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ISC 4220C Spring 2020
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Lab 7 Report

We can use this to construct a linear system by assigning ranking points r_i to team T_i via:

$$r_1 - r_2 = 4$$
$$r_3 - r_1 = 9$$
$$r_1 - r_4 = 6$$
$$r_3 - r_4 = 3$$
$$r_2 - r_4 = 7$$

This is an overdetermined system and does not even have a unique least squares solution because we could always add a constant c to any solution $[r_1 + c, r_2 + c, r_3 + c, r_4 + c]^T$ and still satisfy all the equations equally well. This can be fixed by adding another equation like,

$$r_1 + r_2 + r_3 + r_4 = 20.$$

1. Given these equations, use LLS to rank the teams

```
A = [
    1 -1 0 0;
    -1 0 1 0;
    1 0 0 -1;
    0 0 1 -1;
    0 1 0 -1;
    1 1 1 1;
    ];

f = [4 9 6 3 7 20]';

ahat = (A'*A)\(A'*f)
ahat =
    5.2500
    4.6250
    9.1250
    1.0000
```

Rankings (Best to worst): Team 3 (9.125 points), Team 1 (5.25 points), Team 2 (4.62 points), Team 4 (1 point).

Vary the step-size h between 10^{-15} to 10^{-1} (consider using the `logspace` command), and construct a `log-log` plot of absolute error and h. Note that we can compute the absolute error, since we know that the true value of $f'(\pi/3) = 0.5$.

Using the graphs above, find the (approximately) optimum value of h for the two difference formula, and compare the absolute errors of the two numerical formulae.

2.

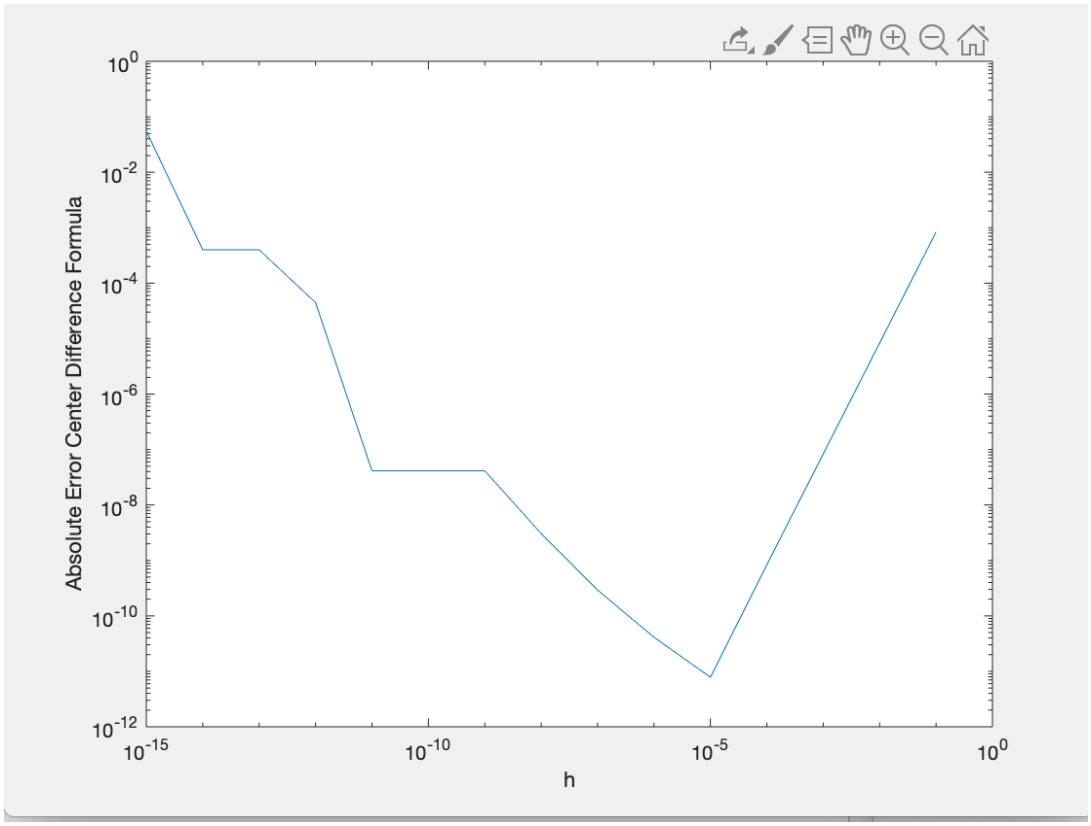
```
h = 10.^(-15:-1)';
trueval = .5;

errorCDF = abs(trueval - centerdf(pi/3,h));
errorFDF = abs(trueval -forwarddf(pi/3,h));

loglog(h,errorCDF)
xlabel('h');
ylabel('Absolute Error Center Difference Formula');

figure
loglog(h,errorFDF)
xlabel('h');
ylabel('Absolute Error Forward Difference Formula');

function val = centerdf(x,h)
val = (sin(x+h) - sin(x-h))./(2.*h);
end

function val = forwarddf(x,h)
    val = (sin(x+h) - sin(x))./h;
end
```

