The luamplib package

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Abstract

Package to have metapost code typeset directly in a document with LuaTEX.

1 Documentation

This packages aims at providing a simple way to typeset directly metapost code in a document with LuaTEX. LuaTEX is built with the lua `mplib` library, that runs metapost code. This package is basically a wrapper (in Lua) for the Lua `mplib` functions and some TEX functions to have the output of the `mplib` functions in the pdf.

The package needs to be in PDF mode in order to output something, as PDF specials are not supported by the DVI format and tools.

The metapost figures are put in a TEX `hbox` with dimensions adjusted to the metapost code.

Using this package is easy: in Plain, type your metapost code between the macros `\mplibcode` and `\endmplibcode`, and in LATEX in the `mplibcode` environment.

The code is from the `luatex-mplib.lua` and `luatex-mplib.tex` files from ConTEXt, they have been adapted to LATEX and Plain by Elie Roux and Philipp Gesang, new functionalities have been added by Kim Dohyun. The changes are:

- a LATEX environment
- all TEX macros start by `mplib`
- use of luatexbase for errors, warnings and declaration
- possibility to use `btex ... etex` to typeset TEX code. `textext()` is a more versatile macro equivalent to `TEX()` from TEX.mp. `TEX()` is also allowed unless TEX.mp is loaded, which should be always avoided.

  N.B. Since v2.5, `btex ... etex` input from external `mp` files will also be processed by luamplib. However, `verbatimtex ... etex` will be entirely ignored in this case.

- `verbatimtex ... etex` (in TEX file) that comes just before `beginfig()` is not ignored, but the TEX code inbetween will be inserted before the following mplib

hbox. Using this command, each mplib box can be freely moved horizontally and/or vertically. Also, a box number might be assigned to mplib box, allowing it to be reused later (see test files). All other `verbatimtex ... etex`'s are ignored. *E.G.*

```
\mplibcode
verbatimtex \moveright 3cm etex; beginfig(0); ... endfig;
verbatimtex \leavevmode etex; beginfig(1); ... endfig;
verbatimtex \leavevmode\lower 1ex etex; beginfig(2); ... endfig;
verbatimtex \endgraf\moveright 1cm etex; beginfig(3); ... endfig;
\endmplibcode
```

N.B. `\endgraf` should be used instead of `\par` inside `verbatimtex ... etex`.

- Notice that, after each figure is processed, macro `\MPwidth` stores the width value of latest figure; `\MPheight`, the height value.
- Since v2.3, new macros `\everymplib` and `\everyendmplib` redefine token lists `\everymplibtoks` and `\everyendmplibtoks` respectively, which will be automatically inserted at the beginning and ending of each mplib code. *E.G.*

```
\everymplib{ verbatimtex \leavevmode etex; beginfig(0); }
\everyendmplib{ endfig; }
\mplibcode % beginfig/endfig not needed; always in horizontal mode
  draw fullcircle scaled 1cm;
\endmplibcode
```

N.B. Many users have complained that mplib figures do not respect alignment commands such as `\centering` or `\raggedleft`. That's because luamplib does not force horizontal or vertical mode. If you want all mplib figures center- (or right-) aligned, please use `\everymplib` command with `\leavevmode` as shown above.

- Since v2.3, `\mpdim` and other raw TEX commands are allowed inside mplib code. This feature is inpired by gmp.sty authored by Enrico Gregorio. Please refer the manual of gmp package for details. *E.G.*

```
\begin{mplibcode}
  draw origin--(\mpdim{\linewidth},0) withpen pencircle scaled 4
  dashed evenly scaled 4 withcolor \myrulecolor;
\end{mplibcode}
```

N.B. Users should not use the protected variant of `btex ... etex` as provided by gmp package. As luamplib automatically protects TEX code inbetween, `\btex` is not supported here.

- Users can choose `numbersystem` option since v2.4. The default value `scaled` can be changed to `double` by declaring `\mplibnumbersystem{double}`. For details see http://github.com/lualatex/luamplib/issues/21.

There are (basically) two formats for metapost: *plain* and *metafun*. By default, the *plain* format is used, but you can set the format to be used by future figures at any time using `\mplibsetformat{`⟨*format name*⟩`}`.

2 Implementation

2.1 Lua module

Use the `luamplib` namespace, since `mplib` is for the metapost library itself. ConTEXt uses `metapost`.

```
luamplib          = luamplib or { }
```

Identification.

```
local luamplib    = luamplib
luamplib.showlog  = luamplib.showlog or false
luamplib.lastlog  = ""

local err, warn, info, log = luatexbase.provides_module({
    name          = "luamplib",
    version       = "2.5.1",
    date          = "2014/02/19",
    description   = "Lua package to typeset Metapost with LuaTeX's MPLib.",
})
```

This module is a stripped down version of libraries that are used by ConTEXt. Provide a few "shortcuts" expected by the imported code.

```
local format, abs = string.format, math.abs

local stringgsub    = string.gsub
local stringfind    = string.find
local stringmatch   = string.match
local stringgmatch  = string.gmatch
local tableconcat   = table.concat
local texsprint     = tex.sprint

local mplib = require ('mplib')
local kpse  = require ('kpse')
```

```
local file = file
if not file then

```

This is a small trick for LaTeX. In LaTeX we read the metapost code line by line, but it needs to be passed entirely to `process()`, so we simply add the lines in `data` and at the end we call `process(data)`.

