Programming Tutorial

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- Performance

Correctness

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  return True
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- Above code is $\mathcal{O}(1)$ solution to an NP-Complete Problem

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Boolean Satisfiability

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- Above code is $\mathcal{O}(1)$ solution to an NP-Complete Problem
- But obviously not a correct solution

Testing

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- You must test your code

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Primality Checker

```
def is_prime(n):
  if n in {0, 1}:
    return False
  for i in range(2, int(n ** 0.5)):
    if n % i == 0:
      return False
  return True
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- What is wrong with above code?

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- Might not be obvious, but easy to see with testing

Test is_prime

```python
for i in range(2, 11):
  print(i, is_prime(i))
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- Incorrect for composite values 4, 6, 8, and 9
- For these values `int(n ** 0.5)` $= \lfloor\sqrt{n}\rfloor = 2$
- Off-by-one error – add 1 to range: `int(n ** 0.5) + 1`

Edge Cases

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    - binary search returning first or last index
    - checking if 0 or 1 is prime
    - traversing a graph with no edges
- Depending on the context, you may also need to test for invalid inputs.

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- Code will be read far more often than it is written
- Maintenance of code is often the highest expense

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  - clang-format for C/C++

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Find the largest product of two 3-digit numbers that is a palindrome.

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Problem

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Brute-Force Solution

Iterate through all 10^6 pairs of products and check if they are palindromic while keeping track of max.

Example of Bad Structure

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Poorly Structured

```
biggest = 0
for a in range(100, 1000):
  for b in range(100, 1000):
    prod = a * b
    is_palindrome = True
    s = str(prod)
    n = len(s)
    # check if number is palindrome
    for i in range(n):
      if s[i] != s[n - i - 1]:
        is_palindrome = False
        break
    if not is_palindrome:
      continue
    else:
      if prod > biggest:
        biggest = prod
print(biggest)
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- code is imperative, not declarative

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biggest = 0
for a in range(100, 1000):
  for b in range(100, 1000):
    if is_palindrome(a * b):
      biggest = max(biggest, a * b)
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    main()
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- basically same code
- clearly describes what the program is doing overall

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- it is clear that `i += 1` increments `i`
- comment is superfluous and distracting

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def is_prime(n):
  if n == 1:
    return False
  elif n in {2, 3}:
    return True
  elif n % 2 == 0:
    return False
  else:
    # we need only check for odd factors
    # up to sqrt(n)
    for i in range(3, int(n ** 0.5) + 1, 2):
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- this comment explains why the code is iterating from `1` to `int(n ** 0.5) + 1`
- without this comment, reader would have to determine for themselves

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Good Code is its Own Best Documentation

- Not an excuse to avoid comments

Good Naming

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Bad Names

```python
def qs(a):
  if len(a) <= 1:
    return a
  else:
    x, z = [], []
    y = a[0]
    for p in a:
      if p < y:
        x.append(p)
      else:
        z.append(p)
    return qs(x) + qs(z)
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  if len(array) <= 1:
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    left, right = [], []
    pivot = array[0]
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- these names convey
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def quick_sort(array):
  if len(array) <= 1:
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  else:
    left, right = [], []
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    for ele in array:
      if ele < pivot:
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- these names convey
  - function is quicksort
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Given an array of integers `nums` and a positive integer k, find whether it is possible to divide `nums` into sets of k consecutive numbers.

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- Keep track of remaining elements in array

Python Implementation

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```
popped = []  # store popped heap values
prev, min_count = heappop(heap)
for i in range(k - 1):
  if not heap:  # ran out of elements
    return False
  else:
      value, count = heappop(heap)
      if value != prev + 1:  # not consecutive
        return False
      else:
        count -= min_count
        prev = value
        if count > 0:
          popped.append((value, count))
for val in popped:
    heappush(heap, val)
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- Remove entry if it becomes 0

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```python
while counts:  # dictionary to store counts
  x = min(counts)
  min_count = counts[x]
  del counts[x]  # remove smallest
  for i in range(1, k):
      if counts[x + i] < min_count:
        return False
      else:
        counts[x + i] -= min_count
        if counts[x + i] == 0:
          del counts[x + i]
```

Thank you