Modul:Math

Vorlage:For This module provides a number of mathematical functions. These functions can be used from #invoke or from other Lua modules.

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Use from other Lua modules

To use the module from normal wiki pages, no special preparation is needed. If you are using the module from another Lua module, first you need to load it, like this:

```
local mm = require('Module:Math')
```

(The `mm` variable stands for **M**odule **M**ath; you can choose something more descriptive if you prefer.)

Most functions in the module have a version for Lua and a version for #invoke. It is possible to use the #invoke functions from other Lua modules, but using the Lua functions has the advantage that you do not need to access a Lua frame object. Lua functions are preceded by `_`, whereas #invoke functions are not.

random

Vorlage:See also

```
{{#invoke:math|random}}
{{#invoke:math|random|max_value}}
{{#invoke:math|random|min_value|max_value}}
```

```
mm._random()
mm._random(max_value)
mm._random(min_value, max_value)
```

Generates a random number.

- If no arguments are specified, the number produced is greater than or equal to 0 and less than 1.
- If one argument is provided, the number produced is an integer between 1 and that argument. The argument must be a positive integer.
- If two arguments are provided, the number produced is an integer between the first and second arguments. Both arguments must be integers, but can be negative.

This function will not work properly for numbers less than -2^{32} and greater than $2^{32} - 1$. If you need to use numbers outside of this range, it is recommended that you use Module:Random.

order

```
{{#invoke:math|order|n}}
```

```
mm._order(n)
```

Determines the order of magnitude of a number.

precision

```
{{#invoke:math|precision|n}}
{{#invoke:math|precision|x=n}}
```

```
mm._precision(number_string)
```

Detemines the precision of a number. For example, for "4" it will return "0", for "4.567" it will return "3", and for "100" it will return "-2".

The function attempts to parse the string representation of the number, and detects whether the number uses E notation. For this reason, when called from Lua, very large numbers or very precise numbers should be directly input as strings to get accurate results. If they are input as numbers, the Lua interpreter will change them to E notation and this function will return the precision of the E notation rather than that of the original number. This is not a problem when the number is called from #invoke, as all input from #invoke is in string format.

max

```
{{#invoke:math|max|v1|v2|v3|...}}
```

```
mm._max(v1, v2, v3, ...)
```

Returns the maximum value from the values specified. Values that cannot be converted to numbers are ignored.

median

```
{{#invoke:math|median|v1|v2|v3|...}}
```

```
mm._median(v1, v2, v3, ...)
```

Returns the median value from the values specified. Values that cannot be converted to numbers are ignored.

min

```
{{#invoke:math|min|v1|v2|v3|...}}
```

```
mm._min(v1, v2, v3, ...)
```

Returns the minimum value from the values specified. Values that cannot be converted to numbers are ignored.

sum

```
{{#invoke:math|sum|v1|v2|v3|...}}
```

```
mm._sum(v1, v2, v3, ...)
```

Returns the sum of the values specified. Values that cannot be converted to numbers are ignored.

average

```
{{#invoke:math|average|v1|v2|v3|...}}
```

```
mm._average(v1, v2, v3, ...)
```

Returns the average of the values specified. (More precisely, the value returned is the arithmetic mean.) Values that cannot be converted to numbers are ignored.

round

```
{{#invoke:math|round|value|precision}}
{{#invoke:math|round|value=value|precision=precision}}
```

```
mm._round(value, precision)
```

Rounds a number to the specified precision.

Note: As of October 2019, there is a bug in the display of some rounded numbers. When trying to round a number that rounds to "n.0", like "1.02", to the nearest tenth of a digit (i.e. Vorlage:Para), this function should display "1.0", but it unexpectedly displays "1". Use the Vorlage:Para parameter instead.

log10

```
{{#invoke:math | log10 | x}}
```

```
mm._log10(x)
```

Returns $\log_{10}(x)$, the logarithm of x using base 10.

