use of Newton's Method to find
approximate roots of the polynomial	approximate roots of the polynomial
f(x) = 1.45 + 0.78*pow(x,1) - 3.03*pow(x,2) -	f(x) = 1.45 + 0.78*pow(x,1) - 3.03*pow(x,2) -
1.15*pow(x,3) + 1.00*pow(x,4)	1.15*pow(x,3) + 1.00*pow(x,4)
Please enter a guess at a root, and a maximum number of	Please enter a guess at a root, and a maximum number of
updates to do, separated by a space.	updates to do, separated by a space.
1.0 4	1.0 4
Running with initial guess 1.000000.	Running with initial guess 1.000000.
0 update(s) done; x is 1.000000000000000; f(x) is -	0 update(s) done; x is 1.000000000000000; f(x) is -
9.499999999999995e-01	9.499999999999995e-01
1 update(s) done; x is 0.799154334038055; f(x) is -	1 update(s) done; x is 0.799154334038055; f(x) is -
4.082592009647401e-02	4.082592009647401e-02
2 update(s) done; x is 0.789490702493091; f(x) is -	2 update(s) done; x is 0.789490702493091; f(x) is -
1.844257849812347e-04	1.844257849812347e-04
3 update(s) done; x is 0.789446648301911; f(x) is -	3 update(s) done; x is 0.789446648301911; f(x) is -
3.908826595733217e-09	3.908826595733217e-09
4 update(s) done; x is 0.789446647368162; f(x) is -	4 update(s) done; x is 0.789446647368162; f(x) is -
4.440892098500626e-16	4.440892098500626e-16
Stopped with approximate solution of 0.7894466474.	Stopped with approximate solution of 0.7894466474.
Mitchell@ttys003 21:23 {0} [exG]$ ./test.out	Mitchell@ttys001 22:19 {0} [exG]$ ./test.out
This program demonstrates use of Newton's Method to find	This program demonstrates use of Newton's Method to find
approximate roots of the polynomial	approximate roots of the polynomial
f(x) = 1.45 + 0.78*pow(x,1) - 3.03*pow(x,2) -	f(x) = 1.45 + 0.78*pow(x,1) - 3.03*pow(x,2) -
1.15*pow(x,3) + 1.00*pow(x,4)	1.15*pow(x,3) + 1.00*pow(x,4)
Please enter a guess at a root, and a maximum number of	Please enter a guess at a root, and a maximum number of
updates to do, separated by a space.	updates to do, separated by a space.
1.6 10	1.6 10
Running with initial guess 1.600000.	Running with initial guess 1.600000.
0 update(s) done; x is 1.600000000000000; f(x) is -	0 update(s) done; x is 1.600000000000000; f(x) is -
3.215599999999999e+00	3.215599999999999e+00
1 update(s) done; x is -0.757478005865107; f(x) is -	1 update(s) done; x is -0.757478005865107; f(x) is -
5.033601557507139e-02	5.033601557507139e-02
2 update(s) done; x is -0.727014138172744; f(x) is	2 update(s) done; x is -0.727014138172744; f(x) is
2.690899366527333e-03	2.690899366527333e-03
3 update(s) done; x is -0.728488476178189; f(x) is	3 update(s) done; x is -0.728488476178189; f(x) is
5.772146689952962e-06	5.772146689952962e-06
4 update(s) done; x is -0.728491652366615; f(x) is	4 update(s) done; x is -0.728491652366615; f(x) is
2.690980771546947e-11	2.690980771546947e-11
Stopped with approximate solution of -0.7284916524.	Stopped with approximate solution of -0.7284916524.
Mitchell@ttys003 21:23 {0} [exG]$ ./test.out	Mitchell@ttys001 22:19 {0} [exG]$ ./test.out

```
This program demonstrates use of Newton's Method to find
approximate roots of the polynomial
f(x) = 1.45 + 0.78*pow(x,1) - 3.03*pow(x,2) -
1.15*pow(x,3) + 1.00*pow(x,4)
Please enter a guess at a root, and a maximum number of
updates to do, separated by a space.
1.8 10
Running with initial guess 1.800000.
0 update(s) done; x is 1.800000000000000; f(x) is -
3.172399999999998e+00
1 update(s) done; x is 3.368941641938672; f(x) is
5.453299577903110e+01
2 update(s) done; x is 2.789754341062644; f(x) is
1.564652553251245e+01
3 update(s) done; x is 2.433108167336762; f(x) is
3.892116274400187e+00
4 update(s) done; x is 2.265542885662034; f(x) is
6.369755201980263e-01
5 update(s) done; x is 2.225371164494491; f(x) is
3.168430569887160e-02
6 update(s) done; x is 2.223154162819966; f(x) is
9.333252154331007e-05
7 update(s) done; x is 2.223147593508815; f(x) is
8.180014443581740e-10
8 update(s) done; x is 2.223147593451238; f(x) is -
3.108624468950438e-15
Stopped with approximate solution of 2.2231475935.
