Global Variables

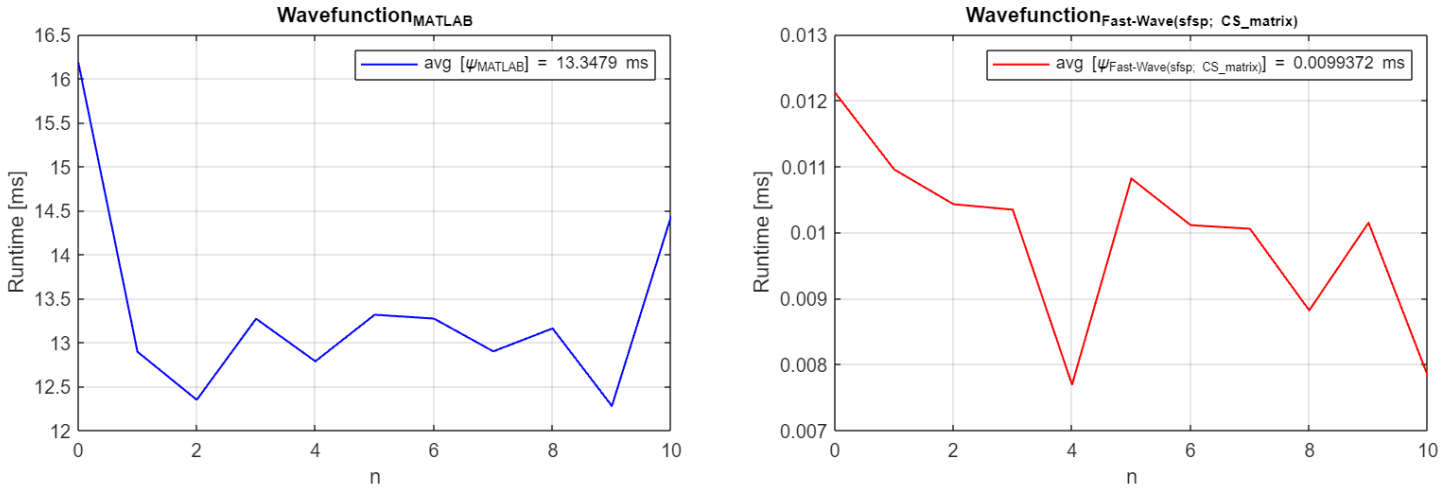
```
prec = 100;
digits(prec);

N_max = 10;
x = 20.0;

x_max = 20.0;
x_min = -20.0;
x_size = 100;

X = linspace(x_max,x_min,x_size);
x_axi_plot = linspace(0,N_max,N_max+1);

wavefunction_MATLAB_1_list = zeros(1,N_max+1);
wavefunction_Fast_Wave_sfsp_1_list = zeros(1,N_max+1);

wavefunction_MATLAB_1_1_list = zeros(1,N_max+1);
wavefunction_Fast_Wave_sfsp_2_list = zeros(1,N_max+1);

wavefunction_MATLAB_2_1_list = zeros(1,N_max+1);
wavefunction_Fast_Wave_sfmp_1_list = zeros(1,N_max+1);

wavefunction_MATLAB_2_2_list = zeros(1,N_max+1);
wavefunction_Fast_Wave_sfmp_2_list = zeros(1,N_max+1);

wavefunction_MATLAB_3_list = zeros(1,N_max+1);
wavefunction_Fast_Wave_mfsp_list = zeros(1,N_max+1);

wavefunction_MATLAB_4_list = zeros(1,N_max+1);
wavefunction_Fast_Wave_mfmp_list = zeros(1,N_max+1);

left = 0.08;
bottom = 0.45;
width = 0.4;
height = 0.4;
```

Tests

Single Fock and Single Position speed test to the Normalized Hermite Coefficents Matrix

```
import py.fast_wave.wavefunction_numba.psi_n_single_fock_single_position

for n = 0:N_max
    f1 = @()(wavefunction_MATLAB_1(n,x,prec));
    f2 = @()(psi_n_single_fock_single_position(uint64(n), x));
    exec_time_1 = timeit(f1) * 1000;
```

