First Summary of IDL

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2. Getting Started with the Basics

- IDL's command syntax:
  COMMAND, (opt) parameters, KEYWORD1=val,...
  parameters must occur in specific order
  IDL is not case sensitive!

- keyword shortcuts:
  PLOT, line, CHARS=3, LINES=2
  ;instead of CHARSIZE=3, LINESTYLE=2
  ;/KEYWORD equal to KEYWORD=1

- special characters:

' ; '	first character of a comment
' @ '	for batch execution
' $ '	indicates a continuation line: PLOT, x, y, $ CHARSIZE=2
'&'	multiple statements in a line: x=FINDGEN(20) & PLOT,x

- Getting help

HELP, data ; help about variable data
HELP, data, OUTPUT=var ;var contains HELP's output
HELP,/MEMORY ; dyn. memory currently in use
HELP,/ROUTINES ; compiled routines

? ; online hypertext help

- Save your data or the routines in the IDL session

SAVE, /ALL ;save all local variables incl. contents
;default file: "idlsave.dat"
SAVE, /ROUTINES ;save all currently compiled IDL
;routines in a platform independent
;binary file
SAVE, x_vec, y_vec, FIlENAME='creaso.sav'
;save "x_vec"+"y_vec" in file creaso.sav

- Restore saved variables or routines

RESTORE, 'CREASO.SAV' ;on different platforms...

- IDL System variables (identified by an " ! " -mark) predefined by IDL
  HELP, /SYSTEM_VARIABIES

- Examples
  PRINT, !PI & PRINT,!DPI & PRINT,!VERSION

- IDL environment:

  PRINT, !DIR ; location of the IDL main directory
  PRINT,!PATH ; list of directories to search für
  ; (user-written) procedures

- ***IDLDE***

  File->Preferences, menu's to set interactiv:
  - *IDL path*
  - *Startup file,* executed in batch fashion
    ; when IDL is started
  - Preferences für editor, graphics

3. Analyzing and Working with Data:

- IDL Variables:
- Names can incl. characters '_', $, 0...9
  (1. character a letter !)
- AII IDL Names are case insensitive
- Size: limited only by memory, not by IDL !

- Variable Types and initializing examples:

	scalars:	arrays:
byte (8 bit)	v=0b	a=BYTARR(10,20)
signed int (16 bit)	v=0; v=0s	a=INTARR(12,...,20)
unsigned int (16 bit)	v=0u; v=0us	a=UINTARR(10,20)
signed long int(32bit)	v=0l	a=LONARR(SO,100)
unsigned long int(32bit)	v=0ul	a=ULONARR(10.20)
signed 64-bit long int	v=0ll	a=ION64ARR(10,S)
unsigned 64-bit long	v=0ull	a=ULON64ARR(S.S)
float	v=0.0	a=FITARR(4000)
double	v=0.0d	a=DBLARR(300, ...)
complex	v=COMPLEX(0,0)	a=COMPLEXARR(..)
double complex	v=DCOMPLEX(1,0)	a=DCOMPLEXARR(..)
string	v= 'Hallo'	a=STRARR(10)

- Variable types and value range:

Type conversion	Range
v1 =BYTE(v)	0 to 255
v1=FIX(v)	-32,768 to +32,767
v1 =UINT(v)	0 to 65,535
v1 =LONG(v)	-2,147,483,648 to +2,147,483,647
v1 =LONG64(v)	-2^63-1 to 2^63-1
v2=FLOAT(v)	±10^38 (6-7 decimals significance)
v2=DOUBLE(v)	±10^308 (-14 dec. sign.)

- Heap variables with **IDL 5**

  objects:
  obj = *obj_new('class')* or *aobj-objarr(10,* ..)

  pointers:
  ptr = *ptr_new(init)* or *aptr-ptrarr(20.* 2, ..)

