**Assignment #1: Warm up**

**Group 2**

Members:

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# Task

*Compute the first and the second derivatives of f (x) analytically.*

1rst derivative:

2nd derivative

# Task

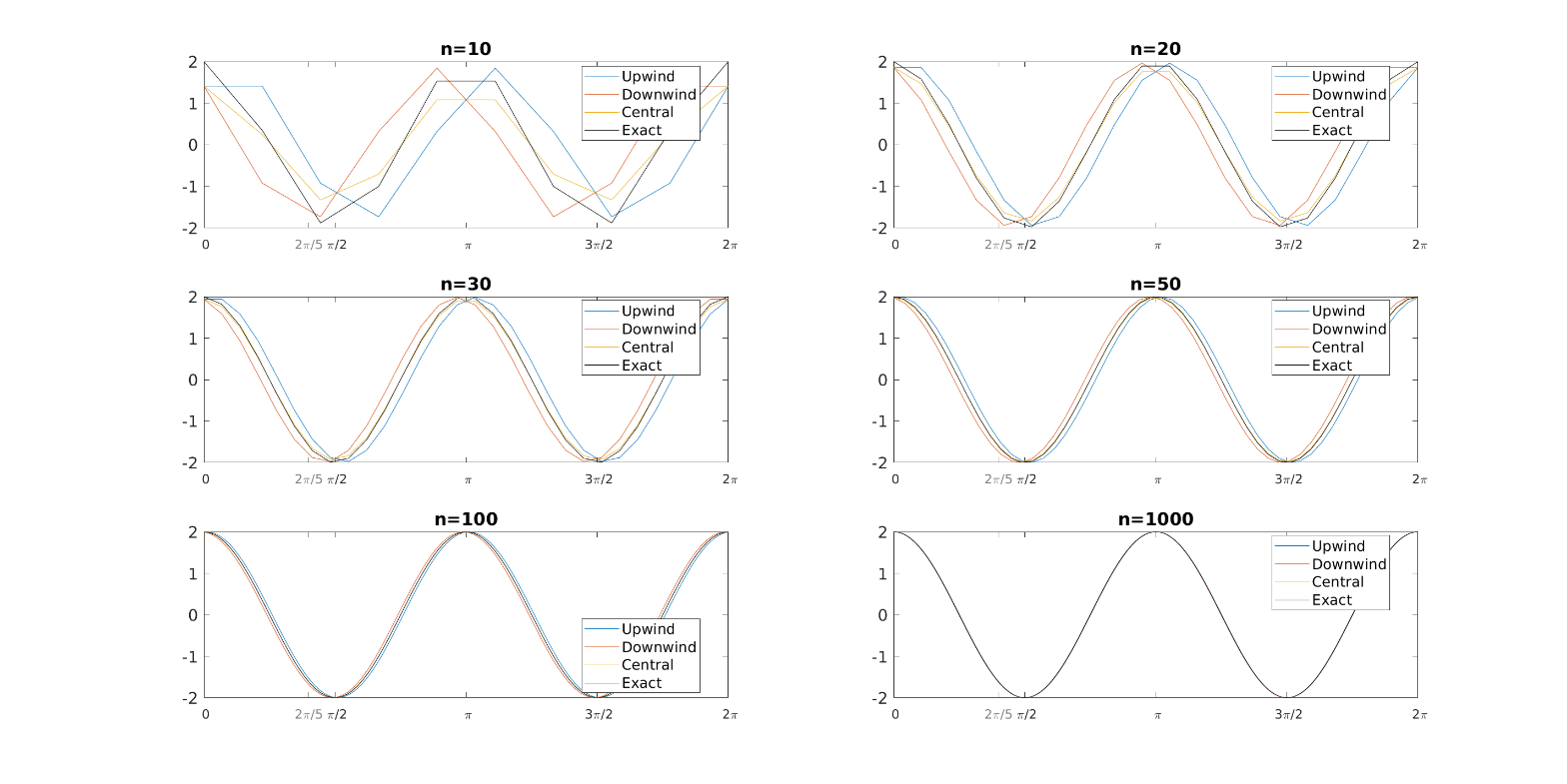
*Compute the first derivative of f (x), namely ∂f /∂x, numerically on x ∈ [0, 2π]. Assume periodic boundaries. Use central, upwind and downwind difference schemes. Choose different resolutions h. Comment on what you observe.*