A few helpers, taken from `l-file.lua`.

```

 file = { }

 function file.replacesuffix(filename, suffix)
     return (stringgsub(filename,"%.[%a%d]+$","")) .. "." .. suffix
 end

 function file.stripsuffix(filename)
     return (stringgsub(filename,"%.[%a%d]+$",""))
 end
end

```

`btex ... etex` in input .mp files will be replaced in finder.

```
local mpreplacedabove = {}

local function replaceinputmpfile (file)
    local fh = io.open(file,"r")
    if not fh then return file end
    local data = fh:read("*all"); fh:close()
    data = stringgsub(data, "\".-\"",
        function(str)
            str = stringgsub(str,"%%","*****PERCENT*****")
            str = stringgsub(str,"([bm])tex%f[^A-Z_a-z]","%1***T***E***X***")
            return str
        end)
    data = stringgsub(data,"%%.-\n","")
    local count,cnt = 0,0
    data,cnt = stringgsub(data,
        "%f[A-Z_a-z]btex%f[^A-Z_a-z]%s*(.-)%s*%f[A-Z_a-z]etex%f[^A-Z_a-z]",
        function(str)
            str = stringgsub(str,"[\n\r]%s*"," ")
            str = stringgsub(str,'"','"&ditto&"')
            return format("rawtextext(\"%s\")",str)
        end)
    count = count + cnt
    data,cnt = stringgsub(data,
        "%f[A-Z_a-z]verbatimtex%f[^A-Z_a-z]%s*(.-)%s*%f[A-Z_a-z]etex%f[^A-Z_a-z]",
        "")
    count = count + cnt
    if count == 0 then
        mpreplacedabove[file] = file
```

```
        return file
    end
    data = stringgsub(data,"([bm])***T***E***X***","%1tex")
    data = stringgsub(data,"*****PERCENT*****","%%")
    local newfile = stringgsub(file,".*/","luamplib_input_")
    fh = io.open(newfile,"w")
    if not fh then return file end
    fh:write(data); fh:close()
    mpreplacedabove[file] = newfile
    return newfile
end

local noneedtoreplace = {
    ["boxes.mp"] = true,
    ["format.mp"] = true,
    ["graph.mp"] = true,
    ["marith.mp"] = true,
    ["mfplain.mp"] = true,
    ["mpost.mp"] = true,
    ["plain.mp"] = true,
    ["rboxes.mp"] = true,
    ["sarith.mp"] = true,
    ["string.mp"] = true,
    ["TEX.mp"] = true,
    ["metafun.mp"] = true,
    ["metafun.mpiv"] = true,
    ["mp-abck.mpiv"] = true,
    ["mp-apos.mpiv"] = true,
    ["mp-asnc.mpiv"] = true,
    ["mp-base.mpiv"] = true,
    ["mp-butt.mpiv"] = true,
    ["mp-char.mpiv"] = true,
    ["mp-chem.mpiv"] = true,
    ["mp-core.mpiv"] = true,
    ["mp-crop.mpiv"] = true,
    ["mp-figs.mpiv"] = true,
    ["mp-form.mpiv"] = true,
    ["mp-func.mpiv"] = true,
    ["mp-grap.mpiv"] = true,
    ["mp-grid.mpiv"] = true,
    ["mp-grph.mpiv"] = true,
    ["mp-idea.mpiv"] = true,
    ["mp-mlib.mpiv"] = true,
    ["mp-page.mpiv"] = true,
    ["mp-shap.mpiv"] = true,
    ["mp-step.mpiv"] = true,
    ["mp-text.mpiv"] = true,
    ["mp-tool.mpiv"] = true,
}
```

As the finder function for `mplib`, use the `kpse` library and make it behave like as if MetaPost was used (or almost, since the engine name is not set this way—not sure if this is a problem).

```
122
123 local mpkpse = kpse.new("luatex", "mpost")
124
125 local function finder(name, mode, ftype)
126     if mode == "w" then
127         return name
128     else
129         local file = mpkpse:find_file(name,ftype)
130         if file then
131             if ftype ~= "mp" or noneedtoreplace[name] then return file end
132             if mpreplacedabove[file] then return mpreplacedabove[file] end
133             return replaceinputmpfile(file)
134         end
135         return mpkpse:find_file(name,stringmatch(name,"[a-zA-Z]+$"))
136     end
137 end
138 luamplib.finder = finder
139
```

The rest of this module is not documented. More info can be found in the LuaTEX manual, articles in user group journals and the files that ship with ConTEXt.

```
140
141 function luamplib.resetlastlog()
142     luamplib.lastlog = ""
143 end
144
```

Below included is section that defines fallbacks for older versions of mplib.

```
145 local mplibone = tonumber(mplib.version()) <= 1.50
146
147 if mplibone then
148
149     luamplib.make = luamplib.make or function(name,mem_name,dump)
150         local t = os.clock()
151         local mpx = mplib.new {
152             ini_version = true,
153             find_file = luamplib.finder,
154             job_name = file.stripsuffix(name)
155         }
156         mpx:execute(format("input %s ;",name))
157         if dump then
158             mpx:execute("dump ;")
159             info("format %s made and dumped for %s in %0.3f seconds",mem_name,name,os.clock()-t)
160         else
161             info("%s read in %0.3f seconds",name,os.clock()-t)
162         end
```

```
        return mpx
    end

    function luamplib.load(name)
        local mem_name = file.replacesuffix(name,"mem")
        local mpx = mplib.new {
            ini_version = false,
            mem_name = mem_name,
            find_file = luamplib.finder
        }
        if not mpx and type(luamplib.make) == "function" then
            -- when i have time i'll locate the format and dump
            mpx = luamplib.make(name,mem_name)
        end
        if mpx then
            info("using format %s",mem_name,false)
            return mpx, nil
        else
            return nil, { status = 99, error = "out of memory or invalid format" }
        end
    end

else

