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Lab 8 Composite Trapezoidal & Simpson's

1. Use the Composite Trapezoidal rule with the indicated values of n to approximate the following integrals.

a) $\int_1^2 xln(x)\, dx,\ n = 4$

```
>> f
f =

@(x) x * log (x)

%  comptrap(a, b, f, n)
>> comptrap(1, 2, f, 4)
h = 0.2500000000
midpoint sum = 1.8664547302
f(a) = 0.0000000000
f(b) = 1.3862943611

ans = 0.6399004777
```

The true value of the definite integral on [1, 2] is 0.6362943611 so the error is 0.0036061166.

3. Use the Composite Simpson's rule to approximate the integrals in Exercise 1.

b) $\int_{-2}^{2} x^3 e^x \, dx, \; n = 4$

```
>> f
f =

@(x) x .^ 3 * e .^ x

%  compsimpson( a, b, f, n)
>> compsimpson(-2, 2, f, 4)
h = 1.0000000000
f(a) = -1.0826822659
f(b) = 59.1124487914
even sum = 0.0000000000
odd sum = 2.3504023873

ans = 22.4771253582
```

The true value of the definite integral on [-2, 2] is 19.92085296 so the error is 2.556272397.

5. Use the Composite Midpoint rule with n + 2 subintervals to approximate the integrals in Exercise 1.

a) $\int_{1}^{2} x ln(x)\, dx,\ n = 4$

```
>> f
f =

@(x) x * log (x)

%  compmidpoint(a, b, f, n)
>> compmidpoint(1, 2, f, 4)
h = 0.1666666667
sum = 1.8992890952

ans = 0.6330963651
```

The true value of the definite integral on [1, 2] is 0.6362943611 so the error is 0.003197996.

11. Determine the values of n and h required to approximate

$\int_0^2 e^{2x} sin(3x)\, dx,\ n = 4$ **to within** 10^{-4}

a) Composite Trapezoidal rule.

$h = \frac{b-a}{n}$, $error = \left|\frac{b-a}{12} h^2 f''(c)\right| \leq 10^{-4}$

$f'(x) = e^{2x}(2sin(3x) + 3cos(3x))$, $f''(x) = e^{2x}(12cos(3x) - 5sin(3x))$

Since the maximum of $f''(x)$ is at $f''(2) \approx 705.3601029$

We have:

$error = \left|\frac{2-0}{12} h^2 f''(2)\right| \leq 10^{-4}$

$\left|\frac{1}{6} h^2 f''(2)\right| \leq 10^{-4} \Rightarrow h^2 \leq \frac{6*10^{-4}}{f''(2)} \Rightarrow h \leq \sqrt{\frac{6*10^{-4}}{f''(2)}} \approx 0.0009222957$

So $h = \frac{b-a}{n} \Rightarrow n = \frac{b-a}{h} = \frac{2-0}{0.0009222957} \approx 2168.5019451225$

So $n \geq 2168$

Therefore $h < 0.0009222957\ and\ n \geq 2168$