mod

```
{{#invoke:math|mod|x|y}}
```

```
mm._mod(x, y)
```

Gets *x* modulo *y*, or the remainder after *x* has been divided by *y*. This is accurate for integers up to 2^{53}; for larger integers Lua's modulo operator may return an erroneous value. This function deals with this problem by returning `0` if the modulo given by Lua's modulo operator is less than 0 or greater than *y*.

gcd

```
{{#invoke:math|gcd|v1|v2|...}}
```

```
mm._gcd(v1, v2, ...)
```

Finds the greatest common divisor of the values specified. Values that cannot be converted to numbers are ignored.

precision_format

```
{{#invoke:math|precision_format|value_string|precision}}
```

```
mm._precision_format(value_string, precision)
```

Rounds a number to the specified precision and formats according to rules originally used for Vorlage:Tl. Output is a string.

Parameter *precision* should be an integer number of digits after the decimal point. Negative values are permitted. Non-integers give unexpected results. Positive values greater than the input precision add zero-padding, negative values greater than the input order can consume all digits.

Formatting 8,765.567 with Vorlage:Tlc gives:

precision	Result
2	8.765,57
-2	8.800
6	8.765,567000
-6	0
2.5	8.765,568042663 3
-2.5	8.854,377448471 5

divide

```
{{#invoke:Math|divide|x|y|round=|precision=}}
```

```
mm._divide(x, y, round, precision)
```

Divide x by y.

- If y if not a number, it is returned.
- Otherwise, if x is not a number, it is returned.
- If round is true ("yes" for #invoke), the result has no decimals
- Precision indicates how many digits of precision the result should have

If any of the arguments contain HTML tags, they are returned unchanged, allowing any errors in calculating the arguments to the division function to be propagated to the calling template.

cleanNumber

```
local number, number_string = mm._cleanNumber(number_string)
```

A helper function that can be called from other Lua modules, but not from #invoke. This takes a string or a number value as input, and if the value can be converted to a number, cleanNumber returns the number and the number string. If the value cannot be converted to a number, cleanNumber returns `nil, nil`.