Boundary:

Backward Difference Scheme (Upwind):

Forward Difference Scheme (Downwind):

Central Difference Scheme:

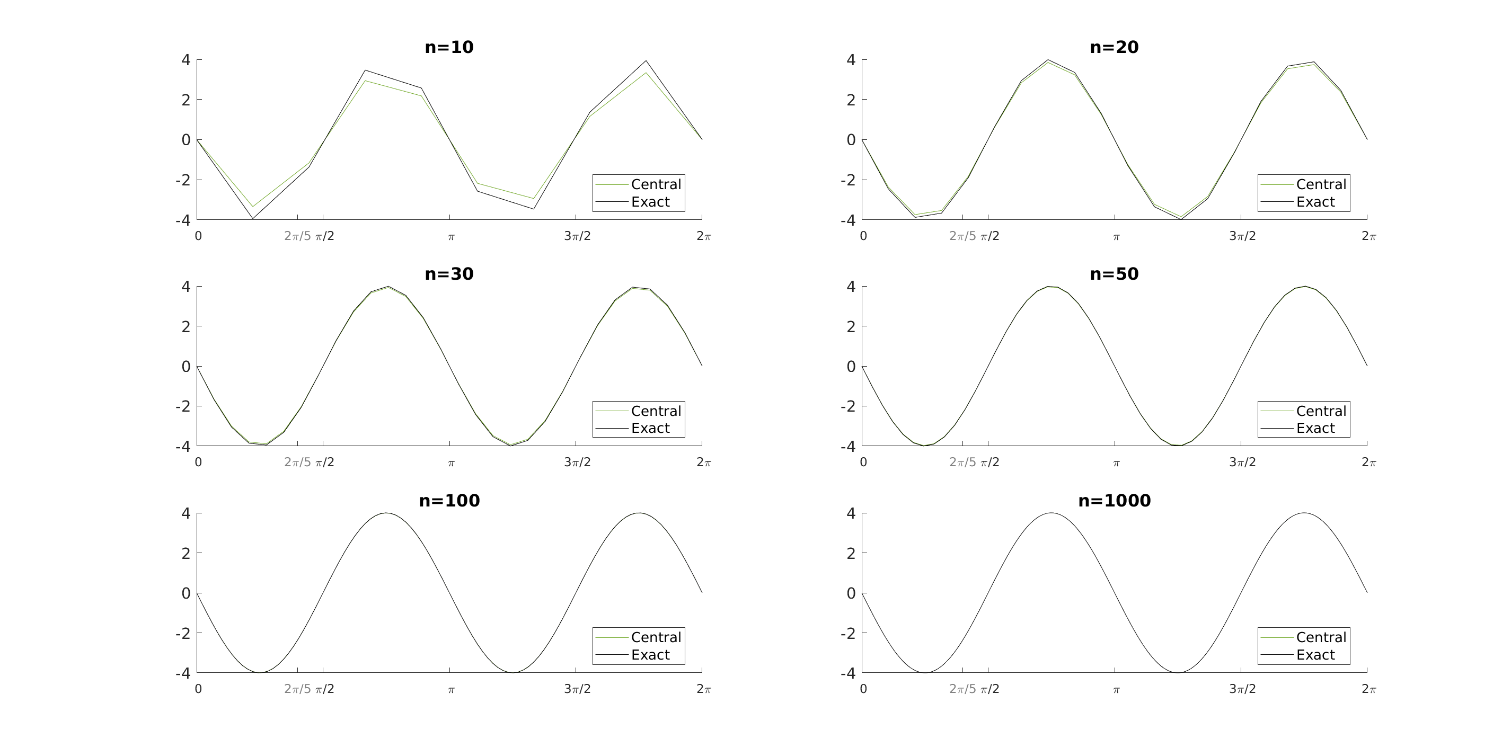
Resolutions: [10,20,30,50,100,1000]

* Shifted left/right
* Central symmetrical to analytic function
* Amplitude smaller
* Explaination to formulas (BDS, FDS, CDS)
* We observe an approximation to the analytical function with increasing resolution.