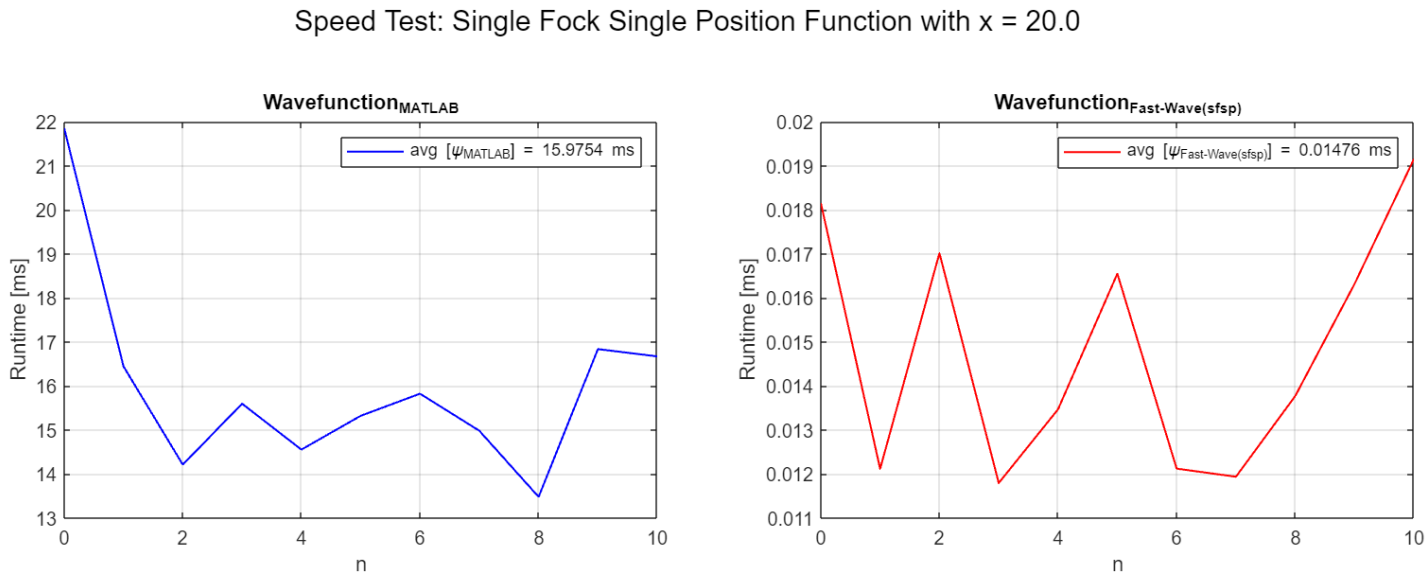
```
    exec_time_2 = timeit(f2) * 1000;
    wavefunction_MATLAB_1_list(n+1) = exec_time_1;
    wavefunction_Fast_Wave_sfsp_1_list(n+1) = exec_time_2;
end

figure('Position', [100, 100, 1200, 800]);
subplot('Position', [left bottom width height]);
plot(x_axi_plot, wavefunction_MATLAB_1_list, 'b-','LineWidth', 1);
grid on;
xlabel('n');
ylabel('Runtime [ms]');
legend(sprintf('avg [\\psi_{MATLAB}] = '+ string(mean(wavefunction_MATLAB_1_list))
+' ms'));
title('Wavefunction_{MATLAB}');

left = 0.59;
subplot('Position', [left bottom width height]);
plot(x_axi_plot, wavefunction_Fast_Wave_sfsp_1_list,'r-','LineWidth', 1);
grid on;
xlabel('n');
ylabel('Runtime [ms]');
title('Wavefunction_{Fast-Wave(sfsp; CS\_matrix)}')
sgtitle('Speed Test: Single Fock Single Position Function with x = 20.0');
legend(sprintf('avg [\\psi_{Fast-Wave(sfsp; CS\\_matrix)}] = '+
string(mean(wavefunction_Fast_Wave_sfsp_1_list))+' ms'));
```



