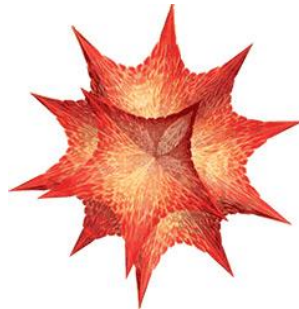


MATHEMATICA LAB III



SEQUENCES

(Lab report due: 15 April)

(A) Graphing sequences

1. Using the *ListPlot* command in Mathematica, plot the ordered pairs (n, a_n) for the first 100 terms of each of the seven sequences below. Based upon this evidence, can you guess whether the sequence converges or diverges? In the former case, try to *estimate* the limit of the sequence. Then find the exact value of the limit using the *Limit* command.

(a) $a_n = \frac{\ln n}{\sqrt{n}}$

(b) $b_n = \frac{n^{10}}{2^n}$

(c) $c_n = \frac{10^n}{n!}$

(d) $d_n = \frac{(3n+1)^3(2n-4)^5}{(2n+3)^4(n+11)^4}$ *Note:* Here you will need to examine at least a few thousand terms.

(e) $e_n = n^{\frac{1}{n}}$

$$(f) \quad f_n = \ln(3n^3 - n^2 + 5) - \ln(n^3 + 5n + 89)$$

$$(g) \quad g_n = \sqrt{n^4 + 4n^2 + 5n + 13} - \sqrt{n^4 - n^2 + 9n + 5}$$

2. (a) It is a well-known and important fact that the sequence $\left\{ \left(1 + \frac{r}{n}\right)^n \right\}$ converges to

e^r . By letting $r = 1$, $\ln 2$, and $\ln 3$, support this result using Mathematica.

(b) Investigate the behavior of the two related sequences $\left\{ \left(1 + \frac{1}{n^2}\right)^n \right\}$ and

$\left\{ \left(1 + \frac{1}{\sqrt{n}}\right)^n \right\}$. Discuss how the sequences differ in their behavior as n

grows large. What do you think accounts for these differences?

3. Investigate the behavior of the sequence $\left\{ (n!)^{\frac{1}{n}} \right\}$. Using Stirling's formula, find a

simpler expression that approximates this sequence.

(B) Recursively defined sequences

Using RecurrenceTable, ListPlot and the Nest command, analyze each of the following sequences and find the limit if it exists.

4. $c_1 = 2$, and $c_n = (c_{n-1} + 3/c_{n-1})/2$ for $n \geq 2$.

5. $c_1 = 2$, and $c_n = (c_{n-1} + 5/c_{n-1})/2$ for $n \geq 2$.

6. $x_1 = 1$ and $x_n = x_{n-1} + \cos(x_{n-1})$ for $n \geq 2$. Can you find the exact value of this limit without employing Mathematica?

7. $y_1 = 5$ and $y_n = 4/(3 + 2y_{n-1})$ for $n \geq 2$.

8. $z_1 = 4$ and $z_n = \cos(z_{n-1})$ for $n \geq 2$.
9. $q_1 = 3$, $q_n = 2 + 1/\sin(q_{n-1})$ for $n \geq 2$.



[Recursive fish](#) by Dan Goodman, Math Dept, University of Warwick

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