```

These are the versions called with sufficiently recent mplib.

```

    local preamble = [[
        boolean mplib ; mplib := true ;
        let dump = endinput ;
        let normalfontsize = fontsize;
        input %s ;
    ]]

    luamplib.make = luamplib.make or function()
    end

    function luamplib.load(name)
        mpreplacedabove = {} -- reset
        local mpx = mplib.new {
            ini_version = true,
            find_file = luamplib.finder,
```

Provides `numbersystem` option since v2.4. Default value `"scaled"` can be changed by declaring `\mplibnumbersystem{double}`. See https://github.com/lualatex/luamplib/issues/21.

```
            math_mode = luamplib.numbersystem,
        }
        local result
        if not mpx then
```

```
            result = { status = 99, error = "out of memory"}
        else
            result = mpx:execute(format(preamble, file.replacesuffix(name,"mp")))
        end
        luamplib.reporterror(result)
        return mpx, result
    end

end

local currentformat = "plain"

local function setformat (name) --- used in .sty
    currentformat = name
end
luamplib.setformat = setformat


luamplib.reporterror = function (result)
    if not result then
        err("no result object returned")
    elseif result.status > 0 then
        local t, e, l = result.term, result.error, result.log
        if t then
            info(t)
        end
        if e then
            err(e)
        end
        if not t and not e and l then
            luamplib.lastlog = luamplib.lastlog .. "\n " .. l
            log(l)
        else
            err("unknown, no error, terminal or log messages")
        end
    else
        return false
    end
    return true
end

local function process_indeed (mpx, data)
    local converted, result = false, {}
    local mpx = luamplib.load(mpx)
    if mpx and data then
        local result = mpx:execute(data)
        if not result then
            err("no result object returned")
        elseif result.status > 0 then
            err("%s",(result.term or "no-term") .. "\n" .. (result.error or "no-error"))
```

```
        elseif luamplib.showlog then
            luamplib.lastlog = luamplib.lastlog .. "\n" .. result.term
            info("%s",result.term or "no-term")
        elseif result.fig then
            converted = luamplib.convert(result)
        else
            err("unknown error, maybe no beginfig/endfig")
        end
    else
        err("Mem file unloadable. Maybe generated with a different version of mplib?")
    end
    return converted, result
end
local process = function (data)
    return process_indeed(currentformat, data)
end
luamplib.process = process

local function getobjects(result,figure,f)
    return figure:objects()
end

local function convert(result, flusher)
    luamplib.flush(result, flusher)
    return true -- done
end
luamplib.convert = convert

local function pdf_startfigure(n,llx,lly,urx,ury)
```

The following line has been slightly modified by Kim.

```
    texsprint(format("\\mplibstarttoPDF{%f}{%f}{%f}{%f}",llx,lly,urx,ury))
end

local function pdf_stopfigure()
    texsprint("\\mplibstoptoPDF")
end

local function pdf_literalcode(fmt,...) -- table
    texsprint(format("\\mplibtoPDF{%s}",format(fmt,...)))
end
luamplib.pdf_literalcode = pdf_literalcode

local function pdf_textfigure(font,size,text,width,height,depth)
```

The following three lines have been modified by Kim.

```
    -- if text == "" then text = "\0" end -- char(0) has gone
    text = text:gsub(".",function(c)
        return format("\\hbox{\\char%i}",string.byte(c)) -- kerning happens in meta-
  post
    end)
```

```
    texsprint(format("\\mplibtextext{%s}{%f}{%s}{%s}{%f}",font,size,text,0,-( 7200/ 7227)/65536*depth))
end
luamplib.pdf_textfigure = pdf_textfigure

local bend_tolerance = 131/65536

local rx, sx, sy, ry, tx, ty, divider = 1, 0, 0, 1, 0, 0, 1

local function pen_characteristics(object)
    local t = mplib.pen_info(object)
    rx, ry, sx, sy, tx, ty = t.rx, t.ry, t.sx, t.sy, t.tx, t.ty
    divider = sx*sy - rx*ry
    return not (sx==1 and rx==0 and ry==0 and sy==1 and tx==0 and ty==0), t.width
end

local function concat(px, py) -- no tx, ty here
    return (sy*px-ry*py)/divider,(sx*py-rx*px)/divider
end

local function curved(ith,pth)
    local d = pth.left_x - ith.right_x
    if abs(ith.right_x - ith.x_coord - d) <= bend_tolerance and abs(pth.x_coord - pth.left_x - d) <= be
erance then
        d = pth.left_y - ith.right_y
        if abs(ith.right_y - ith.y_coord - d) <= bend_tolerance and abs(pth.y_co-
ord - pth.left_y - d) <= bend_tolerance then
            return false
        end
    end
    return true
end

local function flushnormalpath(path,open)
    local pth, ith
    for i=1,#path do
        pth = path[i]
        if not ith then
            pdf_literalcode("%f %f m",pth.x_coord,pth.y_coord)
        elseif curved(ith,pth) then
            pdf_literalcode("%f %f %f %f %f %f c",ith.right_x,ith.right_y,pth.left_x,pth.left_y,pth.x_c
        else
            pdf_literalcode("%f %f l",pth.x_coord,pth.y_coord)
        end
        ith = pth
    end
    if not open then
        local one = path[1]
        if curved(pth,one) then
            pdf_literalcode("%f %f %f %f %f %f c",pth.right_x,pth.right_y,one.left_x,one.left_y,one.x_c
        else
```

```
            pdf_literalcode("%f %f l",one.x_coord,one.y_coord)
        end
    elseif #path == 1 then
        -- special case .. draw point
        local one = path[1]
        pdf_literalcode("%f %f l",one.x_coord,one.y_coord)
    end
    return t
end

local function flushconcatpath(path,open)
    pdf_literalcode("%f %f %f %f %f %f cm", sx, rx, ry, sy, tx ,ty)
    local pth, ith
    for i=1,#path do
        pth = path[i]
        if not ith then
           pdf_literalcode("%f %f m",concat(pth.x_coord,pth.y_coord))
        elseif curved(ith,pth) then
            local a, b = concat(ith.right_x,ith.right_y)
            local c, d = concat(pth.left_x,pth.left_y)
            pdf_literalcode("%f %f %f %f %f %f c",a,b,c,d,concat(pth.x_coord, pth.y_co-
ord))
        else
           pdf_literalcode("%f %f l",concat(pth.x_coord, pth.y_coord))
        end
        ith = pth
    end
    if not open then
        local one = path[1]
        if curved(pth,one) then
            local a, b = concat(pth.right_x,pth.right_y)
            local c, d = concat(one.left_x,one.left_y)
            pdf_literalcode("%f %f %f %f %f %f c",a,b,c,d,concat(one.x_coord, one.y_co-
ord))
        else
            pdf_literalcode("%f %f l",concat(one.x_coord,one.y_coord))
        end
    elseif #path == 1 then
        -- special case .. draw point
        local one = path[1]
        pdf_literalcode("%f %f l",concat(one.x_coord,one.y_coord))
    end
    return t
end
```