- Variable type and structure (array, scalar...) change dynamically:

```
a=FLTARR(20,10)
a=a+1
HELP,a ; get the type, dimensions of 'a'
a=1
HELP,a
```

- Working with Arrays (up to 8 dimensions)
    - Array creation and initialization examples:

```
arr1=[2,8,26,3]                ; by hand
arr2=BYTARR(50, 100)           ;or INTARR( ...), FITARR(...,..
                               ; all elements=0
arr3=BINDGEN(256)              ;or INDGEN( ...),FINDGEN(...)
                               ;elements of arr3=BYTE(index)
```

- Subsetting N-dimensional arrays with 1 D subscripts:

```
arr4=BINDGEN(256,500)      ;create a 2D array
TV, arr4                   ;show array (color bar)
PRINT, arr4[24, 2]         ;
PRINT, arr4[536]           ;
```

- Selecting subarrays with ' * ' and ' : '

' * ' all elements of a column or row:

```
PLOT .arr4[*.17]     ;all (column-) elements of row 17
```

' : ' selecting an arbitrary subscript range, e.g.:

```
arr4[80:220.200:252]=0        ;set all elements of the

TV,arr4                       ; range to 0
```

- Using arrays as indices to other arrays

```
one=[6,5,1,8,4,3]
two=[0,2,4,1]
PRINT, one[two]          ; print one[0]. one[2], ...
```

- Using expressions tor subscripting: WHERE-function:

```
i_vec = WHERE( arr4 LE 100 AND arr4 GE 20)
arr4[i_vec]=255
TV, arr4
```

IDL Operators

- All IDL operators can be used with arrays:

  arr4=arr4 - 100

  arr4=arr4+ (2 * arr4)

- Boolean Operators

  AND, OR, NOT, XOR

- Relational Operators (result 0 (false) or 1 (true))

  GT **G**reater **T**han

  LE **L**ess **E**qual

  EQ **E**qual

  ....

- Minimum '<' and Maximum '>' Operator:

```
x=[5,10,20] >[6,9,30]
PRINT,x
```

- Array concatenation with [...]:

```
v1=[2,3,1]
v2=[2,1,4]
v3=[v1,v2]          ;concatenate v1 with v2
PRINT,v3
```

- Structure variables:

  - 1. Definition of a ***named structure:***

var={*s_name, s_tag* 1: *definition, s_tag2:definition,* ...}

  - 2. Definition of a ***anonymous structure*:**

var={*s_tag1: definition, s_tag2:definition,* ... }

• Example, use of a named structure:

```
var1 = {my_data, $
          date:' ',$          ; date of the measurement
          para:0.0, $         ; measurement parameter
          image: bytarr(256.256)}
var1.date='15.10.2002' ; access a field
```

• duplicate a named structure

```
var2={my_data}          ;copy only the tags
var2=varl               ;copy all contents
```

- Example: use of a vector of structures
  (e.g. to group all datasets together)

```
all_data = REPLICATE({my_data}.5) ;arr. of 5 struct.
all_data[0] = var1                ;set element 1
all_data = [all_data, var2]       ;add an additional
                                  ; structure as element 6
all_data[J].date = '20.04.2002,   ;set value of tag
                                  ; 'date' of vector element 4
dates = all_data.date             ;copy the dates of all
                                  ;structures to variable dates
HELP, dates                       ; .....
```

4. Displaying Data as Line Plots

- Customizing a line plot with more than 60 keywords, examples:

```
(x_vec = FINDGEN(200)/20  y_vec = sin(x_vec))
PLOT, y_vec, CHARSIZE=1.5, PSYM=I, $
  XRANGE=[100,200]
; 1 argument (y: subrange of y_vec), PSYM-PlotSYMbol, see online help
PLOT,x_vec,y_vec, TICKS=10,XTICKFORMAT='(F8.2)'
; 2 arguments! (x + v), x axis customized
; (F8.2)- 8 characters, with 2 places after the decimal point
```

