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CS 3141: Prof. Kamil's Algorithm Analysis
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Homework in Org-mode

Question 1. What is this document?

This is a demonstration of my homework LaTeX class. It is an extension of the `amsart` and should have all of its functionality. These are some of the set symbols: $\mathbb{C} \supset \mathbb{R} \supset \mathbb{Q} \supset \mathbb{Z} \supset \mathbb{N} \supset \mathbb{P}$, then some Greek and other mathematical symbols are, $\alpha, \varepsilon, \partial, \to, \Rightarrow, \hookrightarrow, \twoheadrightarrow, \rightarrowtail$. We can also insert multiple figures as seen in figure 1. There is also an `org-mode` version of this file[1].

FIGURE 1. Al'Khwarizmi

Question 2. Prove that square root of two is irrational.

We show,

Proof by Contradiction. Square root of two is irrational, $\sqrt{2} \notin \mathbb{Q}$.

Assume that $\sqrt{2}$ is rational. Then $\sqrt{2} = p/q$ for some integers p, q with no common factors. Then $2q^2 = p^2$ so p is even. I. e., $p = 2k$ for some k. Then $q^2 = 2k^2$, so q is also even which is a contradiction. QUOD ERAT DEM■

Question 3. What is the cardinality of Natural Numbers?

It is $\aleph_0$ [1]. See also question IV.

Question IV. Is the cardinality of Naturals and Reals the same because they are both infinite?

No, the cardinality of Reals is greater because they are also un-listable (uncountable). See also question 3.

Question 4. Finally the numbered bullets are done with the `enumitem` package,

1) With just bullets,
   - **Cats**
   - *Dogs*

Question 1 (Bonus). State chain rule.

Chain Rule:

$$\zeta(x) = f(g(x)) \quad \text{then according to the chain rule:} \quad \frac{\mathrm{d}\,\zeta}{\mathrm{d}\,x} = \frac{\mathrm{d}\,f}{\mathrm{d}\,g} \times \frac{\mathrm{d}\,g}{\mathrm{d}\,x}$$

[1] Tashfeen's `org-mode` configurations can be found here.

Question 2 (Bonus). Euclidean Algorithm
You may write code as in listing,

```
def gcd(x, y):  # x > y
  x0, x1, y0, y1 = 1, 0, 0, 1
  while (y > 0):
    print('\\gcd(%d, %def) &: %d &&= ' % (x, y, x), end='')
    q, r = divmod(x, y)
    # print('%d \\times %d + %d &&\\quad' % (q, y, r), end='')
    # print('[%d, %d] - %d[%d, %d] = ' % (x0, x1, q, y0, y1), end='')
    x, y = y, r
    x0, x1, y0, y1 = y0, y1, x0 - q * y0, x1 - q * y1
    # print('[%d, %d] \\\\' % (y0, y1))
  return x, x0, x1
```

Listing 1. Euclidean Algorithm for Greatest Common Factor

Question 5. How do we insert in-file code?
Like in listing 2,

```
def fib(n):
  if n == 0: return 0
  if n == 1: return 1
  return fib(n - 1) + fib(n - 2)
print(fib(20))
```

Listing 2. Recursive Python function to calculate n^{th} Fibonacci number.

References

[1] Sandra Lach Arlinghaus and SL Arlinghaus. Part ii. elements of spatial planning: Theory. merging maps: Node labeling strategies. *Unknown*, 1996.

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