# Test-Driven Development

## a Yahtzee game kata


Deep C - a 3 day course

Jon Jagger & Olve Maudal

During the last decade Test-Driven Development has become an established practice for developing software in the industry.

Here we will demonstrate Test-Driven Development in C using a Yahtzee game kata.

# The requirement

Write a C library that can score the lower section of a game of yahtzee.

Yahtzee® NAME _____

| UPPER SECTION | | | HOW TO SCORE | GAME #1 | GAME #2 | GAME #3 | GAME #4 | GAME #5 | GAME #6 |
|---|---|---|---|---|---|---|---|---|---|
| Aces | • | = 1 | Count and Add Only Aces | | | | | | |
| Twos | • • | = 2 | Count and Add Only Twos | | | | | | |
| Threes | • • • | = 3 | Count and Add Only Threes | | | | | | |
| Fours | • • • • | = 4 | Count and Add Only Fours | | | | | | |
| Fives | • • • • • | = 5 | Count and Add Only Fives | | | | | | |
| Sixes | • • • • • • | = 6 | Count and Add Only Sixes | | | | | | |
| TOTAL SCORE | | | → | | | | | | |
| BONUS | If total score is 63 or over | | SCORE 35 | | | | | | |
| TOTAL | Of Upper Section | | → | | | | | | |
| LOWER SECTION | | | | | | | | | |
| 3 of a kind | | | Add Total Of All Dice | | | | | | |
| 4 of a kind | | | Add Total Of All Dice | | | | | | |
| Full House | | | SCORE 25 | | | | | | |
| Sm. Straight | Sequence of 4 | | SCORE 30 | | | | | | |
| Lg. Straight | Sequence of 5 | | SCORE 40 | | | | | | |
| YAHTZEE | 5 of a kind | | SCORE 50 | | | | | | |
| Chance | | | Score Total Of All 5 Dice | | | | | | |
| YAHTZEE BONUS | | | ✓ FOR EACH BONUS | | | | | | |
| | | | SCORE 100 PER ✓ | | | | | | |
| TOTAL | Of Lower Section | | → | | | | | | |
| TOTAL | Of Upper Section | | → | | | | | | |
| GRAND TOTAL | | | → | | | | | | |

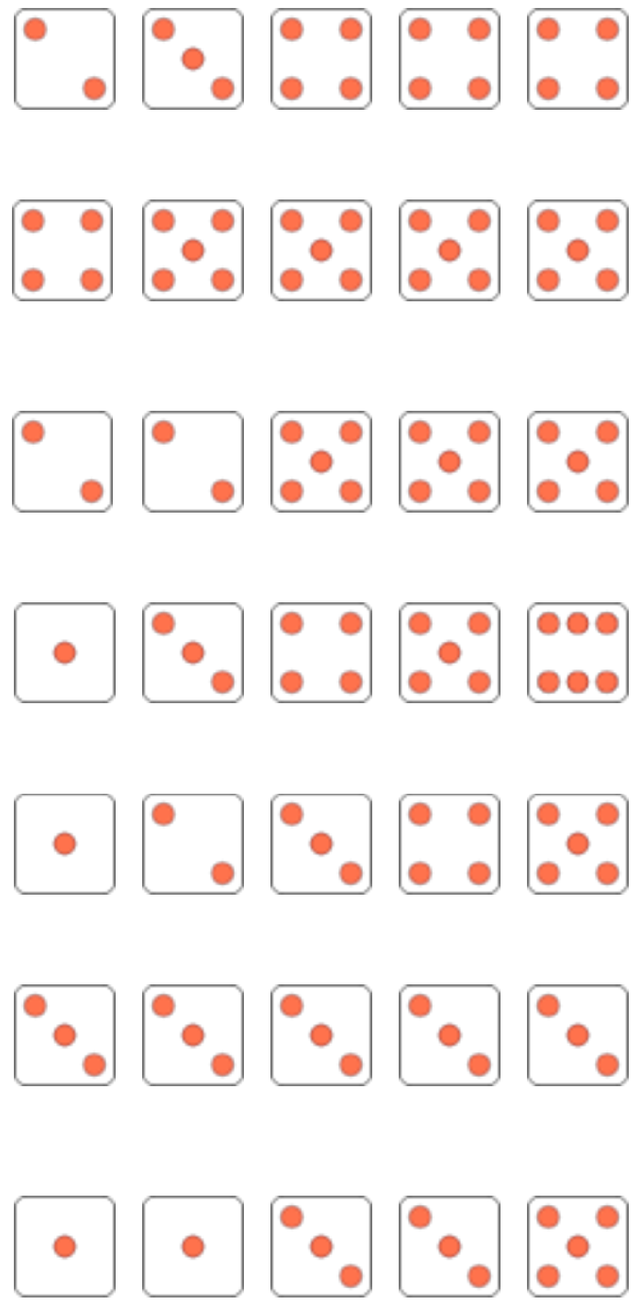


E6100

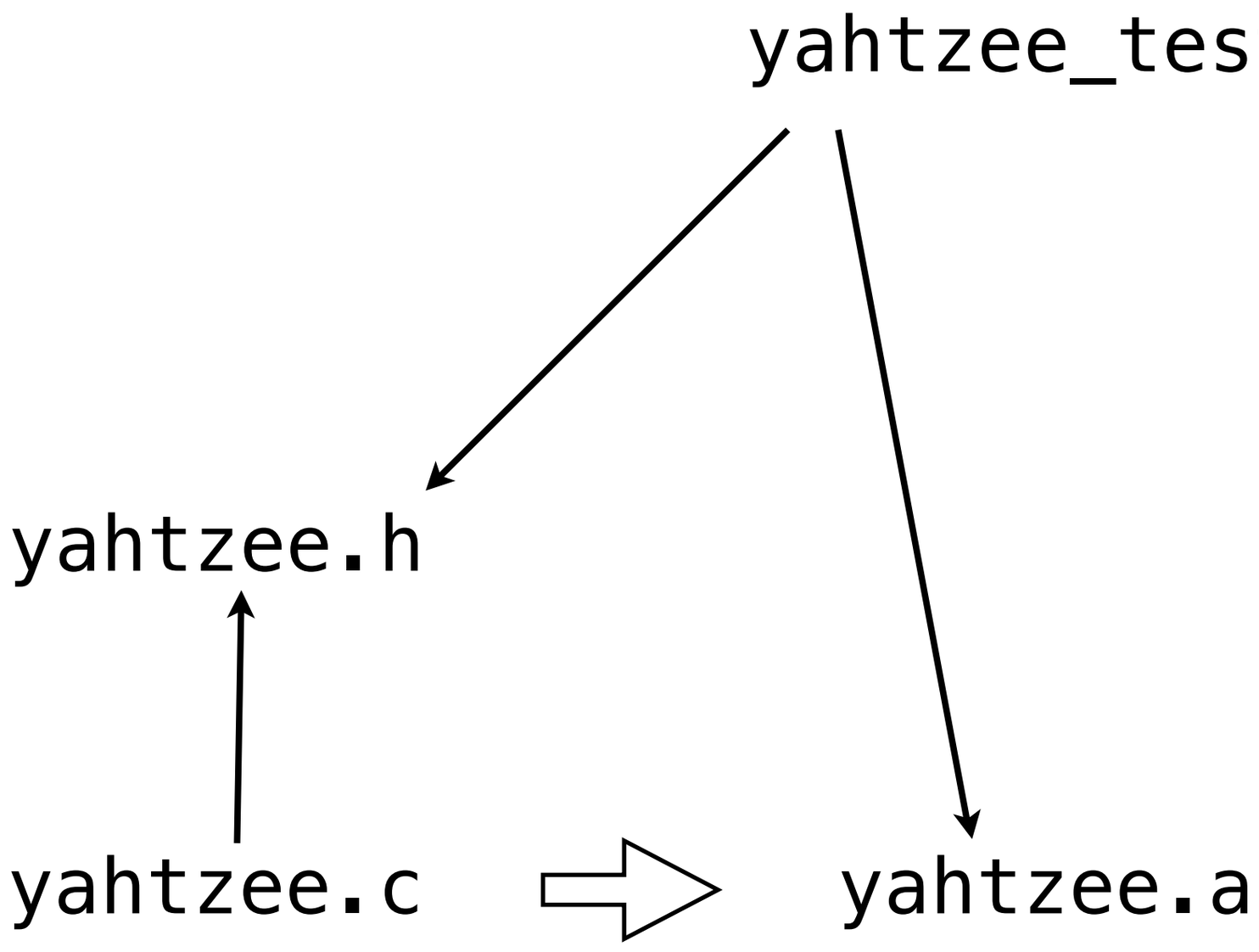
## LOWER SECTION

| | | |
|---|---|---|
| 3 of a kind | | Add Total Of All Dice |
| 4 of a kind | | Add Total Of All Dice |
| Full House | | SCORE 25 |
| Sm. Straight | Sequence of 4 | SCORE 30 |
| Lg. Straight | Sequence of 5 | SCORE 40 |
| YAHTZEE | 5 of a kind | SCORE 50 |
| Chance | | Score Total Of All 5 Dice |

# Examples



(see also http://en.wikipedia.org/wiki/Yahtzee)


yahtzee_tests.c
yahtzee.h
yahtzee.c
yahtzee.a

Makefile

```
CC=gcc
CFLAGS=-std=c99 -O -Wall -Wextra -pedantic
LD=gcc

all: yahtzee.a

yahtzee.a: yahtzee.o
	ar -rcs $@ $^

check: yahtzee_tests
	./yahtzee_tests

yahtzee.o: yahtzee.c yahtzee.h

yahtzee_tests.o: yahtzee_tests.c yahtzee.h

yahtzee_tests: yahtzee_tests.o yahtzee.a
	$(LD) -o $@ $^

clean:
	rm -f *.o *.a yahtzee_tests
```

yahtzee_test.c

```c
#include <assert.h>
#include <stdio.h>

int main(void)
{
    assert(6*9 == 42);

    puts("Yahtzee tests OK");
}
```

```
$ make check
gcc -std=c99 -O -Wa                                    tzee_tests.c
:99 -O -Wa
ahtzee.a
gcc -o  htzee_tests yahtzee_tests.o yahtzee.a
./yahtze_tests
Assertion failed: (6*9 == 42), function main, file yahtzee_tests.c, line 6.
```

**Fail** - Fix - Pass

Our first unit test failed. This is good! Exactly what we want. The rhythm of TDD is : fail, fix, pass... fail, fix, pass

Let's write a proper unit test

yahtzee_test.c

```
#include <assert.h>
#include <stdio.h>

int main(void)
{
    assert(6*7 == 42);

    puts("Yahtzee tests OK");
}
```