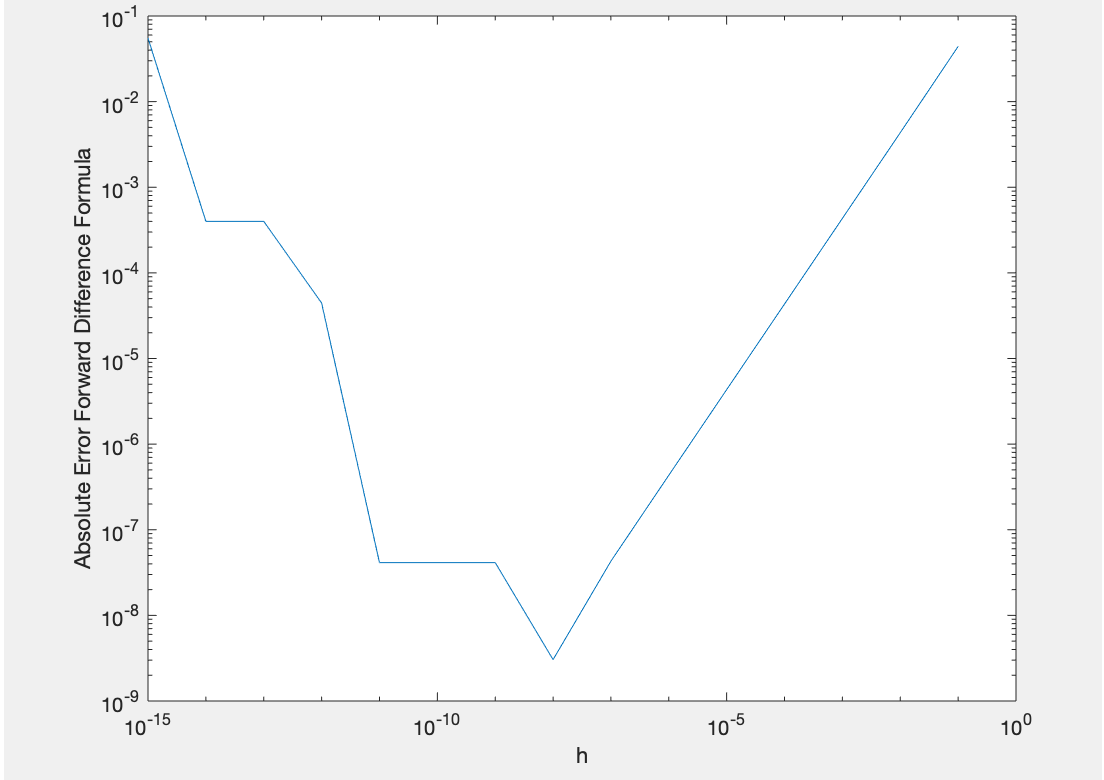
Optimal h for center distance formula: 10^{-5}
Optimal h for forward distance formula: 10^{-8}

Error at optimal h CDF: 7.827×10^{-12}
Error at optimal h FDF: 3.039×10^{-9}.

Center distance formula has less error at optimal h compared to forward distance formula.

Plots below.


Absolute Error Center Difference Formula
h
10^{0}
10^{-2}
10^{-4}
10^{-6}
10^{-8}
10^{-10}
10^{-12}
10^{-15}
10^{-10}
10^{-5}
10^{0}


Absolute Error Forward Difference Formula
h
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-15}
10^{-10}
10^{-5}
10^{0}