See also

Vorlage:Math templates

```
--[[

This module provides a number of basic mathematical operations.

]]

local yesno, getArgs -- lazily initialized

local p = {} -- Holds functions to be returned from #invoke, and functions to mak
local wrap = {} -- Holds wrapper functions that process arguments from #invoke. T

--[[
Helper functions used to avoid redundant code.
]]

local function err(msg)
        -- Generates wikitext error messages.
        return mw.ustring.format('<strong class="error">Formatting error: %s</str
end
```

```
local function unpackNumberArgs(args)
	-- Returns an unpacked list of arguments specified with numerical keys.
	local ret = {}
	for k, v in pairs(args) do
		if type(k) == 'number' then
			table.insert(ret, v)
		end
	end
	return unpack(ret)
end

local function makeArgArray(...)
	-- Makes an array of arguments from a list of arguments that might inclu
	local args = {...} -- Table of arguments. It might contain nils or non-nu
	local nums = {} -- Stores the numbers of valid numerical arguments.
	local ret = {}
	for k, v in pairs(args) do
		v = p._cleanNumber(v)
		if v then
			nums[#nums + 1] = k
			args[k] = v
		end
	end
	table.sort(nums)
	for i, num in ipairs(nums) do
		ret[#ret + 1] = args[num]
	end
	return ret
end

local function fold(func, ...)
	-- Use a function on all supplied arguments, and return the result. The f
	-- and must return a number as an output. This number is then supplied as
	local vals = makeArgArray(...)
	local count = #vals -- The number of valid arguments
	if count == 0 then return
		-- Exit if we have no valid args, otherwise removing the first ar
		nil, 0
	end
	local ret = table.remove(vals, 1)
	for _, val in ipairs(vals) do
		ret = func(ret, val)
	end
	return ret, count
end

--[[
Fold arguments by selectively choosing values (func should return when to choose
]]
local function binary_fold(func, ...)
	local value = fold((function(a, b) if func(a, b) then return a else retur
	return value
end

--[[
random

Generate a random number

Usage:
{{#invoke: Math | random }}
{{#invoke: Math | random | maximum value }}
{{#invoke: Math | random | minimum value | maximum value }}
]]
```

```
function wrap.random(args)
	local first = p._cleanNumber(args[1])
	local second = p._cleanNumber(args[2])
	return p._random(first, second)
end

function p._random(first, second)
	math.randomseed(mw.site.stats.edits + mw.site.stats.pages + os.time() + m
	-- math.random will throw an error if given an explicit nil parameter, so
	if first and second then
		if first <= second then -- math.random doesn't allow the first nu
			return math.random(first, second)
		end
	elseif first then
		return math.random(first)
	else
		return math.random()
	end
end

--[[
order

Determine order of magnitude of a number

Usage:
{{#invoke: Math | order | value }}
]]

function wrap.order(args)
	local input_string = (args[1] or args.x or '0');
	local input_number = p._cleanNumber(input_string);
	if input_number == nil then
		return err('order of magnitude input appears non-numeric')
	else
		return p._order(input_number)
	end
end

function p._order(x)
	if x == 0 then return 0 end
	return math.floor(math.log10(math.abs(x)))
end

--[[
precision

Detemines the precision of a number using the string representation

Usage:
{{ #invoke: Math | precision | value }}
]]

function wrap.precision(args)
	local input_string = (args[1] or args.x or '0');
	local trap_fraction = args.check_fraction;
	local input_number;

	if not yesno then
		yesno = require('Module:Yesno')
	end
	if yesno(trap_fraction, true) then -- Returns true for all input except r
		local pos = string.find(input_string, '/', 1, true);
```

```
                if pos ~= nil then
                        if string.find(input_string, '/', pos + 1, true) == nil t
                                local denominator = string.sub(input_string, pos+
                                local denom_value = tonumber(denominator);
                                if denom_value ~= nil then
                                        return math.log10(denom_value);
                                end
                        end
                end
        end

        input_number, input_string = p._cleanNumber(input_string);
        if input_string == nil then
                return err('precision input appears non-numeric')
        else
                return p._precision(input_string)
        end
end

function p._precision(x)
        if type(x) == 'number' then
                x = tostring(x)
        end
        x = string.upper(x)

        local decimal = x:find('%.')
        local exponent_pos = x:find('E')
        local result = 0;

        if exponent_pos ~= nil then
                local exponent = string.sub(x, exponent_pos + 1)
                x = string.sub(x, 1, exponent_pos - 1)
                result = result - tonumber(exponent)
        end

        if decimal ~= nil then
                result = result + string.len(x) - decimal
                return result
        end

        local pos = string.len(x);
        while x:byte(pos) == string.byte('0') do
                pos = pos - 1
                result = result - 1
