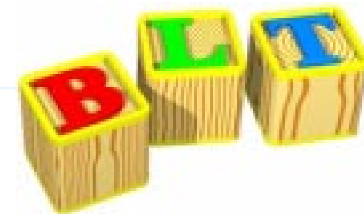
Building Applications with 

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What is BLT?

Set of widgets and new commands.

- Extends the Tcl interpreter, no patching required.

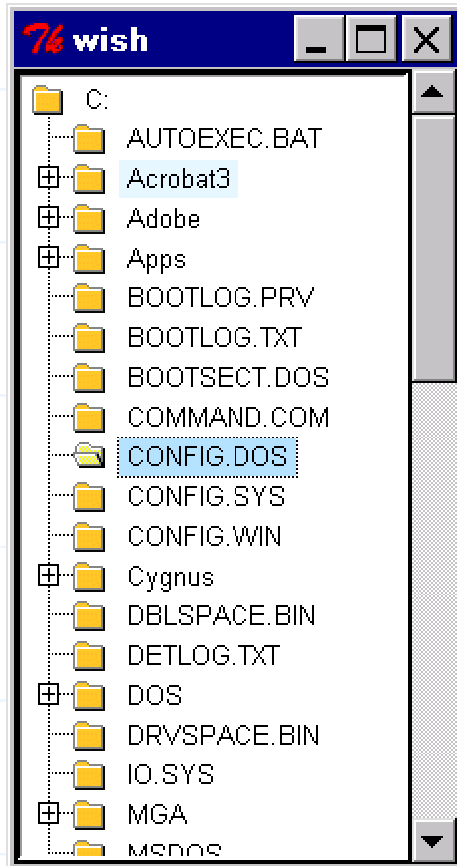
Features:

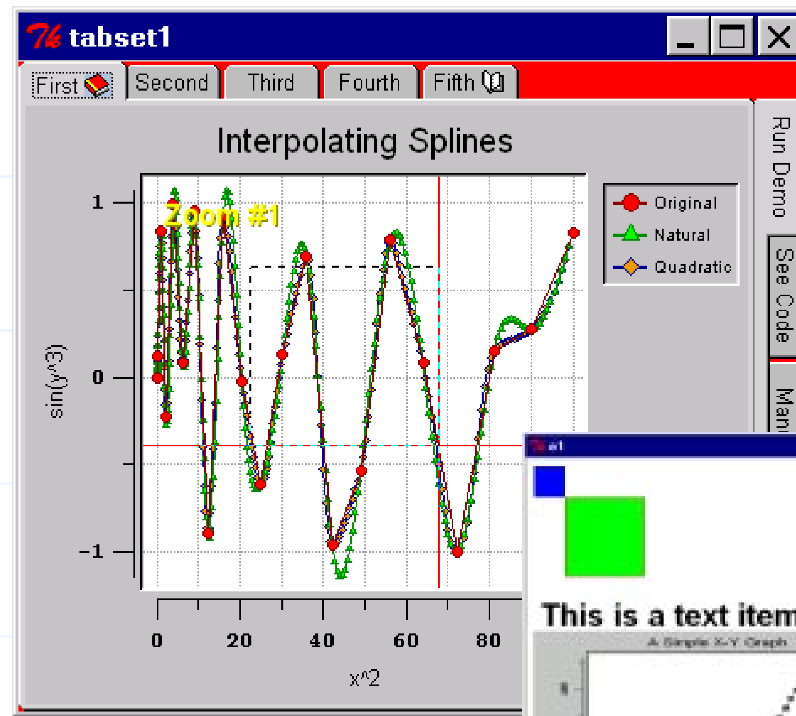
- Graph, stripchart, barchart widgets.
- Table geometry manager
- Hierarchical listbox/table widgets.
- Tabbed notebook widget.
- Drag-and-drop facility.
- Container widget.
- Busy command.
- Bgexec command.
- **…things I need for my Tcl/Tk applications.**

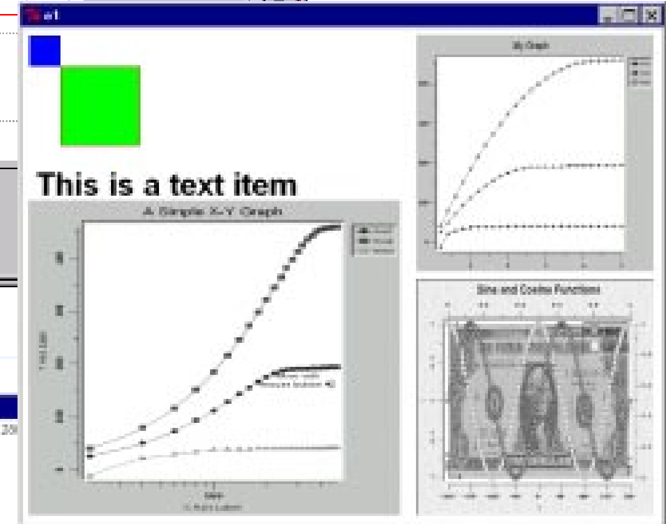
Platforms:

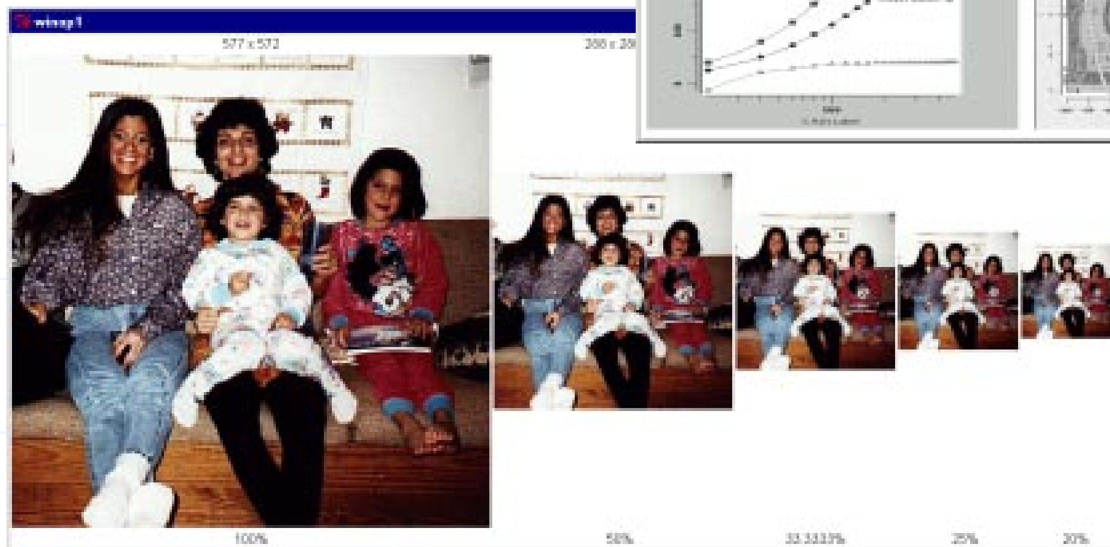
- Unix
- Windows 95/98/NT
- Macintosh soon

What is BLT?

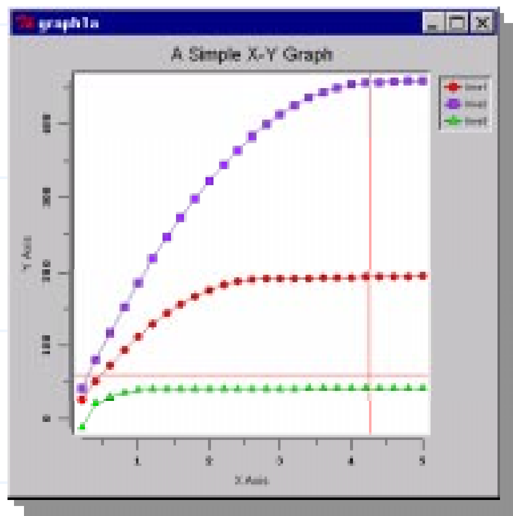


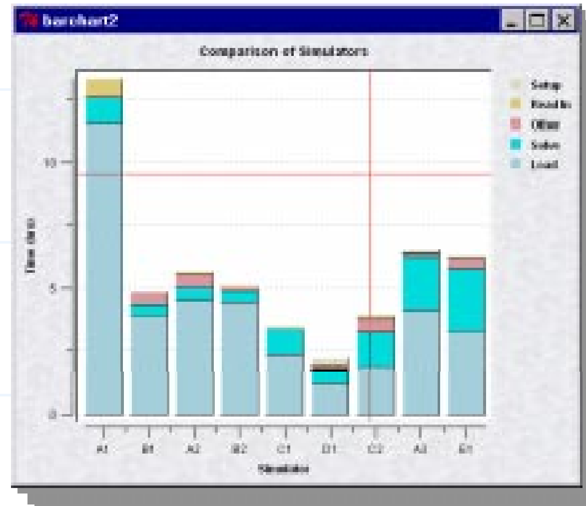


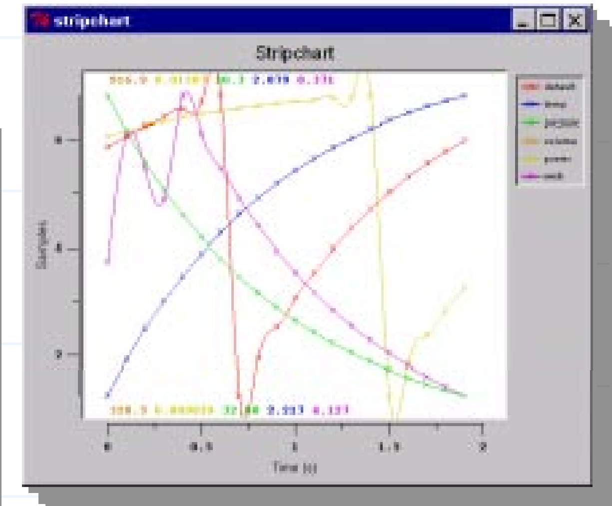




Graphing widgets







Three plotting widgets available:

- **graph** X-Y coordinate graph.
- **barchart** Displays bars at X-Y coordinates.
- **stripchart** Similar to X-Y graph, extra features.

Many features span across all three widgets.

How do I use BLT?

Run special shell with statically linked BLT commands.

```
$ bltwish
```

Dynamically load the BLT package into a vanilla wish.

```
$ wish
% package require BLT
```

Where are the BLT commands?

```
% package require BLT
2.4
% graph .g
invalid command name "graph"
%
```

Can't find "graph" command in the global namespace.

