

ProCo 2017 Round 2

Capture the Heihei



This year's Round 2 packet will include problems in a Capture the Flag (CTF) style. These problems will be covered in a variety of topics which include **cryptography, forensics, reverse engineering, script writing, and miscellaneous.**

Moana has lost her rooster, Heihei, while she was out foraging some coconuts for her family. Heihei is a prized possession and loved pet of the family, believed to bring Moana's family great luck as well as being an excellent alarm clock. Without Heihei, Moana's family may encounter disaster! Help us navigate through various puzzles to capture Heihei.

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Computer Science

Palantir

MEMSQL

ansatz

Microsoft

Google

Cryptography

The Attack of the Wiener (200)

Tui and Sina, Moana's parents, have encountered some numbers drawn into the sand by a rough stick. Fearful that the beach will wash them away, they quickly memorize them but unfortunately the p , q , and d are covered up by the ocean waves before they can read them. Despondent, they tell Moana that they have only recovered two numbers:

$e = 18277181389417903810614508667473023043$

$n = 127940269725925326697057572107792758849$

Help Moana decode this message that was found on the other side of the beach which will reveal to her a very familiar date:

message = 123010438421408015858084853190805677562

Yes and No (100)



Now the entire Motunui tribe wants to help Moana find Heihei. Heihei, being a smart rooster, managed to lay an organized grid of stones and hooks such that it will be easier for Moana to find him. However,

Moana is entirely confused about why Heihei chose only two items to encode his message.

Proconian Cipher (100)

As the sun rises higher in the sky, Moana is running out of time to find her beloved rooster Heihei. She runs around frantically and finds his fresh tracks in the mud near her hut. His tracks seem to lead into the jungle, but she is afraid of what's in there. In the jungle though, she hears a loud drumming and notes down the pattern:

PPPPPPCCCCPCCCCPPPPPCPPPCPPCCPPCCPCPCCCCPPPCPPCCPPCCPPCCPPCCPPCCPC
CCPPPPCPCPPCCPPPPCPCPPPPCCCPCCPPCPCPPPCPCPPPCPPPPPPPPCPCPPCCCP
PPPPPP
PPCPCPCPCCCCPPPPCCPCPCCCPCCPPCCPPCCPPCCPPCCPPCCPPCCCPCCPPCPCPPC
PCPPPPPPPPCPCPPCPCPCCPPCPCPPPCPCPPPCPCPPCPCPCCPCCPPCCPPCPCPPC
PPPCPCPPPCPPPPPPCPCPPPPCCPCCPPPPCPCPPCCPP

One Caesar Palace, Four Caesar Palaces, Seven Caesar Palaces (200)

Exploring deeper into the jungle, Moana encounters a large palace with a large rooster statue at the entrance. This must be where Heihei is hiding! Unfortunately, the door to the palace is locked and she only finds a nearby stone inscribed with the following text:
jqqefjtjhpswnsentauxrag

Ask 11 People About the Twist (200)

Too bad Heihei is nowhere to be found in the palace! But there are other villagers roaming around, so Moana asks for help. Unfortunately, they only provided her with this clue: 93 121 119 111 126 115 119 111 125 54 42 110 121 115 120 113 42 108 124 127 126 111 42 112 121 124 109 111 42 115 125 42 120 111 109 111 125 125 107 124 131 42 126 121 42 112 115 120 110 42 126 114 111 42 125 121 118 127 126 115 121 120 56 42 94 114 111 42 107 120 125 129 111 124 42 115 125 68 42 122 124 58 109 58 105 109 126 112 133 112 121 124 109 111 105 115 125 105 129 115 126 114 105 131 121 127 135 56

Forensics

The Least Significant Bit of Information (300)

Defeated, Moana trudges back to her hut. As she is pixels away from giving up, she looks up at a portrait of Gramma Tala. Suddenly, she finds inspiration and continues the search for Heihei! Here is a link to a copy of Gramma Tala's portrait for reference: goo.gl/R6CPuW.

64 Ways of Placing Different Fishes (200)

Moana sails away from her home island and enters Lalotai, the Realm of Monsters. After surviving hexes from ridiculous fishes and fiends in the sea, she finds Tamatoa, the concatenation of a coconut and a crab. But Tamatoa mistakes Moana has a rare sea treasure, so he captures her and tosses her into his giant pile of treasures. Moana finds among the riches the following image: goo.gl/IMCSyZ.

Reverse Engineering

The Key to Maui's Location (100)

After escaping from the Realm of Monsters, Moana decides to ask Maui for help. Unfortunately, Maui is always on the move, so Moana first must find his current location by entering her password into the GPS. Unfortunately, Maui's password checker is bugged. Since Moana's password is 70342, Maui develops the following function that *should* check if a provided integer x is 70342 (returns true if it is, and false otherwise). Give another integer value of x , besides 70342, that the `password_check` function also returns true for.

```
function password_check (x):  
    if (x % 1000 != 342) return false;  
    y = x / 1000;  
    if (y / 2 == 35) return true;  
  
    return false;
```

The Shapeshifter Maui (200)

Finally, Moana spots Maui on a small island! However, Maui is having trouble using his shapeshifting power today and is currently in a jumble. To help him, Moana writes a program to transform Maui back to his human form. What input will cause the function to return the string “unjumblemeplz”?

```
# In python
def f(a):
    b = ''
    for i in range(len(a)):
        b += a[(i * 100) % len(a)]
    return b

// In C++
std::string f(std::string a) {
    std::string b;
    for (int i = 0; i < a.length(); i++) {
        b += a[(i * 100) % a.length()];
    }
    return b;
}

// In Java
public static String f(String a) {
    String b = "";
    for(int i = 0; i < a.length(); i++) {
        b += a.charAt((i * 100) % a.length());
    }
    return b;
}
```