# Task

*Compute the second derivative of f (x), namely ∂ 2f /∂2x, numerically on x ∈ [0, 2π]. Assume periodic boundaries. Use central difference scheme. Choose different resolutions. Comment on what you observe.*

Resolutions: [10,20,30,50,100,1000]



Comment:

* We found that with increasing resolution the approximation approached the analytical solution. The interpolation did not give a faster convergence, at low resolutions it seems that the interpolation does a worse job of approximating the function particularly between points.
* In order to compare the error we ended up doing a second interpolation as discussed in the Übung with Daniel.
* Amplitude of approximations tend to be smaller such that the function is consistently underestimated at 2 pi / 5

# Task

*Use a linear interpolation scheme to compute the function values at the middle of the grid points. Use different resolutions. Comment on what you observe.*

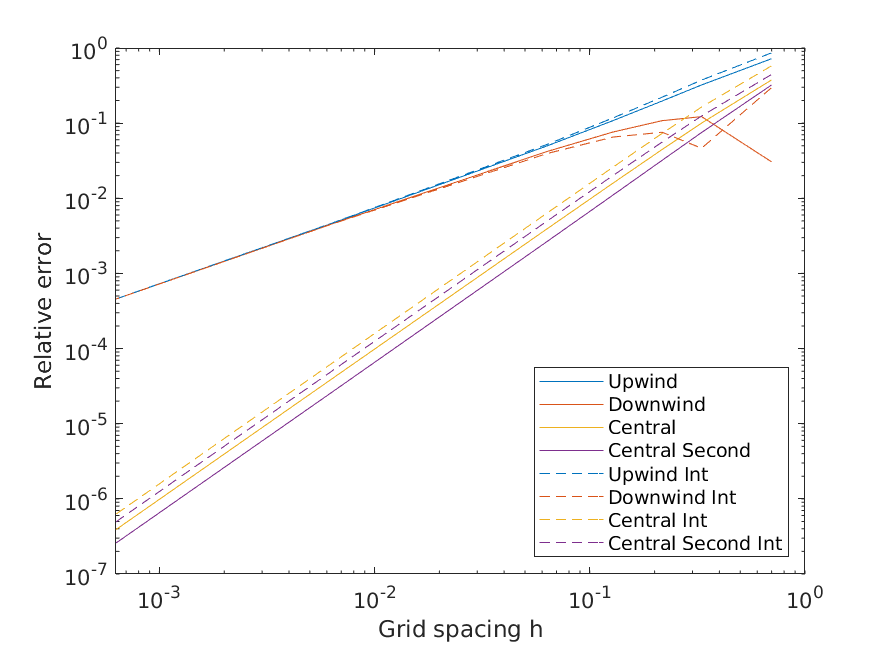
* Some points interpolation more accurate
* Linear interpolant for middle point

# Task

*For tasks 2, 3 and 4, plot the error versus resolution for a given position x = 2π/5. Error plots are done in logarithmic scale, i.e. the logarithm of the relative error Erel is plotted versus the logarithm of grid spacing h. Comment on the slope of the curves you obtain.*

Comment:

* Slope of error of central difference scheme is steeper. Error is smaller.
* Curve of Upwind and Downwind scheme merge into one value with increasing resolution.
* BDS/FDS error 1rst order.
* Slope calculated
* CDS error of magnitude 2. quadratic error
* Taylor series?!



[Report]

1. An acceptable report should include a title page with the assignment number, the group number, a list of the group members' names, and their email addresses

2. The report should include all the necessary plots in the right places

3. The report should describe what the individual plots are showing in their captions, and discuss what they observed from the plots in the main text

4. In the discussion, the observations should be justified by the corresponding theories taught during the lectures

[Code]

1. An acceptable code should execute without any errors

2. The code should address all the tasks specified in the assignment

3. The code should produce correct results

4. The code should display all the necessary plots

5. The code should save all the necessary plots in an appropriate file format (e.g. PNG, EPS, JPEG) that can be included in the report ( print() )

6. All plots should have their axes appropriately labelled (use MATLAB functions *xlabel* and *ylabel* )

7. All plots should have appropriate legends (use function *legend*)

8. All plots should have appropriate titles (use function *title*)

9. All plots should be readable (not overcrowded!)