Solutions Manual

Introduction to Algorithms – A Creative Approach

September 1, 2013

Preface

This is a Solutions Manual for Udi Manber's Introduction to Algorithms – A Creative Approach, a reference book on many Algorithm Courses.

All the solutions were written by students, we can't guarantee that 100% of the solutions are correct, but you are more than welcome to contribute.

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3.5

a. We have that $f(n) = 100n + \log n$ and $g(n) = n + (\log n)^2$. Then let

$$\lim_{n\to\infty} \frac{f(n)}{g(n)} = \lim_{n\to\infty} \frac{100n + \log n}{n + (\log n)^2}$$

By L'Hôpital's rule

$$\lim_{n\to\infty} \frac{100n + \log n}{n + (\log n)^2} = \lim_{n\to\infty} \frac{100 + \frac{1}{n}}{1 + 2\frac{\log n}{n}} = 100$$

$$\therefore f(n) = O(g(n)) \tag{3.1}$$

Now, let

$$\lim_{n\to\infty} \frac{g(n)}{f(n)} = \lim_{n\to\infty} \frac{n + (\log n)^2}{100n + \log n}$$

By L'Hôpital's rule

$$\lim_{n\to\infty} \frac{n + (\log n)^2}{100n + \log n} = \lim_{n\to\infty} \frac{1 + 2\frac{\log n}{n}}{100 + \frac{1}{n}} = \frac{1}{100}$$

$$\therefore g(n) = O(f(n)) \Leftrightarrow f(n) = \Omega(g(n)) \tag{3.2}$$

From (3.1) and (3.2) we have that

$$f(n) = \Theta(g(n))$$

b. We have that $f(n) = \log n$ and $g(n) = \log n^2$. Note that

$$g(n) = \log n^2 = 2\log n = 2f(n)$$

$$\therefore f(n) = \Theta(g(n))$$

c. We have that $f(n) = \frac{n^2}{\log n}$ and $g(n) = n(\log n)^2$. Then let

$$\lim_{n\to\infty} \frac{f(n)}{g(n)} = \lim_{n\to\infty} \frac{\frac{n^2}{\log n}}{n(\log n)^2} = \lim_{n\to\infty} \frac{n}{(\log n)^3}$$

By L'Hôpital's rule

$$\lim_{n\to\infty} \frac{n}{(\log n)^3} = \lim_{n\to\infty} \frac{n}{3(\log n)^2} = \lim_{n\to\infty} \frac{n}{6\log n} = \lim_{n\to\infty} \frac{n}{6} = \infty$$

$$\therefore f(n) \neq O(g(n))$$

Now, let

$$\lim_{n\to\infty} \frac{g(n)}{f(n)} = \lim_{n\to\infty} \frac{n(\log n)^2}{\frac{n^2}{\log n}} = \lim_{n\to\infty} \frac{(\log n)^3}{n}$$

By L'Hôpital's rule

$$\lim_{n\to\infty} \frac{(\log n)^3}{n} = \lim_{n\to\infty} \frac{3(\log n)^2}{n} = \lim_{n\to\infty} \frac{6\log n}{n} = \lim_{n\to\infty} \frac{6}{n} = 0$$

$$\therefore g(n) = O(f(n)) \Leftrightarrow f(n) = \Omega(g(n))$$

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