Day 12 notes

- exercise 11 review
- day 12 recap questions
- exercise 12

Announcements/reminders

- HW2 due *this evening* by 11pm
  - no late submissions!
- HW3 due Friday 2/25 by 11pm

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Exercise 11 review

pairwise_sum.c

When running the program using valgrind:

```
valgrind --leak-check=full ./pairwise_sum
```

a memory leak is reported:

```
==17736== 16 bytes in 1 blocks are definitely lost in loss record 1 of 1
==17736==    at 0x483B7F3: malloc
(in /usr/lib/x86_64-linux-gnu/valgrind/vgpreload_memcheck-amd64-linux.so)
==17736==    by 0x10922B: pairwise_sum (pairwise_sum.c:28)
==17736==    by 0x109399: main (pairwise_sum.c:57)
```

valgrind indicates there is a memory leak: the memory is allocated in
the call to the pairwise_sum function on line 57 of the main function.

Exercise 11 review (continued)

The code:

```
int *pairsum2 = pairwise_sum(pairwise_sum(array, 5), 4);
...
free(pairsum2);
```

Issue: pairwise_sum returns a pointer to a dynamically allocated array, but for the "inner" call, the array is never freed.

Fix:

```
int *a = pairwise_sum(array, 5);
int *pairsum2 = pairwise_sum(a, 4);
...
free(pairsum2);
free(a);
```

Exercise 11 review (continued):

primes.c

Issue: the set_primes function needs to call realloc if the array of results needs to be increased in size.

However, realloc
can and usually does return a pointer to a new dynamic array (with a different memory address).

Unless set_primes can modify
the list pointer in main, the main function has no way of knowing the address of the re-allocated array.

Trace:

set_primes

main

Exercise 11 review (continued):

Solution: change set_primes so that it takes a pointer to the list pointer variable in the main function.

set_primes:

```
// originally
int set_primes( int *list , int capacity )

// updated
int set_primes( int **list , int capacity )
```

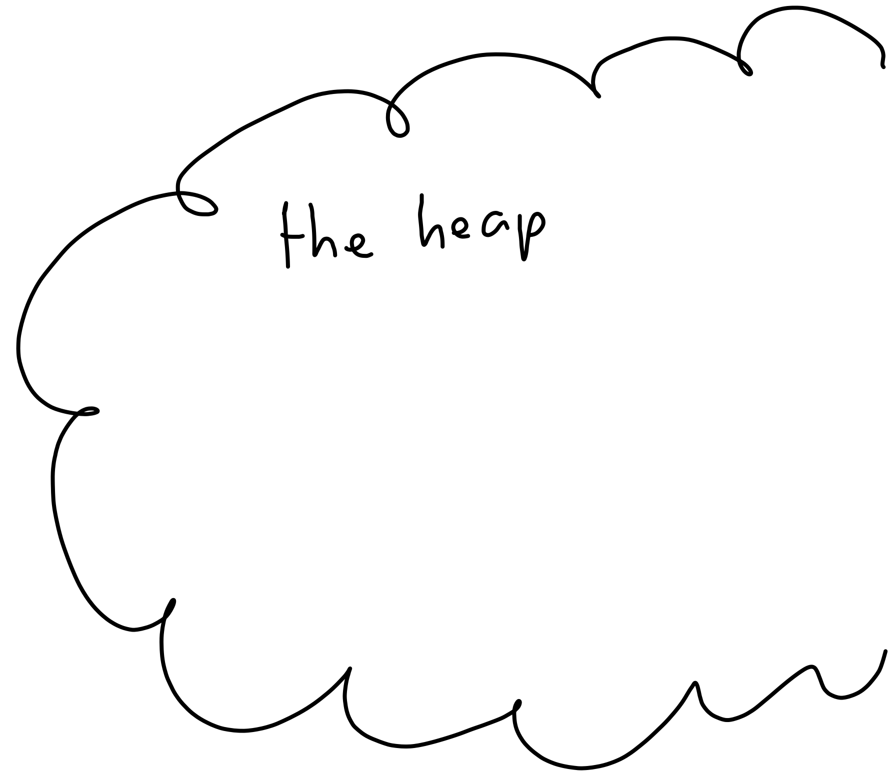
main:

```
int *list = /* initial allocation of array */

// originally
int prime_count = set_primes( list , capacity );

// updated
int prime_count = set_primes( &list , capacity );
```

Trace:

set_primes

main



Exercise 11 review (continued):

Changes to set_primes:

Essentially, everywhere that "list" was mentioned, we now want "*list" so that we are referring to the "list" pointer variable in main.

One issue: array subscript operator has higher precedence than the pointer dereference operator (*)

So, instead of changing

```
list[idx++] = n;
```

to

```
*list[idx++] = n;
```

it should be

```
(*list)[idx++] = n;
```

Day 12 recap questions:

1. What output is printed by the “Example code” below?
2. Assume that arr is an array of 5 int elements. Is the code

   `int *p = arr + 5;`

   legal?
3. Assume that arr is an array of 5 int elements. Is the code

   `int *p = arr + 5; printf("%d\n", *p);`

   legal?
4. What output is printed by the “Example code 2” below?
5. Suppose we have variables

   `int ra1[10] = { 1, 2, 3}; int * ra2 = ra1;`

   and

   `int fun(int *ra);`

   declarations. Will fun(ra1); compile? Will fun(ra2); compile? What if we change the function declaration to

   `int fun(const int ra[]);?`

1.

Trace:

```
// Example code
int arr[] = { 94, 69, 35, 72, 9 };
int *p = arr;
int *q = p + 3;
int *r = q - 1;
printf("%d %d %d\n", *p, *q, *r);
ptrdiff_t x = q - p;
ptrdiff_t y = r - p;
ptrdiff_t z = q - r;
printf("%d %d %d\n", (int)x, (int)y, (int)z);
ptrdiff_t m = p - q;
printf("%d\n", (int)m);
int c = (p < q);
int d = (q < p);
printf("%d %d\n", c, d);
```

2.

Yes. p points to the location just after the last element of arr.
Trying to access the memory that p points to isn't allowed, but just having the pointer is fine.

3.

No. As mentioned in (2), it's not allowed to access a location beyond the bounds of an array. (Doing so is undefined behavior.)

Trace:

4.

Trace:

```
// Example code 2
#include <stdio.h>

int sum(int a[], int n) {
  int x = 0;
  for (int i = 0; i < n; i++) {
    x += a[i];
  }
  return x;
}

int main(void) {
  int data[] = { 23, 59, 82, 42, 67,
                 89, 76, 44, 85, 81 };
  int result = sum(data + 3, 4);
  printf("result=%d\n", result);
  return 0;
}
```

5.

First question: yes. The name of a 1-D array, when used without a subscript operator, can be used as a pointer to the first element of an array.

Second question: yes. A pointer to an int can be freely used as a pointer to const int.

Note that the opposite situation wouldn't work: we can't use a pointer to const int in a constant where a pointer to a non-const int is expected.