Below code has been contributed by Dohyun Kim. It implements `btex` / `etex` functions.

v2.1: `textext()` is now available, which is equivalent to `TEX()` macro from TEX.mp. `TEX()` is synonym of `textext()` unless TEX.mp is loaded.

v2.2: Transparency and Shading

v2.3: \everymplib, \everyendmplib, and allows naked TEX commands.

```
local further_split_keys = {
    ["MPlibTEXboxID"] = true,
    ["sh_color_a"]    = true,
    ["sh_color_b"]    = true,
}

local function script2table(s)
    local t = {}
    for i in stringgmatch(s,"[^\13]+") do
        local k,v = stringmatch(i,"(.-)=(.+)") -- v may contain =.
        if k and v then
            local vv = {}
            if further_split_keys[k] then
                for j in stringgmatch(v,"[^:]+") do
                    vv[#vv+1] = j
                end
            end
            if #vv > 0 then
                t[k] = vv
            else
                t[k] = v
            end
        end
    end
    return t
end

local mplibcodepreamble = [[
vardef rawtextext (expr t) =
    if unknown TEXBOX_:
        image( special "MPlibmkTEXbox="&t; )
    else:
        TEXBOX_ := TEXBOX_ + 1;
        image (
            addto currentpicture doublepath unitsquare
            xscaled TEXBOX_wd[TEXBOX_]
            yscaled (TEXBOX_ht[TEXBOX_] + TEXBOX_dp[TEXBOX_])
            shifted (0, -TEXBOX_dp[TEXBOX_])
            withprescript "MPlibTEXboxID=" &
                          decimal TEXBOX_ & ":" &
                          decimal TEXBOX_wd[TEXBOX_] & ":" &
                          decimal(TEXBOX_ht[TEXBOX_]+TEXBOX_dp[TEXBOX_]);
        )
    fi
enddef;
if known context_mlib:
    defaultfont := "cmtt10";
    let infont = normalinfont;
```

```
    let fontsize = normalfontsize;
    vardef thelabel@#(expr p,z) =
        if string p :
            thelabel@#(p infont defaultfont scaled defaultscale,z)
        else :
            p shifted (z + labeloffset*mfun_laboff@# -
                (mfun_labxf@#*lrcorner p + mfun_labyf@#*ulcorner p +
                (1-mfun_labxf@#-mfun_labyf@#)*llcorner p))
        fi
    enddef;
    def graphictext primary filename =
        if (readfrom filename = EOF):
          errmessage "Please prepare '"&filename&"' in advance with command"&
          " 'pstoedit -ssp -dt -f mpost yourfile.ps "&filename&"'";
        fi
        closefrom filename;
        def data_mpy_file = filename enddef;
        mfun_do_graphic_text (filename)
    enddef;
    if unknown TEXBOX_: def mfun_do_graphic_text text t = enddef; fi
else:
    vardef textext@# (text t) = rawtextext (t) enddef;
fi
def externalfigure primary filename =
    draw rawtextext("\includegraphics{"& filename &"}")
enddef;
def TEX = textext enddef;
def fontmapfile primary filename = enddef;
def specialVerbatimTeX (text t) = special "MPlibVerbTeX="&t; enddef;
def ignoreVerbatimTeX  (text t) = enddef;
let VerbatimTeX = specialVerbatimTeX;
extra_beginfig := extra_beginfig & " let VerbatimTeX = ignoreVerbatimTeX;" ;
extra_endfig   := extra_endfig   & " let VerbatimTeX = specialVerbatimTeX;" ;
]]

local function protecttextext(data)
    local everymplib    = tex.toks['everymplibtoks']    or ''
    local everyendmplib = tex.toks['everyendmplibtoks'] or ''
    data = " " .. everymplib .. data .. everyendmplib
    data = stringgsub(data,
        "%f[A-Z_a-z]btex%f[^A-Z_a-z]%s*(.-)%s*%f[A-Z_a-z]etex%f[^A-Z_a-z]",
        function(str)
            str = stringgsub(str,'"','"&ditto&"')
            return format("rawtextext(\\unexpanded{\"%s\"})",str)
        end)
    data = stringgsub(data,
        "%f[A-Z_a-z]verbatimtex%f[^A-Z_a-z]%s*(.-)%s*%f[A-Z_a-z]etex%f[^A-Z_a-z]",
        function(str)
            str = stringgsub(str,'"','"&ditto&"')
            return format("VerbatimTeX(\\unexpanded{\"%s\"})",str)
```

```
        end)
    data = stringgsub(data, "\".-\"", -- hack for parentheses inside quotes
        function(str)
            str = stringgsub(str,"%(","%%%%LEFTPAREN%%%%")
            str = stringgsub(str,"%)","%%%%RGHTPAREN%%%%")
            return str
        end)
    data = stringgsub(data, "%f[A-Z_a-z]TEX%s*%b()", "\\unexpanded{%1}")
    data = stringgsub(data, "%f[A-Z_a-z]textext%s*%b()", "\\unexpanded{%1}")
    data = stringgsub(data, "%f[A-Z_a-z]textext%.[_a-z]+%s*%b()", "\\unexpanded{%1}")
    data = stringgsub(data, "%%%%LEFTPAREN%%%%", "(") -- restore
    data = stringgsub(data, "%%%%RGHTPAREN%%%%", ")") -- restore
    texsprint(data)
end

luamplib.protecttextext = protecttextext

local factor = 65536*(7227/7200)

local function putTEXboxes (object,prescript)
    local box = prescript.MPlibTEXboxID
    local n,tw,th = box[1],box[2],box[3]
    if n and tw and th then
        local op = object.path
        local first, second, fourth = op[1], op[2], op[4]
        local tx, ty = first.x_coord, first.y_coord
        local sx, sy = (second.x_coord - tx)/tw, (fourth.y_coord - ty)/th
        local rx, ry = (second.y_coord - ty)/tw, (fourth.x_coord - tx)/th
        if sx == 0 then sx = 0.00001 end
        if sy == 0 then sy = 0.00001 end
        pdf_literalcode("q %f %f %f %f %f %f cm",sx,rx,ry,sy,tx,ty)
        texsprint(format("\\mplibputtextbox{%i}",n))
        pdf_literalcode("Q")
    end
end

local TeX_code_t = {}

local function domakeTEXboxes (data)
    local num = tex.count[14] -- newbox register
    if data and data.fig then
        local figures = data.fig
        for f=1, #figures do
            TeX_code_t[f] = nil
            local figure = figures[f]
            local objects = getobjects(data,figure,f)
            if objects then
                for o=1,#objects do
                    local object    = objects[o]
                    local prescript = object.prescript
```

```
                    prescript = prescript and script2table(prescript)
                    local str = prescript and prescript.MPlibmkTEXbox
                    if str then
                        num = num + 1
                        texsprint(format("\\setbox%i\\hbox{%s}",num,str))
                    end
```