Single Fock and Single Position speed test

```
import py.fast_wave.wavefunction_numba.psi_n_single_fock_single_position

for n = 0:N_max
    f1 = @()(wavefunction_MATLAB_1(n,x,prec));
    f2 = @()(psi_n_single_fock_single_position(uint64(n), x, CS_matrix=false));
    exec_time_1 = timeit(f1) * 1000;
    exec_time_2 = timeit(f2) * 1000;
    wavefunction_MATLAB_1_1_list(n+1) = exec_time_1;
    wavefunction_Fast_Wave_sfsp_2_list(n+1) = exec_time_2;
end

figure('Position', [100, 100, 1200, 800]);
subplot('Position', [left bottom width height]);
plot(x_axi_plot, wavefunction_MATLAB_1_1_list, 'b-','LineWidth', 1);
grid on;
xlabel('n');
ylabel('Runtime [ms]');
```

```
legend(sprintf('avg [\\psi_{MATLAB}] = '+ string(mean(wavefunction_MATLAB_1_1_list))
+' ms'));
title('Wavefunction_{MATLAB}');

left = 0.59;
subplot('Position', [left bottom width height]);
plot(x_axi_plot, wavefunction_Fast_Wave_sfsp_2_list,'r-','LineWidth', 1);
grid on;
xlabel('n');
ylabel('Runtime [ms]');
title('Wavefunction_{Fast-Wave(sfsp)}');
sgtitle('Speed Test: Single Fock Single Position Function with x = 20.0');
legend(sprintf('avg [\\psi_{Fast-Wave(sfsp)}] = '+
string(mean(wavefunction_Fast_Wave_sfsp_2_list))+' ms'));
```