Fail - **Fix** - Pass

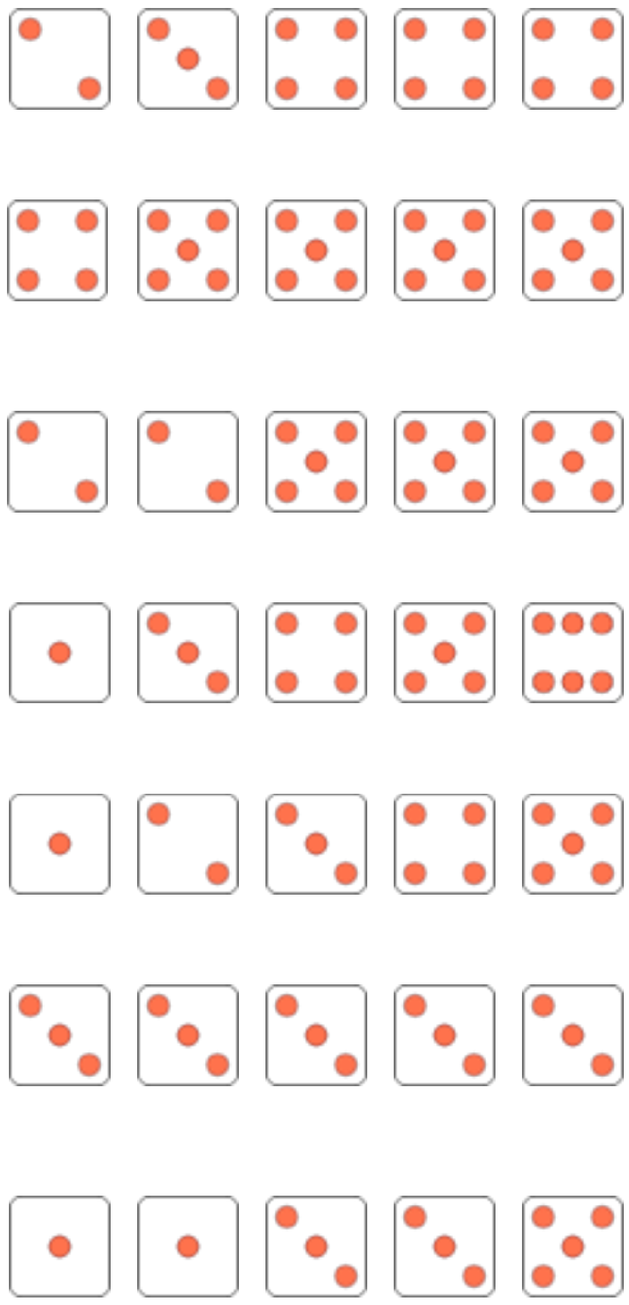
Fail - Fix - **Pass**

```
$ make check
gcc -std=c99 -O -                    -o yahtzee_tests.o yahtzee_tests.c
gcc -o yahtzee_te                    .a
./yahtzee_tests
Yahtzee tests OK
```

All tests are OK!

## LOWER SECTION

| | | |
|---|---|---|
| 3 of a kind | | Add Total Of All Dice |
| 4 of a kind | | Add Total Of All Dice |
| Full House | | SCORE 25 |
| Sm. Straight | Sequence of 4 | SCORE 30 |
| Lg. Straight | Sequence of 5 | SCORE 40 |
| YAHTZEE | 5 of a kind | SCORE 50 |
| Chance | | Score Total Of All 5 Dice |



yahtzee_test.c

```
#include "yahtzee.h"
#include <assert.h>
#include <stdio.h>

int main(void)
{


    puts("Yahtzee tests OK");
}
```

yahtzee.c

```
#include "yahtzee.h"

int score_three_of_a_kind(const int dice[5])
{
    return ??
}
```

what should we return?

Remember fail-fix-pass? Return something that you know will fail.

yahtzee.h

```
int score_three_of_a_kind(const int dice[5]);
```

yahtzee_test.c

```
#include "yahtzee.h"
#include <assert.h>
#include <stdio.h>

int main(void)
{
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);

    puts("Yahtzee tests OK");
}
```

yahtzee.c

```
#include "yahtzee.h"

int score_three_of_a_kind(const int dice[5])
{
    return 0;
}
```

yahtzee.h

```
int score_three_of_a_kind(const int dice[5]);
```

yahtzee_test.c

```
#include "yahtzee.h"
#include <assert.h>
#include <stdio.h>

int main(void)
{
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);

    puts("Yahtzee tests OK");
}
```

**Fail** - Fix - Pass

```
Assertion failed: (score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2)
```

yahtzee.c

```
#include "yahtzee.h"

int score_three_of_a_kind(const int dice[5])
{
    return 7;
}
```

Congratulation. We have completed our first proper fail-fix-pass cycle.

Returning 7 is a minimal change to make it pass. This is OK because what we are concerned about now is just to make sure that the "wiring" of the test is OK. Is the test really being called and is it testing the right function?

Fail - **Fix** - Pass

yahtzee.h

```
int score_three_of_a_kind(const int dice[5]);
```

yahtzee_test.c

```
#include "yahtzee.h"
#include <assert.h>
#include <stdio.h>

int main(void)
{
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);

    puts("Yahtzee tests OK");
}
```

Let's add another unit

Fail - Fix - **Pass**

```
Yahtzee tests OK
```

yahtzee.c

```
#include "yahtzee.h"

int score_three_of_a_kind(const int dice[5])
{
    return 7;
}
```

yahtzee.h

```
int score_three_of_a_kind(const int dice[5]);
```

yahtzee_test.c

```
#include "yahtzee.h"
#include <assert.h>
#include <stdio.h>

int main(void)
{
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);


    puts("Yahtzee tests OK");
}
```

yahtzee.c

```
#include "yahtzee.h"

int score_three_of_a_kind(const int dice[5])
{
    return 7;
}
```

Should we "cheat" again and check for the last dice, if 4 then return 10 otherwise 7?

No! Another principle of TDD is that while you are supposed to do simple and "naive" increments you are not allowed to do "obviously stupid" stuff.

yahtzee.h

```
int score_t
```

A simple and naive thing to do here is to just **sum the dice** and return the value. That would satisfy all the tests and we know the functionality will eventually be needed.

```
#include <assert.h>
#include <stdio.h>

int main(void)
{
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);
    assert(score_three_of_a_kind((int[5]){1,1,1,3,4}) == 3+3+4);

    puts("Yahtzee tests OK");
}
```

**Fail** - Fix - Pass

```
Assertion failed: (score_three_of_a_kind((int[5]){1,1,1,3,4}) == 3+3+4)
```

yahtzee.c

```c
#include "yahtzee.h"

int score_three_of_a_kind(const int dice[5])
{
    return 7;
}
```

yahtzee.h

```c
int score_three_of_a_kind(const int dice[5]);
```

yahtzee_test.c

```c
#include "yahtzee.h"
#include <assert.h>
#include <stdio.h>

int main(void)
{
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);
    assert(score_three_of_a_kind((int[5]){1,1,1,3,4}) == 3+3+4);

    puts("Yahtzee tests OK");
}
```

yahtzee.c

```
#include "yahtzee.h"

int score_three_of_a_kind(const int dice[5])
{
    return 7;
}
```

yahtzee.c

```
#include "yahtzee.h"

int score_three_of_a_kind(const int dice[5])
{
    return sum_of_dice(dice);
}
```

yahtzee.c

```
#include "yahtzee.h"









int score_three_of_a_kind(const int dice[5])
{
    return sum_of_dice(dice);
}
```

yahtzee.c

```
#include "yahtzee.h"

static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (int die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

int score_three_of_a_kind(const int dice[5])
{
    return sum_of_dice(dice);
}
```

But wait a minute. When indexing an array in C you should really use **size_t**. Let's fix it now as all tests are OK

Fail - **Fix** - Pass

Fail - Fix - **Pass**

```
Yahtzee tests OK
```

yahtzee.c

```
#include "yahtzee.h"

static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (int die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

int score_three_of_a_kind(const int dice[5])
{
    return sum_of_dice(dice);
}
```

yahtzee.c

```
#include "yahtzee.h"


static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (int die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

int score_three_of_a_kind(const int dice[5])
{
    return sum_of_dice(dice);
}
```

yahtzee.c

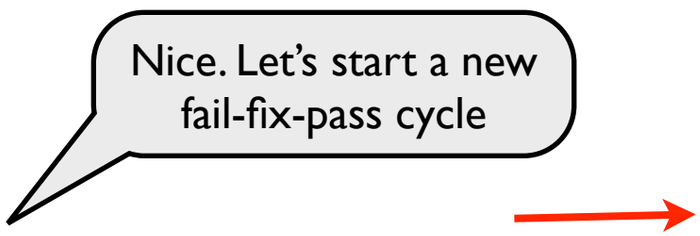
```
#include "yahtzee.h"
#include <stddef.h>

static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (int die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

int score_three_of_a_kind(const int dice[5])
{
    return sum_of_dice(dice);
}
```

yahtzee.c

```
#include "yahtzee.h"
#include <stddef.h>

static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

int score_three_of_a_kind(const int dice[5])
{
    return sum_of_dice(dice);
}
```

yahtzee.c

```
#include "yahtzee.h"
#include <stddef.h>

static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

int score_three_of_a_kind(const int dice[5])
{
    return sum_of_dice(dice);
}
```




```
Yahtzee tests OK
```

yahtzee.c

```
#include "yahtzee.h"
#include <stddef.h>

static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

int score_three_of_a_kind(const int dice[5])
{
    return sum_of_dice(dice);
}
```

yahtzee_test.c

```
#include "yahtzee.h"
#include <assert.h>
#include <stdio.h>

int main(void)
{
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);
    assert(score_three_of_a_kind((int[5]){1,1,1,3,4}) == 3+3+4);


    puts("Yahtzee tests OK");
}
```

yahtzee.c

```
#include "yahtzee.h"
#include <stddef.h>

static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

int score_three_of_a_kind(const int dice[5])
{
    return sum_of_dice(dice);
}
```

So how do we fix this?

We need to check that we really have three of a kind.

yahtzee_test.c

```
#include "yahtzee.h"
#include <assert.h>
#include <stdio.h>

int main(void)
{
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);
    assert(score_three_of_a_kind((int[5]){1,1,1,3,4}) == 3+3+4);
    assert(score_three_of_a_kind((int[5]){1,2,3,4,5}) == 0);

    puts("Yahtzee tests OK");
}
```

**Fail** - Fix - Pass

```
Assertion failed: (score_three_of_a_kind((int[5]){1,2,3,4,5}) == 0)
```

yahtzee.c

```
#include "yahtzee.h"
#include <stddef.h>

static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

int score_three_of_a_kind(const int dice[5])
{
    return sum_of_dice(dice);
}
```

yahtzee.c

```
#include "yahtzee.h"
#include <stddef.h>

static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

int score_three_of_a_kind(const int dice[5])
{
        return sum_of_dice(dice);
}
```

yahtzee.c

```
#include "yahtzee.h"
#include <stddef.h>

static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

int score_three_of_a_kind(const int dice[5])
{
    if (have_three_of_a_kind(dice))
        return sum_of_dice(dice);
}
```

yahtzee.c

```
#include "yahtzee.h"
#include <stddef.h>

static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

int score_three_of_a_kind(const int dice[5])
{
    if (have_three_of_a_kind(dice))
        return sum_of_dice(dice);

}
```

yahtzee.c

```
#include "yahtzee.h"
#include <stddef.h>

static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

int score_three_of_a_kind(const int dice[5])
{
    if (have_three_of_a_kind(dice))
        return sum_of_dice(dice);
    return 0;
}
```

yahtzee.c

```
#include "yahtzee.h"
#include <stddef.h>

static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

int score_three_of_a_kind(const int dice[5])
{
    if (have_three_of_a_kind(dice))
        return sum_of_dice(dice);
    return 0;
}
```

yahtzee.c

```
#include "yahtzee.h"
#include <stddef.h>

static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

int score_three_of_a_kind(const int dice[5])
{
    if (have_three_of_a_kind(dice))
        return sum_of_dice(dice);
    return 0;
}
```

yahtzee.c

```
#include "yahtzee.h"
#include <stddef.h>

static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}
```

```


int score_three_of_a_kind(const int dice[5])
{
    if (have_three_of_a_kind(dice))
        return sum_of_dice(dice);
    return 0;
}
```

yahtzee.c

```
#include "yahtzee.h"
#include <stddef.h>

static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

static bool have_three_of_a_kind(const int dice[5])
{
    for (int face = 1; face <= 6; face++)
        if (count_face(face,dice) == 3)
            return true;
    return false;
}

int score_three_of_a_kind(const int dice[5])
{
    if (have_three_of_a_kind(dice))
        return sum_of_dice(dice);
    return 0;
}
```