`verbatimtex ... etex` before `beginfig()` is not ignored, but the TEX code inbetween is inserted before the mplib box.

```
                    local texcode = prescript and prescript.MPlibVerbTeX
                    if texcode and texcode ~= "" then
                        TeX_code_t[f] = texcode
                    end
                end
            end
        end
    end
end

local function makeTEXboxes (data)
    data = stringgsub(data, "##", "#") -- restore # doubled in input string
    local mpx = luamplib.load(currentformat)
    if mpx and data then
        local result = mpx:execute(mplibcodepreamble .. data)
        domakeTEXboxes(result)
    end
    return data
end

luamplib.makeTEXboxes = makeTEXboxes

local function processwithTEXboxes (data)
    local num = tex.count[14] -- the same newbox register
    local prepreamble = "TEXBOX_ := "..num..";\n"
    while true do
        num = num + 1
        local box = tex.box[num]
        if not box then break end
        prepreamble = prepreamble ..
        "TEXBOX_wd["..num.."] := "..box.width /factor..";\n"..
        "TEXBOX_ht["..num.."] := "..box.height/factor..";\n"..
        "TEXBOX_dp["..num.."] := "..box.depth /factor..";\n"
    end
    process(prepreamble .. mplibcodepreamble .. data)
end

luamplib.processwithTEXboxes = processwithTEXboxes