Mitchell@ttys003 21:23 {0} [exG]$ ./test.out
This program demonstrates use of Newton's Method to find
approximate roots of the polynomial
f(x) = 1.45 + 0.78*pow(x,1) - 3.03*pow(x,2) -
1.15*pow(x,3) + 1.00*pow(x,4)
Please enter a guess at a root, and a maximum number of
updates to do, separated by a space.
-4.9 10
Running with initial guess -4.900000.
0 update(s) done; x is -4.900000000000000; f(x) is
6.366541500000002e+02
1 update(s) done; x is -3.682586792591736; f(x) is
1.988315861602772e+02
2 update(s) done; x is -2.792782092071352; f(x) is
6.152307486560385e+01
3 update(s) done; x is -2.154146355902563; f(x) is
1.873771511369693e+01
4 update(s) done; x is -1.709692969524729; f(x) is
5.550965265339927e+00
5 update(s) done; x is -1.416516273962120; f(x) is
1.560088387483382e+00
6 update(s) done; x is -1.241764686358543; f(x) is
3.889185355548186e-01
7 update(s) done; x is -1.158552879036898; f(x) is
6.926890137589847e-02
8 update(s) done; x is -1.135842956725481; f(x) is
4.584744310158761e-03
9 update(s) done; x is -1.134112442806661; f(x) is
2.581306211357770e-05
10 update(s) done; x is -1.134102588756783; f(x) is
8.350702351833661e-10
10 updates performed, solution still not good enough.
Mitchell@ttys003 21:24 {0} [exG]$ ./test.out
This program demonstrates use of Newton's Method to find
approximate roots of the polynomial
f(x) = 1.45 + 0.78*pow(x,1) - 3.03*pow(x,2) -
1.15*pow(x,3) + 1.00*pow(x,4)
Please enter a guess at a root, and a maximum number of
updates to do, separated by a space.
-4.8 10
Running with initial guess -4.800000.
0 update(s) done; x is -4.800000000000000; f(x) is
5.859171999999999e+02
1 update(s) done; x is -3.609082335341513; f(x) is
1.828922472361626e+02
2 update(s) done; x is -2.739520499139934; f(x) is
5.654175045866470e+01
3 update(s) done; x is -2.116476165436881; f(x) is
1.719481254798258e+01
4 update(s) done; x is -1.684131848769382; f(x) is
5.080194869870039e+00
```

```
This program demonstrates use of Newton's Method to find
approximate roots of the polynomial
f(x) = 1.45 + 0.78*pow(x,1) - 3.03*pow(x,2) -
1.15*pow(x,3) + 1.00*pow(x,4)
Please enter a guess at a root, and a maximum number of
updates to do, separated by a space.
1.8 10
Running with initial guess 1.800000.
0 update(s) done; x is 1.800000000000000; f(x) is -
3.172399999999998e+00
1 update(s) done; x is 3.368941641938672; f(x) is
5.453299577903110e+01
2 update(s) done; x is 2.789754341062644; f(x) is
1.564652553251245e+01
3 update(s) done; x is 2.433108167336762; f(x) is
3.892116274400187e+00
4 update(s) done; x is 2.265542885662034; f(x) is
6.369755201980263e-01
5 update(s) done; x is 2.225371164494491; f(x) is
3.168430569887160e-02
6 update(s) done; x is 2.223154162819966; f(x) is
9.333252154331007e-05
7 update(s) done; x is 2.223147593508815; f(x) is
8.180014443581740e-10
8 update(s) done; x is 2.223147593451238; f(x) is -
3.108624468950438e-15
Stopped with approximate solution of 2.2231475935.
Mitchell@ttys001 22:19 {0} [exG]$ ./test.out
This program demonstrates use of Newton's Method to find
approximate roots of the polynomial
f(x) = 1.45 + 0.78*pow(x,1) - 3.03*pow(x,2) -
1.15*pow(x,3) + 1.00*pow(x,4)
Please enter a guess at a root, and a maximum number of
updates to do, separated by a space.
-4.9 10
Running with initial guess -4.900000.
