COMP110 WORKSHEET C: COMPUTATIONAL COMPLEXITY

Version 1.0
BSc Computing for Games

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Tasks

This worksheet tests your understanding of the concept of computational complexity, as well as your ability to communicate this understanding in writing.

Consider the following algorithm:

```
1:  procedure HasDuplicate(list)
2:      let n be the length of list
3:      for i = 0, 1, ..., n − 1 do
4:          for j = 0, 1, ..., n − 1 do
5:              if i ≠ j and list[i] = list[j] then
6:                  return true
7:              end if
8:          end for
9:      end for
10:     return false
11: end procedure
```

(a) **State** what task this algorithm performs.
(b) **Explain** why the worst case running time of the algorithm is quadratic, i.e. $O(n^2)$.

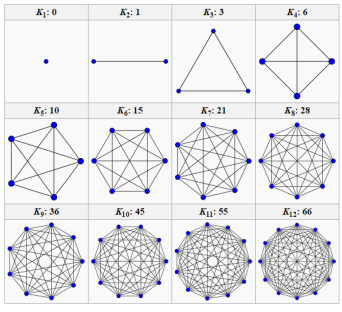
Now suppose that the **for** loop on line 4 is changed so that j ranges from 0 to $i - 1$.

(c) **Explain** why the algorithm is still correct.
(d) **Explain** why the algorithm will run approximately twice as fast.
(e) Is the time complexity of the algorithm still quadratic? **Explain** your answer.

Now consider the following algorithm, which performs the same task as the first:

```
1:  procedure HasDuplicate(list)
2:      let n be the length of list
3:      sortedList ← sort(list)
4:      for i = 1, 2, ..., n − 1 do
5:          if list[i − 1] = list[i] then
6:              return true
7:          end if
8:      end for
9:      return false
10: end procedure
```

(f) With reference to an appropriate source, **write down** the time complexity of Python's built-in `sort` function, in big-O notation.
(g) Thus **write down** the time complexity of the above algorithm in big-O notation. **Explain** your answer.
(h) If the size of the input list is large, which of these two algorithms is likely to run faster? **Explain** your answer.
(i) **Suggest one** reason why a programmer might choose the "slower" algorithm over the "faster" one.



Considering every pair of elements in a data structure often leads to quadratic complexity.

Submission instructions

If you did not already do so for a previous worksheet, **fork** the GitHub repository at the following URL:

`https://github.com/Falmouth-Games-Academy/comp110-worksheets`

Within the `worksheet_C` directory (which you should create if it does not exist), write your answers to questions (a)–(i) in the `README.md` file. Open a **pull request**.

Attend the scheduled worksheet feedback session on **Monday October 24th 2016**, ensuring that you have uploaded all material to GitHub and opened a pull request before this time.

Marking criteria

Remember that **it is better to submit incomplete work than to submit nothing at all**. Any attempt, even unfinished, will receive a passing grade.

Your work will be marked according to the following criteria:

- Where appropriate, are your answers **correct**?
- Are your explanations **clear**, **concise** and **accurate**?
- Where you have obtained information from external sources, are they **properly cited**?