```

Transparency and Shading

```
local pdf_objs = {}

-- objstr <string> => obj <number>, new <boolean>
local function update_pdfobjs (os)
    local on = pdf_objs[os]
    if on then
        return on,false
    end
    on = pdf.immediateobj(os)
    pdf_objs[os] = on
    return on,true
end

local transparancy_modes = { [0] =  "Normal",
    "Normal",       "Multiply",     "Screen",       "Overlay",
    "SoftLight",    "HardLight",    "ColorDodge",   "ColorBurn",
    "Darken",       "Lighten",      "Difference",   "Exclusion",
    "Hue",          "Saturation",   "Color",        "Luminosity",
    "Compatible",
}

local function update_tr_res(res,mode,opaq)
    local os = format("<</BM /%s/ca %g/CA %g/AIS false>>",mode,opaq,opaq)
    local on, new = update_pdfobjs(os)
    if new then
        res = res .. format("/MPlibTr%s%g %i 0 R",mode,opaq,on)
    end
    return res
end

local function tr_pdf_pageresources(mode,opaq)
    local res = ""
    res = update_tr_res(res, "Normal", 1)
    res = update_tr_res(res, mode, opaq)
    if res ~= "" then
        local tpr = tex.pdfpageresources -- respect luaotfload-colors
        if not stringfind(tpr,"/ExtGState<<.*>>") then
            tpr = tpr.."/ExtGState<<>>"
        end
        tpr = stringgsub(tpr,"/ExtGState<<","%1"..res)
        tex.set("global","pdfpageresources",tpr)
    end
end

-- luatexbase.mcb is not yet updated: "finish_pdffile" callback is missing

local function sh_pdfpageresources(shtype,domain,colorspace,colora,colorb,coordinates)
    local os, on, new
    os = format("<</FunctionType 2/Domain [ %s ]/C0 [ %s ]/C1 [ %s ]/N 1>>",
                domain, colora, colorb)
```

```
    on = update_pdfobjs(os)
    os = format("<</ShadingType %i/ColorSpace /%s/Function %i 0 R/Coords [ %s ]/Extend [ true true ]/AntiAlias true>>",
                shtype, colorspace, on, coordinates)
    on, new = update_pdfobjs(os)
    if not new then
        return on
    end
    local res = format("/MPlibSh%i %i 0 R", on, on)
    local ppr = pdf.pageresources or ""
    if not stringfind(ppr,"/Shading<<.*>>") then
        ppr = ppr.."/Shading<<>>"
    end
    pdf.pageresources = stringgsub(ppr,"/Shading<<","%1"..res)
    return on
end

local function color_normalize(ca,cb)
    if #cb == 1 then
        if #ca == 4 then
            cb[1], cb[2], cb[3], cb[4] = 0, 0, 0, 1-cb[1]
        else -- #ca = 3
            cb[1], cb[2], cb[3] = cb[1], cb[1], cb[1]
        end
    elseif #cb == 3 then -- #ca == 4
        cb[1], cb[2], cb[3], cb[4] = 1-cb[1], 1-cb[2], 1-cb[3], 0
    end
end

local function do_preobj_color(object,prescript)
    -- transparency
    local opaq = prescript and prescript.tr_transparency
    if opaq then
        local mode = prescript.tr_alternative or 1
        mode = transparancy_modes[tonumber(mode)]
        tr_pdf_pageresources(mode,opaq)
        pdf_literalcode("/MPlibTr%s%g gs",mode,opaq)
    end
    -- color
    local cs = object.color
    if cs and #cs > 0 then
        pdf_literalcode(luamplib.colorconverter(cs))
    end
    -- shading
    local sh_type = prescript and prescript.sh_type
    if sh_type then
        local domain  = prescript.sh_domain
        local centera = prescript.sh_center_a
        local centerb = prescript.sh_center_b
        local colora  = prescript.sh_color_a or {0};
```

```
        local colorb  = prescript.sh_color_b or {1};
        if #colora > #colorb then
            color_normalize(colora,colorb)
        elseif #colorb > #colora then
            color_normalize(colorb,colora)
        end
        local colorspace
        if     #colorb == 1 then colorspace = ”DeviceGray”
        elseif #colorb == 3 then colorspace = ”DeviceRGB”
        elseif #colorb == 4 then colorspace = ”DeviceCMYK”
        else   return opaq
        end
        colora = tableconcat(colora, ” ”)
        colorb = tableconcat(colorb, ” ”)
        local shade_no
        if sh_type == ”linear” then
            local coordinates = format(”%s %s”,centera,centerb)
            shade_no = sh_pdfpageresources(2,domain,colorspace,colora,colorb,coordinates)
        elseif sh_type == ”circular” then
            local radiusa = prescript.sh_radius_a
            local radiusb = prescript.sh_radius_b
            local coordinates = format(”%s %s %s %s”,centera,radiusa,centerb,radiusb)
            shade_no = sh_pdfpageresources(3,domain,colorspace,colora,colorb,coordinates)
        end
        pdf_literalcode(”q /Pattern cs”)
        return opaq,shade_no
    end
    return opaq
end

local function do_postobj_color(tr,sh)
    if sh then
        pdf_literalcode(”W n /MPlibSh%s sh Q”,sh)
    end
    if tr then
        pdf_literalcode(”/MPlibTrNormal1 gs”)
    end
end

```

End of `btex` – `etex` and Transparency/Shading patch.

```

local function flush(result,flusher)
    if result then
        local figures = result.fig
        if figures then
            for f=1, #figures do
                info(”flushing figure %s”,f)
                local figure = figures[f]
                local objects = getobjects(result,figure,f)
```

```
                local fignum = tonumber(stringmatch(figure:filename(),"([%d]+)$") or fig-
ure:charcode() or 0)
                local miterlimit, linecap, linejoin, dashed = -1, -1, -1, false
                local bbox = figure:boundingbox()
                local llx, lly, urx, ury = bbox[1], bbox[2], bbox[3], bbox[4] -- faster than un-
pack
                if urx < llx then
                    -- invalid
                    pdf_startfigure(fignum,0,0,0,0)
                    pdf_stopfigure()
                else
```

Insert `verbatimtex` code before mplib box.

```
                    if TeX_code_t[f] then
                        texsprint(TeX_code_t[f])
                    end
                    pdf_startfigure(fignum,llx,lly,urx,ury)
                    pdf_literalcode("q")
                    if objects then
                        for o=1,#objects do
                            local object        = objects[o]
                            local objecttype    = object.type
```

Change from ConTEXt code: the following 5 lines are part of the `btex...etex` patch.
Again, colors are processed at this stage.

```
                            local prescript     = object.prescript
                            prescript = prescript and script2table(prescript) -- pre-
script is now a table
                            local tr_opaq,shade_no = do_preobj_color(object,prescript)
                            if prescript and prescript.MPlibTEXboxID then
                                putTEXboxes(object,prescript)
                            elseif objecttype == "start_bounds" or objecttype == "stop_bounds" then
                                -- skip
                            elseif objecttype == "start_clip" then
                                pdf_literalcode("q")
                                flushnormalpath(object.path,t,false)
                                pdf_literalcode("W n")
                            elseif objecttype == "stop_clip" then
                                pdf_literalcode("Q")
                                miterlimit, linecap, linejoin, dashed = -1, -1, -1, false
                            elseif objecttype == "special" then
                                -- not supported
                            elseif objecttype == "text" then
                                local ot = object.transform -- 3,4,5,6,1,2
                                pdf_literalcode("q %f %f %f %f %f %f cm",ot[3],ot[4],ot[5],ot[6],ot[1],
                                pdf_textfigure(object.font,object.dsize,object.text,object.width,object
                                pdf_literalcode("Q")
                            else
```