yahtzee.c

```
#include "yahtzee.h"
#include <stddef.h>

static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

static bool have_three_of_a_kind(const int dice[5])
{
    for (int face = 1; face <= 6; face++)
        if (count_face(face,dice) == 3)
            return true;
    return false;
}

int score_three_of_a_kind(const int dice[5])
{
    if (have_three_of_a_kind(dice))
        return sum_of_dice(dice);
    return 0;
}
```

yahtzee.c

```
#include "yahtzee.h"
#include <stddef.h>

static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}
```

```


static bool have_three_of_a_kind(const int dice[5])
{
    for (int face = 1; face <= 6; face++)
        if (count_face(face,dice) == 3)
            return true;
    return false;
}

int score_three_of_a_kind(const int dice[5])
{
    if (have_three_of_a_kind(dice))
        return sum_of_dice(dice);
    return 0;
}
```

yahtzee.c

```
#include "yahtzee.h"
#include <stddef.h>

static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

static int count_face(int face, const int dice[5])
{
    int count = 0;
    for (size_t die = 0; die < 5; die++)
        if (dice[die] == face)
            count++;
    return count;
}

static bool have_three_of_a_kind(const int dice[5])
{
    for (int face = 1; face <= 6; face++)
        if (count_face(face,dice) == 3)
            return true;
    return false;
}

int score_three_of_a_kind(const int dice[5])
{
    if (have_three_of_a_kind(dice))
        return sum_of_dice(dice);
    return 0;
}
```

yahtzee.c

```
#include "yahtzee.h"
#include <stddef.h>

static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

static int count_face(int face, const int dice[5])
{
    int count = 0;
    for (size_t die = 0; die < 5; die++)
        if (dice[die] == face)
            count++;
    return count;
}

static bool have_three_of_a_kind(const int dice[5])
{
    for (int face = 1; face <= 6; face++)
        if (count_face(face,dice) == 3)
            return true;
    return false;
}

int score_three_of_a_kind(const int dice[5])
{
    if (have_three_of_a_kind(dice))
        return sum_of_dice(dice);
    return 0;
}
```

yahtzee.c

```
#include "yahtzee.h"
#include <stddef.h>

static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

static int count_face(int face, const int dice[5])
{
    int count = 0;
    for (size_t die = 0; die < 5; die++)
        if (dice[die] == face)
            count++;
    return count;
}

static bool have_three_of_a_kind(const int dice[5])
{
    for (int face = 1; face <= 6; face++)
        if (count_face(face,dice) == 3)
            return true;
    return false;
}

int score_three_of_a_kind(const int dice[5])
{
    if (have_three_of_a_kind(dice))
        return sum_of_dice(dice);
    return 0;
}
```

yahtzee.c

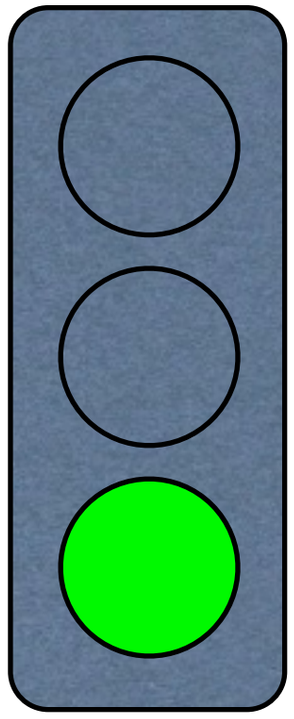
```c
#include "yahtzee.h"
#include <stddef.h>



static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

static int count_face(int face, const int dice[5])
{
    int count = 0;
    for (size_t die = 0; die < 5; die++)
        if (dice[die] == face)
            count++;
    return count;
}

static bool have_three_of_a_kind(const int dice[5])
{
    for (int face = 1; face <= 6; face++)
        if (count_face(face,dice) == 3)
            return true;
    return false;
}

int score_three_of_a_kind(const int dice[5])
{
    if (have_three_of_a_kind(dice))
        return sum_of_dice(dice);
    return 0;
}
```

yahtzee.c

```
#include "yahtzee.h"
#include <stddef.h>
#include <stdbool.h>

static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

static int count_face(int face, const int dice[5])
{
    int count = 0;
    for (size_t die = 0; die < 5; die++)
        if (dice[die] == face)
            count++;
    return count;
}

static bool have_three_of_a_kind(const int dice[5])
{
    for (int face = 1; face <= 6; face++)
        if (count_face(face,dice) == 3)
            return true;
    return false;
}

int score_three_of_a_kind(const int dice[5])
{
    if (have_three_of_a_kind(dice))
        return sum_of_dice(dice);
    return 0;
}
```

yahtzee.c

```
#include "yahtzee.h"
#include <stddef.h>
#include <stdbool.h>

static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

static int count_face(int face, const int dice[5])
{
    int count = 0;
    for (size_t die = 0; die < 5; die++)
        if (dice[die] == face)
            count++;
    return count;
}

static bool have_three_of_a_kind(const int dice[5])
{
    for (int face = 1; face <= 6; face++)
        if (count_face(face,dice) == 3)
            return true;
    return false;
}

int score_three_of_a_kind(const int dice[5])
{
    if (have_three_of_a_kind(dice))
        return sum_of_dice(dice);
    return 0;
}
```



```
Yahtzee tests OK
```

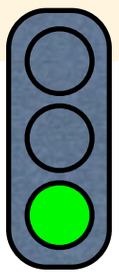
yahtzee_test.c

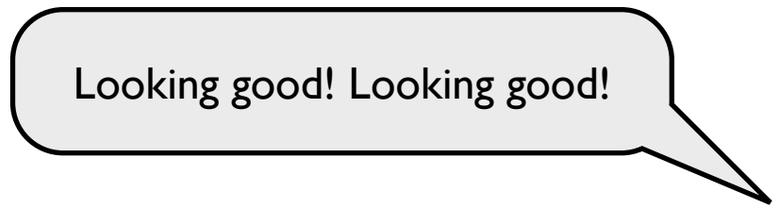
```
...
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);
    assert(score_three_of_a_kind((int[5]){1,1,1,3,4}) == 3+3+4);
    assert(score_three_of_a_kind((int[5]){1,2,3,4,5}) == 0);
```

yahtzee_test.c

```
...
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);
    assert(score_three_of_a_kind((int[5]){1,1,1,3,4}) == 3+3+4);
    assert(score_three_of_a_kind((int[5]){1,2,3,4,5}) == 0);
    assert(score_three_of_a_kind((int[5]){5,3,5,5,2}) == 15+5);
```

```
Yahtzee tests OK
```

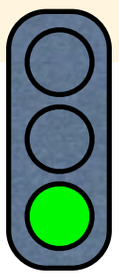


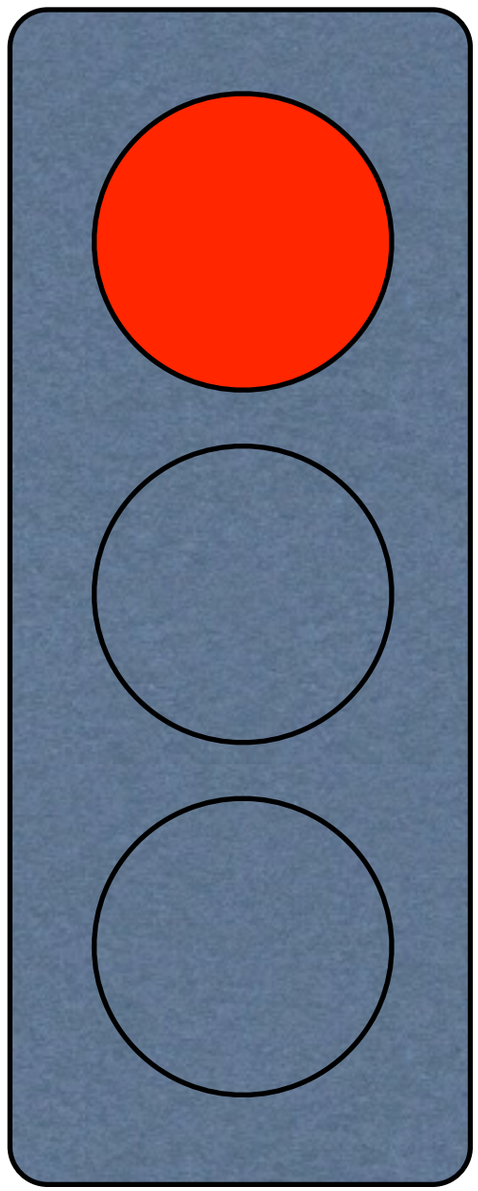



yahtzee_test.c

```
...
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);
    assert(score_three_of_a_kind((int[5]){1,1,1,3,4}) == 3+3+4);
    assert(score_three_of_a_kind((int[5]){1,2,3,4,5}) == 0);
    assert(score_three_of_a_kind((int[5]){5,3,5,5,2}) == 15+5);
    assert(score_three_of_a_kind((int[5]){1,1,6,6,6}) == 18+2);
```

```
Yahtzee tests OK
```





Looking good! Looking good!

yahtzee_test.c

```
...
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);
    assert(score_three_of_a_kind((int[5]){1,1,1,3,4}) == 3+3+4);
    assert(score_three_of_a_kind((int[5]){1,2,3,4,5}) == 0);
    assert(score_three_of_a_kind((int[5]){5,3,5,5,2}) == 15+5);
    assert(score_three_of_a_kind((int[5]){1,1,6,6,6}) == 18+2);
    assert(score_three_of_a_kind((int[5]){6,1,6,6,6}) == 18+7);
```

Oh no... what happened?

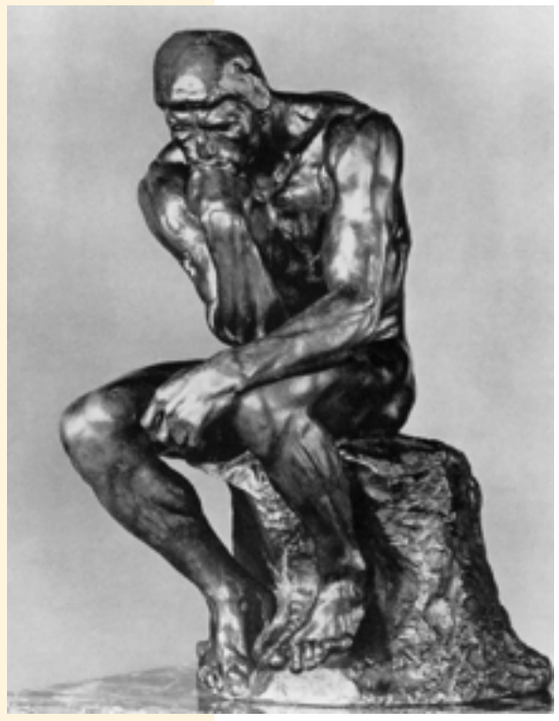
```
Assertion failed: (score_three_of_a_kind((int[5]){6,1,6,6,6}) == 18+7)
```

yahtzee.c

```
...
static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

static int count_face(int face, const int dice[5])
{
    int count = 0;
    for (size_t die = 0; die < 5; die++)
        if (dice[die] == face)
            count++;
    return count;
}

static bool have_three_of_a_kind(const int dice[5])
{
    for (int face = 1; face <= 6; face++)
        if (count_face(face,dice) == 3)
            return true;
    return false;
}

int score_three_of_a_kind(const int dice[5])
{
    if (have_three_of_a_kind(dice))
        return sum_of_dice(dice);
    return 0;
}
```

But of course...

it should be ***at least*** three...



