Lab 8: Discrete Fourier Transform

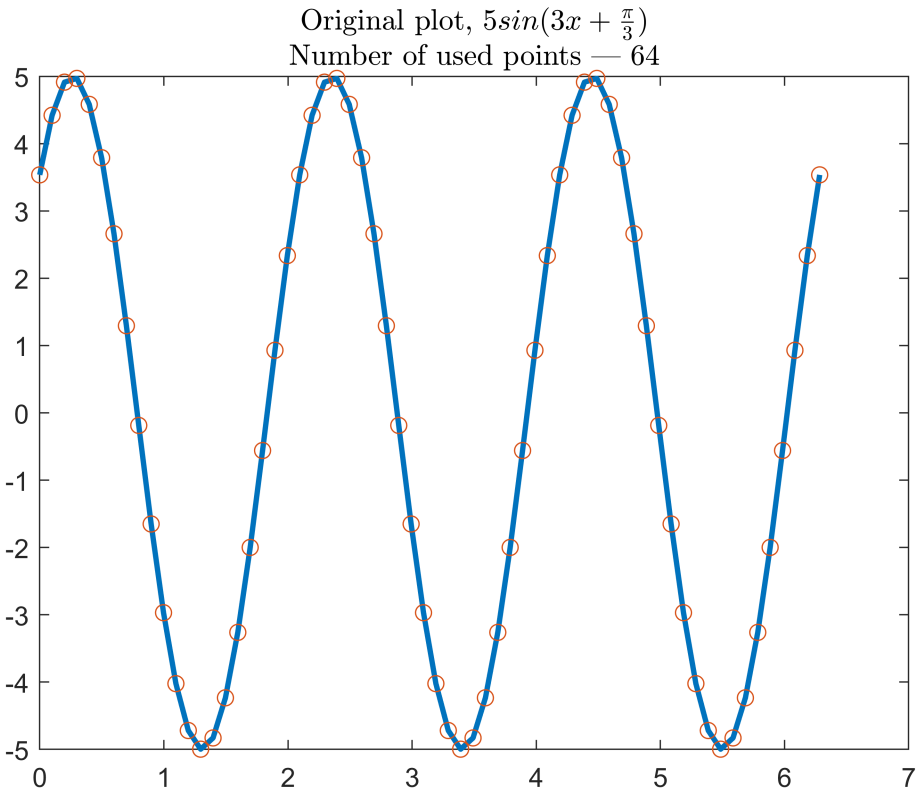
Simple periodic function

Let's choose the function: $5sin(3x+\frac{\pi}{3})$

```
n = 2^6
```

```
n = 64
```

```
x = linspace(0,2*pi,n);
y = 5*sin(3*x+pi/4);
plot(x,y,"LineWidth",2)
title(["Original plot, $5sin(3x+\frac{\pi}{3})$","Number of used points --- " + num2str(n)],"In
hold on
scatter(x,y)
hold off
```



Interpolation, using Fourier Transform

```
% Let's make F_4 for checking that it is what we need

F_4 = conj(dftmtx(4)) % because they use different formula inside
```

```
F_4 = 4×4 complex
   1.0000 + 0.0000i   1.0000 + 0.0000i   1.0000 + 0.0000i   1.0000 + 0.0000i
```

```
   1.0000 + 0.0000i   0.0000 + 1.0000i  -1.0000 + 0.0000i   0.0000 - 1.0000i
   1.0000 + 0.0000i  -1.0000 + 0.0000i   1.0000 + 0.0000i  -1.0000 + 0.0000i
   1.0000 + 0.0000i   0.0000 - 1.0000i  -1.0000 + 0.0000i   0.0000 + 1.0000i
```

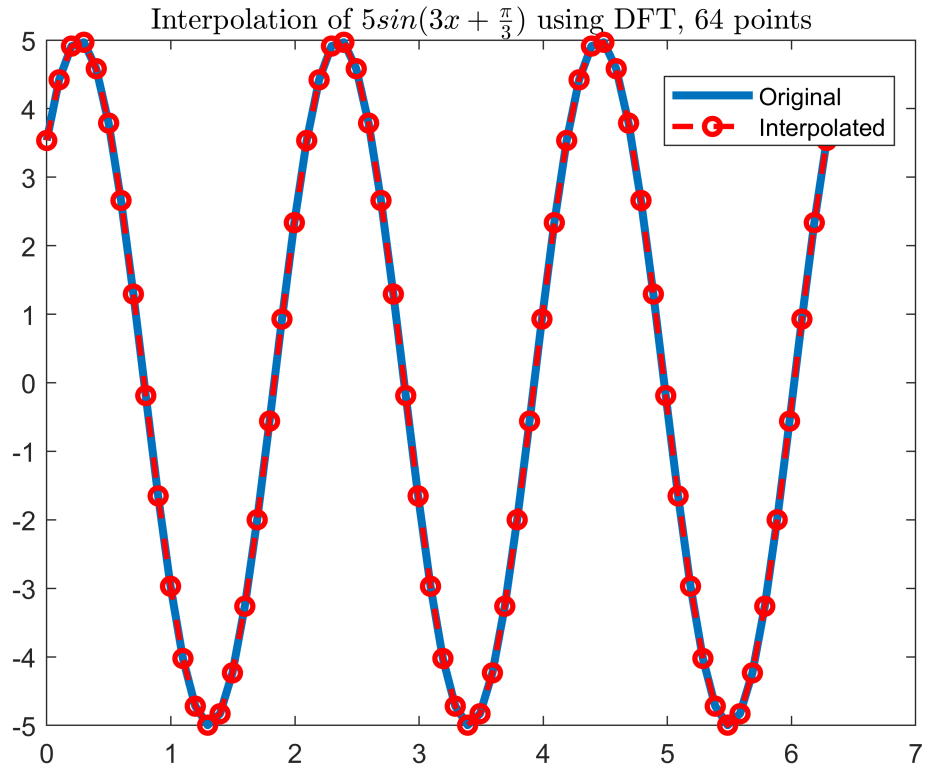
```
F_64 = conj(dftmtx(n));

% Let's find our args of functions
C = linsolve(F_64,y');

Y_new = zeros(n,1);
for t=1:n
    temp = 0;
    for j=1:n
        temp = C(j)*exp(2*pi/n*(t-1)*(j-1)*1i);
        Y_new(t) = Y_new(t) + temp;
    end
end
error_interpolation = rms(y'-Y_new)
```

```
error_interpolation = 4.2429e-14
```

```
p=plot(x,y,x,real(Y_new),'r--o');
p(1).LineWidth = 3;
p(2).LineWidth = 2;
title("Interpolation of $5sin(3x+\frac{\pi}{3})$ using DFT, " + num2str(n) + " points",'interpr
legend("Original","Interpolated")
```