Color stuffs are modified and moved to several lines above.

```
                                local ml = object.miterlimit
                                if ml and ml ~= miterlimit then
                                    miterlimit = ml
                                    pdf_literalcode("%f M",ml)
                                end
                                local lj = object.linejoin
                                if lj and lj ~= linejoin then
                                    linejoin = lj
                                    pdf_literalcode("%i j",lj)
                                end
                                local lc = object.linecap
                                if lc and lc ~= linecap then
                                    linecap = lc
                                    pdf_literalcode("%i J",lc)
                                end
                                local dl = object.dash
                                if dl then
                                    local d = format("[%s] %i d",tableconcat(dl.dashes or {}," "),dl.of
                                    if d ~= dashed then
                                        dashed = d
                                        pdf_literalcode(dashed)
                                    end
                                elseif dashed then
                                   pdf_literalcode("[] 0 d")
                                   dashed = false
                                end
                                local path = object.path
                                local transformed, penwidth = false, 1
                                local open = path and path[1].left_type and path[#path].right_type
                                local pen = object.pen
                                if pen then
                                   if pen.type == 'elliptical' then
                                        transformed, penwidth = pen_characteris-
   tics(object) -- boolean, value
                                        pdf_literalcode("%f w",penwidth)
                                        if objecttype == 'fill' then
                                            objecttype = 'both'
                                        end
                                   else -- calculated by mplib itself
                                        objecttype = 'fill'
                                   end
                                end
                                if transformed then
                                    pdf_literalcode("q")
                                end
                                if path then
                                    if transformed then
                                        flushconcatpath(path,open)
                                    else
                                        flushnormalpath(path,open)
```

```
                                    end
```

Change from ConTEXt code: color stuff

```
                                    if not shade_no then ----- conflict with shad-
ing
                                        if objecttype == ”fill” then
                                            pdf_literalcode(”h f”)
                                        elseif objecttype == ”outline” then
                                            pdf_literalcode((open and ”S”) or ”h S”)
                                        elseif objecttype == ”both” then
                                            pdf_literalcode(”h B”)
                                        end
                                    end
                                end
                                if transformed then
                                    pdf_literalcode(”Q”)
                                end
                                local path = object.htap
                                if path then
                                    if transformed then
                                        pdf_literalcode(”q”)
                                    end
                                    if transformed then
                                        flushconcatpath(path,open)
                                    else
                                        flushnormalpath(path,open)
                                    end
                                    if objecttype == ”fill” then
                                        pdf_literalcode(”h f”)
                                    elseif objecttype == ”outline” then
                                        pdf_literalcode((open and ”S”) or ”h S”)
                                    elseif objecttype == ”both” then
                                        pdf_literalcode(”h B”)
                                    end
                                    if transformed then
                                        pdf_literalcode(”Q”)
                                    end
                                end
--                              if cr then
--                                  pdf_literalcode(cr)
--                              end
                            end
```

Added to ConTEXt code: color stuff

```
                                do_postobj_color(tr_opaq,shade_no)
                            end
                        end
                        pdf_literalcode(”Q”)
                        pdf_stopfigure()
                    end
```

```
            end
        end
    end
end
luamplib.flush = flush

local function colorconverter(cr)
    local n = #cr
    if n == 4 then
        local c, m, y, k = cr[1], cr[2], cr[3], cr[4]
        return format("%.3g %.3g %.3g %.3g k %.3g %.3g %.3g %.3g K",c,m,y,k,c,m,y,k), "0 g 0 G"
    elseif n == 3 then
        local r, g, b = cr[1], cr[2], cr[3]
        return format("%.3g %.3g %.3g rg %.3g %.3g %.3g RG",r,g,b,r,g,b), "0 g 0 G"
    else
        local s = cr[1]
        return format("%.3g g %.3g G",s,s), "0 g 0 G"
    end
end
luamplib.colorconverter = colorconverter
```

2.2 TEX package

⟨*package⟩

First we need to load some packages.

```
\bgroup\expandafter\expandafter\expandafter\egroup
\expandafter\ifx\csname ProvidesPackage\endcsname\relax
  \input luatexbase-modutils.sty
\else
  \NeedsTeXFormat{LaTeX2e}
  \ProvidesPackage{luamplib}
    [2014/02/19 v2.5.1 mplib package for LuaTeX]
  \RequirePackage{luatexbase-modutils}
  \RequirePackage{pdftexcmds}
\fi
```

Loading of lua code.

```
\RequireLuaModule{luamplib}
```

Set the format for metapost.

```
\def\mplibsetformat#1{%
  \directlua{luamplib.setformat("\luatexluaescapestring{#1}")}}
```

MPLib only works in PDF mode, we don't do anything if we are in DVI mode, and we output a warning.

```
\ifnum\pdfoutput>0
    \let\mplibtoPDF\pdfliteral
\else
    %\def\MPLIBtoPDF#1{\special{pdf:literal direct #1}} % not ok yet
    \def\mplibtoPDF#1{}
```

```
    \expandafter\ifx\csname PackageWarning\endcsname\relax
      \write16{}
      \write16{Warning: MPLib only works in PDF mode, no figure will be output.}
      \write16{}
    \else
      \PackageWarning{mplib}{MPLib only works in PDF mode, no figure will be output.}
    \fi
\fi
\def\mplibsetupcatcodes{%
  %catcode`\{=12 %catcode`\}=12
  \catcode`\#=12
  \catcode`\^=12 \catcode`\~=12 \catcode`\_=12
  %catcode`\%=12 %% don't in Plain!
  \catcode`\&=12 \catcode`\$=12
}
```