Boats (400)

Instead of being grateful to Moana, he says “you’re welcome” instead and steals her boat! Now Moana is stranded on the island. She calls the ocean for help, but the ocean only responds with this cryptic program. What input to this program returns the number 393215?

```

# Python
def f(n):
    a = 1
    b = 1
    l = []

    while b <= n:
        c = 2 ** (a - 1)
        for d in range(c):
            l.insert(2 * d, b)
            b += 1
        a += 1

    return l[(len(l)-3)/2] + l[(len(l)+1)/2]

def g(n):
    i = f(n)
    j = f(n+1)
    if i == j:
        return -1
    else:
        return i

print g(input())

// C++
int f(int n) {
    int a = 1;
    int b = 1;
    std::vector<int> l;

    while(b <= n) {
        double c = pow(2, a-1);
        for(int d = 0; d < c; d++) {
            l.insert(l.begin() + 2 * d, b);
            b++;
        }
        a++;
    }
    return l[(l.size()-3)/2] + l[(l.size()+1)/2];
}

int g(int n) {

```

```

    int i = f(n);
    int j = f(n+1);
    if(i == j) {
        return -1;
    } else {
        return i;
    }
}

// Java
public static int f(int n) {
    int a = 1;
    int b = 1;
    ArrayList<Integer> l = new ArrayList<Integer>();

    while(b <= n) {
        double c = Math.pow(2, a-1);
        for(int d = 0; d < c; d++) {
            l.add(2 * d, b);
            b++;
        }
        a++;
    }
    return l.get((l.size()-3)/2) + l.get((l.size()+1)/2);
}

public static int g(int n) {
    int i = f(n);
    int j = f(n+1);
    if(i == j) {
        return -1;
    } else {
        return i;
    }
}
}

```

Script Writing

Zipped Up (100)

With her new boat, Moana zips through the waves and catches up to Maui. She forces him to help her look for Heihei, so they seek out Te

Fiti. But Te Fiti only gives them a treasure chest. To open the treasure chest, they must input a password consisting of her favorite animal and a random number between 1 and 1000. Unfortunately, Te Fiti forgot the random number she used. Can you help them? Here is the link to the treasure chest: goo.gl/GpdgYW.

Consider the Coconut, Consider the Tree (1: 100, 2: 100, 3: 200)

After cracking the treasure chest, Moana and Maui find a coconut inside! They crack open the coconut to find a URL:
[https://en.wikipedia.org/wiki/Moana_\(2016_film\)](https://en.wikipedia.org/wiki/Moana_(2016_film)).

Since they are very familiar with websites, they use the inspect tool on their favorite web browser. Using the inspect tool reveals the tree structure that web pages utilize to define the structure of the web page itself.

The underlying html tag structure looks something like a sort of tree structure. Each open tag (such as <title>) must be accompanied by a corresponding closing tag (such as </title>), with some exceptions.

```
<head>
  <title>
  </title>
</head>
<body>
  <div>
    <p>
    </p>
  </div>
</body>
```

Moana and Maui drank the coconut juice as well, but that gave them a brain freeze. As a result, they are unable to answer the following questions. Can you help them?

1. How many tags (ex. one tag would be <p> later followed by a </p>) exist on the page you are currently viewing? (100)

2. How many tags do not have a corresponding closing tag (ex. one tag would be <p> with no </p>) -- the exception stated above? (100)
3. What is the maximum depth achieved on the page you are currently viewing? For example, the above example web page achieves a maximum depth of 3. (200)

Miscellaneous

Songs of Our Elders (100)

After drinking the coconut juice, Moana begins to hallucinate. She sees her grandmother Tala who turns into a manta ray. Moana asks Tala if she knows where Heihei is hiding, but since Tala is a manta ray now, she only replies in numbers. However, Tala begins to sing a familiar song before Moana breaks out of the vision. Meanwhile, Maui had been dreaming about his past surfs of the internet at this website (you can also google Moana Original Motion Picture Soundtrack):

<https://itunes.apple.com/us/album/moana-original-motion-picture-soundtrack/id1168827568>

10 6 6
7 2 5 9
3 4 4
5 2 1
8 1 1 2 7
1 1 1 1 3
1 3 6 9
1 8 2
4 9 1 9
1 2 2 1
1 2 1 5 1 1

Finale: Assembly

We Know the Way (1: 100, 2: 200, 3: 300, 4: 400)

Finally, Moana has overcome all the obstacles and her journey has ended right back where she started from: her hut. Yet before she can land on the island and find Heihei, she must pass **four** magical barriers, each placed by Tala to protect evil from striking Moana's home. Each barrier is sealed by **four** locks, which must be unlocked by specifying certain incantations, as represented by some numbers. However, say the wrong incantation for a lock, and it will explode!

Luckily, the elder managed to express the logic of the locks in terms of assembly code, a low-level language which approximates the hardware of a computer. The elder also has provided code in Python, Java, and C++ to simulate the assembly locks -- running the code will simulate the lock behavior.

Help Moana find the inputs to unlock the barriers, and to avoid exploding the locks!

Python: goo.gl/b1JqWp

Java: goo.gl/TEcxes

C++: goo.gl/a2OzcB