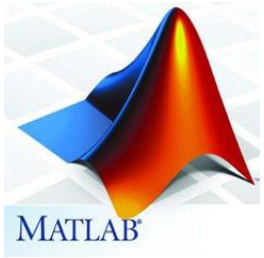


Introduction à la programmation objet avec Matlab

Jacques Grelet IR US191 IMAGO
Plouzané

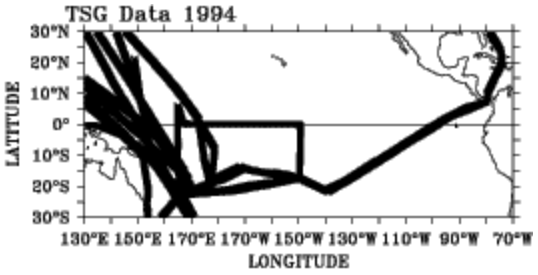
1982 -1986
Electronicien Océanographe

FOCAL Atlantique Equatorial

1986 – 1994 Nouméa

SST: Sea Surface Technician

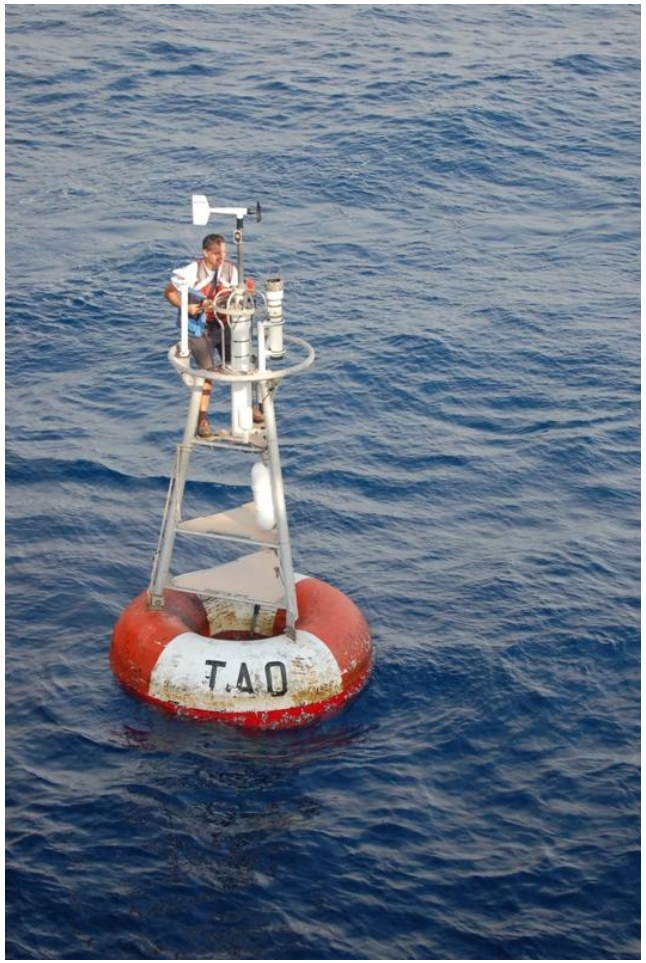
- Programme SURTOPAC
- Réseaux navires marchands
  - XBT
  - Thermosalinographe SST-SSS



1995 -2001
Afrique de l'Ouest
PICOLO - PIRATA

2001 – 2016

IRD Bretagne– campus IFREMER
US191 IMAGO – laboratoire mesures physiques



Contexte de travail

- 82 campagnes océanographiques
- 1747 jours en mer
- Plusieurs casquettes à bord
  - Chef de mission - organisation des campagnes
  - Réalisation (quart) - mise en œuvre du matériel
  - Traitement des données
  - Electronicien sur l'Antea
- Langages programmation
  - Basic HP, C / C++, Java, Matlab ,Perl, PHP, Python, Golang
- Développement de boite à outils
- Productivité
  - Softs de traitement et visualisation
    - TSG-QC
    - dataGUI
  - Toolbox
    - Oceano
    - Datagui.netcdf