Oh no... what happened?

```
Assertion failed: (score_three_of_a_kind((int[5]){6,1,6,6,6}) == 18+7)
```

yahtzee.c

```
...
static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

static int count_face(int face, const int dice[5])
{
    int count = 0;
    for (size_t die = 0; die < 5; die++)
        if (dice[die] == face)
            count++;
    return count;
}


static bool have_three_of_a_kind(const int dice[5])
{
    for (int face = 1; face <= 6; face++)
        if (count_face(face,dice) == 3)
            return true;
    return false;
}

int score_three_of_a_kind(const int dice[5])
{
    if (have_three_of_a_kind(dice))
        return sum_of_dice(dice);
    return 0;
}
```

yahtzee.c

```
...
static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

static int count_face(int face, const int dice[5])
{
    int count = 0;
    for (size_t die = 0; die < 5; die++)
        if (dice[die] == face)
            count++;
    return count;
}
```



```
static bool have_three_of_a_kind(const int dice[5])
{
    for (int face = 1; face <= 6; face++)
        if (count_face(face,dice) == 3)
            return true;
    return false;
}

int score_three_of_a_kind(const int dice[5])
{
    if (have_at_least_three_of_a_kind(dice))
        return sum_of_dice(dice);
    return 0;
}
```

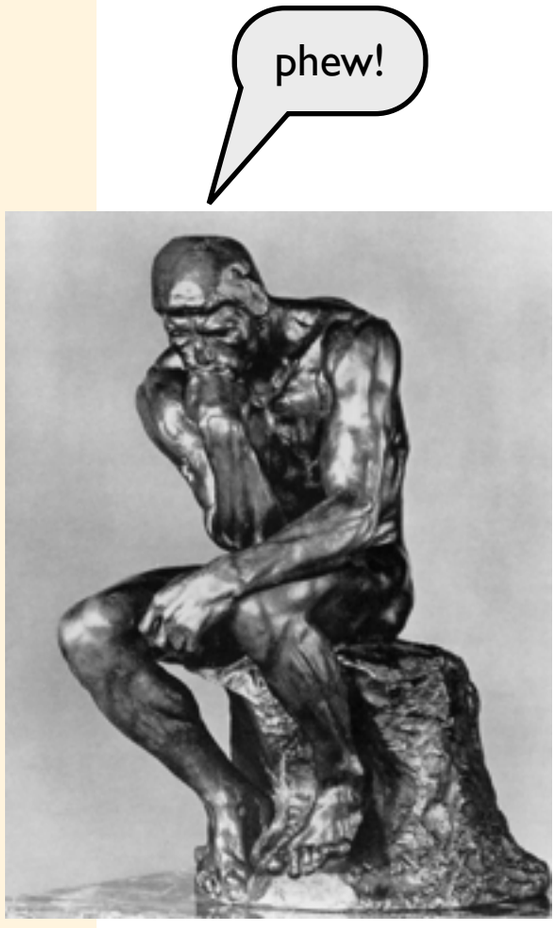
yahtzee.c

```
...
static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

static int count_face(int face, const int dice[5])
{
    int count = 0;
    for (size_t die = 0; die < 5; die++)
        if (dice[die] == face)
            count++;
    return count;
}
```

```

static bool have_at_least_three_of_a_kind(const int dice[5])
{
    for (int face = 1; face <= 6; face++)
        if (count_face(face,dice) == 3)
            return true;
    return false;
}

int score_three_of_a_kind(const int dice[5])
{
    if (have_at_least_three_of_a_kind(dice))
        return sum_of_dice(dice);
    return 0;
}
```

yahtzee.c

```
...
static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

static int count_face(int face, const int dice[5])
{
    int count = 0;
    for (size_t die = 0; die < 5; die++)
        if (dice[die] == face)
            count++;
    return count;
}

static bool have_at_least_three_of_a_kind(const int dice[5])
{
    for (int face = 1; face <= 6; face++)
        if (count_face(face,dice) >= 3)
            return true;
    return false;
}

int score_three_of_a_kind(const int dice[5])
{
    if (have_at_least_three_of_a_kind(dice))
        return sum_of_dice(dice);
    return 0;
}
```




```
Yahtzee tests OK
```

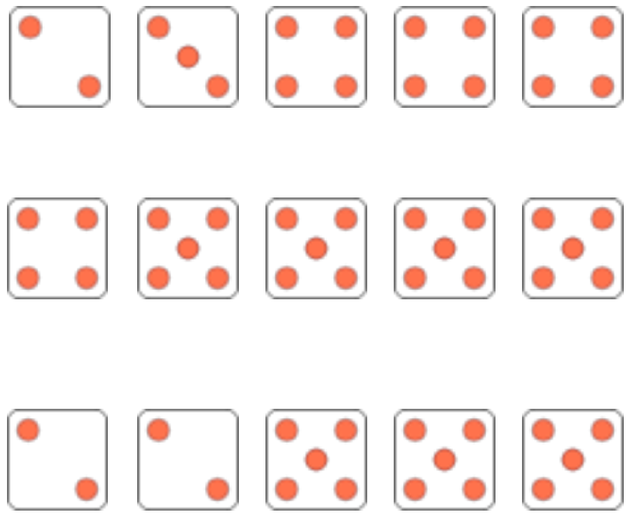
Now we have a decent implementation of three of a kind

yahtzee_test.c

```
...
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);
    assert(score_three_of_a_kind((int[5]){1,1,1,3,4}) == 3+3+4);
    assert(score_three_of_a_kind((int[5]){1,2,3,4,5}) == 0);
    assert(score_three_of_a_kind((int[5]){5,3,5,5,2}) == 15+5);
    assert(score_three_of_a_kind((int[5]){1,1,6,6,6}) == 18+2);
    assert(score_three_of_a_kind((int[5]){6,1,6,6,6}) == 18+7);
```

## LOWER SECTION

| | | |
|---|---|---|
| 3 of a kind | | Add Total Of All Dice |
| 4 of a kind | | Add Total Of All Dice |
| Full House | | SCORE 25 |
| Sm. Straight | Sequence of 4 | SCORE 30 |
| Lg. Straight | Sequence of 5 | SCORE 40 |
| YAHTZEE | 5 of a kind | SCORE 50 |
| Chance | | Score Total Of All 5 Dice |



yahtzee_test.c

```
...
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);
    assert(score_three_of_a_kind((int[5]){1,1,1,3,4}) == 3+3+4);
    assert(score_three_of_a_kind((int[5]){1,2,3,4,5}) == 0);
    assert(score_three_of_a_kind((int[5]){5,3,5,5,2}) == 15+5);
    assert(score_three_of_a_kind((int[5]){1,1,6,6,6}) == 18+2);
    assert(score_three_of_a_kind((int[5]){6,1,6,6,6}) == 18+7);
```

yahtzee.h

```
int score_three_of_a_kind(const int dice[5]);
```

yahtzee_test.c

```
...
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);
    assert(score_three_of_a_kind((int[5]){1,1,1,3,4}) == 3+3+4);
    assert(score_three_of_a_kind((int[5]){1,2,3,4,5}) == 0);
    assert(score_three_of_a_kind((int[5]){5,3,5,5,2}) == 15+5);
    assert(score_three_of_a_kind((int[5]){1,1,6,6,6}) == 18+2);
    assert(score_three_of_a_kind((int[5]){6,1,6,6,6}) == 18+7);

    assert(score_four_of_a_kind((int[5]){1,1,1,1,5}) == 9);
```

yahtzee.c

```
int score_four_of_a_kind(const int dice[5])
{
    return ??
}
```

what should we return?

Remember fail-fix-pass? First we want a failing test

yahtzee.h

```
int score_three_of_a_kind(const int dice[5]);
int score_four_of_a_kind(const int dice[5]);
```

yahtzee_test.c

```
...
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);
    assert(score_three_of_a_kind((int[5]){1,1,1,3,4}) == 3+3+4);
    assert(score_three_of_a_kind((int[5]){1,2,3,4,5}) == 0);
    assert(score_three_of_a_kind((int[5]){5,3,5,5,2}) == 15+5);
    assert(score_three_of_a_kind((int[5]){1,1,6,6,6}) == 18+2);
    assert(score_three_of_a_kind((int[5]){6,1,6,6,6}) == 18+7);

    assert(score_four_of_a_kind((int[5]){1,1,1,1,5}) == 9);
```

yahtzee.c

```
int score_four_of_a_kind(const int dice[5])
{
    return 0;
}
```

yahtzee.h

```
int score_three_of_a_kind(const int dice[5]);
int score_four_of_a_kind(const int dice[5]);
```

yahtzee_test.c

```
...
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);
    assert(score_three_of_a_kind((int[5]){1,1,1,3,4}) == 3+3+4);
    assert(score_three_of_a_kind((int[5]){1,2,3,4,5}) == 0);
    assert(score_three_of_a_kind((int[5]){5,3,5,5,2}) == 15+5);
    assert(score_three_of_a_kind((int[5]){1,1,6,6,6}) == 18+2);
    assert(score_three_of_a_kind((int[5]){6,1,6,6,6}) == 18+7);

    assert(score_four_of_a_kind((int[5]){1,1,1,1,5}) == 9);
```

**Fail** - Fix - Pass

```
Assertion failed: (score_four_of_a_kind((int[5]){1,1,1,1,5}) == 9)
```

yahtzee.c

```
int score_four_of_a_kind(const int dice[5])
{
    return 9;
}
```


yahtzee.h

```
int score_three_of_a_kind(const int dice[5]);
int score_four_of_a_kind(const int dice[5]);
```

yahtzee_test.c

```
...
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);
    assert(score_three_of_a_kind((int[5]){1,1,1,3,4}) == 3+3+4);
    assert(score_three_of_a_kind((int[5]){1,2,3,4,5}) == 0);
    assert(score_three_of_a_kind((int[5]){5,3,5,5,2}) == 15+5);
    assert(score_three_of_a_kind((int[5]){1,1,6,6,6}) == 18+2);
    assert(score_three_of_a_kind((int[5]){6,1,6,6,6}) == 18+7);

    assert(score_four_of_a_kind((int[5]){1,1,1,1,5}) == 9);
```


```
Yahtzee tests OK
```

yahtzee.c

```
int score_four_of_a_kind(const int dice[5])
{
    return 9;
}
```

yahtzee.h

```
int score_three_of_a_kind(const int dice[5]);
int score_four_of_a_kind(const int dice[5]);
```

yahtzee_test.c

```
...
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);
    assert(score_three_of_a_kind((int[5]){1,1,1,3,4}) == 3+3+4);
    assert(score_three_of_a_kind((int[5]){1,2,3,4,5}) == 0);
    assert(score_three_of_a_kind((int[5]){5,3,5,5,2}) == 15+5);
    assert(score_three_of_a_kind((int[5]){1,1,6,6,6}) == 18+2);
    assert(score_three_of_a_kind((int[5]){6,1,6,6,6}) == 18+7);

    assert(score_four_of_a_kind((int[5]){1,1,1,1,5}) == 9);
```

yahtzee.c

```
int score_four_of_a_kind(const int dice[5])
{
    return 9;
}
```

yahtzee.h

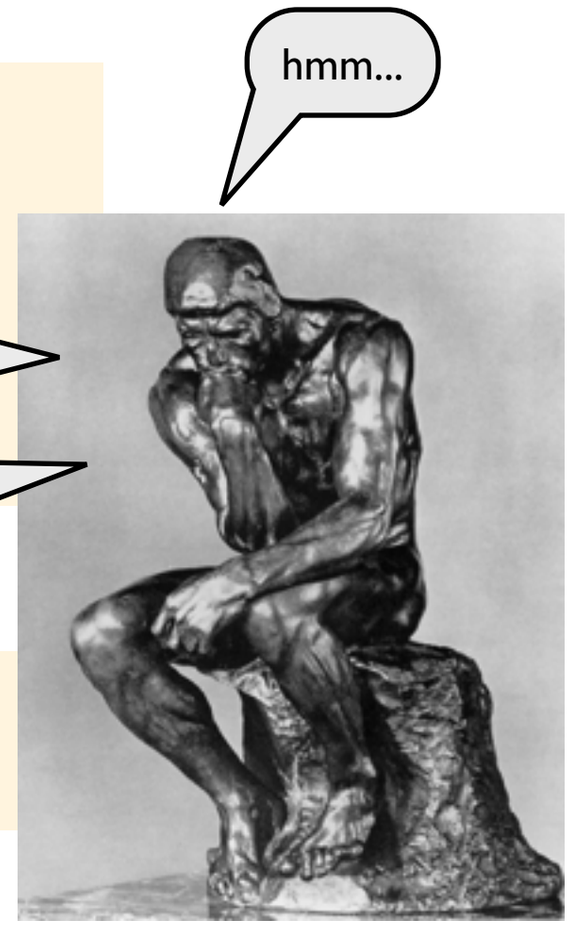
```
int score_three_of_a_kind(const int dice[5]);
int score_four_of_a_kind(const int dice[5]);
```