Make `btex...etex` box zero-metric.

```
\def\mplibputtextbox#1{\vbox to 0pt{\vss\hbox to 0pt{\raise\dp#1\copy#1\hss}}}
```

The Plain-specific stuff.

```
\bgroup\expandafter\expandafter\expandafter\egroup
\expandafter\ifx\csname ProvidesPackage\endcsname\relax
\def\mplibcode{%
  \begingroup
  \bgroup
  \mplibsetupcatcodes
  \mplibdocode %
}
\long\def\mplibdocode#1\endmplibcode{%
  \egroup
  \def\mplibtemp{\directlua{luamplib.protecttextext([===[\unexpanded{#1}]===])}}%
  \directlua{luamplib.tempdata = luamplib.makeTEXboxes([===[\mplibtemp]===])}%
  \directlua{luamplib.processwithTEXboxes(luamplib.tempdata)}%
  \endgroup
}
\else
```

The LaTeX-specific parts: a new environment.

```
\newenvironment{mplibcode}{\toks@{}\ltxdomplibcode}{}
\def\ltxdomplibcode{%
  \begingroup
  \mplibsetupcatcodes
  \ltxdomplibcodeindeed %
}
%
\long\def\ltxdomplibcodeindeed#1\end#2{%
  \endgroup
  \toks@\expandafter{\the\toks@#1}%
  \ifnum\pdf@strcmp{#2}{mplibcode}=\z@
    \def\reserved@a{\directlua{luamplib.protecttextext([===[\the\toks@]===])}}%
```

```
    \directlua{luamplib.tempdata=luamplib.makeTEXboxes([===[\reserved@a]===])}%
    \directlua{luamplib.processwithTEXboxes(luamplib.tempdata)}%
    \end{mplibcode}%
  \else
    \toks@\expandafter{\the\toks@\end{#2}}\expandafter\ltxdomplibcode
  \fi
}
\fi
```

`\everymplib` & `\everyendmplib`: macros redefining `\everymplibtoks` & `\everyendmplibtoks` respectively

```
\newtoks\everymplibtoks
\newtoks\everyendmplibtoks
\protected\def\everymplib{%
  \begingroup
  \mplibsetupcatcodes
  \mplibdoeverymplib
}
\def\mplibdoeverymplib#1{%
  \endgroup
  \everymplibtoks{#1}%
}
\protected\def\everyendmplib{%
  \begingroup
  \mplibsetupcatcodes
  \mplibdoeveryendmplib
}
\def\mplibdoeveryendmplib#1{%
  \endgroup
  \everyendmplibtoks{#1}%
}
\def\mpdim#1{ begingroup \the\dimexpr #1\relax\space endgroup } % gmp.sty
\def\mplibnumbersystem#1{\directlua{luamplib.numbersystem = "#1"}}
```

We use a dedicated scratchbox.

```
\ifx\mplibscratchbox\undefined \newbox\mplibscratchbox \fi
```

We encapsulate the litterals.

```
\def\mplibstarttoPDF#1#2#3#4{%
  \hbox\bgroup
  \xdef\MPllx{#1}\xdef\MPlly{#2}%
  \xdef\MPurx{#3}\xdef\MPury{#4}%
  \xdef\MPwidth{\the\dimexpr#3bp-#1bp\relax}%
  \xdef\MPheight{\the\dimexpr#4bp-#2bp\relax}%
  \parskip0pt%
  \leftskip0pt%
  \parindent0pt%
  \everypar{}%
  \setbox\mplibscratchbox\vbox\bgroup
  \noindent
}
```

```
\def\mplibstoptoPDF{%
  \egroup %
  \setbox\mplibscratchbox\hbox %
    {\hskip-\MPllx bp%
     \raise-\MPlly bp%
     \box\mplibscratchbox}%
  \setbox\mplibscratchbox\vbox to \MPheight
    {\vfill
     \hsize\MPwidth
     \wd\mplibscratchbox0pt%
     \ht\mplibscratchbox0pt%
     \dp\mplibscratchbox0pt%
     \box\mplibscratchbox}%
  \wd\mplibscratchbox\MPwidth
  \ht\mplibscratchbox\MPheight
  \box\mplibscratchbox
  \egroup
}
```

Text items have a special handler.

```
\def\mplibtextext#1#2#3#4#5{%
  \begingroup
  \setbox\mplibscratchbox\hbox
    {\font\temp=#1 at #2bp%
     \temp
     #3}%
  \setbox\mplibscratchbox\hbox
    {\hskip#4 bp%
     \raise#5 bp%
     \box\mplibscratchbox}%
  \wd\mplibscratchbox0pt%
  \ht\mplibscratchbox0pt%
  \dp\mplibscratchbox0pt%
  \box\mplibscratchbox
  \endgroup
}
```

That's all folks!

⟨/package⟩

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End of Terms and Conditions

Appendix: How to Apply These Terms to Your New Programs

If you develop a new program, and you want it to be of the greatest possible use to the public, the best way to achieve this is to make it free software which everyone can redistribute and change under these terms.

To do so, attach the following notices to the program. It is safest to attach them to the start of each source file to most effectively convey the exclusion of warranty; and each file should have at least the "copyright" line and a pointer to where the full notice is found.

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>
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Also add information on how to contact you by electronic and paper mail.

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> Gnomovision comes with ABSOLUTELY NO WARRANTY; for details type 'show w'.
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The hypothetical commands `show w` and `show c` should show the appropriate parts of the General Public License. Of course, the commands you use may be called something other than `show w` and `show c`; they could even be mouse-clicks or menu items--whatever suits your program.

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>
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