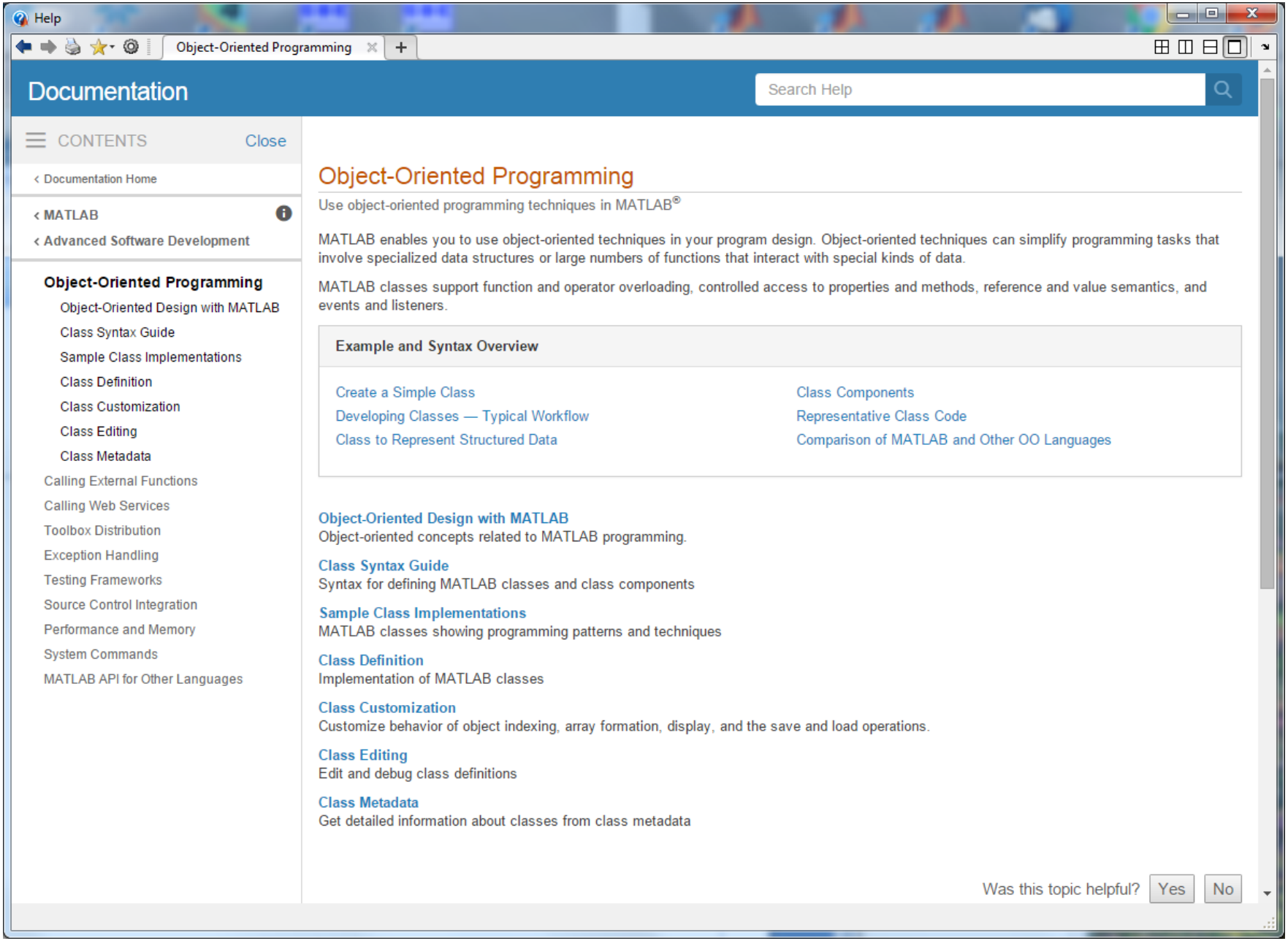
Présentation de Matlab

Les plus:

- Logiciel scientifique: éditeur Mathworks
- Langage interprété, objet
- Environnement de développement très complet
- Nombreuses toolbox
  - Payantes: map, images, signal, compilateur, …
  - Libres: m_map, xUnit, …
- Réalisation d'interfaces graphiques riches, **interactives**
- Multiplateformes
- Une aide très bien faite,
- Partage de codes: matlab central, github
- Aide en ligne: stackoverflow, developpez.com

Les moins:

- Propriétaire, coût des licences élevées: éducation, individuelles, groupes, jetons
- Performance: interprété, mémoire
- Function is obsolete and will be discontinued. function will be removed in a future release of MATLAB