yahtzee_test.c

```
...
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);
    assert(score_three_of_a_kind((int[5]){1,1,1,3,4}) == 3+3+4);
    assert(score_three_of_a_kind((int[5]){1,2,3,4,5}) == 0);
    assert(score_three_of_a_kind((int[5]){5,3,5,5,2}) == 15+5);
    assert(score_three_of_a_kind((int[5]){1,1,6,6,6}) == 18+2);
    assert(score_three_of_a_kind((int[5]){6,1,6,6,6}) == 18+7);

    assert(score_four_of_a_kind((int[5]){1,1,1,1,5}) == 9);
    assert(score_four_of_a_kind((int[5]){1,1,3,1,5}) == 0);
```

yahtzee.c

```
int score_four_of_a_kind(const int dice[5])
{
    if (have_at_least_fou


}
```




yahtzee.h

```
int score_three_of_a_kind(const int dice[5]);
int score_four_of_a_kind(const int dice[5]);
```

yahtzee_test.c

```
...
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);
    assert(score_three_of_a_kind((int[5]){1,1,1,3,4}) == 3+3+4);
    assert(score_three_of_a_kind((int[5]){1,2,3,4,5}) == 0);
    assert(score_three_of_a_kind((int[5]){5,3,5,5,2}) == 15+5);
    assert(score_three_of_a_kind((int[5]){1,1,6,6,6}) == 18+2);
    assert(score_three_of_a_kind((int[5]){6,1,6,6,6}) == 18+7);

    assert(score_four_of_a_kind((int[5]){1,1,1,1,5}) == 9);
    assert(score_four_of_a_kind((int[5]){1,1,3,1,5}) == 0);
```

yahtzee.c

```
int score_four_of_a_kind(const int dice[5])
{
    return 9;


}
```

yahtzee.h

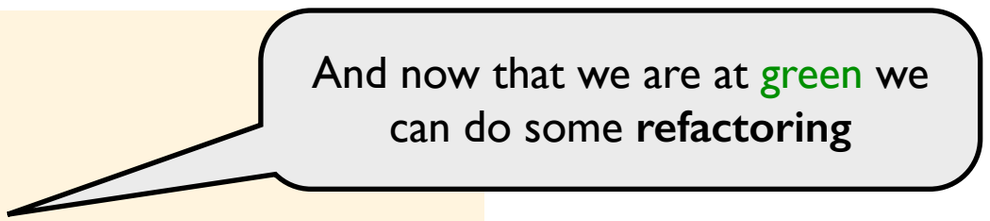
```
int score_three_of_a_kind(const int dice[5]);
int score_four_of_a_kind(const int dice[5]);
```

yahtzee_test.c

```
...
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);
    assert(score_three_of_a_kind((int[5]){1,1,1,3,4}) == 3+3+4);
    assert(score_three_of_a_kind((int[5]){1,2,3,4,5}) == 0);
    assert(score_three_of_a_kind((int[5]){5,3,5,5,2}) == 15+5);
    assert(score_three_of_a_kind((int[5]){1,1,6,6,6}) == 18+2);
    assert(score_three_of_a_kind((int[5]){6,1,6,6,6}) == 18+7);

    assert(score_four_of_a_kind((int[5]){1,1,1,1,5}) == 9);
    assert(score_four_of_a_kind((int[5]){1,1,3,1,5}) == 0);
```

yahtzee.c

```
int score_four_of_a_kind(const int dice[5])
{
    return 9;


}
```




yahtzee.h

```
int score_three_of_a_kind(const int dice[5]);
int score_four_of_a_kind(const int dice[5]);
```

yahtzee_test.c

```
...
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);
    assert(score_three_of_a_kind((int[5]){1,1,1,3,4}) == 3+3+4);
    assert(score_three_of_a_kind((int[5]){1,2,3,4,5}) == 0);
    assert(score_three_of_a_kind((int[5]){5,3,5,5,2}) == 15+5);
    assert(score_three_of_a_kind((int[5]){1,1,6,6,6}) == 18+2);
    assert(score_three_of_a_kind((int[5]){6,1,6,6,6}) == 18+7);

    assert(score_four_of_a_kind((int[5]){1,1,1,1,5}) == 9);
    //assert(score_four_of_a_kind((int[5]){1,1,3,1,5}) == 0);
```

```
Yahtzee tests OK
```

yahtzee.c

```
...
static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

static int count_face(int face, const int dice[5])
{
    int count = 0;
    for (size_t die = 0; die < 5; die++)
        if (dice[die] == face)
            count++;
    return count;
}
```

```
static bool have_at_least_three_of_a_kind(const int dice[5])
{
    for (int face = 1; face <= 6; face++)
        if (count_face(face,dice) >= 3)
            return true;
    return false;
}

int score_three_of_a_kind(const int dice[5])
{
    if (have_at_least_three_of_a_kind(dice))
        return sum_of_dice(dice);
    return 0;
}
```

yahtzee.c

```
...
static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

static int count_face(int face, const int dice[5])
{
    int count = 0;
    for (size_t die = 0; die < 5; die++)
        if (dice[die] == face)
            count++;
    return count;
}

static bool have_at_least_n_of_a_kind(const int dice[5])
{
    for (int face = 1; face <= 6; face++)
        if (count_face(face,dice) >= 3)
            return true;
    return false;
}

int score_three_of_a_kind(const int dice[5])
{
    if (have_at_least_n_of_a_kind(dice))
        return sum_of_dice(dice);
    return 0;
}
```

yahtzee.c

```
...
static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

static int count_face(int face, const int dice[5])
{
    int count = 0;
    for (size_t die = 0; die < 5; die++)
        if (dice[die] == face)
            count++;
    return count;
}

static bool have_at_least_n_of_a_kind(int n, const int dice[5])
{
    for (int face = 1; face <= 6; face++)
        if (count_face(face,dice) >= n)
            return true;
    return false;
}

int score_three_of_a_kind(const int dice[5])
{
    if (have_at_least_n_of_a_kind(3, dice))
        return sum_of_dice(dice);
    return 0;
}
```

And now we have prepared the ground for implementing score_four_of_a_kind()

```
Yahtzee tests OK
```

yahtzee.c

```
int score_four_of_a_kind(const int dice[5])
{
    return 9;


}
```

yahtzee.h

```
int score_three_of_a_kind(const int dice[5]);
int score_four_of_a_kind(const int dice[5]);
```

yahtzee_test.c

```
...
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);
    assert(score_three_of_a_kind((int[5]){1,1,1,3,4}) == 3+3+4);
    assert(score_three_of_a_kind((int[5]){1,2,3,4,5}) == 0);
    assert(score_three_of_a_kind((int[5]){5,3,5,5,2}) == 15+5);
    assert(score_three_of_a_kind((int[5]){1,1,6,6,6}) == 18+2);
    assert(score_three_of_a_kind((int[5]){6,1,6,6,6}) == 18+7);

    assert(score_four_of_a_kind((int[5]){1,1,1,1,5}) == 9);
    //assert(score_four_of_a_kind((int[5]){1,1,3,1,5}) == 0);
```

```
Yahtzee tests OK
```

yahtzee.c

```
int score_four_of_a_kind(const int dice[5])
{
    return 9;


}
```

yahtzee.h

```
int score_three_of_a_kind(const int dice[5]);
int score_four_of_a_kind(const int dice[5]);
```

yahtzee_test.c

```
...
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);
    assert(score_three_of_a_kind((int[5]){1,1,1,3,4}) == 3+3+4);
    assert(score_three_of_a_kind((int[5]){1,2,3,4,5}) == 0);
    assert(score_three_of_a_kind((int[5]){5,3,5,5,2}) == 15+5);
    assert(score_three_of_a_kind((int[5]){1,1,6,6,6}) == 18+2);
    assert(score_three_of_a_kind((int[5]){6,1,6,6,6}) == 18+7);

    assert(score_four_of_a_kind((int[5]){1,1,1,1,5}) == 9);
    assert(score_four_of_a_kind((int[5]){1,1,3,1,5}) == 0);
```

**Fail** - Fix - Pass

```
Assertion failed: (score_four_of_a_kind((int[5]){1,1,1,1,5}) == 9)
```

yahtzee.c

```
int score_four_of_a_kind(const int dice[5])
{
    if (have_at_least_n_of_a_kind(4, dice))
        return sum_of_dice(dice);
    return 0;
}
```

Fail - **Fix** - Pass

yahtzee.h

```
int score_three_of_a_kind(const int dice[5]);
int score_four_of_a_kind(const int dice[5]);
```

yahtzee_test.c

```
...
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);
    assert(score_three_of_a_kind((int[5]){1,1,1,3,4}) == 3+3+4);
    assert(score_three_of_a_kind((int[5]){1,2,3,4,5}) == 0);
    assert(score_three_of_a_kind((int[5]){5,3,5,5,2}) == 15+5);
    assert(score_three_of_a_kind((int[5]){1,1,6,6,6}) == 18+2);
    assert(score_three_of_a_kind((int[5]){6,1,6,6,6}) == 18+7);

    assert(score_four_of_a_kind((int[5]){1,1,1,1,5}) == 9);
    assert(score_four_of_a_kind((int[5]){1,1,3,1,5}) == 0);
```

Fail - Fix - **Pass**

```
Yahtzee tests OK
```

yahtzee.c

```
int score_four_of_a_kind(const int dice[5])
{
    if (have_at_least_n_of_a_kind(4, dice))
        return sum_of_dice(dice);
    return 0;
}
```

yahtzee.h

```
int score_three_of_a_kind(const int dice[5]);
int score_four_of_a_kind(const int dice[5]);
```