                if pos <= 0 then
                        return 0
                end
        end

        return result
end


--[[
max

Finds the maximum argument

Usage:
{{#invoke:Math| max | value1 | value2 | ... }}

Note, any values that do not evaluate to numbers are ignored.
]]
```

```
function wrap.max(args)
	return p._max(unpackNumberArgs(args))
end

function p._max(...)
	local max_value = binary_fold((function(a, b) return a > b end), ...)
	if max_value then
		return max_value
	end
end

--[[
median

Find the median of set of numbers

Usage:
{{#invoke:Math | median | number1 | number2 | ...}}
OR
{{#invoke:Math | median }}
]]

function wrap.median(args)
	return p._median(unpackNumberArgs(args))
end

function p._median(...)
	local vals = makeArgArray(...)
	local count = #vals
	table.sort(vals)

	if count == 0 then
		return 0
	end

	if p._mod(count, 2) == 0 then
		return (vals[count/2] + vals[count/2+1])/2
	else
		return vals[math.ceil(count/2)]
	end
end

--[[
min

Finds the minimum argument

Usage:
{{#invoke:Math| min | value1 | value2 | ... }}
OR
{{#invoke:Math| min }}

When used with no arguments, it takes its input from the parent
frame.  Note, any values that do not evaluate to numbers are ignored.
]]

function wrap.min(args)
	return p._min(unpackNumberArgs(args))
end

function p._min(...)
	local min_value = binary_fold((function(a, b) return a < b end), ...)
	if min_value then
		return min_value
```

```
        end
end

--[[
sum

Finds the sum

Usage:
{{#invoke:Math| sum | value1 | value2 | ... }}
OR
{{#invoke:Math| sum }}

Note, any values that do not evaluate to numbers are ignored.
]]

function wrap.sum(args)
        return p._sum(unpackNumberArgs(args))
end

function p._sum(...)
        local sums, count = fold((function(a, b) return a + b end), ...)
        if not sums then
                return 0
        else
                return sums
        end
end

--[[
average

Finds the average

Usage:
{{#invoke:Math| average | value1 | value2 | ... }}
OR
{{#invoke:Math| average }}

Note, any values that do not evaluate to numbers are ignored.
]]

function wrap.average(args)
        return p._average(unpackNumberArgs(args))
end

function p._average(...)
        local sum, count = fold((function(a, b) return a + b end), ...)
        if not sum then
                return 0
        else
                return sum / count
        end
end

--[[
round

Rounds a number to specified precision

Usage:
{{#invoke:Math | round | value | precision }}

--]]
```

```
function wrap.round(args)
	local value = p._cleanNumber(args[1] or args.value or 0)
	local precision = p._cleanNumber(args[2] or args.precision or 0)
	if value == nil or precision == nil then
		return err('round input appears non-numeric')
	else
		return p._round(value, precision)
	end
end

function p._round(value, precision)
	local rescale = math.pow(10, precision or 0);
	return math.floor(value * rescale + 0.5) / rescale;
end

--[[
log10

returns the log (base 10) of a number

Usage:
{{#invoke:Math | log10 | x }}
]]

function wrap.log10(args)
	return math.log10(args[1])
end

--[[
mod

Implements the modulo operator

Usage:
{{#invoke:Math | mod | x | y }}

--]]

function wrap.mod(args)
	local x = p._cleanNumber(args[1])
	local y = p._cleanNumber(args[2])
	if not x then
		return err('first argument to mod appears non-numeric')
	elseif not y then
		return err('second argument to mod appears non-numeric')
	else
		return p._mod(x, y)
	end
end

function p._mod(x, y)
	local ret = x % y
	if not (0 <= ret and ret < y) then
		ret = 0
	end
	return ret
end

--[[
gcd

Calculates the greatest common divisor of multiple numbers
```

```
Usage:
{{#invoke:Math | gcd | value 1 | value 2 | value 3 | ... }}
--]]

function wrap.gcd(args)
	return p._gcd(unpackNumberArgs(args))
end

function p._gcd(...)
	local function findGcd(a, b)
		local r = b
		local oldr = a
		while r ~= 0 do
			local quotient = math.floor(oldr / r)
			oldr, r = r, oldr - quotient * r
		end
		if oldr < 0 then
			oldr = oldr * -1
		end
		return oldr
	end
	local result, count = fold(findGcd, ...)
	return result
end

--[[
precision_format

Rounds a number to the specified precision and formats according to rules
originally used for {{template:Rnd}}.  Output is a string.

Usage:
{{#invoke: Math | precision_format | number | precision }}
]]

function wrap.precision_format(args)
	local value_string = args[1] or 0
	local precision = args[2] or 0
	return p._precision_format(value_string, precision)
end

function p._precision_format(value_string, precision)
	-- For access to Mediawiki built-in formatter.
	local lang = mw.getContentLanguage();

	local value
	value, value_string = p._cleanNumber(value_string)
	precision = p._cleanNumber(precision)

	-- Check for non-numeric input
	if value == nil or precision == nil then
		return err('invalid input when rounding')
	end

	local current_precision = p._precision(value)
	local order = p._order(value)

	-- Due to round-off effects it is neccesary to limit the returned precisi
	-- some circumstances because the terminal digits will be inaccurately re
	if order + precision >= 14 then
		if order + p._precision(value_string) >= 14 then
