Lab01: An introduction to SciComp@UNC environment

1 TeXmacs

TeXmacs is an editor especially well suited for scientific work:

- Even more so than Emacs, TeXmacs can be extensively customized. Much of the editor is written in Scheme (a LISP descendent). Several customizations of TeXmacs have been carried out in SciComp@UNC.
- Mathematical text is easily written, in legible form, e.g. from the IBVP $q\colon [0,\infty)\times[0,1]\to\mathbb{R}$

$$\begin{cases} q_t = q_{xx} \text{ in } (0,1) \\ q(t=0,x) = f(x) \text{ on } [0,1] \\ q(t,0) = g_0(t),\, q(t,1) = g_1(t) \end{cases}, \tag{1}$$

  semidiscretization at nodes $x_i = ih$, $h = 1$
- The text can be exported to LaTeX, HTML, PDF formats.
- Computations can be interspersed, such that one obtains a "living" document that contains the code used to produce results.

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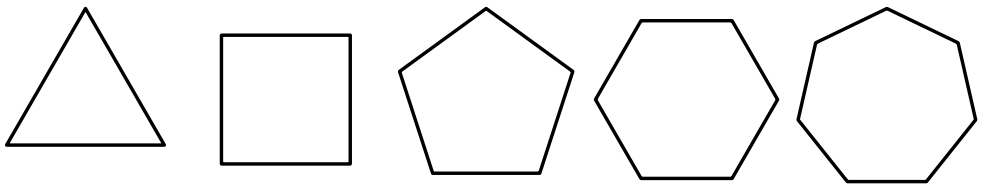
2 Embedded sessions

The public-domain Linux environment encourages compatibility among conforming applications, such that they can work together to solve complex tasks. This approach is in marked contrast to closed-form commercial operating systems (Windows, macOS) and applications. Even commercial programs (e.g., Mathematica) that conform to standard Linux practices can work in concert with other applications.

Within SciComp@UNC, TeXmacs has been configured to embed sessions of other applications:

Asymptote. A general purpose vector graphics language

```
Asymptote] size(5cm);
           for (int n = 3; n <= 7; ++n) {
           draw(shift(2.2*n, 0) *
           polygon(n));}
```



```
Asymptote]
```

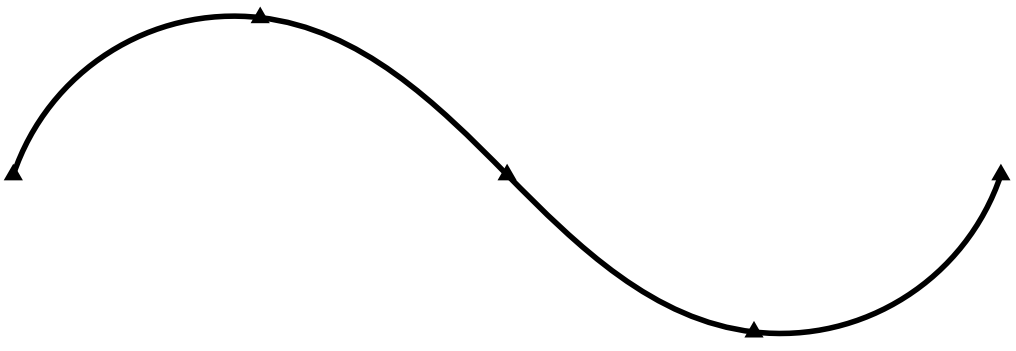
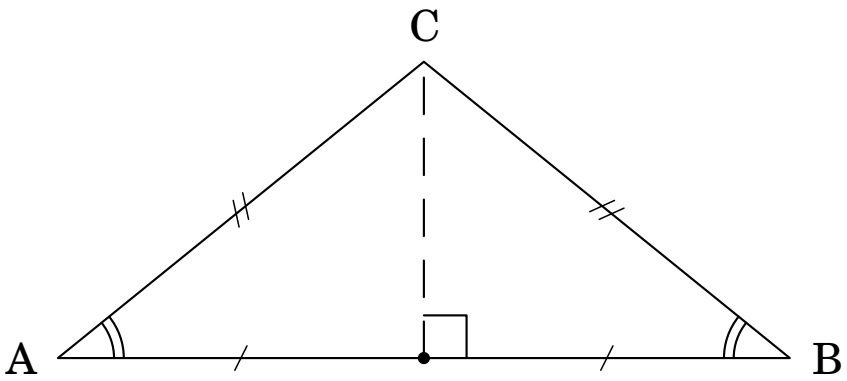