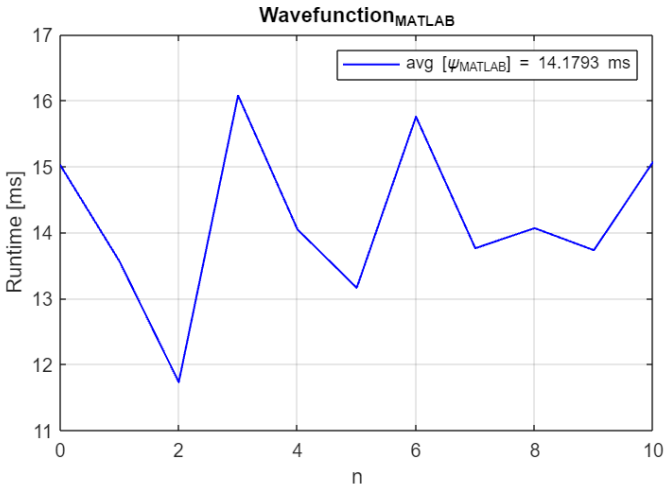


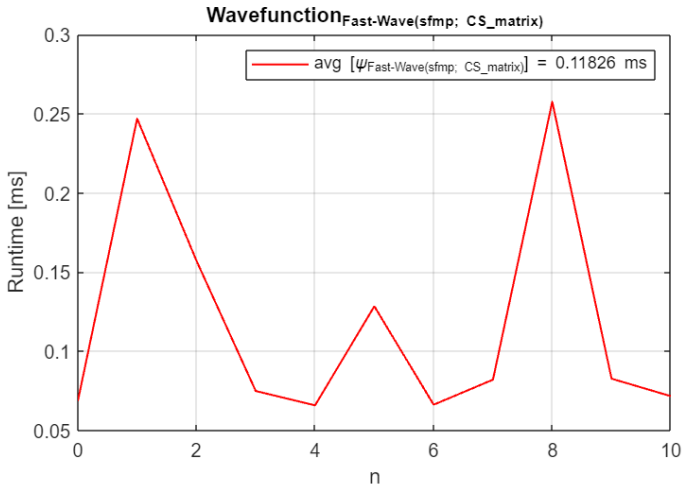
Single Fock and Multiple Position speed test to the Normalized Hermite Coefficents Matrix

```
import py.fast_wave.wavefunction_numba.psi_n_single_fock_multiple_position

left = 0.08;

for n = 0:N_max
```

```
    f1 = @()(wavefunction_MATLAB_1(n,x,prec));
    f2 = @()(psi_n_single_fock_multiple_position(uint64(n), py.numpy.array(X)));
    exec_time_1 = timeit(f1) * 1000;
    exec_time_2 = timeit(f2) * 1000;
    wavefunction_MATLAB_2_1_list(n+1) = exec_time_1;
    wavefunction_Fast_Wave_sfmp_1_list(n+1) = exec_time_2;
end

figure('Position', [50, 50, 1200, 800]);
subplot('Position', [left bottom width height]);
plot(x_axi_plot, wavefunction_MATLAB_2_1_list, 'b-','LineWidth', 1);
grid on;
xlabel('n');
ylabel('Runtime [ms]');
legend(sprintf('avg [\\psi_{MATLAB}] = '+ string(mean(wavefunction_MATLAB_2_1_list))
+' ms'));
title('Wavefunction_{MATLAB}');

left = 0.59;
subplot('Position', [left bottom width height]);
plot(x_axi_plot, wavefunction_Fast_Wave_sfmp_1_list,'r-','LineWidth', 1);
grid on;
xlabel('n');
ylabel('Runtime [ms]');
title('Wavefunction_{Fast-Wave(sfmp; CS\_matrix)}');
sgtitle(sprintf('Speed Test: Single Fock Multiple Position Function with X: [(-20)\
\rightarrow 20;100]'));
legend(sprintf('avg [\\psi_{Fast-Wave(sfmp; CS\\_matrix)}] = '+
string(mean(wavefunction_Fast_Wave_sfmp_1_list))+' ms'));
```

Speed Test: Single Fock Multiple Position Function with X: [(-20) → 20;100]