			precision = 13 - order;
		end
	end
```

```
	-- If rounding off, truncate extra digits
	if precision < current_precision then
		value = p._round(value, precision)
		current_precision = p._precision(value)
	end

	local formatted_num = lang:formatNum(math.abs(value))
	local sign

	-- Use proper unary minus sign rather than ASCII default
	if value < 0 then
		sign = '−'
	else
		sign = ''
	end

	-- Handle cases requiring scientific notation
	if string.find(formatted_num, 'E', 1, true) ~= nil or math.abs(order) >=
		value = value * math.pow(10, -order)
		current_precision = current_precision + order
		precision = precision + order
		formatted_num = lang:formatNum(math.abs(value))
	else
		order = 0;
	end
	formatted_num = sign .. formatted_num

	-- Pad with zeros, if needed
	if current_precision < precision then
		local padding
		if current_precision <= 0 then
			if precision > 0 then
				local zero_sep = lang:formatNum(1.1)
				formatted_num = formatted_num .. zero_sep:sub(2,2

				padding = precision
				if padding > 20 then
					padding = 20
				end

				formatted_num = formatted_num .. string.rep('0',
			end
		else
			padding = precision - current_precision
			if padding > 20 then
				padding = 20
			end
			formatted_num = formatted_num .. string.rep('0', padding)
		end
	end

	-- Add exponential notation, if necessary.
	if order ~= 0 then
		-- Use proper unary minus sign rather than ASCII default
		if order < 0 then
			order = '−' .. lang:formatNum(math.abs(order))
		else
			order = lang:formatNum(order)
		end

		formatted_num = formatted_num .. '<span style="margin:0 .15em 0
	end
```

```
        return formatted_num
end

--[[
divide

Implements the division operator

Usage:
{{#invoke:Math | divide | x | y | round= | precision= }}

--]]
function wrap.divide(args)
        local x = args[1]
        local y = args[2]
        local round = args.round
        local precision =  args.precision
        if not yesno then
                yesno = require('Module:Yesno')
        end
        return p._divide(x, y, yesno(round), precision)
end

function p._divide(x, y, round, precision)
        if y == nil or y == "" then
                return err("Empty divisor")
        elseif not tonumber(y) then
                if type(y) == 'string' and string.sub(y, 1, 1) == '<' then
                        return y
                else
                        return err("Not a number: " .. y)
                end
        elseif x == nil or x == "" then
                return err("Empty dividend")
        elseif not tonumber(x) then
                if type(x) == 'string' and string.sub(x, 1, 1) == '<' then
                        return x
                else
                        return err("Not a number: " .. x)
                end
        else
                local z = x / y
                if round then
                        return p._round(z, 0)
                elseif precision then
                        return p._round(z, precision)
                else
                        return z
                end
        end
end

--[[
Helper function that interprets the input numerically.  If the
input does not appear to be a number, attempts evaluating it as
a parser functions expression.
]]

function p._cleanNumber(number_string)
        if type(number_string) == 'number' then
                -- We were passed a number, so we don't need to do any processing
                return number_string, tostring(number_string)
        elseif type(number_string) ~= 'string' or not number_string:find('%S') th
                -- We were passed a non-string or a blank string, so exit.
```

```
                return nil, nil;
        end

        -- Attempt basic conversion
        local number = tonumber(number_string)

        -- If failed, attempt to evaluate input as an expression
        if number == nil then
                local success, result = pcall(mw.ext.ParserFunctions.expr, numbe
                if success then
                        number = tonumber(result)
                        number_string = tostring(number)
                else
                        number = nil
                        number_string = nil
                end
        else
                number_string = number_string:match("^%s*(.-)%s*$") -- String is
                number_string = number_string:match("^%+(.*)$") or number_string
                if number_string:find('^%-?0[xX]') then
                        -- Number is using 0xnnn notation to indicate base 16; us
                        number_string = tostring(number)
                end
        end

        return number, number_string
end

--[[
Wrapper function that does basic argument processing. This ensures that all funct
frame or the parent frame, and it also trims whitespace for all arguments and rem
]]

local mt = { __index = function(t, k)
        return function(frame)
                if not getArgs then
                        getArgs = require('Module:Arguments').getArgs
                end
                return wrap[k](getArgs(frame))  -- Argument processing is left to
        end
end }

return setmetatable(p, mt)
```