Commands live in **blt** namespace.

- Not automatically exported into global namespace.

Two ways to access the BLT commands.

- Prefix BLT commands with **blt::**

```
package require BLT
blt::graph .g
```

- Import all the BLT commands into the global namespace.

```
package require BLT
namespace import blt::*
graph .g
```

Building applications with BLT

How to plot data with the graph widget.

Zooming and scrolling.

Annotations.

Building your own zooming graph.

Customizing the graph:

- Axes, legend, grid, crosshairs.

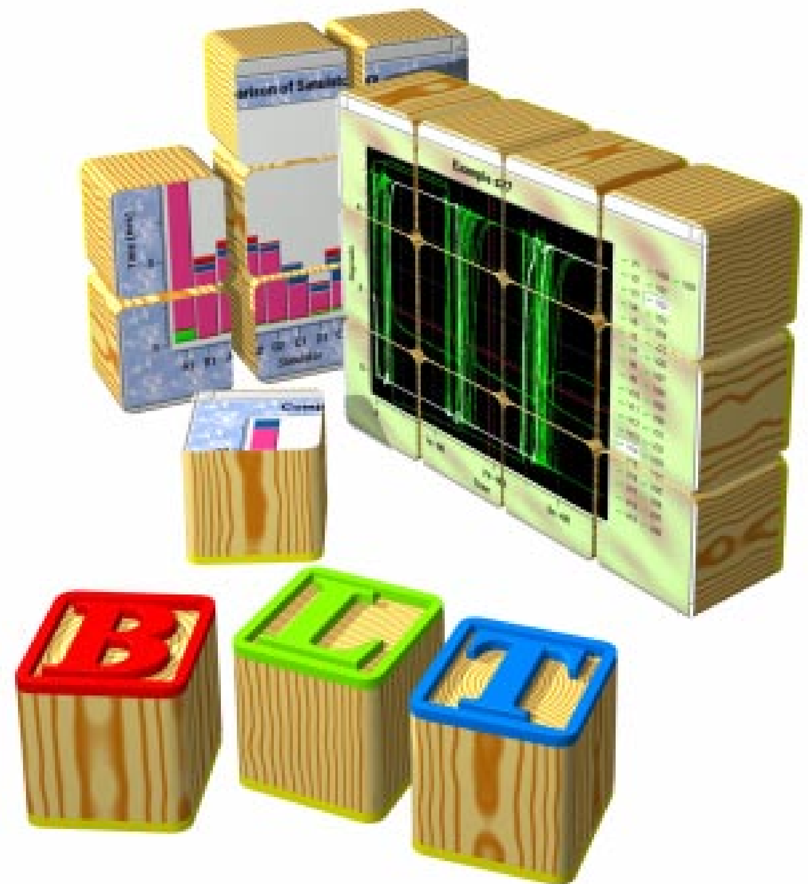
Interactive graphs.

Data handling.

Printing.

Advanced features.

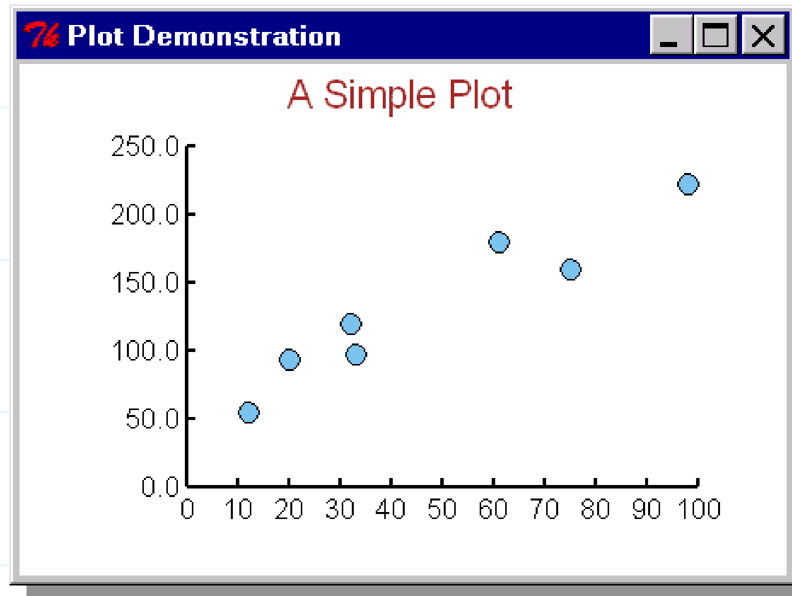
Managing graphs with tabsets.

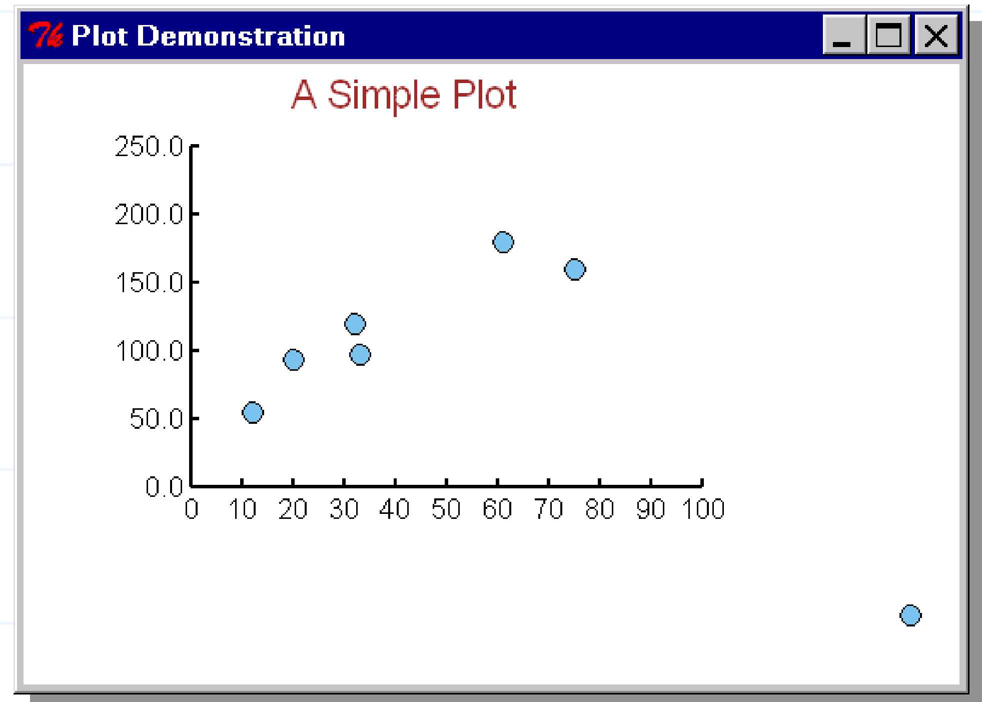


Using the canvas widget

Graph drawn on the canvas using Tcl code.

Example in Tk widget demo.





Problems:

- Lots of Tcl code, lots of details to handle.
- Slow, scales badly with large data sets.
- Zooming broken.

No code for resizing.

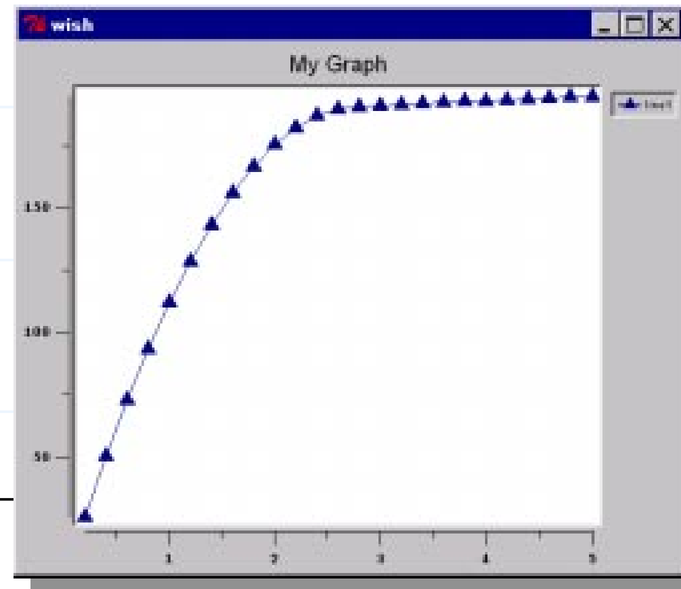
Graph widget

Create graph widget and add **data elements** with `element` operation.

X-Y coordinates are lists of numbers.

Assorted configuration options control element's appearance.

- **-symbol**
- **-linewidth**
- **-fill**
- **-outline**
- **-smooth**



Circle
Cross
Diamond
Plus
Splus
Scross
Square
Triangle
Bitmap

Symbol types

```
package require BLT
namespace import blt::*
graph .g -title "My Graph"
pack .g
.g element create line1 -symbol triangle \
   -xdata {0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 … } \
   -ydata {2.61825e+01 5.04696e+01 7.28517e+01 … }
```

Data elements

Represents a set of data. Symbols are the data points.

Usually drawn as a single trace.

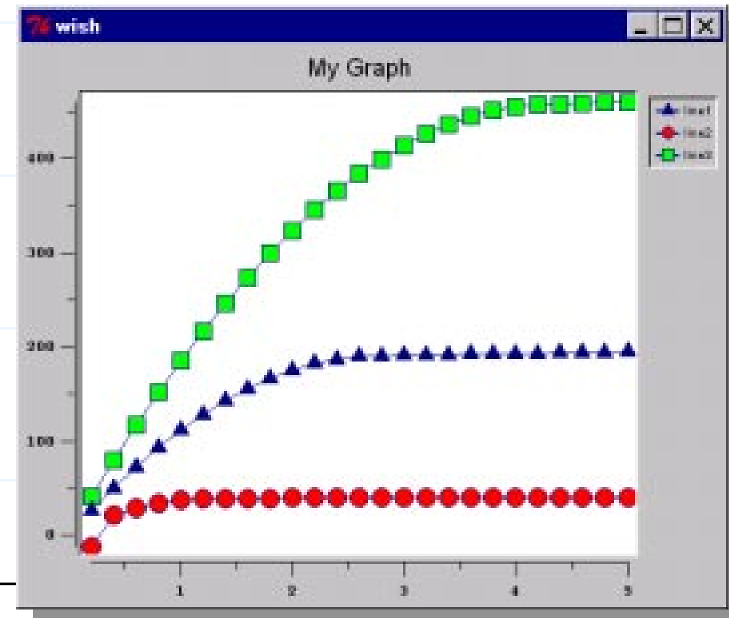
Each element has entry in legend.