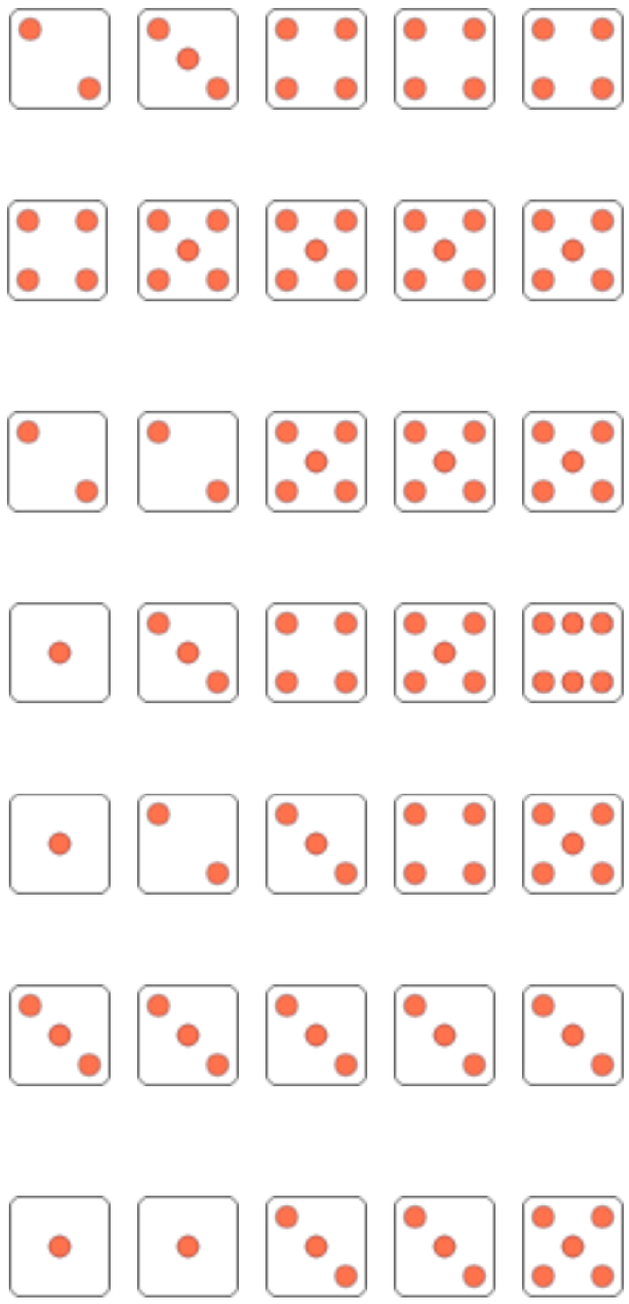
yahtzee_test.c

```
...
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);
    assert(score_three_of_a_kind((int[5]){1,1,1,3,4}) == 3+3+4);
    assert(score_three_of_a_kind((int[5]){1,2,3,4,5}) == 0);
    assert(score_three_of_a_kind((int[5]){5,3,5,5,2}) == 15+5);
    assert(score_three_of_a_kind((int[5]){1,1,6,6,6}) == 18+2);
    assert(score_three_of_a_kind((int[5]){6,1,6,6,6}) == 18+7);

    assert(score_four_of_a_kind((int[5]){1,1,1,1,5}) == 9);
    assert(score_four_of_a_kind((int[5]){1,1,3,1,5}) == 0);
    assert(score_four_of_a_kind((int[5]){1,1,1,1,1}) == 5);
```

```
Yahtzee tests OK
```

## LOWER SECTION

| | | |
|---|---|---|
| 3 of a kind ✓ | | Add Total Of All Dice |
| 4 of a kind ✓ | | Add Total Of All Dice |
| Full House | | SCORE 25 |
| Sm. Straight | Sequence of 4 | SCORE 30 |
| Lg. Straight | Sequence of 5 | SCORE 40 |
| YAHTZEE | 5 of a kind | SCORE 50 |
| Chance | | Score Total Of All 5 Dice |



yahtzee_test.c

yahtzee.h

```
int score_three_of_a_kind(const int dice[5]);
int score_four_of_a_kind(const int dice[5]);
```

yahtzee_test.c

```
    assert(score_full_house((int[5]){3,3,3,5,5}) == 25);
```

yahtzee.c

```
int score_full_house(const int dice[5])
{
    return 0;
}
```

yahtzee.h

```
int score_three_of_a_kind(const int dice[5]);
int score_four_of_a_kind(const int dice[5]);
int score_full_house(const int dice[5]);
```

yahtzee_test.c

```
    assert(score_full_house((int[5]){3,3,3,5,5}) == 25);
```

**Fail** - Fix - Pass

```
Assertion failed: (score_full_house((int[5]){3,3,3,5,5}) == 25)
```

yahtzee.c

```
int score_full_house(const int dice[5])
{
    return 25;
}
```

Fail - **Fix** - Pass

yahtzee.h

```
int score_three_of_a_kind(const int dice[5]);
int score_four_of_a_kind(const int dice[5]);
int score_full_house(const int dice[5]);
```

yahtzee_test.c

```
    assert(score_full_house((int[5]){3,3,3,5,5}) == 25);
```

Fail - Fix - **Pass**

```
Yahtzee tests OK
```

yahtzee.c

```
int score_full_house(const int dice[5])
{
    return 25;
}
```

Fix?

We know how to do this!

yahtzee.h

```
int score_three_of_a_kind(const int dice[5]);
int score_four_of_a_kind(const int dice[5]);
int score_full_house(const int dice[5]);
```

yahtzee_test.c

```
    assert(score_full_house((int[5]){3,3,3,5,5}) == 25);
    assert(score_full_house((int[5]){3,3,1,5,5}) == 0);
```

**Fail** - Fix - Pass

```
Assertion failed: (score_full_house((int[5]){3,3,1,5,5}) == 0)
```

yahtzee.c

```
static bool have_exactly_n_of_a_kind(int n, const int dice[5])
{
    for (int face = 1; face <= 6; face++)
        if (count_face(face,dice) == n)
            return true;
    return false;
}

int score_full_house(const int dice[5])
{
    if (have_exactly_n_of_a_kind(3, dice) &&
        have_exactly_n_of_a_kind(2, dice))
        return 25;
    return 0;
}
```

Fail - **Fix** - Pass

yahtzee.h

```
int score_three_of_a_kind(const int dice[5]);
int score_four_of_a_kind(const int dice[5]);
int score_full_house(const int dice[5]);
```

yahtzee_test.c

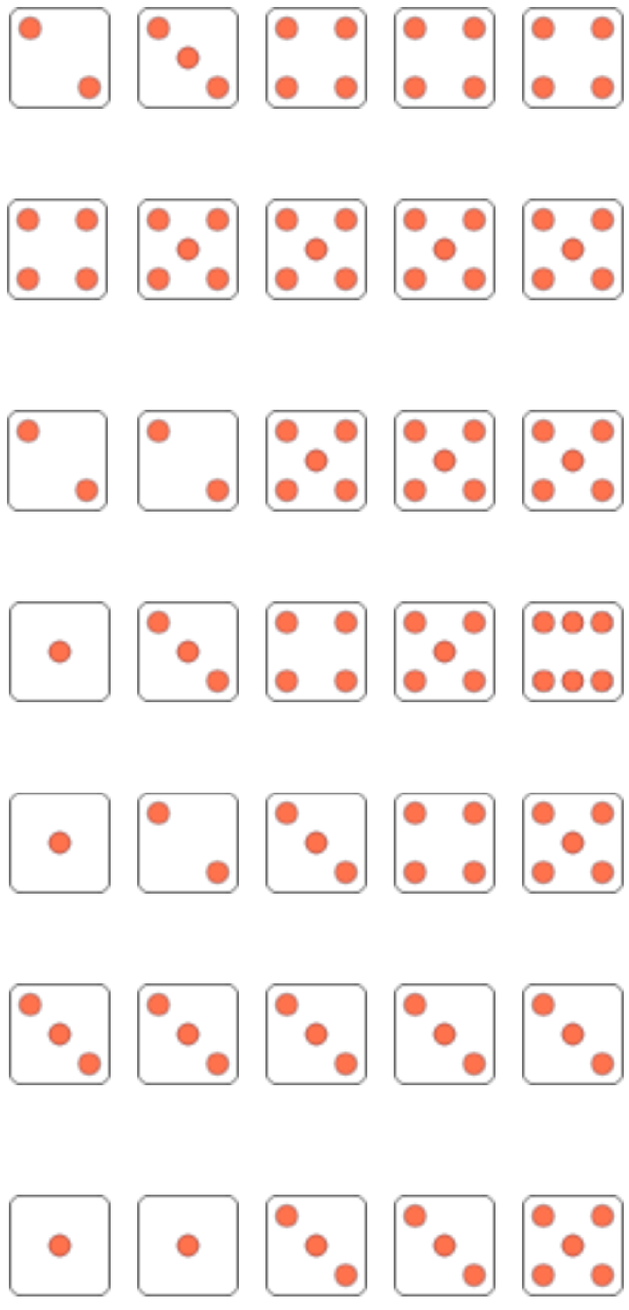
```
    assert(score_full_house((int[5]){3,3,3,5,5}) == 25);
    assert(score_full_house((int[5]){3,3,1,5,5}) == 0);
```

Fail - Fix - **Pass**

```
Yahtzee tests OK
```

## LOWER SECTION

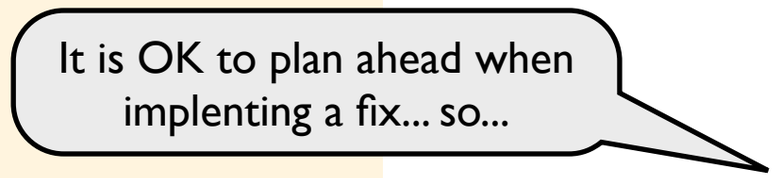
| | | |
|---|---|---|
| 3 of a kind ✓ | | Add Total Of All Dice |
| 4 of a kind ✓ | | Add Total Of All Dice |
| Full House ✓ | | SCORE 25 |
| Sm. Straight | Sequence of 4 | SCORE 30 |
| Lg. Straight | Sequence of 5 | SCORE 40 |
| YAHTZEE | 5 of a kind | SCORE 50 |
| Chance | | Score Total Of All 5 Dice |



yahtzee.c

```
int score_small_straight(const int dice[5])
{
    return 0;
}
```






yahtzee_test.c

```
    assert(score_small_straight((int[5]){1,2,3,4,1}) == 30);
```

```
Assertion failed: (score_small_straight((int[5]){1,2,3,4,1}) == 30)
```

yahtzee.c

```
int score_small_straight(const int dice[5])
{
    if (have_at_least_n_in_a_row(4,dice))
        return 30;
    return 0;
}
```

It is OK to plan ahead when implenting a fix... so...

we know that we need **five in a row** soon. So therefore we do **n in a row** now

yahtzee_test.c

```
    assert(score_small_straight((int[5]){1,2,3,4,1}) == 30);
```

```
Assertion failed: (score_small_straight((int[5]){1,2,3,4,1}) == 30)
```

yahtzee.c

```
int have_at_least_n_in_a_row(int n, const int dice[5])
{



}
```

?

But how to implement this?

Use your head and think for a while...
TDD is **not** about not thinking!

```
int score_small_straight(const int dice[5])
{
    if (have_at_least_n_in_a_row(4,dice))
        return 30;
    return 0;
}
```

yahtzee_test.c

```
    assert(score_small_straight((int[5]){1,2,3,4,1}) == 30);
```

```
Assertion failed: (score_small_straight((int[5]){1,2,3,4,1}) == 30)
```

yahtzee.c

```
int have_at_least_n_in_a_row(int n, const int dice[5])
{
    int max_seq_len = 0;
    int seq_len = 0;
    for (int face = 1; face <= 6; face++) {
        if (count_face(face,dice) == 0)
            seq_len = 0;
        else
            seq_len++;
        if (seq_len > max_seq_len)
            max_seq_len = seq_len;
    }
    return max_seq_len >= n;
}
```

Fail - **Fix** - Pass

```
int score_small_straight(const int dice[5])
{
    if (have_at_least_n_in_a_row(4,dice))
        return 30;
    return 0;
}
```

yahtzee_test.c

```
    assert(score_small_straight((int[5]){1,2,3,4,1}) == 30);
```