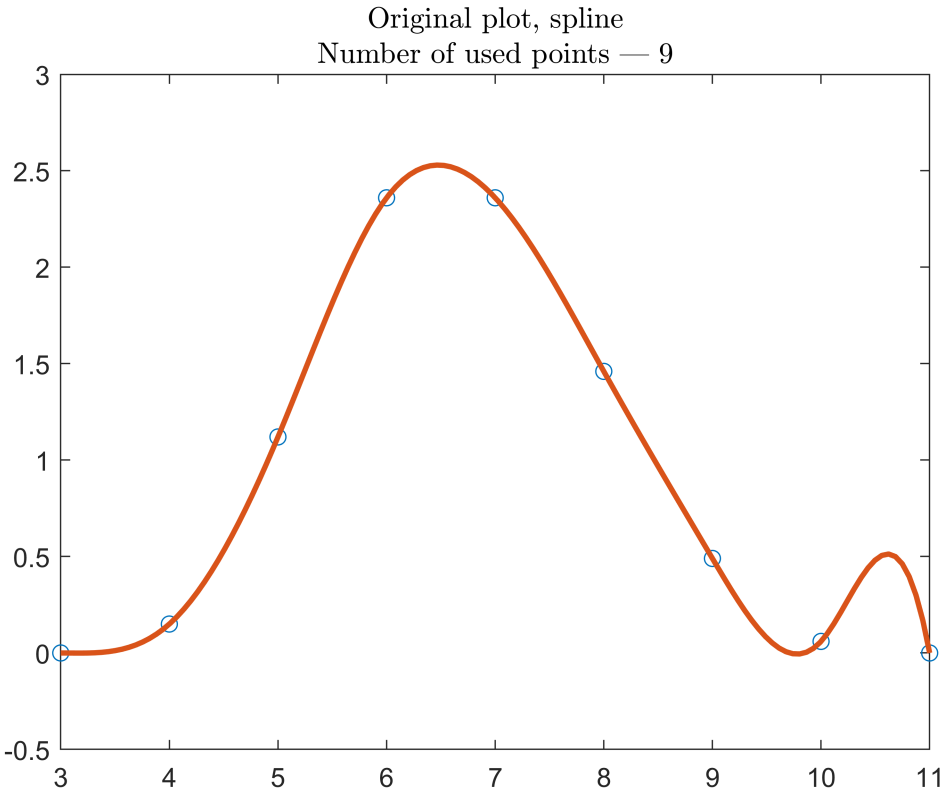


Interpolation, complex example

```
% boundaries
a = 3;
b = 11;
x_exp2 = a:b;
y_exp2 = [0 .15 1.12 2.36 2.36 1.46 .49 .06 0];
cs = spline(x_exp2,[0 y_exp2 -3]);
n_spline = 128
```

```
n_spline = 128
```

```
xx_spline = linspace(a,b,n_spline);
yy_spline = ppval(cs,xx_spline);
p_spline = plot(x_exp2,y_exp2,'o',xx_spline,yy_spline,'-');
p_spline(2).LineWidth=2;
title(["Original plot, spline","Number of used points --- 9"],"Interpreter","latex")
```




```
% Transform from a-b to 0-2pi
mapping = linsolve([0 1;2*pi 1],[a;b])
```

```
mapping = 2×1
    1.2732
    3.0000
```

```
F_128 = conj(dftmtx(n_spline));

% Let's find our args of functions
C_spline = linsolve(F_128,yy_spline');

Y_new_spline = zeros(n_spline,1);
for t=1:n_spline
    temp = 0;
    for j=1:n_spline
        temp = C_spline(j)*exp(2*pi/n_spline*(t-1)*(j-1)*1i);
        Y_new_spline(t) = Y_new_spline(t) + temp;
    end
end
error_interpolation_spline = rms(y'-Y_new)
```

```
error_interpolation_spline = 4.2429e-14
```

```
p=plot(xx_spline,yy_spline,xx_spline,real(Y_new_spline),'r--o');
p(1).LineWidth = 3;
p(2).LineWidth = 1;
title("Interpolation of the spline using DFT, " + num2str(n_spline) + " points",'interpreter',
legend("Original","Interpolated")
```