Z-ordering

- First elements created sit on top of later.

Axes auto-scale

- Data determines range of axes.

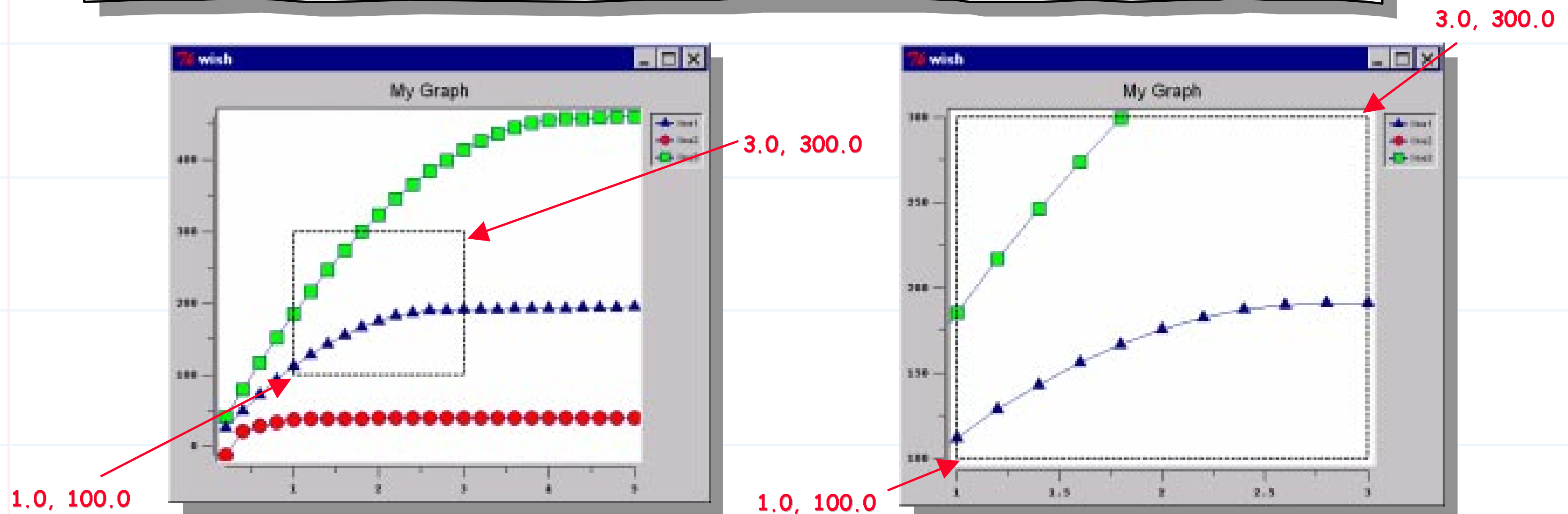



```
…
.g element create line2 -symbol circle -fill red \
   -xdata {0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 … } \
   -ydata {-1.14471e+01 2.09373e+01 2.84608e+01 … }
.g element create line3 -symbol square -fill green \
   -xdata {0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 … } \
   -ydata {4.07008e+01 7.95658e+01 1.16585e+02 … }
```

Zooming and scrolling

Graph's **axis** operation controls range of points displayed.

```
.g axis configure x -min 1.0 -max 3.0
.g axis configure y -max 100.0 -max 300.0
```



Graph is automatically redrawn displaying the selected range.

- Set **-min** and **-max** to the empty string to restore auto-scaling.

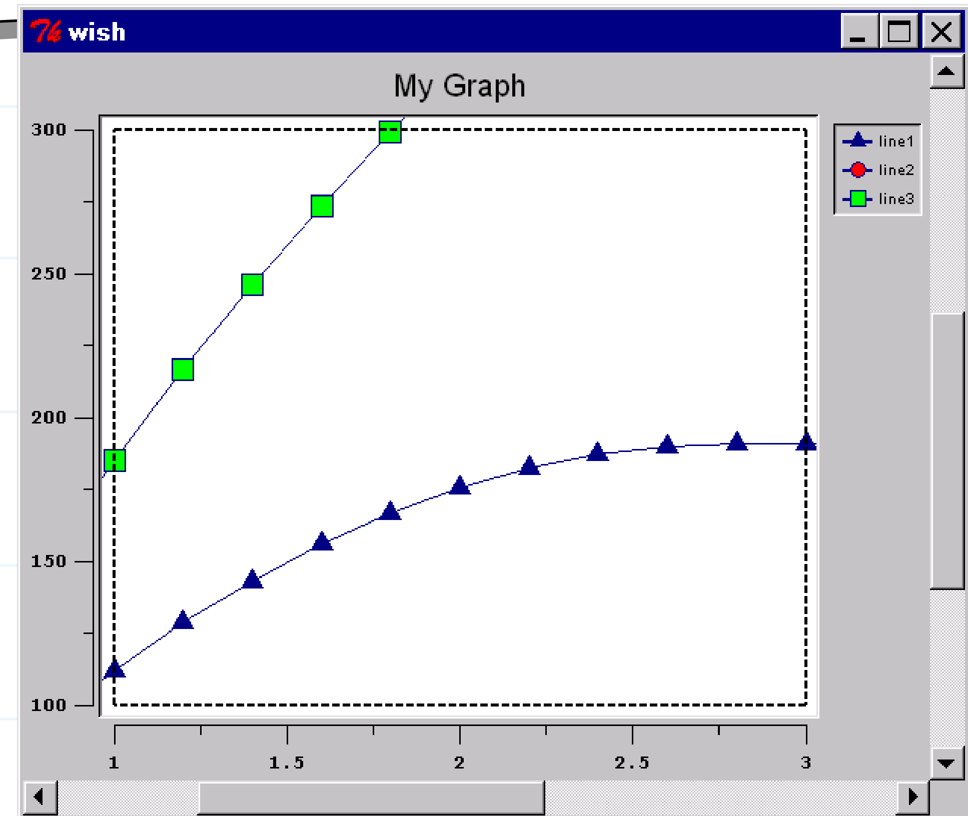
To scroll, add or subtract *same* amount from both min and max.

Scrolling (cont'd)

Can attach a scrollbar to any axis.

```
scrollbar .hs -command {.g axis view x } -orient horizontal
scrollbar .vs -command {.g axis view y } -orient vertical
.g axis configure x -scrollcommand { .hs set }
.g axis configure y -scrollcommand { .vs set }
```

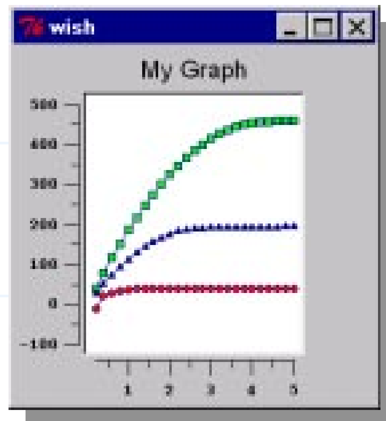
- Just like attaching scrollbar to any Tk widget.
- Viewport defined by the current **`-min`** and **`-max`** values.



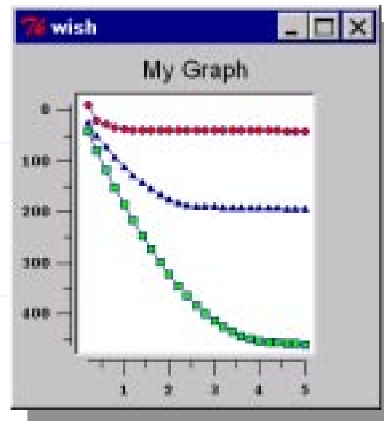
Customizing axes

Assorted options set appearance using **axis configure** operation.

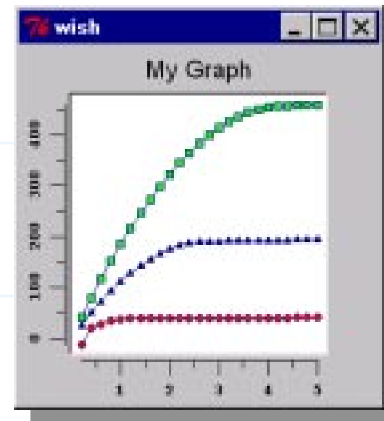
Changes made on Y-axis only.



