Problem 1: Birthday attack

Implement a birthday attack for a hash function with 48 bit output. The python code in birthday.py contains template code, fill in the code for the function find_collision.

Problem 2: One-way functions

Which of the following are one-way functions? For each function that is a one-way function, explain why (no formal proof required). For each function that is not a one-way function, write an attack in Python. (Code for all the functions, including test code is provided in owf.py. You only need to fill in the functions advi for attacking function fi.)

Hint: Out of the four functions, one is a OWF, the other three are not.

Note: Formally, of course, the question would have to be “is the function a (τ, ε)-OWF?” and τ and ε would have to be specified. I am omitting specific τ and ε, instead, you are to interpret “is an OWF” as “there is no attack in reasonable time and with resonable success probability”.

Note: You may assume that the RSA assumption holds. And that $E_{AES}$ is a PRF. (For reasonable τ, ε, again.)

Note: Remember that to break a one-way function, it is sufficient to find some preimage, not necessarily the “true” one that was fed into the one-way function.

(a) $f_1(x) := 0$ for all $x \in \{0, 1\}^n$.

(b) $f(N, e, x) := (N, e, x^e \mod N)$ where the domain of f is the set of all $(N, e, x)$ where $N$ is an RSA modulus, $e$ is relatively prime to $N$, and $x \in \{0, \ldots, N - 1\}$.

(c) $f(N, e, x) := x^e \mod N$ where the domain of f is the set of all $(N, e, x)$ where $N$ is an RSA modulus, $e$ is relatively prime to $N$, and $x \in \{0, \ldots, N - 1\}$.

(d) $f(k, x) := E_{AES}(k, x)$. 