0 update(s) done; x is -4.900000000000000; f(x) is
6.366541500000002e+02
1 update(s) done; x is -3.682586792591736; f(x) is
1.988315861602772e+02
2 update(s) done; x is -2.792782092071352; f(x) is
6.152307486560385e+01
3 update(s) done; x is -2.154146355902563; f(x) is
1.873771511369693e+01
4 update(s) done; x is -1.709692969524729; f(x) is
5.550965265339927e+00
5 update(s) done; x is -1.416516273962120; f(x) is
1.560088387483382e+00
6 update(s) done; x is -1.241764686358543; f(x) is
3.889185355548186e-01
7 update(s) done; x is -1.158552879036898; f(x) is
6.926890137589847e-02
8 update(s) done; x is -1.135842956725481; f(x) is
4.584744310158761e-03
9 update(s) done; x is -1.134112442806661; f(x) is
2.581306211357770e-05
10 update(s) done; x is -1.134102588756783; f(x) is
8.350702351833661e-10
10 updates performed, solution still not good enough.
Mitchell@ttys001 22:19 {0} [exG]$ ./test.out
This program demonstrates use of Newton's Method to find
approximate roots of the polynomial
f(x) = 1.45 + 0.78*pow(x,1) - 3.03*pow(x,2) -
1.15*pow(x,3) + 1.00*pow(x,4)
Please enter a guess at a root, and a maximum number of
updates to do, separated by a space.
-4.8 10
Running with initial guess -4.800000.
0 update(s) done; x is -4.800000000000000; f(x) is
5.859171999999999e+02
1 update(s) done; x is -3.609082335341513; f(x) is
1.828922472361626e+02
2 update(s) done; x is -2.739520499139934; f(x) is
5.654175045866470e+01
3 update(s) done; x is -2.116476165436881; f(x) is
1.719481254798258e+01
4 update(s) done; x is -1.684131848769382; f(x) is
5.080194869870039e+00
```

5 update(s) done; x is -1.400420498862172; f(x) is 1.419965705529570e+00 6 update(s) done; x is -1.233078423204510; f(x) is 3.491090297747030e-01 7 update(s) done; x is -1.155372672226102; f(x) is 5.965980569434337e-02 8 update(s) done; x is -1.135439304126264; f(x) is 3.516731278879748e-03 9 update(s) done; x is -1.134108413976470; f(x) is 1.525952628567140e-05 10 update(s) done; x is -1.134102588549394; f(x) is 2.918416619479558e-10 Stopped with approximate solution of -1.1341025885.	5 update(s) done; x is -1.400420498862172; f(x) is 1.419965705529570e+00 6 update(s) done; x is -1.233078423204510; f(x) is 3.491090297747030e-01 7 update(s) done; x is -1.155372672226102; f(x) is 5.965980569434337e-02 8 update(s) done; x is -1.135439304126264; f(x) is 3.516731278879748e-03 9 update(s) done; x is -1.134108413976470; f(x) is 1.525952628567140e-05 10 update(s) done; x is -1.134102588549394; f(x) is 2.918416619479558e-10 Stopped with approximate solution of -1.1341025885.

Exercise 13.1

exH.c

```
// exH.c
// ENCM 369 Winter 2016 Lab 1 Exercise H

#include <stdio.h>

void print_array(const char *str, const int *a, int n);
/* Prints the string given by str on stdout, then
 * prints a[0], a[1], ..., a[n - 1] on stdout on a single line. */

void sort_array(int *x, int n);
/* Sorts x[0], x[1], ..., x[n - 1] from smallest to largest. */

int main(void)
{
  int test_array[] = { 4000, 5000, 7000, 1000, 3000, 4000, 2000, 6000 };

  print_array("before sorting ...", test_array, 8);
  sort_array(test_array, 8);
  print_array("after sorting ...", test_array, 8);
  return 0;
}

void print_array(const char *str, const int *a, int n)
{
  int i = 0;
  puts(str);
  start_for_a:
    if (i >= n)
      goto end_for_a;
    printf("    %d", a[i]);
    i++;
```

```
    goto start_for_a;
  end_for_a:
    ;
  printf("\n");
}

void sort_array(int *x, int n)
{
  // This is an implementation of an algorithm called insertion sort.

  int outer = 1;
  int inner;
  int v;
  start_for_b:
    if (outer >= n)
      goto end_for_b;
    v = x[outer];
    inner = outer;
    start_while_a:
      if (inner <= 0)
        goto end_while_a;
      if (v >= x[inner-1])
        goto end_while_a;
      x[inner] = x[inner-1];
      inner--;
      goto start_while_a;
    end_while_a:
      ;
    x[inner] = v;
    outer++;
    goto start_for_b;
  end_for_b:
    ;
}
```