Fail - Fix - **Pass**

```
Yahtzee tests OK
```

yahtzee.c

```
int have_at_least_n_in_a_row(int n, const int dice[5])
{
    int max_seq_len = 0;
    int seq_len = 0;
    for (int face = 1; face <= 6; face++) {
        if (count_face(face,dice) == 0)
            seq_len = 0;
        else
            seq_len++;
        if (seq_len > max_seq_len)
            max_seq_len = seq_len;
    }
    return max_seq_len >= n;
}
```

```
int score_small_straight(const int dice[5])
{
    if (have_at_least_n_in_a_row(4,dice))
        return 30;
    return 0;
}
```

yahtzee_test.c

```
    assert(score_small_straight((int[5]){1,2,3,4,1}) == 30);
    assert(score_small_straight((int[5]){1,1,1,1,1}) == 0);
```

```
Yahtzee tests OK
```

yahtzee.c

```
int have_at_least_n_in_a_row(int n, const int dice[5])
{
    int max_seq_len = 0;
    int seq_len = 0;
    for (int face = 1; face <= 6; face++) {
        if (count_face(face,dice) == 0)
            seq_len = 0;
        else
            seq_len++;
        if (seq_len > max_seq_len)
            max_seq_len = seq_len;
    }
    return max_seq_len >= n;
}
```

```
int score_small_straight(const int dice[5])
{
    if (have_at_least_n_in_a_row(4,dice))
        return 30;
    return 0;
}
```

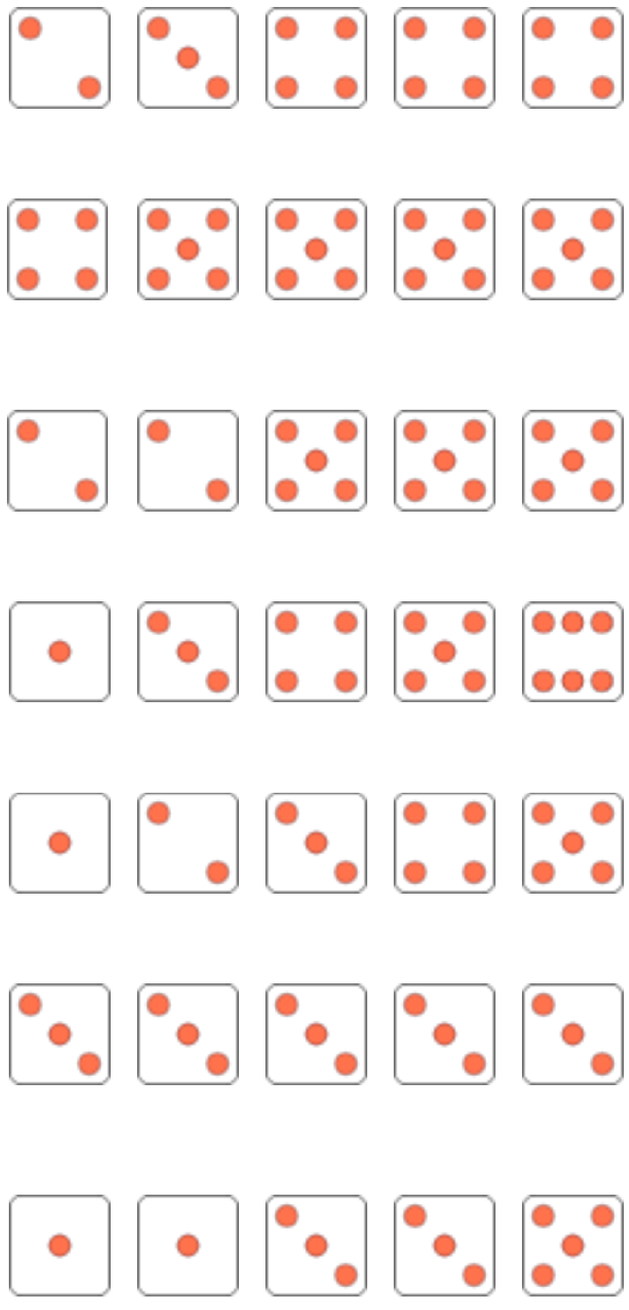
yahtzee_test.c

```
    assert(score_small_straight((int[5]){1,2,3,4,1}) == 30);
    assert(score_small_straight((int[5]){1,1,1,1,1}) == 0);
    assert(score_small_straight((int[5]){6,5,4,3,2}) == 30);
```

```
Yahtzee tests OK
```

## LOWER SECTION

| | |
|---|---|
| 3 of a kind ✓ | Add Total Of All Dice |
| 4 of a kind ✓ | Add Total Of All Dice |
| Full House ✓ | SCORE 25 |
| Sm. Straight Sequence of 4 ✓ | SCORE 30 |
| Lg. Straight Sequence of 5 | SCORE 40 |
| YAHTZEE 5 of a kind | SCORE 50 |
| Chance | Score Total Of All 5 Dice |



yahtzee_test.c

```
    assert(score_large_straight((int[5]){1,2,3,4,5}) == 30);
```

yahtzee.c

```
int score_large_straight(const int dice[5])
{
    return 0;
}
```

**Fail** - Fix - Pass

```
Assertion failed: (score_large_straight((int[5]){1,2,3,4,5}) == 30)
```

yahtzee.c

```
int score_large_straight(const int dice[5])
{
    return 0;
}
```

```
int have_at_least_n_in_a_row(int n, const int dice[5])
{
    int max_seq_len = 0;
    int seq_len = 0;
    for (int face = 1; face <= 6; face++) {
        if (count_face(face,dice) == 0)
            seq_len = 0;
        else
            seq_len++;
        if (seq_len > max_seq_len)
            max_seq_len = seq_len;
    }
    return max_seq_len >= n;
}
```


yahtzee.c

```
int score_large_straight(const int dice[5])
{
    if (have_at_least_n_in_a_row(5,dice))
        return 40;
    return 0;
}
```

Fail - **Fix** - Pass

There is a bug in the test.

yahtzee_test.c

```
assert(score_large_straight((int[5]){1,2,3,4,5}) == 30);
```

What?
**Inconceivable**

```
Assertion failed: (score_large_straight((int[5]){1,2,3,4,5}) == 30)
```

yahtzee.c

```
int score_large_straight(const int dice[5])
{
    if (have_at_least_n_in_a_row(5,dice))
        return 40;
    return 0;
}
```

yahtzee_test.c

```
    assert(score_large_straight((int[5]){1,2,3,4,5}) == 30);
```

yahtzee.c

```
int score_large_straight(const int dice[5])
{
    if (have_at_least_n_in_a_row(5,dice))
        return 40;
    return 0;
}
```

Fail - **Fix** - Pass

yahtzee_test.c

```
    assert(score_large_straight((int[5]){1,2,3,4,5}) == 40);
```

Fail - Fix - **Pass**

```
Yahtzee tests OK
```

yahtzee.c

```
int score_large_straight(const int dice[5])
{
    if (have_at_least_n_in_a_row(5,dice))
        return 40;
    return 0;
}
```

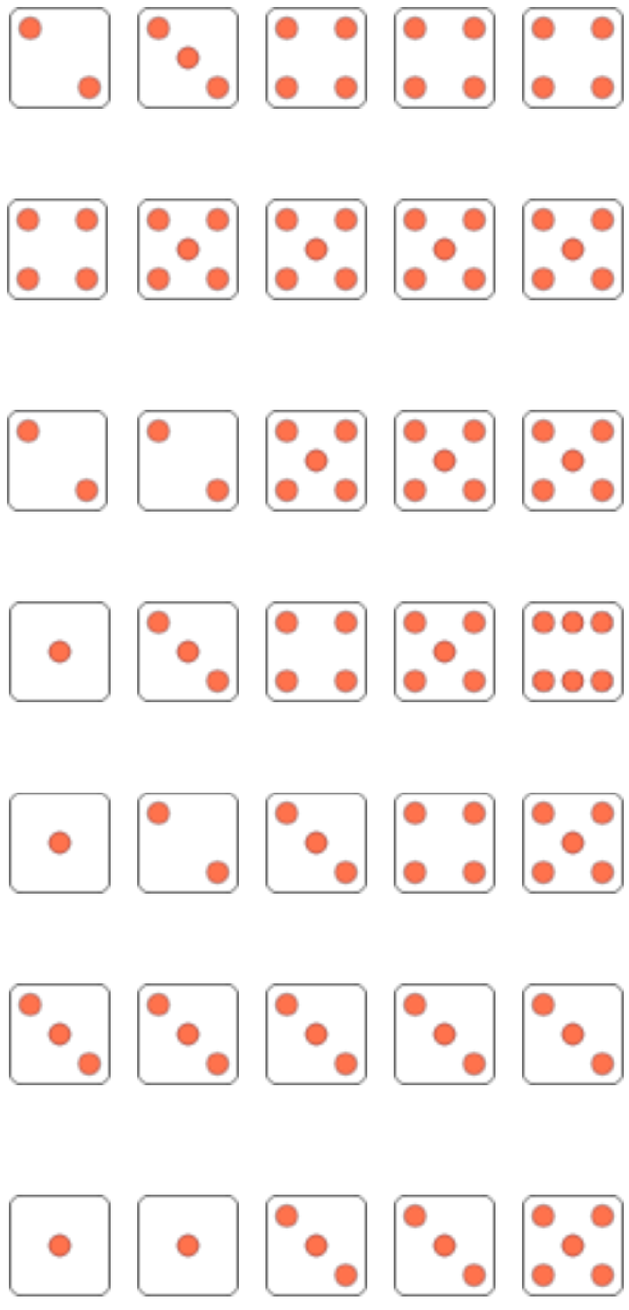
yahtzee_test.c

```
    assert(score_large_straight((int[5]){1,2,3,4,5}) == 40);
    assert(score_large_straight((int[5]){6,6,6,6,6}) == 0);
    assert(score_large_straight((int[5]){6,5,4,2,3}) == 40);
```

```
Yahtzee tests OK
```

## LOWER SECTION

| | |
|---|---|
| 3 of a kind ✓ | Add Total Of All Dice |
| 4 of a kind ✓ | Add Total Of All Dice |
| Full House ✓ | SCORE 25 |
| Sm. Straight Sequence of 4 ✓ | SCORE 30 |
| Lg. Straight Sequence of 5 ✓ | SCORE 40 |
| YAHTZEE 5 of a kind | SCORE 50 |
| Chance | Score Total Of All 5 Dice |



yahtzee.c

```
int score_yahtzee(const int dice[5])
{
    return 0;
}
```

yahtzee_test.c

```
    assert(score_yahtzee((int[5]){1,1,1,1,1}) == 50);
    assert(score_yahtzee((int[5]){6,6,6,6,6}) == 50);
    assert(score_yahtzee((int[5]){1,1,4,1,1}) == 0);
```

**Fail** - Fix - Pass

```
Assertion failed: (score_yahtzee((int[5]){1,1,1,1,1}) == 50)
```

yahtzee.c

```
int score_yahtzee(const int dice[5])
{
    return have_exactly_n_of_a_kind(5,dice) ? 50 : 0;
}
```