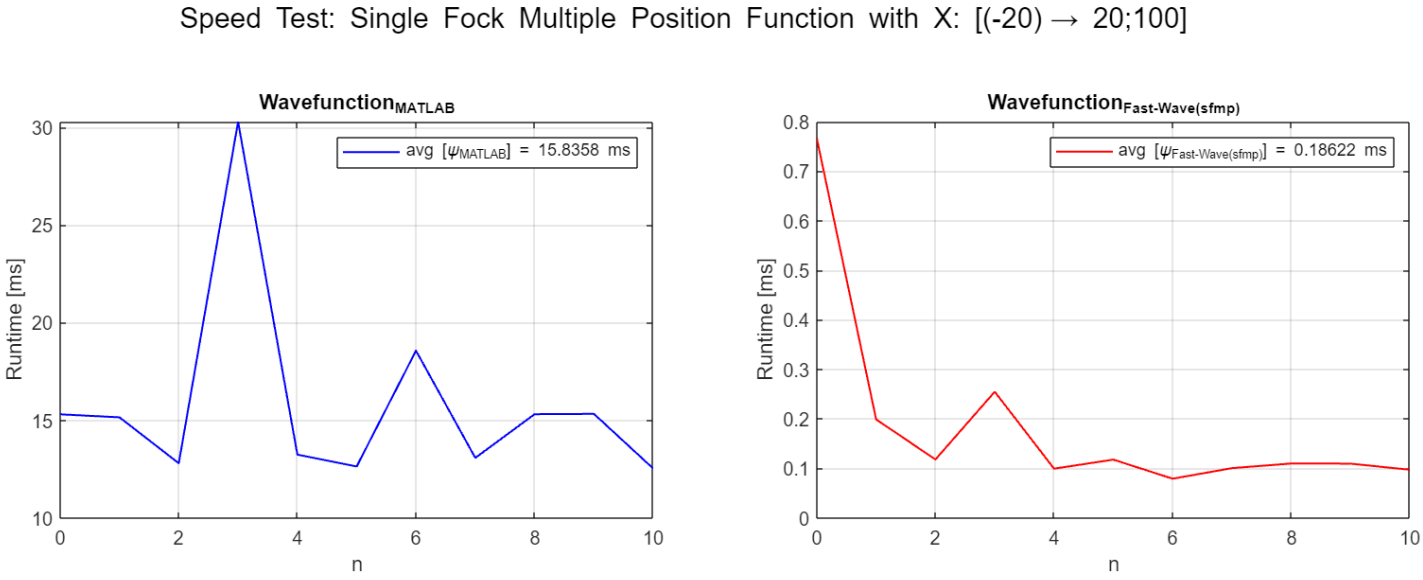




Single Fock and Multiple Position speed test

```
import py.fast_wave.wavefunction_numba.psi_n_single_fock_multiple_position

left = 0.08;

for n = 0:N_max
    f1 = @()(wavefunction_MATLAB_1(n,x,prec));
    f2 = @()(psi_n_single_fock_multiple_position(uint64(n), py.numpy.array(X),
CS_matrix=false));
    exec_time_1 = timeit(f1) * 1000;
    exec_time_2 = timeit(f2) * 1000;
    wavefunction_MATLAB_2_2_list(n+1) = exec_time_1;
    wavefunction_Fast_Wave_sfmp_2_list(n+1) = exec_time_2;
end

figure('Position', [50, 50, 1200, 800]);
subplot('Position', [left bottom width height]);
plot(x_axi_plot, wavefunction_MATLAB_2_2_list, 'b-','LineWidth', 1);
grid on;
```

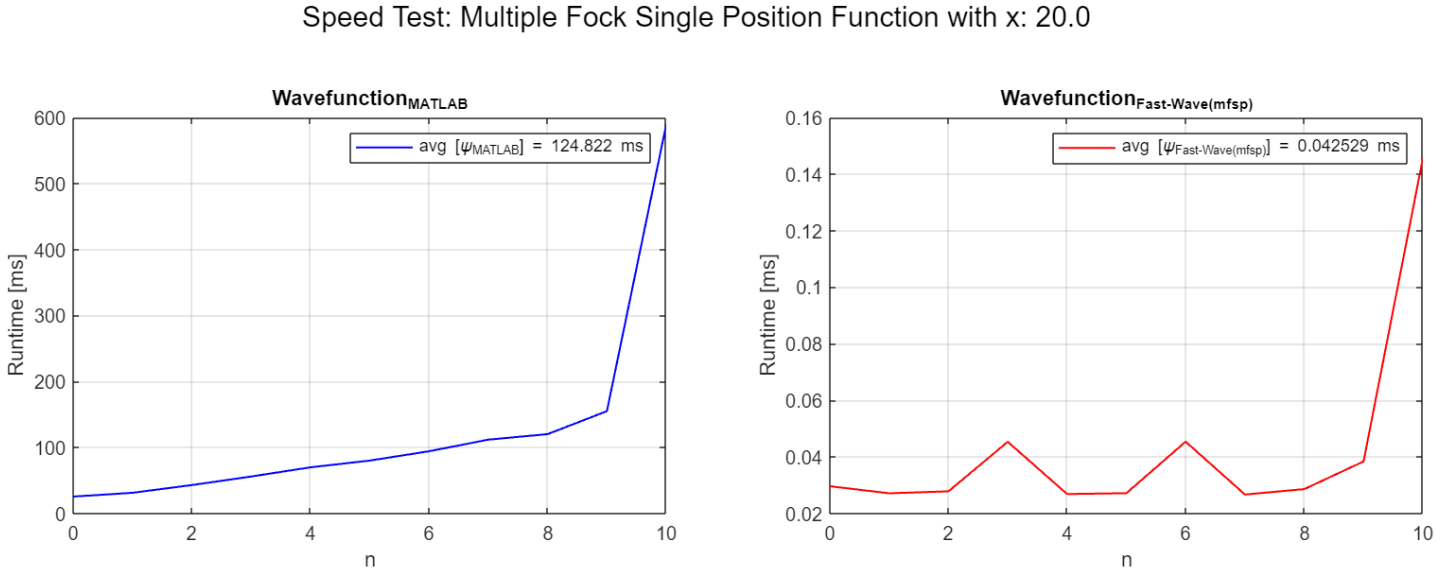
```
xlabel('n');
ylabel('Runtime [ms]');
legend(sprintf('avg [\\psi_{MATLAB}] = '+ string(mean(wavefunction_MATLAB_2_2_list))
+' ms'));
title('Wavefunction_{MATLAB}');

left = 0.59;
subplot('Position', [left bottom width height]);
plot(x_axi_plot, wavefunction_Fast_Wave_sfmp_2_list,'r-','LineWidth', 1);
grid on;
xlabel('n');
ylabel('Runtime [ms]');
title('Wavefunction_{Fast-Wave(sfmp)}');
sgtitle(sprintf('Speed Test: Single Fock Multiple Position Function with X: [(-20)\
\rightarrow 20;100]'));
legend(sprintf('avg [\\psi_{Fast-Wave(sfmp)}] = '+
string(mean(wavefunction_Fast_Wave_sfmp_2_list))+' ms'));
```



