ÖGOR Summer-Workshop for PhD-candidates and Post-Docs

An introduction to Julia and JuMP for Operations Research

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Topic 2

Some basics


The journey of a thousand miles begins with a single step.
Lao Tzu

How to assign a value to a variable (1/2)...

Integer (Int8, Int16, Int32, Int64):

```
julia> zipcode = 44000
```

44000 is an integer literal

Float (Float16, Float32, Float64):

```
julia> price = 29.95
```

29.95 is a floating point literal

Boolean:

```
julia> positive = true
```

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How to assign a value to a variable (2/2)...

Character:

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julia> dot = '.'
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String:

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julia> sentence = "."
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Name of variables

Julia manages the unicode characters.

Exemples of valid names for a variable :

- greek letters:

```
\Delta + [TAB]
```

- an emoji:

```
\:smile:  + [TAB]
```

- etc.

(see `https://docs.julialang.org/en/v1/manual/unicode-input/`)

How to get the type of an expression...

Definition:

```
typeof(...)
```

Example:

```
julia> typeof(zipcode)
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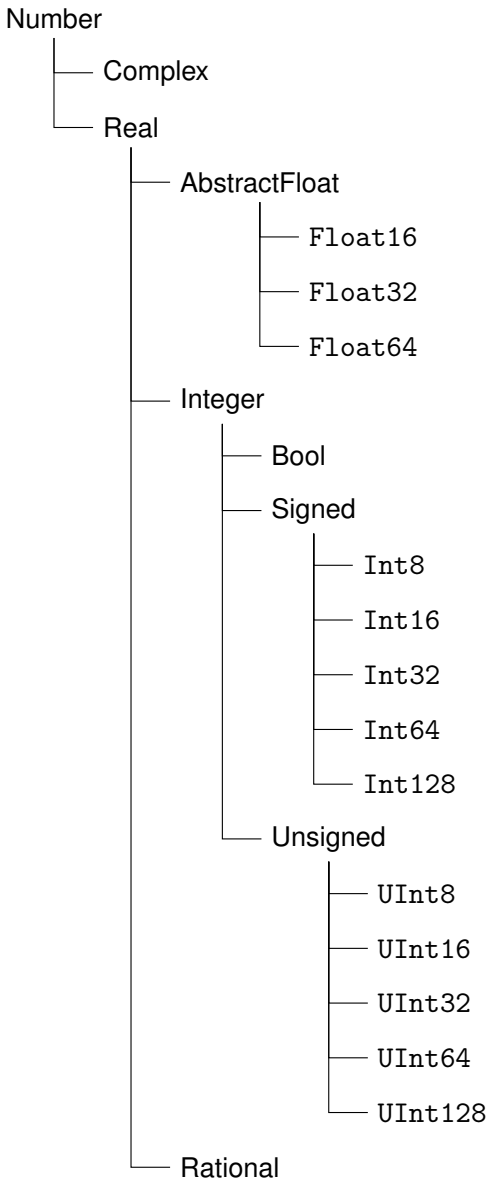
Partial hierarchy of types for numbers



For a type T,

Function	*Definition*
supertypef(T)	parent type
subtypes(T)	child type(s)

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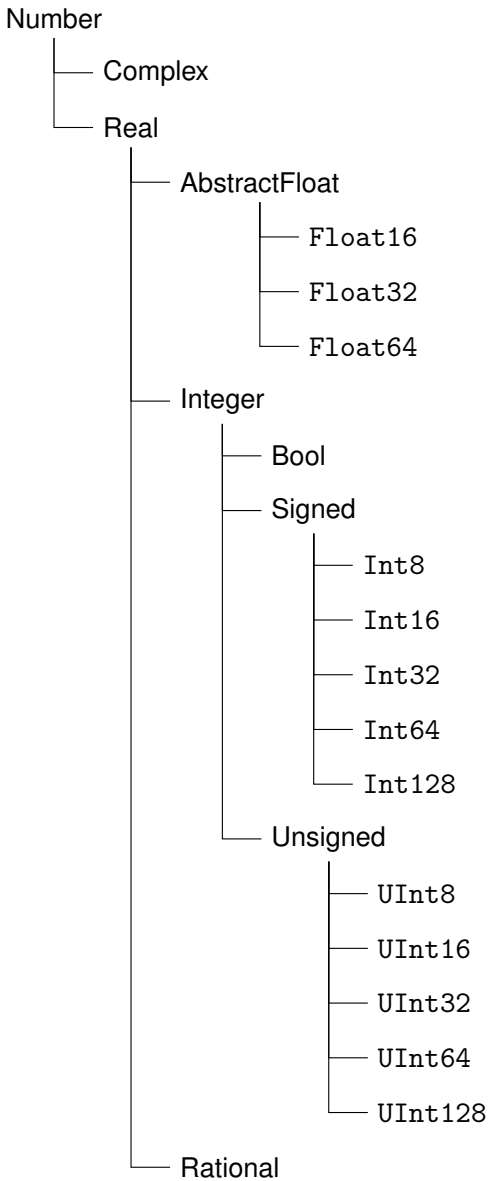

For a type T,

Function	*Definition*
supertypef(T)	parent type
subtypes(T)	child type(s)

Integer and floating point numbers

For a type T,

Function	*Definition*
sizeof(T)	number of bytes used to represent a value of this type
typemax(T)	largest value for this type
typemin(T)	smallest value for this type

Example:

T	*Signed?*	*sizeof(T)*	*typemin(T)*	*typemax(T)*
Int16	yes	2	$-2^{15} = -32768$	$2^{15} - 1 = 32767$

Constants

Definition:

```
const variable = value
```

Example:

```
julia> const g = 9.81
```

Some predefined symbolic constants:

`pi`	or	π	value of pi
`Inf`			positive infinity of type Float64
`NaN`			not a number

How to print (1/3)...

Display without carriage return:

```
print(...)
```

Display with carriage return:

```
println(...)
```

Examples:

```
julia> print(price)
julia> println()
julia> println(zipcode)
```

```
julia> println("Zip Code:  ", zipcode)
julia> println(zipcode, " | ", price, "€ ", dot)
julia> println("Zip Code:  $zipcode")
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How to print (2/3)...