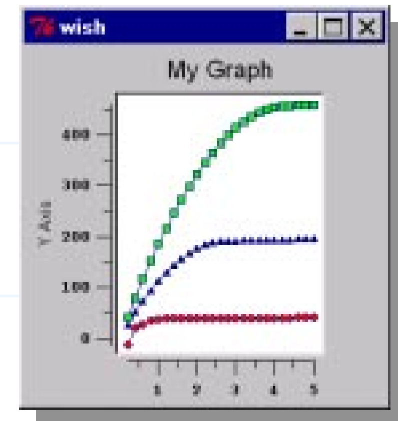
`-loose yes`



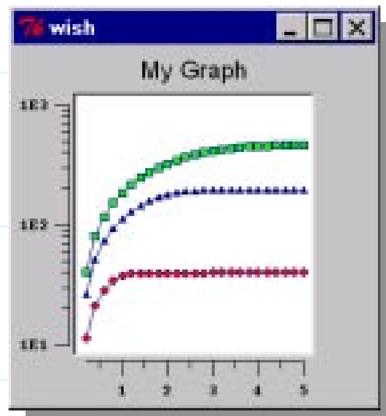
`-descending yes`



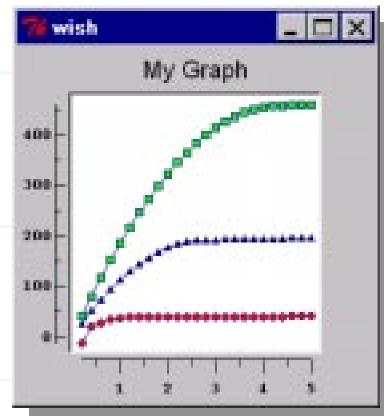
`-rotate 90`



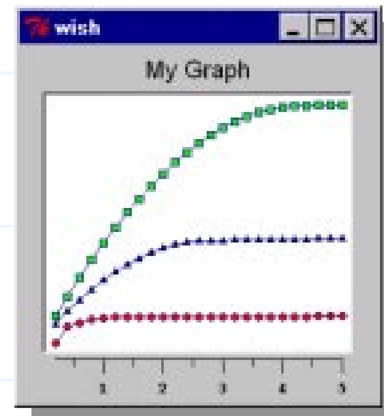
`-title "Y Axis"`



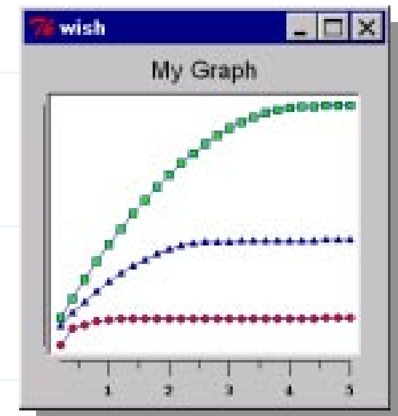
`-logscale yes`



`-ticklength -5`



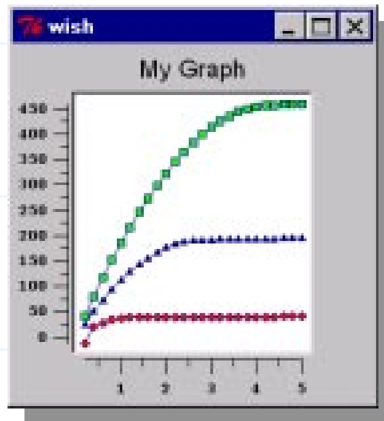
`-hide yes`



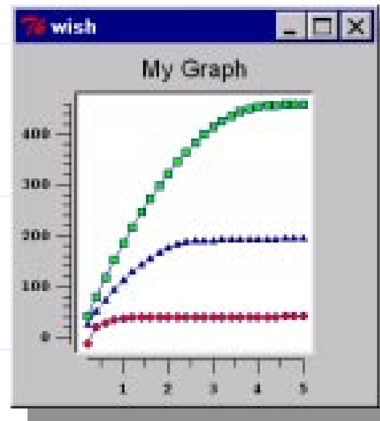
`-showticks no`

Customizing axes (cont'd)

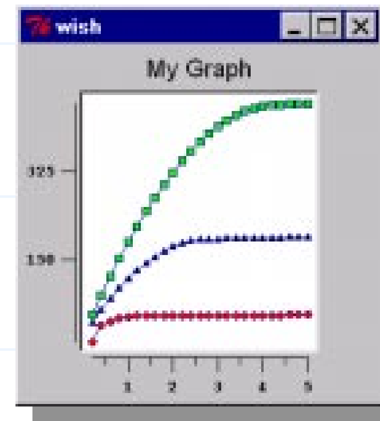
Tick positions and labels also controlled by axis configuration options.



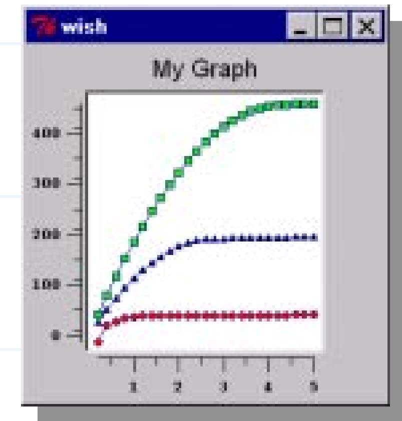
`-stepsize 50.0`



`-subdivisions 5`



`-majorticks {150 325}`

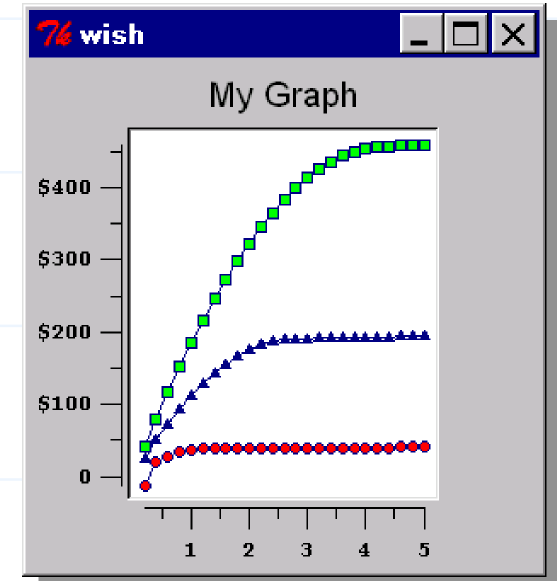


`-minorticks {.1 .5}`

Labels customized by specifying callback proc.

```
proc FormatTick { widget x } {
    if { $x != 0.0 } { return \$$x }
    return $x
}
.g axis configure y \
    -command FormatTick
```

Don't modify graph within callback proc.

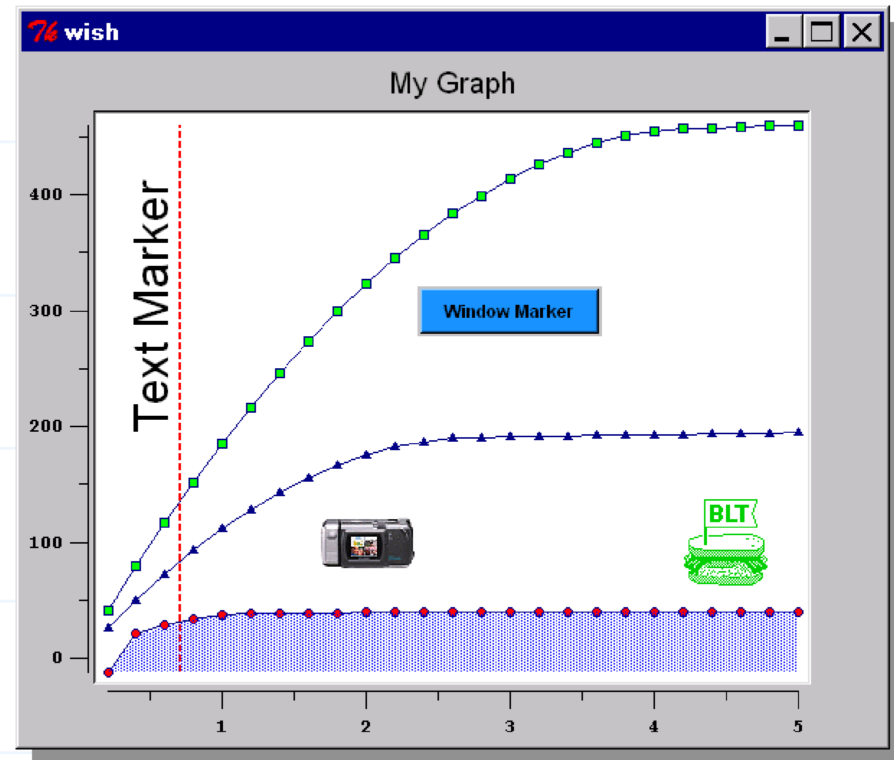


Annotations

Markers are used to highlight or annotate areas.

Six types of markers:

- text
- line
- polygon
- bitmap
- image
- window




```
.g marker create text -text "Text Marker" -rotate 90 \
    -coords { 0.5 300 } -font { Helvetica 20 }
.g marker create line -coords { 0.7 -Inf 0.7 Inf } \
    -dashes dash -linewidth 2 -outline red
image create photo myImage -file images/qv100.t.gif
.g marker create image -image myImage -coords {2.0 100.0}
button .g.button -text "Window Marker" -bg dodgerblue
.g marker create window -window .g.button -coords {3 300}
```

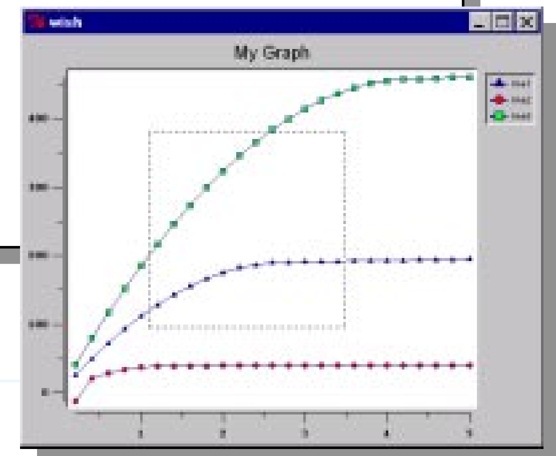
Marker positions in graph coordinates.

Example: Zooming graph

Already know how to zoom in/out of a graph.

```
proc Zoom { graph x1 y1 x2 y2 } {
    if { $x1 > $x2 } {
        $graph axis configure x -min $x2 -max $x1
    } elseif { $x1 < $x2 } {
        $graph axis configure x -min $x1 -max $x2
    }
    if { $y1 > $y2 } {
        $graph axis configure y -min $y2 -max $y1
    } elseif { $y1 < $y2 } {
        $graph axis configure y -min $y1 -max $y2
    }
}
proc Unzoom { graph } {
    $graph axis configure x y -min {} -max {}
}
```

Can configure more than one axis at a time.

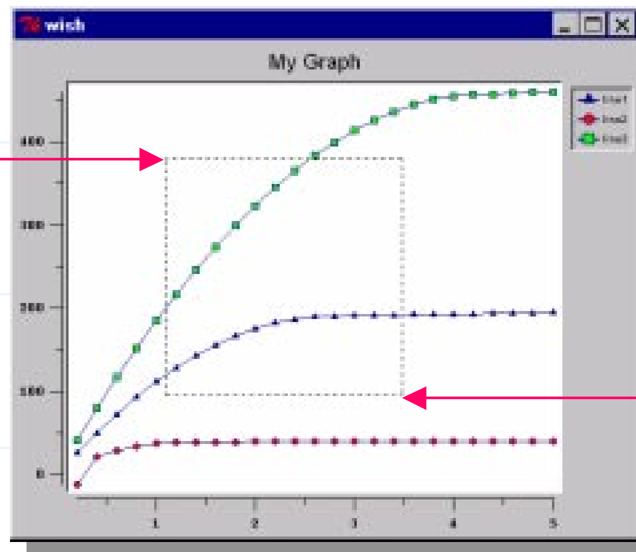


Zooming graph (cont'd)

Create user-selectable zoom region. Drawn with a line marker.

- ButtonPress-1 — Selects first corner of zoom region.
- B1-Motion — Draws outline. Position is opposite corner of region.
- ButtonRelease-1 — Deletes outline, zooms to selected region.

ButtonPress: Select 1st corner.



ButtonRelease: Select 2nd corner.