Multiple Fock and Single Position speed test

```
import py.fast_wave.wavefunction_numba.psi_n_multiple_fock_single_position
```

```
left = 0.08;

for n = 0:N_max
    f1 = @()(wavefunction_MATLAB_3(n,x,prec));
    f2 = @()(psi_n_multiple_fock_single_position(uint64(n),x));
    exec_time_1 = timeit(f1) * 1000;
    exec_time_2 = timeit(f2) * 1000;
    wavefunction_MATLAB_3_list(n+1) = exec_time_1;
    wavefunction_Fast_Wave_mfsp_list(n+1) = exec_time_2;
end

figure('Position', [50, 50, 1200, 800]);
subplot('Position', [left bottom width height]);
plot(x_axi_plot, wavefunction_MATLAB_3_list, 'b-','LineWidth', 1);
grid on;
xlabel('n');
ylabel('Runtime [ms]');
legend(sprintf('avg [\\psi_{MATLAB}] = '+ string(mean(wavefunction_MATLAB_3_list))
+' ms'));
title('Wavefunction_{MATLAB}');

left = 0.59;
subplot('Position', [left bottom width height]);
plot(x_axi_plot, wavefunction_Fast_Wave_mfsp_list,'r-','LineWidth', 1);
grid on;
xlabel('n');
ylabel('Runtime [ms]');
title('Wavefunction_{Fast-Wave(mfsp)}');
sgtitle(sprintf('Speed Test: Multiple Fock Single Position Function with x: 20.0'));
legend(sprintf('avg [\\psi_{Fast-Wave(mfsp)}] = '+
string(mean(wavefunction_Fast_Wave_mfsp_list))+' ms'));
```



Multiple Fock and Multiple Position speed test

```
import py.fast_wave.wavefunction_numba.psi_n_multiple_fock_multiple_position

left = 0.08;

for n = 0:N_max
    f1 = @()(wavefunction_MATLAB_4(n,X,prec));
    f2 = @()(psi_n_multiple_fock_multiple_position(uint64(n),py.numpy.array(X)));
    exec_time_1 = timeit(f1) * 1000;
    exec_time_2 = timeit(f2) * 1000;
    wavefunction_MATLAB_4_list(n+1) = exec_time_1;
    wavefunction_Fast_Wave_mfmp_list(n+1) = exec_time_2;
end

figure('Position', [50, 50, 1200, 800]);
subplot('Position', [left bottom width height]);
plot(x_axi_plot, wavefunction_MATLAB_4_list, 'b-','LineWidth', 1);
grid on;
xlabel('n');
ylabel('Runtime [ms]');
```

```
legend(sprintf('avg [\\psi_{MATLAB}] = '+ string(mean(wavefunction_MATLAB_4_list))
+' ms'));
title('Wavefunction_{MATLAB}');

left = 0.59;
subplot('Position', [left bottom width height]);
plot(x_axi_plot, wavefunction_Fast_Wave_mfmp_list,'r-','LineWidth', 1);
grid on;
xlabel('n');
ylabel('Runtime [ms]');
title('Wavefunction_{Fast-Wave(mfmp)}');
sgtitle(sprintf('Speed Test: Multiple Fock Multiple Position Function with X:
[(-20)\\rightarrow 20;100]'));
legend(sprintf('avg [\\psi_{Fast-Wave(mfmp)}] = '+
string(mean(wavefunction_Fast_Wave_mfmp_list))+' ms'));
```

Speed Test: Multiple Fock Multiple Position Function with X: [(-20) → 20;100]