Figure 1. Figure generated using folded Asymptote code

Eukleides. An environment for generation of geometrical figures

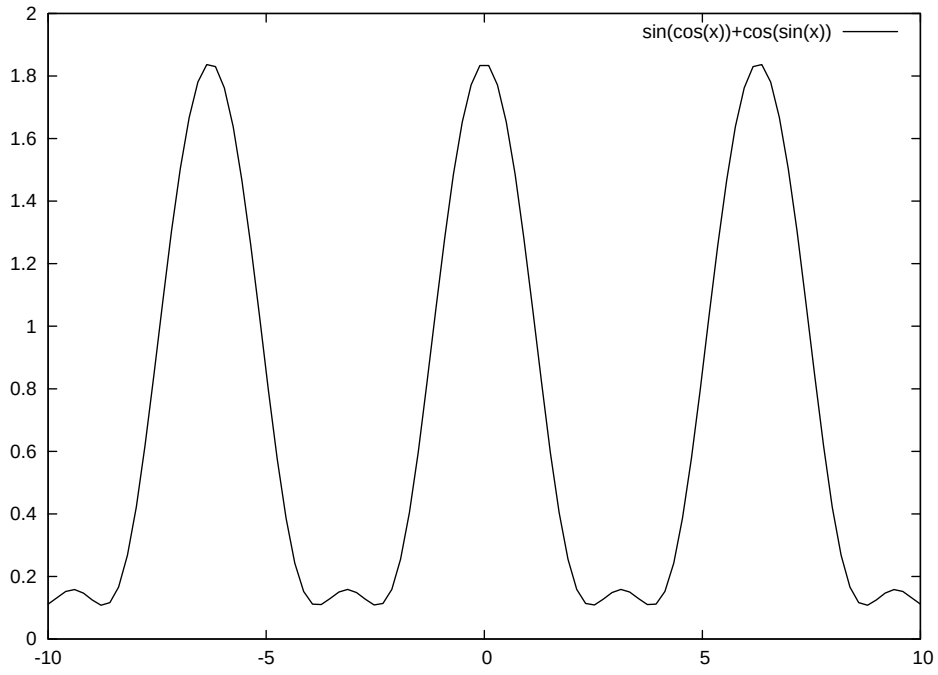
```
Eukleides] box -1, -1, 7, 3

           A B C isosceles
           H = projection(C, line(A, B))

           draw
            (A.B.C)
             C.H dashed
             H
           end

           label
             A 180:
             B 0:
             C 90:
             B, H, C right
             B, A, C double
             C, B, A double
             A.H
             B.H
             A.C double
             C.B double
           end
```




```
Eukleides]
```

Gnuplot. Gnuplot is graphics application

```
GNUplot] plot sin(cos(x))+cos(sin(x))
```



GNUplot]

Lisp.

```
;; Loading file /opt/TeXmacs/plugins/lisp/clisp/clisp-init.lisp ...
;;  Loading file lisp/tmlib.lisp ...
;;  Loaded file lisp/tmlib.lisp
;; Loaded file /opt/TeXmacs/plugins/lisp/clisp/clisp-init.lisp
CLisp> (car '(a b c))

  A
CLisp> (cdr '(a b c))

  (B C)
CLisp>
```

Mathematica.

```
Mathematica
In[1]:= N[Pi,1000]
```

3.14159265358979323846264338327950288419716939937510582097494459230781640628620899862803482534211706798214\
08651328230664709384460955058223172535940812848111745028410270193852110555964462294895493038196442881097566\
59334461284756482337867831652712019091456485669234603486104543266482133936072602491412737245870066063155881\
74881520920962829254091715364367892590360011330530548820466521384146951941511609433057270365759591953092186\
11738193261179310511854807446237996274956735188575272489122793818301194912983367336244065664308602139494639\
52247371907021798609437027705392171762931767523846748184676694051320005681271452635608277857713427577896091\
73637178721468440901224953430146549585371050792279689258923542019956112129021960864034418159813629774771309\
96051870721134999999837297804995105973173281609631859502445945534690830264252230825334468503526193118817101\
00031378387528865875332083814206171776691473035982534904287554687311595628638823537875937519577818577805321\
71226806613001927876611195909216420199

```
In[2]:= 100!
```

93326215443944152681699238856266700490715968264381621468592963895217599993229915608941463976156518286253697\
92082722375825118521091686400000000000000000000000

```
In[4]:= D[Sin[Cos[x]]+Cos[Sin[x]],{x,10}]
```

$$945\sin^5(x)\sin(\sin(x)) - 2205\sin^3(x)\sin(\sin(x)) + \sin(x)\sin(\sin(x)) - 945\cos(\cos(x))\cos^5(x) + 2205\cos(\cos(x))\cos^3(x) - \cos(\cos(x))\cos(x) + \cos^{10}(x)(-\cos(\sin(x))) - 120\cos^8(x)\cos(\sin(x)) + 45\sin(x)\sin(\sin(x))\cos^8(x) + 630\sin^2(x)\cos^6(x)\cos(\sin(x)) - 2352\cos^6(x)\cos(\sin(x)) + 2730\sin(x)\sin(\sin(x))\cos^6(x) - 3150\sin^3(x)\sin(\sin(x))\cos^4(x) + 15750\sin^2(x)\cos^4(x)\cos(\sin(x)) - 4725\sin^2(x)\cos^4(x)\sin(\cos(x)) - 5440\cos^4(x)\cos(\sin(x)) - 3150\cos^4(x)\sin(\cos(x)) + 19530\sin(x)\sin(\sin(x))\cos^4(x) + 3150\sin^4(x)\cos(\cos(x))\cos^3(x) +$$

