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Lab Summary 4/3/09

In this lab we covered finite differencing. Finite differencing is a method used to approximate solutions to differential equations by approximating differences. We noted that finite differencing is based on a Taylor series expansion.

Using Taylor's theorem, we obtained:

$f(x+\Delta x) = f(x_0) + f'(x_0)\Delta x$, by assuming higher order terms are negligible.

Then we discussed the forward differencing approximation using this and we obtained:

$$f'(x_0) = \frac{f(x_0+\Delta x) - f(x_0)}{\Delta x}$$

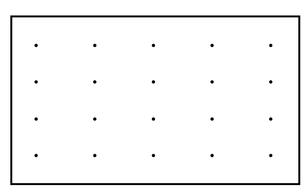
Then we went over backward differencing approximation:

$$f'(x_0) = \frac{f(x-\Delta x) - f(x_0)}{\Delta x}$$

Finally we discussed centered difference approximation, which is using both the forward and backward difference approximations in one method. If we subtract the expression we obtained for the backward difference approximation from the expression we have for the forward difference approximation, we obtain:

$$f'(x_0) = \frac{f(x_0+\Delta x) - f(x_0-\Delta x)}{2\Delta x}$$

Then we started to talk about successive over relaxation, which is a process which is used to speed up the convergence. We went over an example using streamfunction and the steps were:



1. Assign Boundary Conditions
2. Guess ψ_{guess} in the box
3. Calculate new ψ (ψ_{new}) using centered difference approximation
4. $\psi_{new} - \psi_{guess} = \text{Res}$, where Res is the residual term, and repeat until Res is close to 0

Successive over relaxation: $\text{Res} = \dfrac{\psi_{new} - \psi_{old}}{\omega}$, where $\omega > 1$ is the over relaxation parameter.