Help
Object-Oriented Programming
Documentation
Search Help
CONTENTS
Close
Documentation Home
MATLAB
Advanced Software Development
Object-Oriented Programming
Object-Oriented Design with MATLAB
Class Syntax Guide
Sample Class Implementations
Class Definition
Class Customization
Class Editing
Class Metadata
Calling External Functions
Calling Web Services
Toolbox Distribution
Exception Handling
Testing Frameworks
Source Control Integration
Performance and Memory
System Commands
MATLAB API for Other Languages
Object-Oriented Programming
Use object-oriented programming techniques in MATLAB®
MATLAB enables you to use object-oriented techniques in your program design. Object-oriented techniques can simplify programming tasks that involve specialized data structures or large numbers of functions that interact with special kinds of data.
MATLAB classes support function and operator overloading, controlled access to properties and methods, reference and value semantics, and events and listeners.
Example and Syntax Overview
Create a Simple Class
Developing Classes — Typical Workflow
Class to Represent Structured Data
Class Components
Representative Class Code
Comparison of MATLAB and Other OO Languages
Object-Oriented Design with MATLAB
Object-oriented concepts related to MATLAB programming.
Class Syntax Guide
Syntax for defining MATLAB classes and class components
Sample Class Implementations
MATLAB classes showing programming patterns and techniques
Class Definition
Implementation of MATLAB classes
Class Customization
Customize behavior of object indexing, array formation, display, and the save and load operations.
Class Editing
Edit and debug class definitions
Class Metadata
Get detailed information about classes from class metadata
Was this topic helpful?
Yes
No

Structure

```
% structure
field = 'temp';
value = [10, 20, 30];
field2 = 'psal';
value2 = [33, 34, 35];
s = struct(field,value,field2,value2)
var = 'dens';
s.(var) = [20,21,22];
s.psali = 3
vars = {'temp', 'psal'}
for var = vars
  s.(char(var))
end
save('test.mat', s)
load('test.mat')
```

Visualiser le code sous GitHub

Executer avec Tutorialpoint.com

Create a Simple Class

```
classdef myFirstClass
  %MESURE Cette class devrait remplacer une structure
  %   usage: m = myFirstClass
  %   m.field = 'temp'
  %     m.value=[10 20 30]
  properties
    field
    value
  end

  methods
    function self = myFirstClass()
    end
  end

end
```

myFirstClass.m

run_myFirstClass.m

Important: si vous modifiez votre classe, faire un « clear class » ou « clear all » dans la console

Property Set Methods

```
classdef myFirstClass2
  properties
    field
    value
  end

  methods
    function self = myFirstClass2()
    end
    function self = set.field(self,f)
      if ischar(f)
      self.field = f;
      else
        error('myFirstClass2:set.field: not a string');
      end
    end
  end

end
```

run_myFirstClass2.m

Property Get Methods

```
classdef myFirstClass2b
  properties
    field
    value
  end

  methods
    function self = myFirstClass2b() % constructor
    end
    function self = set.field(self,f)
      if ischar(f)
        self.field = f;
      else
        error('myFirstClass2:set.field: not a string');
      end
    end
    function str = get.field(self)
      str = sprintf('property field: %s\n', self.field);
    end

  end  % end of public function

end % end of myFirstClass2b class
```

run_myFirstClass2b.m

containers.Map class

```
%% containers.Map (à partir de R2008b)
mapObj = containers.Map(keySet,valueSet)
mapObj = containers.Map('KeyType',kType,'ValueType',vType)

theKeys =   {'temp', 'psal', 'oxy', 'dens'};
theValues = {[10 20 30], [33 34 35],[120 130 140], [ 22 23 24]};
m = containers.Map(theKeys, theValues)

keys(m)
values(m)
m('flu2') = [0.6 0.7 0.8];
for k = keys(m)
  k = char(k);
  disp(k), disp(m(k))
end
```

run_containersMap.m

Hashtable (table hachage)

myFirstClassContainer

```
classdef myFirstClassContainer
  properties
   map % containers.Map
  end

  methods
    function self = myFirstClassContainer(theKeys, theValues) % constructor
      self.map = containers.Map(theKeys, theValues);
    end

  end  % end of public function

end % myFirstClassContainer
```