Fail - **Fix** - Pass

yahtzee_test.c

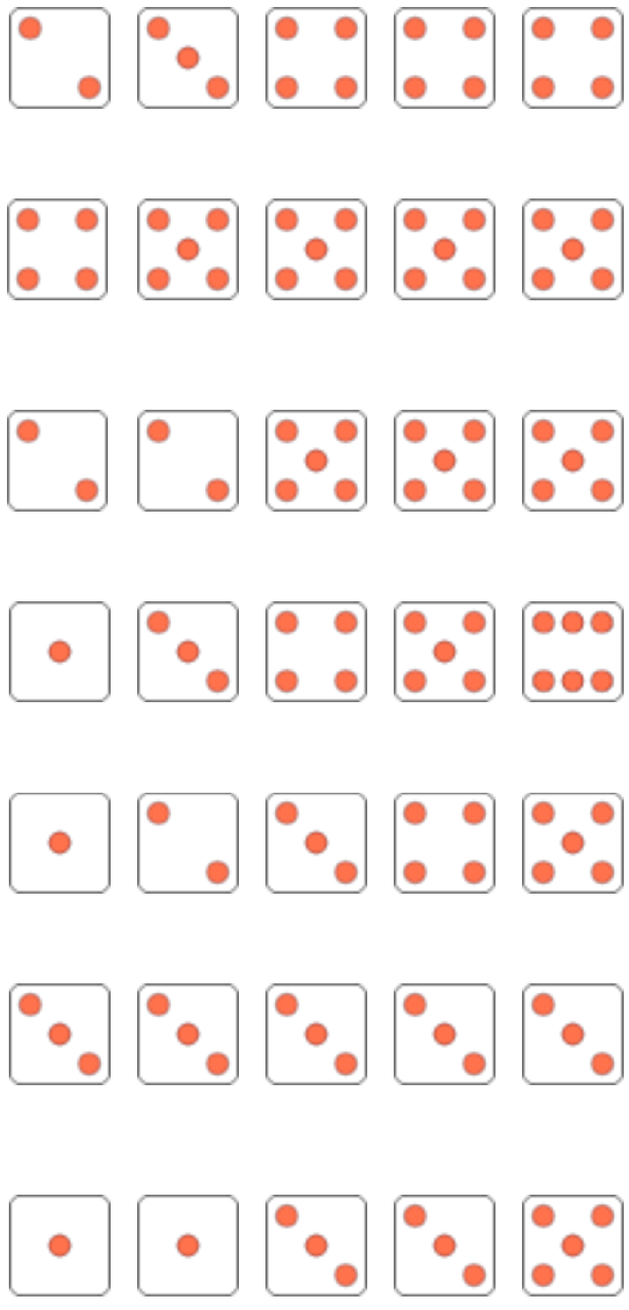
```
    assert(score_yahtzee((int[5]){1,1,1,1,1}) == 50);
    assert(score_yahtzee((int[5]){6,6,6,6,6}) == 50);
    assert(score_yahtzee((int[5]){1,1,4,1,1}) == 0);
```

Fail - Fix - **Pass**

```
Yahtzee tests OK
```

## LOWER SECTION

| | |
|---|---|
| 3 of a kind ✓ | Add Total Of All Dice |
| 4 of a kind ✓ | Add Total Of All Dice |
| Full House ✓ | SCORE 25 |
| Sm. Straight Sequence of 4 ✓ | SCORE 30 |
| Lg. Straight Sequence of 5 ✓ | SCORE 40 |
| YAHTZEE 5 of a kind ✓ | SCORE 50 |
| Chance | Score Total Of All 5 Dice |



yahtzee.c

```
int score_chance(const int dice[5])
{
    return sum_of_dice(dice);
}
```

yahtzee.h

```
int score_three_of_a_kind(const int dice[5]);
int score_four_of_a_kind(const int dice[5]);
int score_full_house(const int dice[5]);
int score_small_straight(const int dice[5]);
int score_large_straight(const int dice[5]);
int score_yahtzee(const int dice[5]);
```

yahtzee.c

```

int score_chance(const int dice[5])
{
    return sum_of_dice(dice);
}
```

yahtzee.h

```
int score_three_of_a_kind(const int dice[5]);
int score_four_of_a_kind(const int dice[5]);
int score_full_house(const int dice[5]);
int score_small_straight(const int dice[5]);
int score_large_straight(const int dice[5]);
int score_yahtzee(const int dice[5]);
int score_chance(const int dice[5]);
```

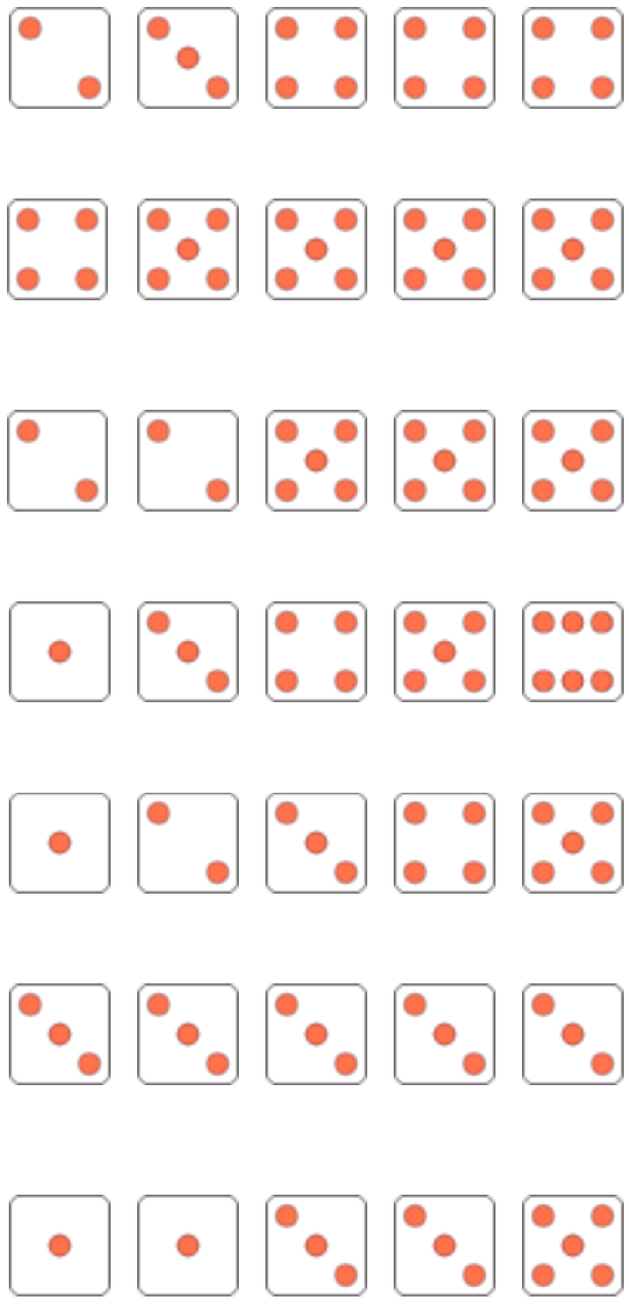
yahtzee_test.c

```

    assert(score_chance((int[5]){1,1,4,1,1}) == 8);
    assert(score_chance((int[5]){2,3,4,5,6}) == 20);
    assert(score_chance((int[5]){6,6,6,6,6}) == 30);
```

```
Yahtzee tests OK
```

## LOWER SECTION

| | |
|---|---|
| 3 of a kind ✓ | Add Total Of All Dice |
| 4 of a kind ✓ | Add Total Of All Dice |
| Full House ✓ | SCORE 25 |
| Sm. Straight Sequence of 4 ✓ | SCORE 30 |
| Lg. Straight Sequence of 5 ✓ | SCORE 40 |
| YAHTZEE 5 of a kind ✓ | SCORE 50 |
| Chance ✓ | Score Total Of All 5 Dice |



## yahtzee.h

```
int score_three_of_a_kind(const int dice[5]);
int score_four_of_a_kind(const int dice[5]);
int score_full_house(const int dice[5]);
int score_small_straight(const int dice[5]);
int score_large_straight(const int dice[5]);
int score_yahtzee(const int dice[5]);
int score_chance(const int dice[5]);
```

## Makefile

```
CC=gcc
CFLAGS=-std=c99 -O -Wall -Wextra -pedantic
LD=gcc

all: yahtzee.a

yahtzee.a: yahtzee.o
	ar -rcs $@ $^

check: yahtzee_tests
	./yahtzee_tests

yahtzee.o: yahtzee.c yahtzee.h

yahtzee_tests.o: yahtzee_tests.c yahtzee.h

yahtzee_tests: yahtzee_tests.o yahtzee.a
	$(LD) -o $@ $^

clean:
	rm -f *.o *.a yahtzee_tests
```

## yahtzee_tests.c

```
#include "yahtzee.h"
#include <stdio.h>
#include <assert.h>

int main(void)
{
    assert(score_three_of_a_kind((int[5]){1,1,1,2,2}) == 3+2+2);
    assert(score_three_of_a_kind((int[5]){1,1,1,6,4}) == 3+10);
    assert(score_three_of_a_kind((int[5]){1,1,6,1,4}) == 3+10);
    assert(score_three_of_a_kind((int[5]){1,6,1,2,4}) == 0);
    assert(score_three_of_a_kind((int[5]){6,6,6,6,6}) == 30);

    assert(score_four_of_a_kind((int[5]){1,1,1,1,5}) == 9);
    assert(score_four_of_a_kind((int[5]){1,1,3,1,5}) == 0);
    assert(score_four_of_a_kind((int[5]){1,1,1,1,1}) == 5);

    assert(score_full_house((int[5]){3,3,3,5,5}) == 25);
    assert(score_full_house((int[5]){3,3,5,5,5}) == 25);
    assert(score_full_house((int[5]){3,3,1,5,5}) == 0);

    assert(score_small_straight((int[5]){1,2,3,4,6}) == 30);
    assert(score_small_straight((int[5]){2,3,4,5,6}) == 30);
    assert(score_small_straight((int[5]){2,3,1,5,6}) == 0);
    assert(score_small_straight((int[5]){6,5,4,3,3}) == 30);

    assert(score_large_straight((int[5]){1,2,3,4,5}) == 40);
    assert(score_large_straight((int[5]){6,6,6,6,6}) == 0);
    assert(score_large_straight((int[5]){6,5,4,2,3}) == 40);

    assert(score_yahtzee((int[5]){1,1,1,1,1}) == 50);
    assert(score_yahtzee((int[5]){6,6,6,6,6}) == 50);
    assert(score_yahtzee((int[5]){1,1,4,1,1}) == 0);

    assert(score_chance((int[5]){1,1,4,1,1}) == 8);
    assert(score_chance((int[5]){2,3,4,5,6}) == 20);
    assert(score_chance((int[5]){6,6,6,6,6}) == 30);

    puts("Yahtzee tests OK");
}
```

# yahtzee.c

```c
#include "yahtzee.h"
#include <stdbool.h>
#include <stddef.h>

static int sum_of_dice(const int dice[5])
{
    int sum = 0;
    for (size_t die = 0; die < 5; die++)
        sum += dice[die];
    return sum;
}

static int count_face(int face, const int dice[5])
{
    int count = 0;
    for (size_t die = 0; die < 5; die++)
        if (dice[die] == face)
            count++;
    return count;
}

static bool have_at_least_n_of_a_kind(int n, const int dice[5])
{
    for (int face = 1; face <= 6; face++)
        if (count_face(face,dice) >= n)
            return true;
    return false;
}

static bool have_exactly_n_of_a_kind(int n, const int dice[5])
{
    for (int face = 1; face <= 6; face++)
        if (count_face(face,dice) == n)
            return true;
    return false;
}

int have_at_least_n_in_a_row(int n, const int dice[5])
{
    int max_seq_len = 0;
    int seq_len = 0;
    for (int face = 1; face <= 6; face++) {
        if (count_face(face,dice) == 0)
            seq_len = 0;
        else
            seq_len++;
        if (seq_len > max_seq_len)
            max_seq_len = seq_len;
    }
    return max_seq_len >= n;
}
```

```c
int score_three_of_a_kind(const int dice[5])
{
    if (have_at_least_n_of_a_kind(3, dice))
        return sum_of_dice(dice);
    return 0;
}

int score_four_of_a_kind(const int dice[5])
{
    if (have_at_least_n_of_a_kind(4, dice))
        return sum_of_dice(dice);
    return 0;
}

int score_full_house(const int dice[5])
{
    if (have_exactly_n_of_a_kind(3, dice) &&
        have_exactly_n_of_a_kind(2, dice))
        return 25;
    return 0;
}

int score_small_straight(const int dice[5])
{
    if (have_at_least_n_in_a_row(4,dice))
        return 30;
    return 0;
}

int score_large_straight(const int dice[5])
{
    if (have_at_least_n_in_a_row(5,dice))
        return 40;
    return 0;
}

int score_yahtzee(const int dice[5])
{
    if (have_exactly_n_of_a_kind(5, dice))
        return 50;
    return 0;
}

int score_chance(const int dice[5])
{
    return sum_of_dice(dice);
}
```