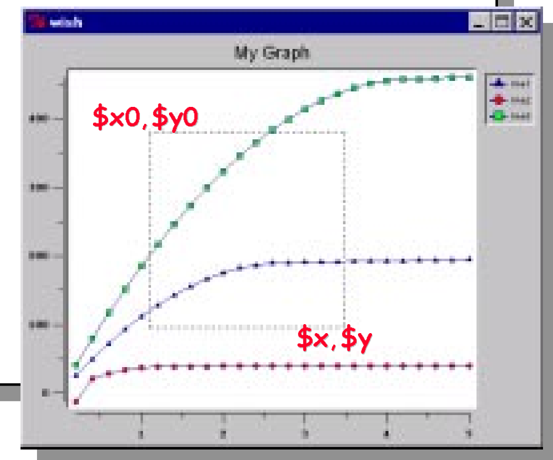
```
bind .g <ButtonPress-1>   { RegionStart %W %x %y }
bind .g <B1-Motion>       { RegionMotion %W %x %y }
bind .g <ButtonRelease-1> { RegionEnd %W %x %y }
bind .g <ButtonRelease-3> { Unzoom %W }
```

Zooming graph (cont'd)

```
proc RegionStart { graph x y } {
    global x0 y0
    $graph marker create line -coords { } -name myLine \
        -dashes dash -xor yes
    set x0 $x;  set y0 $y
}
proc RegionMotion { graph x y } {
    global x0 y0
    $graph marker coords myLine \
      "$x0 $y0 $x0 $y $x $y $x $y0 $x0 $y0"
}
proc RegionEnd { graph x y } {
    global x0 y0
    $graph marker delete myLine
    Zoom $graph $x0 $y0 $x $y
}
```

Markers without coordinates aren't drawn.

Name the marker, so we can refer to it.



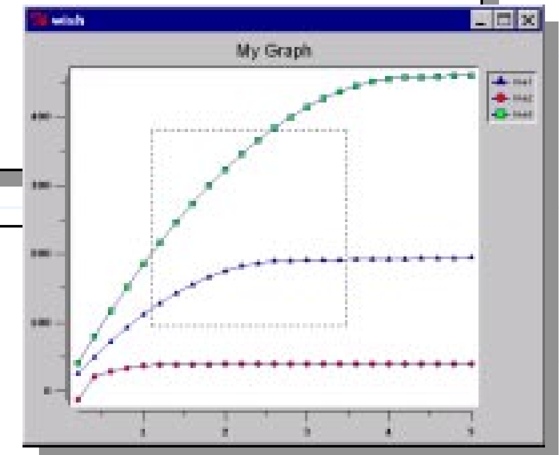
- First corner of region saved in global variables **x0** and **y0**.
- Line marker can be erased with redrawing graph with **-xor** option.
- Marker **coords** operation changes line coordinates.
- Delete marker when done.

Converting to/from graph coordinates

Example doesn't work. Need to translate **screen** to **graph** coordinates.

- Mouse location is in *screen* coordinates (relative to the widget).
- Markers are positioned in *graph* coordinates.

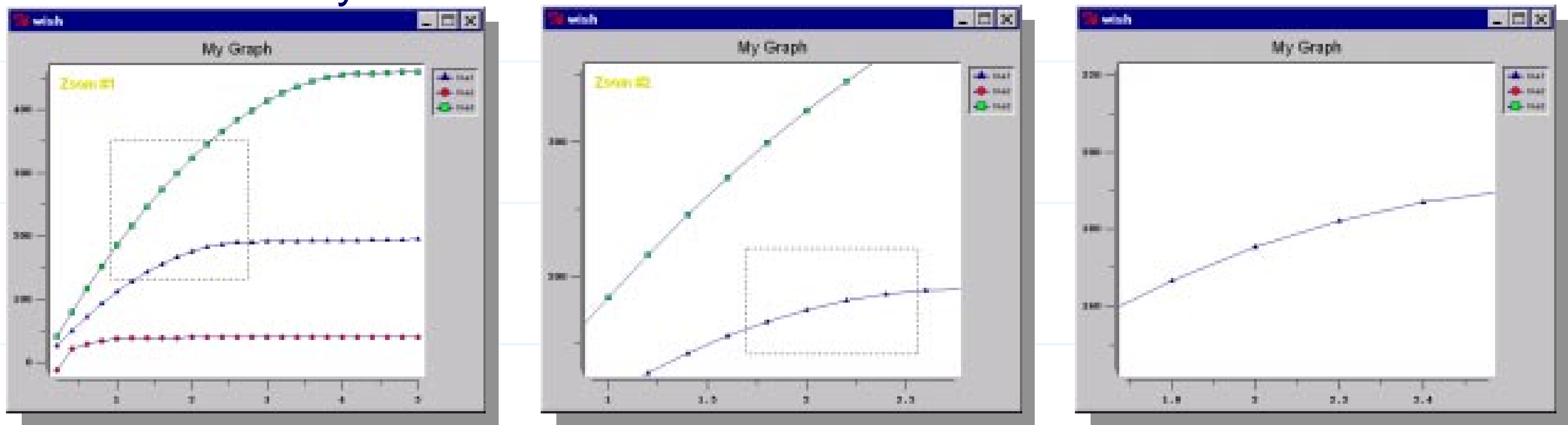
```
# Screen to graph coordinates
set graphX [.g axis invtranform x $screenX]

# Graph to screen coordinates
set screenX [.g axis transform x $graphX]
```




```
proc RegionStart { graph x y } {
    set x [$graph axis invtransform x $x]
    set y [$graph axis invtransform y $y]
    …
}
proc RegionMotion { graph x y } {
    set x [$graph axis invtransform x $x]
    set y [$graph axis invtransform y $y]
    …
}
```

Zooming graph (cont'd)

Can recursively zoom further and further in.



Add feature: Stack zoom levels so user can pop back to previous zoom.

```
set zoomStack {}
proc Zoom { graph x1 y1 x2 y2 } {
     PushZoom $graph
     …
     busy hold $graph ; update ; busy release $graph
}
proc Unzoom { graph } {
     if { ![EmptyZoom] } { eval [PopZoom] }
     busy hold $graph ; update ; busy release $graph
}
```

Use Tcl list as zoom stack.

Busy command prevents accidental zoom/unzoom.

Zooming graph (cont'd)

Create zoom stack. Push/pop graph commands to restore axis ranges.

```
proc PushZoom { graph } {
    global zoomStack
    set x1 [$graph axis cget x -min]
    set x1 [$graph axis cget x -max]
    set y1 [$graph axis cget y -min]
    set y2 [$graph axis cget y -max]
    set cmd "$graph axis configure x -min $x1 -max $x2 ;
      $graph axis configure y -min $y1 -max $y2"
    lappend zoomStack $cmd
}
proc PopZoom {} {
    global zoomStack
    set cmd [lindex $zoomStack end]
    set zoomStack [lreplace $zoomStack end end]
    return $cmd
}
proc EmptyZoom {} {
    global zoomStack
    expr {[llength $zoomStack] == 0}
}
```

Get current axis ranges.

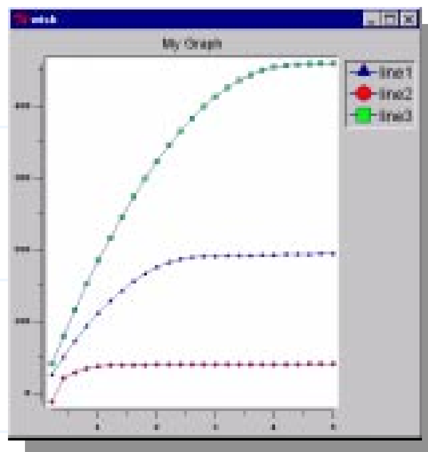
Stack commands to restore to current zoom level.

Pop last command off and remove it.

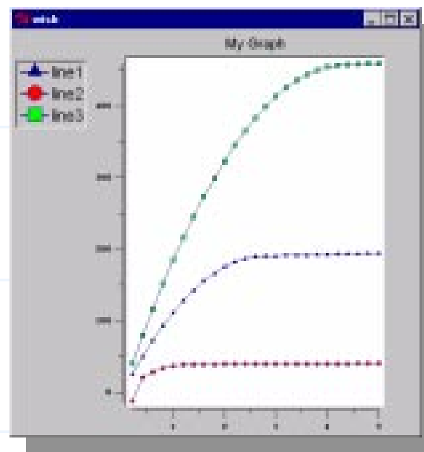
Legend

legend component controls position/appearance of legend.

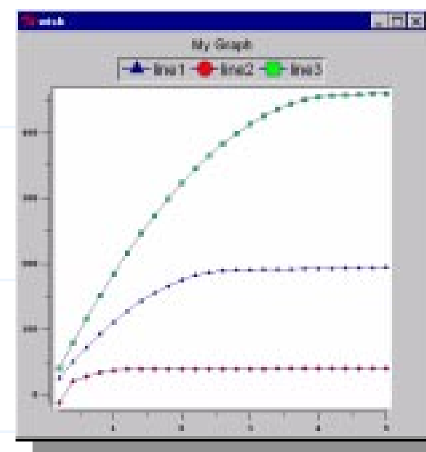
graph **legend configure** *?option value...?*



