CSC165, Winter 2013
Assignment 3
Due Wednesday April 3rd, 11:59 p.m.

This assignment gives you some practice with asymptotic proofs (big-Oh, big-Omega, big-Theta), halting problem reductions, and limits. You may work in groups of no more than three students, and you should produce a single solution in a PDF file named `a3.pdf`, submitted to MarkUs. You must produce `a3.pdf` by **typing** your solutions and processing the typed input into a PDF with your favourite word processor or typesetting program. Handwritten and then scanned PDF files are huge and often illegible.

You will receive 20% of the marks for any question you either leave blank, or write "I cannot answer this." You will receive substantial parts marks if you present the outline of a proof/disproof with clear indication of the steps you are unable to complete.

All your proofs must use the course proof structure. If you are not sure whether to prove or disprove, write the proof structure, making it clear which steps you cannot justify.

1. **Prove or disprove:** $5n^3 - 3n^2 + 2n + 3$ is in $\mathcal{O}(2n^3 - n^2 + n + 1)$.

2. **Prove or disprove:** $5n^3 - 3n^2 + 2n + 3$ is in $\Omega(2n^3 - n^2 + n + 1)$.

3. **Prove or disprove:** $15 \ln n$ is in $\Omega(n/3)$. **Hint:** Consider using limit techniques from calculus, including l'Hôpital's rule as part of this proof. Please talk to your TA/instructor/Help Centre when needed.

4. **Prove or disprove:** 3^n is in $\mathcal{O}(2^n)$. **Hint:** Consider using the limit techniques of calculus and notice that

$$\lim_{n\to\infty} \frac{3^n}{2^n} = \lim_{n\to\infty} \left(\frac{3}{2}\right)^n$$

5. Prove that the function `true_that` below is not computable:

```
def true_that(f, I, n) :
    """
    Return true when the if statement on line n of function f
    executes on input I, and false otherwise.
    """
```

Emulate the technique from the course notes to reduce `halt` to `true_that`