- Plotting multiple datasets

```
y1 = y_vec/EXP(x_vec)
OPLOT, x_vec, y1, COLOR = 150, IINESTYLE =2. $
  THICK =2
```

- Customising the axes
  - axis types:

  [XYZ]STYLE (XSTYLE,YSTYLE,ZSTYLE) keywords:
  each option encode in a bit, s. online help

PLOT, FINDGEN(180), XSTYLE=(1 +8)
; exact range + no x-box

- Customising the axes:
    - tick intervals:

[XYZ]TICKS : number of major tick intervals
[XYZ]MINOR : number of minor tick intervals
TICKLEN and [XYZ]TICKLEN:
tick length between -1 and 1

- Use of multiple axes: *AXIS* procedure

```
PLOT, x_vec, y_vec, ystyle=8        ;ystyle=8: no box
AXIS,10, /YAXIS,YRANGE=[-5,5], $
        /SAVE, COLOR=160
        ;draw an additional y-axis + save new data coord.
OPLOT,x_vec, 8*y1, LINESTYLE=2, COLOR=160
```

• IDL has 3 coordinate systems !:

DATA : established by PLOT,SURFACE
DEVICE : system of the graphics device(pixels)
NORMAL: range from 0 ...1 in the plot window

• Use the system variables !X, !Y (+ !Z) to change the default values für the axis settings.
Structure fields correspond to keywords:

```
!X.STYLE = 1          ;new default: exact axis range
!Y.RANGE = [0, 5]     ;new default y range
```

- Drawing lines (or plotting points) with

  PLOTS, xcoord_vec, ycoord_vec, /data

  xcoord_vec, ycoord_vec: providing the x-v coordinates of the points to be connected.

- Example:

```
PLOT.x_vec.y_vec  ;establish data coordinates!
x=[4.6.6.4.4]
y=[O.35,0.35,0.5,0.5,0.35]
PLOTS, x, y./DATA. color=200 ; plot a box
                             ; and fill it with POLYFILL
```

- Annotation keywords:
  TITLE. [XYZ]TITLE, CHARSIZE, [XYZ]CHARSIZE
  Create a line plot with a title, a y-title and a larger charsize (e.g.: 2):

Explicit labels for tick marks with keywords:

```
[XYZ]TICKNAME        ; set to astring array
[XYZ]TICKFORMAT      ; define a function for tick labels
```

- Axes with date/time labels
  - New with IDL 5.4: TIMEGEN
    - returns an array of time values (double "Julian dates")
    - contains several keywords to provide specific date/time data generation ""

```
time = TIMEGEN(200, UNITS = 'Seconds', $
START = JULDAY(04, 23, 2002,10,20,30))
    ;time vector starting on April, 23rd,1 0:20,
    ;also try UNITS = 'Days' ...
```

• Axes with date/time labels, example:

```
dummy = LABEL_DATE(DATE_FORMAT=['%I:%S '])
;Label_date specifies axis format ("Minutes:Seconds")

PLOT, time, y_vec, $
XTICKUNITS = 'Time', $        ;specify axis type
XTICKFORMAT = 'LABEL_DATE', $    ;use internally
                        ;stored result of LABEL_DATE
XTICKINTERVAL = 0.5          ;specify tick interval
```

(see file w9-timeaxis.pro)

- Adding text to any graphics with XYOUTS:

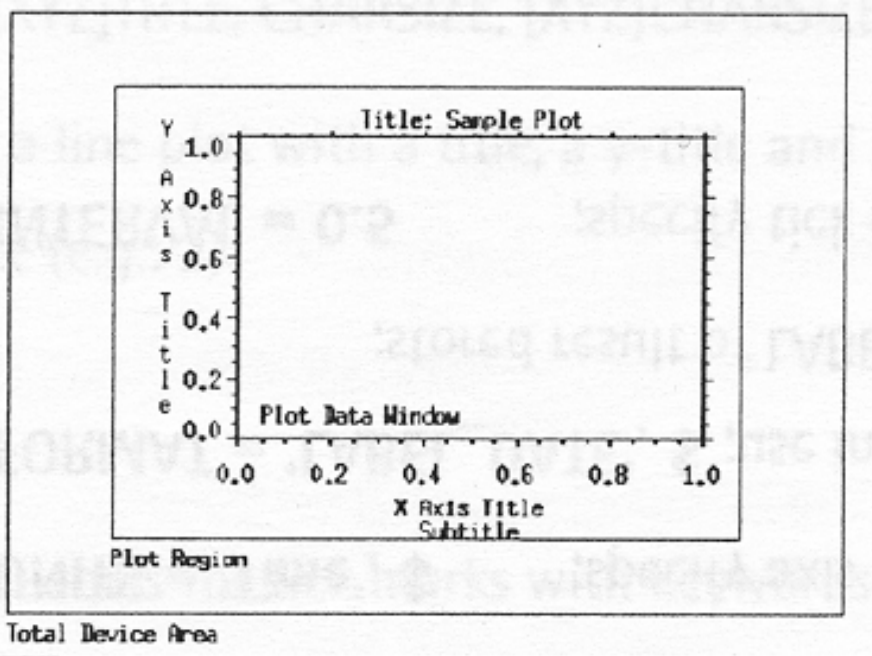
```
PLOT, x_vec, y1
XYOUTS, 5, 0.3, 'TEXT', CHARS=3        ;/DATA default!
```

Exercise:

Position text in the center of the plot window:

```
 XYOUTS, ... , ... .' ...'. INORMAL,ALIGNMENT=0.5
```

- Positioning a PLOT (a SURFACE ...) in the window:



- Plot Data Window in normalized coord. .

PLOT, x_vec, y_vec, POSITION=[0.2, 0.2, 0.8, 0.9]
!P.POSITION=[O.2,0.2,O.8.0.9] ; or system variable !P
;coord. of lower Jeft + upper right corner!

- Multiple plots in one display window

```
!P.MULTI=[O.3,2]
                ; IP.MULTI(1)=3:        3 columns
                ; !P.MULTI(2)=2:        2 rows
 ...                          ;create some plots

!P.MULTI=O                   ; reset
```

• PLOTTING in 3D space, example:

SURFACE.DIST(40),/NODATA,/SAVE

; /SAVE: save 3d to 2d-transformation matrix

; /NODATA don't plot dummy data

PLOT. x_vec. y_vec. /T3D.ZVALUE=1.0./NOERASE

; /T3D : use transformation matrix !P.T to create a planar plot at ZVALUE= 1.0 (norm. coord.)

- IDL library routines for setting up

  a transformation matrix similar to SURFACE

SURFR, AX=45
PLOT. x_vec . y_vec. CHARSIZE=2./T3d
; ZVALUE=O default !

- Change your 3D coordinate system with T3D

  T3D, / YZEXCH ;exchange *y* and *z* axis
  PLOT, x_vec. y_vec./T3D./NOERASE.ZVALUE=1
  exchange of x and *y* with keyword !XYEXCH ,
  exchange of x and *z* with keyword !XZEXCH

- library routine to plot *z=f(x,y)* in a 3d box:
  plot_3dbox, x_vec, y_vec, (x_vec+y_vec). $
  /XI_plane, /yz_plane

- LIVE_PLOT: Interactiv tool created with the IDL object graphics system:

;example: plot with 2 (or more) curves

x-FINDGEN(200)

LIVE_PLOT, sin(x/10), cos(x/20) ;select objects and ;open the properties dialogs

yNew = 0.01. x. sin(x/10) ;add another curve:

LIVE_OPlOT, yNew

;;add other graphics objects. e.g. live_text. ‘Live_Tool Test'

(wg_livetest.pro)