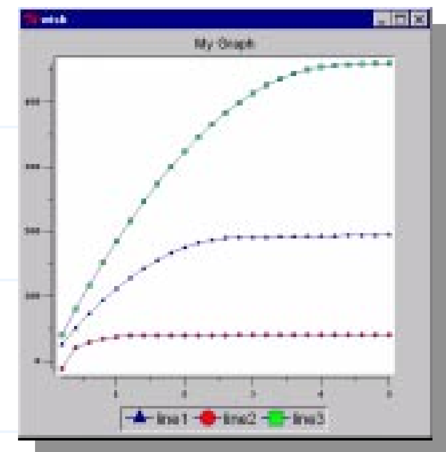
-position right



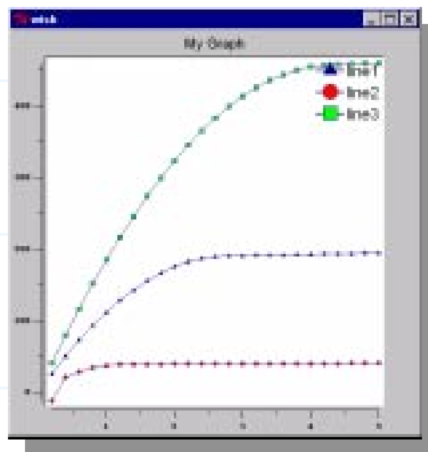
-position left



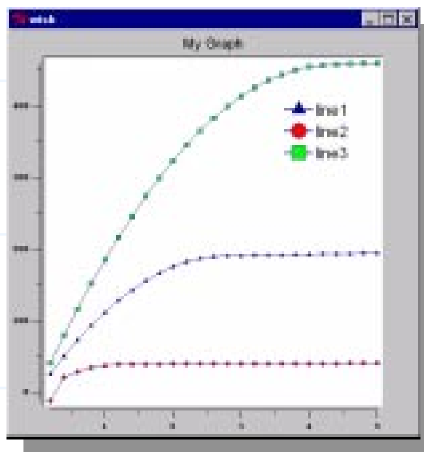
-position top



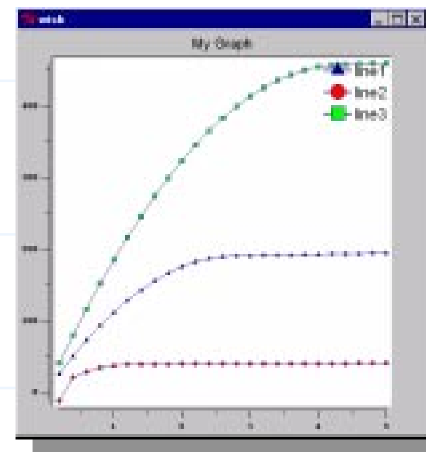
-position bottom



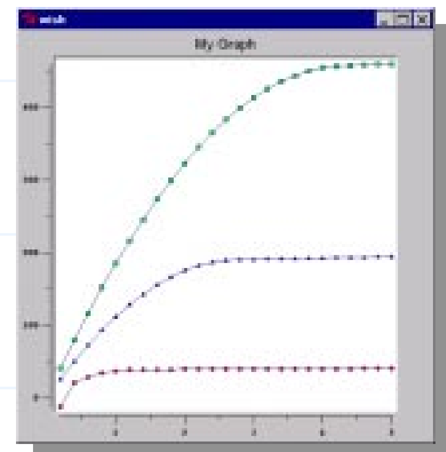
-position plotarea



-position @450,100



-raised yes

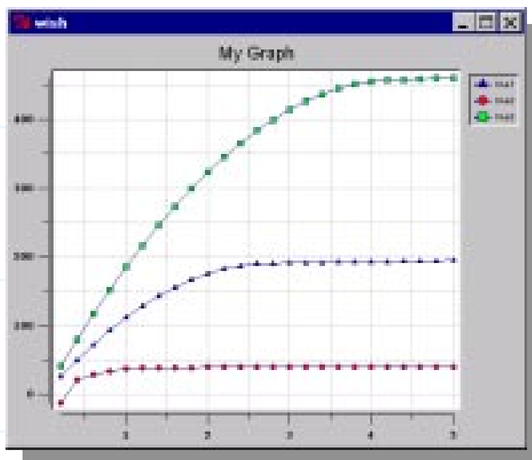


-hide yes

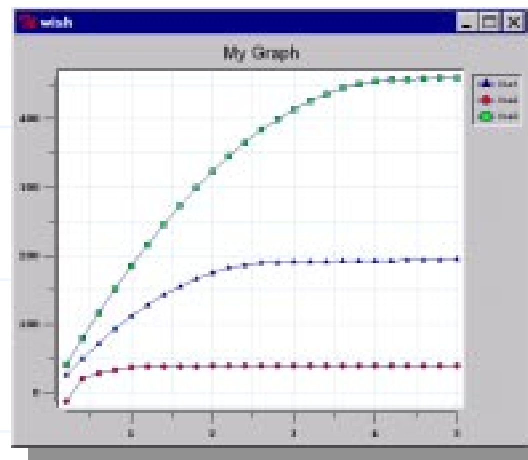
Grids

`grid` component controls appearance of built-in grid.

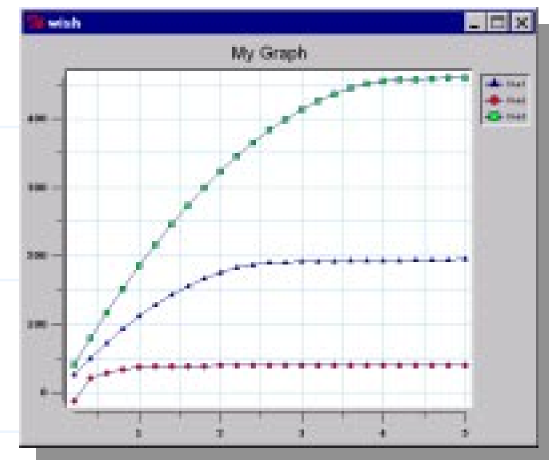
- Extensions of major/minor ticks of each axis running across the plotting area.



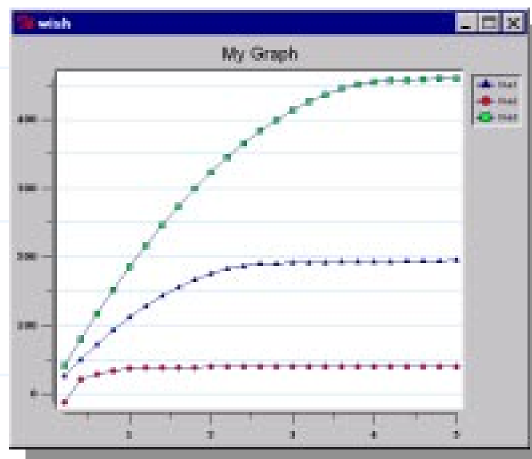
`-hide no`



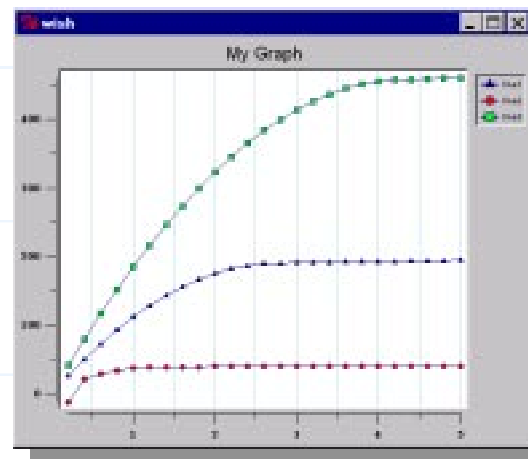
`-color lightblue`



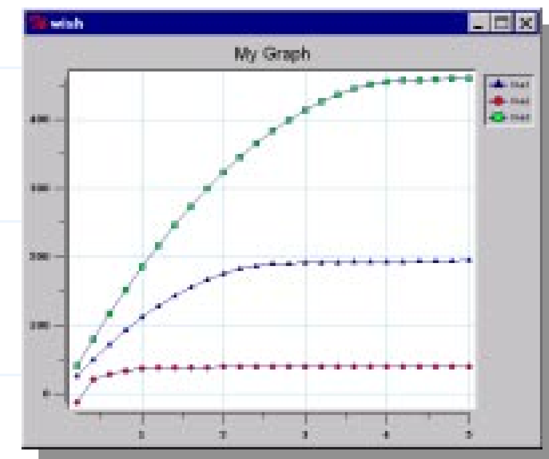
`-dashes 0`



`-mapx {}`



`-mapy {}`

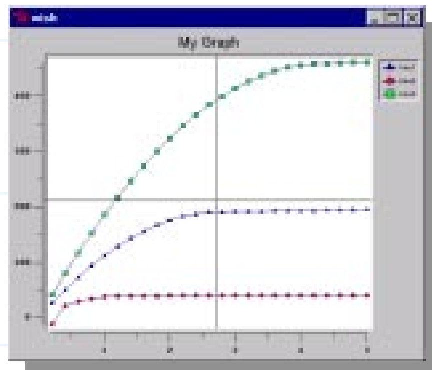


`-minor no`

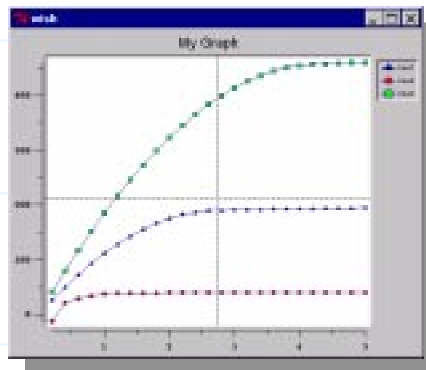
Crosshairs

crosshairs component controls position/appearance of crosshairs.

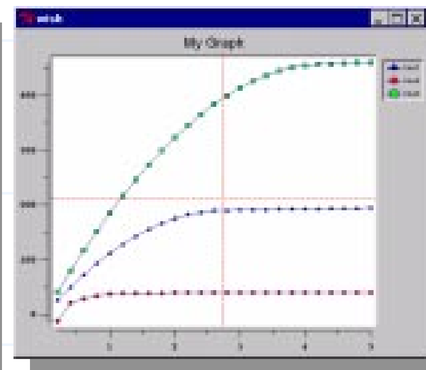
- Two intersecting lines (one vertical and one horizontal) running across plotting area.
- Used to finely position mouse in relation to coordinate axes.



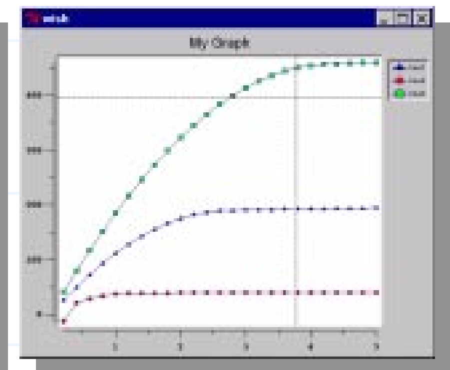
-hide no



-dashes dash



-color red



-position @450,100

```
.g crosshairs on
.g crosshairs configure -color red -dashes 2

bind .g <Motion> {
    .g crosshairs configure -position @%x,%y
}
```

Interactive graphs

Zooming graph example of interactive graph.

All graph widgets/plotting packages draw graphs.

- Convert data points to screen pixels.
- Graphs *better* on paper. Higher resolution.

Two-way communication (back annotation) lets graph become powerful tool.

- Convert screen coordinates back to data points.
- Examples: identify data points, compute slopes, area under curve, etc.

Identifying data points

Elements have **closest** operation to identify points/traces.

graph **element closest** *x y varName ?options? ?elemName…?*

Returns "1" if a closest element is found, otherwise "0".

