

# Introduction to Matlab

Functional Programming

and Current Uses at ITTC

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# **M-Files**

- •M-files
  - -M-files can be used to create functional
    - programs
      - •Loops, switches, if...then statements
      - •Functions

# Loops

## •Loops

for variable = expression
 statement...
end

while logical\_expr statement... end



## •Switches

switch switch\_expr

case case\_expr

statement...

case case\_expr

statement...

otherwise

statement...

end



# if...then

# •if...then

if logical\_expr

statement...

else

statement...

end



# **Functions**

# Functions are stored in m-filesM-file must begin with a declaration

function [out] = function\_name(arg1, arg2, ..., argN)



# **Functions**

# •Example: Trapezoid Rule for Numerical Integration



$$\int_{a}^{b} f(x)dx \approx h\left(\frac{1}{2}y_{0} + y_{1} + y_{2} + \dots + \frac{1}{2}y_{n}\right)$$



# **Functions**

```
function [sum] = trpzdint(f,a1,b1,points)
x=linspace(a1,b1,points);
h=x(2)-x(1);
f=eval(f);
sum=0;
for n=1:points
    if((n==1)|(n==points))
        sum=sum+(1/2)*f(n);
    else
        sum=sum+f(n);
    end
end
```

sum=h\*sum;

# Matlab Uses

# •Common Engineering Uses

- -Mathematical Modeling
- -Interpretation / Presentation of Results
- -Filter Synthesis
- -System Stability Analysis
- -Statistics
- -Computer-controlled Experiments
- -Logging Experimental Data

#### **Objective :**

To characterize surface and sub – surface layers of Mars.

#### **Principles :**

- Every material on earth can be characterized by its Permittivity.
- Permittivity contrast in layered media causes reflection of incident EM Wave.

#### **Challenges :**

- Radar return is corrupted by noise & scattering components.
- ➤ This is a non linear problem !

#### Solution :

Model Based Signal Processing !



Model the radar return using Propagation model, scattering model and noise model.

Permittivity profile can be obtained by minimizing the mean square error (MSE) between measured and modeled data.



**Permittivity Profile** 

# How can MATLAB help?

Modeling:

Simulation of physical phenomenon(e.g, propagation, scattering, noise).

## Signal Processing:

Filtering, System effect compensation, model parameter estimation.

Analysis:

Spectral Analysis (using Fourier transforms, other spectral estimation techniques)





Use Iterative Non-linear parameter Estimation techniques



#### Simulation results

- . Type of radar: FMCW radar
- . Freq range: 2-8 GHz
- . Duration of chirp: 10 mS
- . Free space Range resolution: 2.5cm
- . SNR of simulated data: 10 dB

## Near-Surface Internal Layers in Polar Ice Sheets



## The Clutter Problem



## The Solution – Phased Array Processing



Basic Principle: Constructive & Destructive Interference

Actual Implementation



## Computer Simulation of Rough Surface Clutter using MATLAB



## Signal Processing Techniques Applied to Simulated Data

