NUMERICAL METHODS

1) the expression for true error in calculating the derivative of $\sin(2x)$ at $x=\pi/4$ by using the approximate expression $f'(x) \approx \frac{f(x+h)-f(x)}{h}$ is

Solution:

- Exact solution: (True value)

$f(x) = \sin(2x)$

$f'(x) = 2\cos(2x)$

$f'(\frac{\pi}{4}) = 2\cos(2\frac{\pi}{4})$

- Approximate solution: (Approx. value)

$f'(x) \approx \frac{f(x+h)-f(x)}{h}$

$f(x) = \sin(2x)$

$f'(x) \approx \frac{\sin(2(x+h)) - \sin(2x)}{h}$

$= \frac{\sin(2x)\cos(2h) + \cos(2x)\sin(2h) - \sin(2x)}{h}$

$f'(\frac{\pi}{4}) \approx \frac{\sin(2\frac{\pi}{4})\cos(2h) + \cos(2\frac{\pi}{4})\sin(2h) - \sin(2\frac{\pi}{4})}{h}$

$= \frac{\sin(\frac{\pi}{2})\cos(2h) + \cos(\frac{\pi}{2})\sin(2h) - \sin(\frac{\pi}{2})}{h}$

$= \frac{(1)\cos(2h) + (0)\sin(2h) - 1}{h}$

$= \frac{\cos(2h)-1}{h}$

Let: E_t = true error

E_t = True value − Approximate value

$= 0 - \frac{\cos(2h)-1}{h}$

$$E_t = \frac{1-\cos(2h)}{h}$$

2) the truncation error in calculating $f'(2)$ for $f(x) = x^2$ by $f'(x) \approx \frac{f(x+h)-f(x)}{h}$ with $h=0.2$ is

Solution:

- Approximate value:

$f'(x) \approx \frac{f(x+h)-f(x)}{h}$

$x=2,\ h=0.2$

$f'(2) \approx \frac{f(2+0.2)-f(2)}{0.2}$

$= \frac{f(2.2)-f(2)}{0.2}$

$= \frac{2.2^2 - 2^2}{0.2}$

$= 4.2$

- True value

$f(x) = x^2$

$f'(x) = 2x$

$f'(2) = 2(2)$

$= 4$

E_t = True value − Approx. value

$= 4 - 4.2$

$$E_t = -0.2$$

3) In the calculation of the volume of a cube of nominal size 5", the uncertainty in the measurement of each side is 10%. The uncertainty in the measurement of the volume would be _____.

Solution:

$V = a^3$, where a is the length of the side of cube

$|\Delta V| = \left|\frac{dV}{da}\Delta a\right| = \left|3a^2\Delta a\right| = \left|3\frac{a^3}{a}\Delta a\right|$

$= \left|3\frac{V}{a}\Delta a\right| = \left|3\frac{\Delta a}{a}\right|$

$\left|\frac{\Delta V}{V}\right| = 3 \times 0.1$

$= 0.3$

$$\left|\frac{\Delta V}{V}\right| = 30\%$$

Numerical Analysis Problems And Solutions

Ying Liu

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