Writes information into a Tcl array variable.

- **name** Name of closest element.
- **dist** Distance from element.
- **index** Index of closest data point.
- **x** and **y** The X-Y graph coordinates of the closest point.

```
.g element closest 300 400 myInfo
.g element closest 200 400 myInfo -halo 1.0i
.g element closest 1 40 myInfo -interpolate yes
.g element closest 20 10 myInfo line2 line1

puts "$myInfo(name) is closest at $myInfo(index)"
```

Options:

- **-halo** Selects cut-off radius from screen coordinate.
- **-interpolate** Search for closest point on trace, not just data points.

Binding to graph components

You can **bind** to elements, markers, and legend entries.

```
.g element bind line1 <Enter> {
    puts "Touched element"
}
.g marker bind myLine <Enter> {
    puts "Touched marker"
}
.g legend bind line1 <ButtonPress-1> {
    puts "selected line1"
}
```

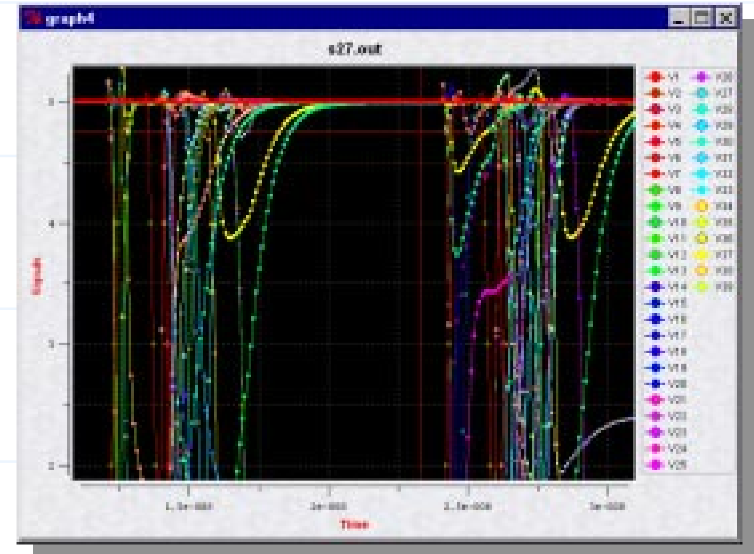
Each component has its own **bind** operation.

- Similar to binding to canvas items.
- Can bind to mouse and key events, create binding tags, etc.

Find currently selected item using **get** operation.

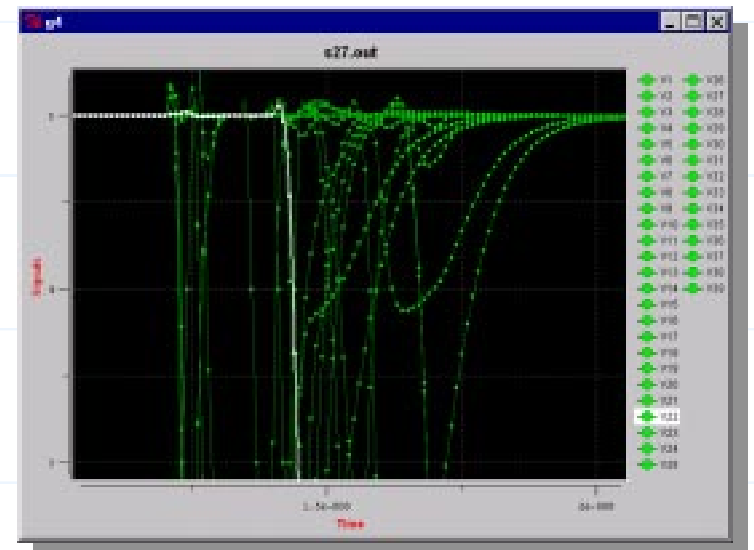
```
set elem [.g element get current]
set marker [.g marker get current]
set elem [.g legend get current]
```

Example: active legend



How do you display many elements?

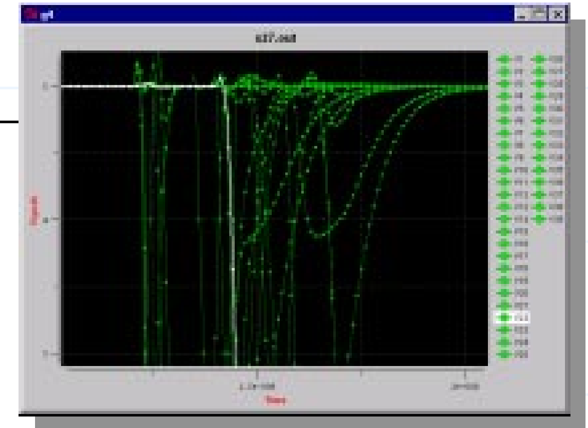
- Typical to have lots of elements.
- Rotating colors/line styles doesn't help.
- Clutter hides behavior of data.



Let user interactively highlight elements.

- Draw all elements the same style.
- Moving mouse over element highlights legend entry.
- Clicking on entry highlights its element.

Active legend (cont'd)



```
.g element bind all <Shift-Enter> {
    Highlight %W [%W element get current]
}
.g element bind all <Shift-Leave> {
    Unhighlight %W [%W element get current]
}
.g legend bind all <ButtonPress-1> {
    Highlight %W [%W legend get current]
}
.g legend bind all <ButtonRelease-1> {
    Unhighlight %W [%W legend get current]
}
```

Binding tag **all** is automatically set for elements, markers, legend entries.

Can include/exclude tags with **-bindtags** configuration option.

```
.g element configure line1 -bindtags { myTag all }
.g marker configure myLine -bindtags { myTag all }
```

- Element and marker tags reside in different tables.
- Legend uses element's tags.

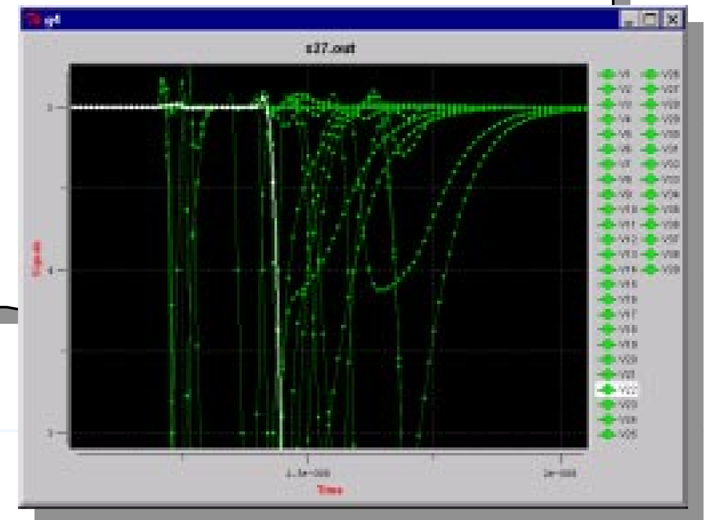
Active legend (cont'd)

Both legend and elements have **activate** and **deactivate** operations.

When active:

- Legend entry drawn with **-activebackground** color.
- Element is drawn with active colors, on top of plot (regardless of Z-order).

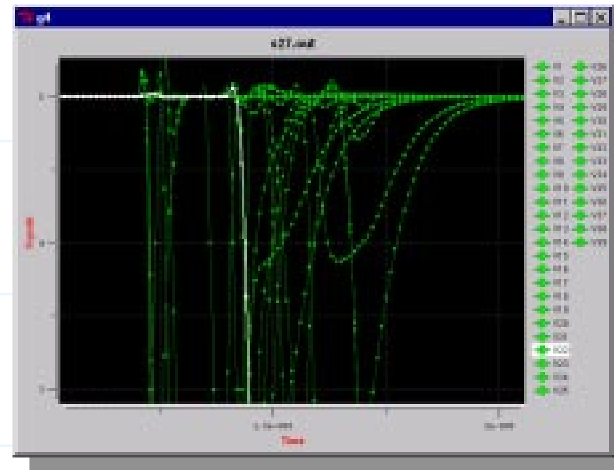
```
proc Highlight { graph elem } {
    $graph element activate $elem
    $graph legend activate $elem
}
proc Unhighlight { graph elem } {
    $graph element deactivate $elem
    $graph legend deactivate $elem
}
```



Data handling

Managing large sets of X-Y coordinate data as Tcl lists is slow, cumbersome.

- Doesn't scale. Ok for demos, not for real life problems.



39 elements
361 x-values
361 y-values

28,158 String-to-double conversions

Don't they all have the same x-values?

Problems:

- Two representations of data.
  - ✓ Tcl lists representing X and Y coordinate vectors.
  - ✓ Internal binary format (doubles) stored in graph widget.
- String-to-binary conversions are expensive.
  - ✓ Often, data starts in binary format. Converted to strings, just to be converted back to doubles.
- Widget doesn't have data analysis operations.
  - ✓ Data *trapped* inside of widget.

Vectors

Vector is a *data object*.

- Represents array of doubles.

Access data via either Tcl command or array variable.

- Creating vector automatically creates both new Tcl command and array.

New Tcl command by the same name as vector is created.

```
vector create x
x set { 0 1e-10 2e-10 3e-10 4e-10 5e-10 6e-10 7e-10 8e-10
   9e-10 1e-09 1.1e-09 1.2e-09 1.3e-09 1.4e-09 1.5e-09 … }
puts [x length]
puts $x(0)
```

Variable by the same name as vector is also created

Recognized by graph widgets.

- Can be used instead of lists of numbers.
- Graph automatically redraws when vector is changed.
- Data is shared. More than one graph can use same vector.

```
vector create x
vector create y
x set {…}
y set {…}
.g element configure -xdata x -ydata y
```

Vectors: array interface

Can access vector data via Tcl array variable.

- Arrays indexed by integers, starting from 0.
- Special indices (user-defined ones can be added):

end	Returns the last value.
++end	Automatically appends new slot to vector. Index of new slot.
min	Returns the minimum value.
max	Returns the maximum value.

- Range of elements can be specified (with colons).

```
vector create x(50)
set x(0) 20.0
set x(end) 30.0
set x(++end) 31.0
puts "Range of values: $x(min) to $x(max)"
puts "First twenty values are $x(0:19)"
set x(40:50) -1
```

Can specify initial vector size.
All values default to 0.0.