Display in c-like style:

```
@printf(...)
```

Example:

```
julia> using Printf
```

```
julia> @printf("Zip Code:  %d \n",zipcode)
julia> @printf("π = %.2f \n", pi)
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Display an expression and result:

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@show ...
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Get input from users (1/3)...

Read a line of text from from the console (STDIN) until a [NEWLINE]:

```
readline()
```

Example:

```
julia> name = readline()
```

The type of `name`, obtained with `typeof(name)`, is `string`.

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Get input from users (2/3)...

Read numerical data types from console:

```
parse()
```

...convert a numeric string (Float or Int) into a numerical value.

Example:

```
julia> num = parse(Int64, readline())
```

The type of `num`, obtained with `typeof(num)`, is `Int64`.

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Read N lines of text input from the console:

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N lines are stored as the entries of a one-dimensional String array.
Lines must be delimited with [NEWLINE] or by pressing [ENTER].
[Ctrl-D] to stop taking input.

Example:

```
julia> lines = readlines()
```

See also `TerminalMenus` for simple interactive menus in the terminal (an example is given in the project).

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How to write a comment...

Definition:

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# ...
```

```
#= ...  =#
```

Example:

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julia> # this is a line comment
```

```
julia> #= And this
       is a block of comment
       =#
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How to do basic math...

Arithmetic operators

With `a` and `b`, two variables:

Operator	*Expression*	*Name*
`-`	`-a`	unary minus
`+`	`a + b`	sum
`-`	`a - b`	difference
`*`	`a * b`	product
`/`	`a / b`	quotient
`^`	`a ^ b`	power
`÷`	`a ÷ b`	integer divide
`%`	`a % b`	modulus

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How to do basic math...

Updating operators

With `a` and `b`, two variables:

Operator	*example*	*equivalent to*
`+=`	`a+=b`	`a=a+b`
`-=`	`a-=b`	`a=a-b`
`*=`	`a*=b`	`a=a*b`
`/=`	`a/=b`	`a=a/b`
`^=`	`a^=b`	`a=a^b`
`÷=`	`a÷=b`	`a=a÷b`
`%=`	`a%=b`	`a=a%b`

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`÷=`	`a÷=b`	`a=a÷b`
`%=`	`a%=b`	`a=a%b`

How to do basic math...

Numeric comparisons operators

With `a` and `b`, two variables:

Operator	*Expression*	*Name*
`==`	`a == b`	equality
`!=` or $\neq$	`a != b`	inequality
`<`	`a < b`	less than
`<=` or $\leqslant$	`a <= b`	less than or equal to
`>`	`a > b`	greater than
`>=` or $\geqslant$	`a >= b`	greater than or equal to

A selection of usual functions available (1/4)

Arithmetic functions

With `x` and `y`, two variables; `n` and `p`, two integer variables:

Function	*Description*
`div(x,y)`	truncated division; quotient rounded towards zero
`mod(x,y)`	modulus
`abs(x)`	a positive value with the magnitude of x
`sign(x)`	indicates the sign of x, returning -1, 0, or +1
`sqrt(x)`	square root of x
`exp(x)`	e^x
`exp2(x)`	2^x
`log(x)`	natural logarithm of x
`log(b,x)`	base b logarithm of x
`factorial(n)`	$n!$
`binomial(n,p)`	the binomial coefficient

A selection of usual functions available (2/4)

Rounding functions

With `x`, a variable and `T`, a numeric type:

Function	*Description*	*Return type*
`round(x)`	round x to the nearest integer	`typeof(x)`
`round(T,x)`	round x to the nearest integer	`T`
`round(x,digits=n)`	round to n digits after the decimal place	`typeof(x)`
`floor(x)`	round x towards -Inf	`typeof(x)`
`floor(T,x)`	round x towards -Inf	`T`
`ceil(x)`	round x towards +Inf	`typeof(x)`
`ceil(T,x)`	round x towards +Inf	`T`
`trunc(x)`	round x towards zero	`typeof(x)`
`trunc(T,x)`	round x towards zero	`T`

A selection of usual functions available (3/4)

Trigonometric functions

With `x`, a variable:

Function	*Description*
`sin(x)`	Compute sine of x, where x is in radians
`cos(x)`	Compute cosine of x, where x is in radians
`tan(x)`	Compute tangent of x, where x is in radians
`sind(x)`	Compute sine of x, where x is in degrees
`cosd(x)`	Compute cosine of x, where x is in degrees
`tand(x)`	Compute tangent of x, where x is in degrees
`deg2rad(x)`	Convert x from degrees to radians
`rad2deg(x)`	Convert x from radians to degrees

A selection of usual functions available (4/4)

functions on strings

With `c`, a character, `s`,`s2`, strings, :

Function	*Description*
`reverse(s)`	Reverse a string
`occursin(c,s)`	Determine if `c` is a substring of `s`
`split(s,c)`	Split `s` into an array of substrings on occurrences of `c`
`endswith(s,s2)`	Return true if `s` ends with `s2`
`uppercase(s)`	Return `s` with all characters converted to uppercase
`textwidth(s)`	Give the number of columns needed to print `s`
`isdigit(c)`	Test if `c` is a decimal digit (0-9)
`isletter(c)`	Test if `c` is a letter

At this stage, julia is a super calculator

Review and exercises

(notebook)