myFirstClassContainer.m

run_myFirstClassContainers.m

mySecondClassContainer

```
classdef mySecondClassContainer < containers.Map
  properties
  end

  methods
    function self = mySecondClassContainer(theKeys, theValues)
      % call containers.Map constructeur
      self@containers.Map(theKeys, theValues)
    end

  end  % end of public function

end % end of mySecondClassContainer class
```

mySecondClassContainer.m

run_mySecondClassContainers.m

mySecondClassContainer is a handle class now, inherit from containers.Map

Class Definition and File Organization

- **Attributes for Class Members**
  - Class Attributes
  - Method Attributes
  - Property Attributes
  - Event Attributes
- **Kinds of Classes :**
  - Comparison of Handle and Value Classes
- **Class Hierarchies**
  - Inheritance : interface, abstract,
- **Namespaces**
  - **dataGUI.netcdf**
- **Class Files and Folders**
  - Exemple: datagui

Value Class

```
theKeys =   {'temp', 'psal', 'oxy', 'dens'};
theValues = {[10 20 30], [33 34 35],[120 130 140], [ 22 23 24]};
m = mySecondClassContainer(theKeys, theValues)
a=m
a =
  Map with properties:
        Count: 4
      KeyType: char
    ValueType: any
m('flu2') = [0.6 0.7 0.8]
m =
  Map with properties:
        Count: 5
      KeyType: char
    ValueType: any
 a =
  Map with properties:
        Count: 5
      KeyType: char
    ValueType: any
```

Class handle

```
theKeys =   {'temp', 'psal', 'oxy', 'dens'};
theValues = {[10 20 30], [33 34 35],[120 130 140], [ 22 23 24]};
m = mySecondClassContainer(theKeys, theValues)
a=m
a =
  Map with properties:
        Count: 4
      KeyType: char
    ValueType: any
m('flu2') = [0.6 0.7 0.8]
m =
  Map with properties:
        Count: 5
      KeyType: char
    ValueType: any
 a =
  Map with properties:
        Count: 5
      KeyType: char
    ValueType: any
```

Nested functions

```
function parent
    disp('This is the parent function')
    nestedfx

    function nestedfx
         disp('This is the nested function')
    end
end
```

- Les fonctions imbriquées peuvent utiliser des variables qui ne sont pas passées explicitement comme arguments d'entrée. Elles partagent le même espace de travail (workspace) que la fonction parent.
- Dans une fonction parent, vous pouvez créer un handle vers une fonction imbriquée qui contient les données nécessaires pour exécuter la fonction imbriquée.

Passage de paramètres

- Fonctions:

```
[out1, out2,…] = function(var1, var2,…)
```

- Setappdata/getappdata:

```
tsg = getappdata( hMainFig, 'tsg_data');
setappdata( hMainFig, 'tsg_data', tsg);
```

- Propriété « userdata » des objets graphiques:

```
% The callback to detect the mouse motion can be set to on
hMainFig = figure;
set( hMainFig, 'UserData', 'ButtonMotionOn');
```

- guihandles/guidata:

```
guidata(object_handle,data)
data = guidata(object_handle)
```

- findobj:

```
% enable toolbar menu pushtool
hdl_pushtool = findobj('-regexp','Tag', 'PUSHTOOL_');
 set(hdl_pushtool, 'Enable', 'on');
```

Anomymous Functions

Syntax:

```
h = @(arglist)anonymous_function
```

Exemple:

```
sqr = @(n) n.^2;
x = sqr(3)
```

Callback Function Syntax

```
plot(x,y,'ButtonDownFcn',{@lineCallback,'--','*'})

function lineCallback(src,evt,arg1,arg2)
    src.Color = 'red';
    src.LineStyle = arg1;
    src.Marker = arg2;
end

uimenu(hClimatoMenu,'Label','Annual', 'Checked','on','Enable', 'on',...
    'Callback', {@ClimatoSelectMenuCallback, 'annual', value});

function ClimatoSelectMenuCallback(hObject, eventdata, climato, time)
…
end
```

A éviter:

```
e = uicontrol('pushbutton','string', 'callback','s_conf = guihandles;
    uipanel_voff(''Application des polynomes P,T'',s_conf);clear st_deb_prs
    st_deb_tmp;');
```

Lecture de fichier, vectorisation

Fichiers:

```
# file_type = ascii
*END*
 322.500000    28.8567  0.000e+00
 322.500012    28.8573  0.000e+00
 322.500023    28.8579  0.000e+00
```