$22050 \sin^2(x) \cos(\cos(x)) \cos^3(x) + 630 \sin^6(x) \cos^2(x) \sin(\cos(x)) - 4725 \sin^4(x) \cos^2(x) \cos(\sin(x)) +$
$15750 \sin^4(x) \cos^2(x) \sin(\cos(x)) - 22050 \sin^3(x) \sin(\sin(x)) \cos^2(x) + 25515 \sin^2(x) \cos^2(x) \cos(\sin(x)) +$
$25515 \sin^2(x) \cos^2(x) \sin(\cos(x)) - 256 \cos^2(x) \cos(\sin(x)) + 255 \cos^2(x) \sin(\cos(x)) + 7125 \sin(x) \sin(\sin(x)) \cos^2(x) -$
$\sin^{10}(x) \sin(\cos(x)) - 45 \sin^8(x) \cos(\cos(x)) \cos(x) - 120 \sin^8(x) \sin(\cos(x)) - 2730 \sin^6(x) \cos(\cos(x)) \cos(x) -$
$2352 \sin^6(x) \sin(\cos(x)) - 19530 \sin^4(x) \cos(\cos(x)) \cos(x) - 3150 \sin^4(x) \cos(\sin(x)) - 5440 \sin^4(x) \sin(\cos(x)) -$
$7125 \sin^2(x) \cos(\cos(x)) \cos(x) + 255 \sin^2(x) \cos(\sin(x)) - 256 \sin^2(x) \sin(\cos(x))$

```
In[5]:= 1 == 2
```

False

```
In[6]:= 1 == 1
```

True

```
In[7]:= Eq = x==1
```

$x = 1$

```
In[8]:= Eq /. x->1
```

True

```
In[9]:= ODE = y'[x] + x y[x] == Sin[x]
```

$y'(x) + x\, y(x) = \sin(x)$

```
In[14]:= sol = DSolve[ODE,y[x],x]
```

$$\left\{\left\{y(x) \to c_1\, e^{-\frac{x^2}{2}} - \frac{1}{2} i \sqrt{\frac{\pi}{2}}\, e^{\frac{1}{2}-\frac{x^2}{2}} \left(\text{erfi}\left(\frac{x+i}{\sqrt{2}}\right) - \text{erfi}\left(\frac{}{x-i}\sqrt{2}\right)\right)\right\}\right\}$$

```
In[17]:= z[x_] = y[x] /. sol[[1,1]]
```

$$c_1\, e^{-\frac{x^2}{2}} - \frac{1}{2} i \sqrt{\frac{\pi}{2}}\, e^{\frac{1}{2}-\frac{x^2}{2}} \left(\text{erfi}\left(\frac{x+i}{\sqrt{2}}\right) - \text{erfi}\left(\frac{}{x-i}\sqrt{2}\right)\right)$$

```
In[15]:= sol[[1,1]]
```

$$y(x) \to c_1\, e^{-\frac{x^2}{2}} - \frac{1}{2} i \sqrt{\frac{\pi}{2}}\, e^{\frac{1}{2}-\frac{x^2}{2}} \left(\text{erfi}\left(\frac{x+i}{\sqrt{2}}\right) - \text{erfi}\left(\frac{}{x-i}\sqrt{2}\right)\right)$$

```
In[18]:= z[1.]
```

$0.606531\, c_1 + (1.21479 + 0.\, i)$

```
In[19]:=
```

Maxima.

```
(%i1) diff(sin(x),x);
```

$(\%o1)\ \cos(x)$

```
(%i2)
```

Octave.

.

$$A = \begin{pmatrix} 0.45229 & 0.22986 & 0.70938 \\ 0.65207 & 0.84622 & 0.8479 \\ 0.28058 & 0.5938 & 0.36148 \end{pmatrix}, A^{-1} = \begin{pmatrix} -11.373 & 19.462 & -23.333 \\ 0.12663 & -2.0461 & 4.5509 \\ 8.6198 & -11.746 & 13.402 \end{pmatrix}$$

```
octave> A=rand(3)
```

$$\begin{pmatrix} 0.93125 & 0.050603 & 0.82831 \\ 0.22199 & 0.11851 & 0.75259 \\ 0.09635 & 0.24193 & 0.66373 \end{pmatrix}$$

```
octave> inv(A)
```

$$\begin{pmatrix} 1.5894 & -2.5636 & 0.9233 \\ 1.15 & -8.273 & 7.9454 \\ -0.6499 & 3.3876 & -1.5235 \end{pmatrix}$$

```
octave>
```

Python.

```
Python] from pylab import *
Python] x=arange(0.,3.15,0.01); y=sin(x); plot(x,y);
```

```
Python] show()
    None
Python]
```

Shell.

```
   Shell session inside TeXmacs pid = 26400
Shell] pwd
   /home/student
Shell] ls
   bearclaw  documents  ecss0.log   mitran-web  research  Wolfram Mathematica
   courses   Downloads  fontconfig  perl5       TeXmacs
   Desktop   ecbx0.log  mitran      projects    tmp
Shell]
```