…

Code:

```
fid = fopen(fileName);
[A,count] = fscanf( fid, '%g', [columns,inf] );
nb = count / columns;
disp( [num2str(nb),' records'] );
fclose(fid);    % close file
A=A'; % transpose matrix
% read first 10 lines
JulianDay = data(1,1:10)
```

Les expressions régulières: regex

```
% extract software version
% ex: * Software Version Seasave V 7.16
s = regexp(str,  '^*\s*Software Version Seasave.*(?<version>\d+\.\d+)', 'names');
  if ~isempty(s)
    self.Seasave_Version = s.version
    continue
  end

% extract NMEA Longitude
% ex: * NMEA Longitude = 023 00.01 W
match = regexp( str,  '^*\s*NMEA
    Longitude\s*=\s*(?<degree>\d+)\s+(?<minute>\d+\.\d+)\s*(?<hemi>\w{1})', 'names ');
  if ~isempty(match)
    deg  = match.degree;
    min  = match.minute;
    hemi  = match.hemi;
    self.Longnum = str2double(DegMin_2_Dec(sprintf('%s%s',deg, min), hemi));
    continue
end

Tester ses regex: regexcoach
```

Les expressions régulières: regex

```
> str = 'Pressure [dbar]‘;
> toks = regexp( str, '^(?<name>.*)?\s+\[(?<unit>.*)\]$','names');

toks =

 struct with fields:
    name: 'Pressure'
    unit: 'dbar‘

> tr = 'Date Time Latitude Temp‘;
> dr = regexp( str, ' ','split')

hdr =

  1×4 cell array
    'Date'    'Time'    'Latitude'    'Temp'
```

MATLAB > R2014b

- **MATLAB < R2014b**

```
> f = figure
f = 1
```

- **MATLAB > R2014b**

```
>> f = figure
f = Figure (1) with properties:
        Number: 1
        Name: ''
        Color: [0.9400 0.9400 0.9400]
        Position: [680 558 560 420]
        Units: 'pixels‘
```

```
% get the figure number, starting in R2014b figure became an object
if verLessThan('matlab','8.4')
    figureNumber = num2str(f);
else
    figureNumber = num2str(f.Number);
End
cmd = ['print -f' ,figureNumber, ' -d', printer, ' ', fileName extension];
eval(cmd);
```

Astuces (à compléter)

Commentaires multilignes:

%{
…
Block of COMMENTS HERE
…
…
%}

Pour rédiger du code:

Mettre un point d'arrêt.

Lancer l'exécution en mode run.

Ecrire le code puis l'évaluer avec F9

Méthode display():

Supprimer le ; en fin de ligne appel la méthode display sur l'objet

Tests unitaires

- Le but est de tester chaque élément du code avant et après chaque modifications ou ajout de fonctionnalités
- Méthode agile:
  - écrire les tests avant le développement du code métier
- Frameworks
  - matlab-xunit
  - unit-test(intégré à Matlab R2013b)
- Exemple: dataGUI +tests
  - > runxunit datagui.tests
  - > runtests

Quelques exemples

- Paquetage dataGUI
  - datagui.dynaload: code
    - Descripteur : fichiers Excel/csv/json
    - Structure NetCDF indépendante du code de l'application
  - datagui.netcdf : représentation d'un fichier NetCDF en mémoire
  - datagui.ncload: charge les variables dans l'espace de travail
  - datagui.ncdump: émule la commande ncdump Unidata
  - Datagui: exemples
  - Netcdf et formulaire: github
  - Lecture de fichier Excel classe excelRead.m
  - Lecture de fichier ODV: classe odcReaderWriter
- TSG-QC
  - TSG-QC: code sous subversion
- dataGUI
  - dataGUI: version 1

Liens utiles

- MATLAB Object-Oriented Programming
- MATLAB Files Exchange: Matlab Central
- Aide en ligne: stackoverflow, developpez.com
- Undocumented Matlab **(**360 articles)
- Exécuter du code MATLAB/SCILAB en ligne: Coding ground
- GitHub : https://github.com/jgrelet
- Blog du l'US191 IMAGO
  - TSG-QC
  - dataGUI
  - ….
- MATLAB Tools for Oceanographic Analysis: SEA-MAT