Vectors: command interface

Tcl command associated with vector has several operations:

- **append** Appends the lists of values or other vectors.
- **binread** Reads binary data into vector.
- **delete** Deletes elements by index.
- **dup** Creates a copy of vector.
- **expr** Computes vector expressions.
- **length** Queries or resets number of elements.
- **merge** Returns list of merged elements of two of more vectors.
- **range** Returns values of vector elements between two indices.
- **search** Returns indices of a specified value or range of values.
- **seq** Generates a sequence of values.
- **sort** Sorts the vector. If other vectors are listed, rearranged in same manner.
- **variable** Maps a Tcl variable to vector.

```
proc myProc { vector } {
    $vector variable x
    set x(0) 20.0
    set x(end) 30.0
}
```

Kind of like "upvar". Remaps the vector's variable to the local variable "x".

Vectors: expressions

Vector's **expr** operation does both scalar and vector math.

- Arithmetic operators `+- * / ^ %`
- Logic operators `== != ! && || < > <= >=`
- Math functions `abs acos asin atan ceil cos cosh exp floor hypot log log10 sin sinh sqrt tan tanh`
- Addition functions `adev kurtosis length max mean median min norm prod q1 q3 random round srandom sdev skew sort var`

```
x expr { x + 1 }
x expr { x + y }
x expr { x * (y + 1)}
x expr { sin(x) + cos(y) + sin($number) }

set sum [vector expr sum(x)]
```

Can build data analysis routines from vector expressions.

- Fast. Computes vector expressions in C, not Tcl.

Graphs and vectors

Graph widgets accept vectors instead of Tcl lists for data.

```
vector create x
vector create y
graph .g1
graph .g2
.g1 element create line1 -xdata x -ydata y
.g2 element create line1 -xdata x -ydata y
```

- Two different graphs can share the same vectors.

Graphs automatically notified/redrawn when vector changes.

```
set x(0) 2.0
set y(0) 3.2
```

- No code needed to reconfigure the graph elements.

Vectors: C API

C API also exists for vectors.

- Read data from special file format.
- Custom data analysis routines.
- Fast graph updates.

Example: Load data from C.

- Add new Tcl command **LoadData** to call vector C API.

```
vector create x
vector create y
graph .g
.g element create line1 -xdata x -ydata y
…
LoadData x y
```

Use two vector C API functions:

Blt_GetVector	Retrieves an existing vector.
Blt_ResetVector	Resets the vector data and notifies graphs.

Example: writing to vectors

```
#include "tcl.h"
#include "blt.h"
static int
LoadDataCmd(ClientData clientData, Tcl_Interp *interp, int argc, char **argv)
{
   Blt_Vector *xVec, *yVec;
   double *x, *y;
   if (Blt_GetVector(interp, argv[1], &xVec) != TCL_OK) {
          return TCL_ERROR;
   }
   if (Blt_GetVector(interp, argv[2], &yVec) != TCL_OK) {
          return TCL_ERROR;
   }
   x = (double *)malloc(sizeof(double) * 1000);
   y = (double *)malloc(sizeof(double) * 1000);
   /* Fill the arrays */
   if (Blt_ResetVector(interp, xVec, x, 100, 1000, TCL_DYNAMIC) != TCL_OK) {
          return TCL_ERROR;
   }
   if (Blt_ResetVector(interp, yVec, y, 100, 1000, TCL_DYNAMIC) != TCL_OK) {
          return TCL_ERROR;
   }
   return TCL_OK;
}
```

argv[1] is "x"

argv[2] is "y"

Arrays of doubles.

elements used.

elements in array.

Example: reading from vector

Vector token really pointer to actual vector, not a copy (so be careful).

Use macros to access vector fields:

- **Blt_VecData, Blt_VecLength, Blt_VecSize**

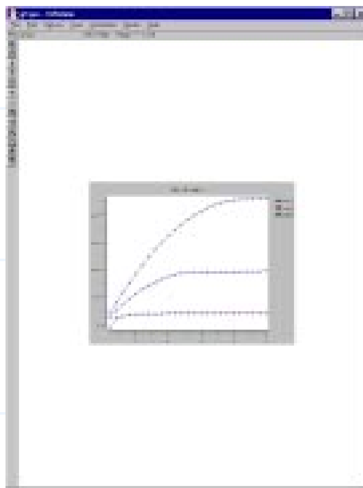
```
#include "tcl.h"
#include "blt.h"
static int
GetDataCmd(ClientData clientData, Tcl_Interp *interp, int argc, char **argv)
{
   Blt_Vector *xVec;
   double *x;
   int size, length, n;
   if (Blt_GetVector(interp, argv[1], &xVec) != TCL_OK) {
         return TCL_ERROR;
   }
   x = Blt_VecData(xVec);
   length = Blt_VecLength(xVec);
   size = Blt_VecSize(xVec);
   for (n = 0; n < length; n++) {
     /* Do something with data */
     printf("#%d is %f\n", n, x[n]);
   }
   printf("There are %d free slots left\n", size - length);
   return TCL_OK;
}
```

If you change the array, you must call Blt_ResetVector.

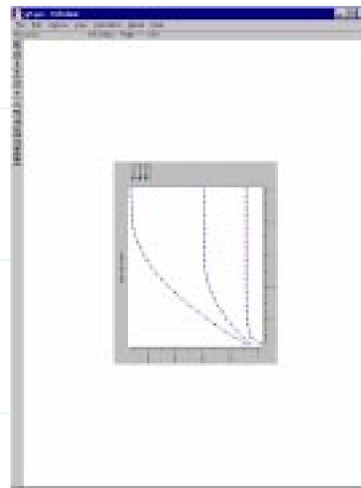
Printing graphs

Graph's **postscript** operation generates encapsulated PostScript.

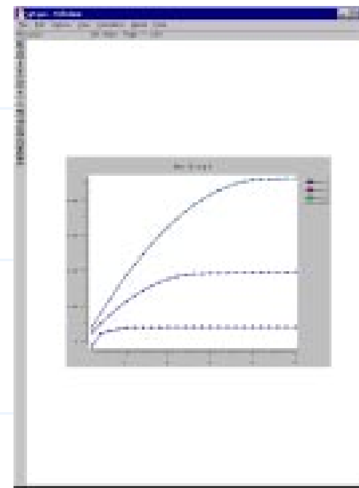
```
.g postscript configure -landscape yes -maxpect yes
.g postscript output myFile.ps
```



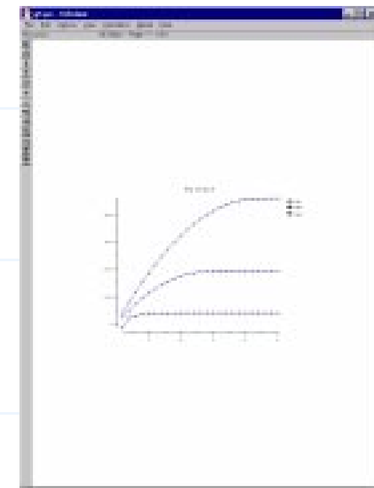
-center yes



-landscape yes



-maxpect yes



-decorations no

- File name is optional. PostScript is returned as the result of **output** operation.
- Other options control graph, border, and paper size.

Printing under Windows 95/NT

printer command lets you send raw EPS to a PostScript printer.

```
set output [.g postscript output]
set pid [printer open {QMS ColorScript 100 v49.4}]
printer write $pid $output
printer close $pid
```

Query printer settings with **getattr** operation. Written to array variable.

```
set pid [printer open {QMS ColorScript 100 v49.4}]
printer getattr $pid myArray
puts "Paper size is $myArray(PaperSize)"
puts "Page orientation is $myArray(Orientation)"
```

Adjust printer settings with **setattr** operation.

```
set myArray(PaperSize) Letter
set myArray(Orientation) Landscape
printer setattr $pid myArray
printer write $pid $output
printer close $pid
```

Printing to non-PS printers

Graph has two Windows-specific print operations (still experimental).

print1

- Write bitmap image to printer.
- Usually works regardless of printer capabilities.
- Poorer quality. Jagged lines and fonts.

print2

- Draws directly to print device.
- Might not work on all printers.
- Quality is much better.

```
set pid [printer open {QMS ColorScript 100 v49.4}]
.g print1 $pid
printer close $pid

set pid [printer open {QMS ColorScript 100 v49.4}]
.g print2 $pid
printer close $pid
```

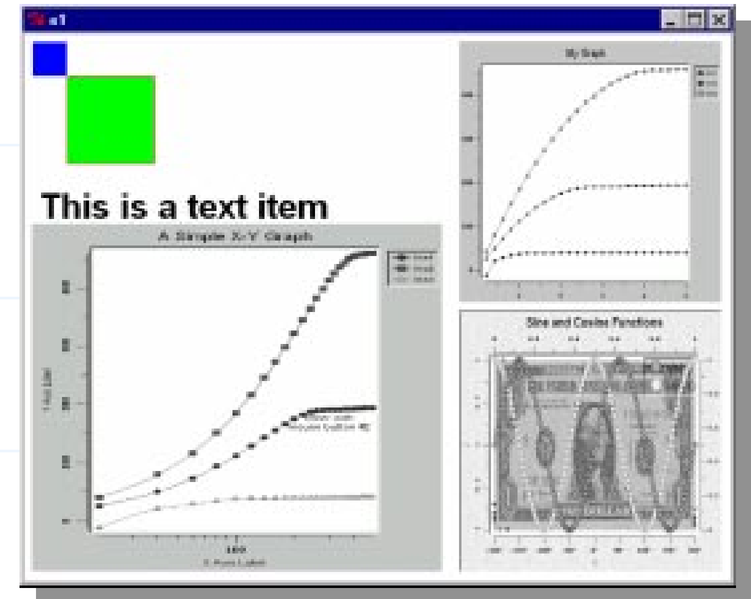
Customized printing

How do I tile graphs on a single a page?

- Graph outputs only a single plot.

New **eps** canvas item places EPS files.

- Reads preview image format output by graph.
- Prints item using encapsulated PostScript, not screen image.
- EPS is scaled/translated accordingly to match canvas item.
- Use canvas code as template for tiling, etc.
- Regular canvas items for annotations.




```
canvas .c -width 6.75i -height 5.25i -bg white
.c create eps 10 620 -file xy.ps -anchor sw
.c create eps 500 10 -file g1.ps -width 300 -height 300
.c create eps 500 320 -file out.ps -width 300 -height 300
.c create text 20 200 -text "This is a text item" \
        -anchor w -font { Helvetica 24 bold }
.c create rectangle 10 10 50 50 -fill blue
.c create rectangle 50 50 150 150 -fill green -outline red
```

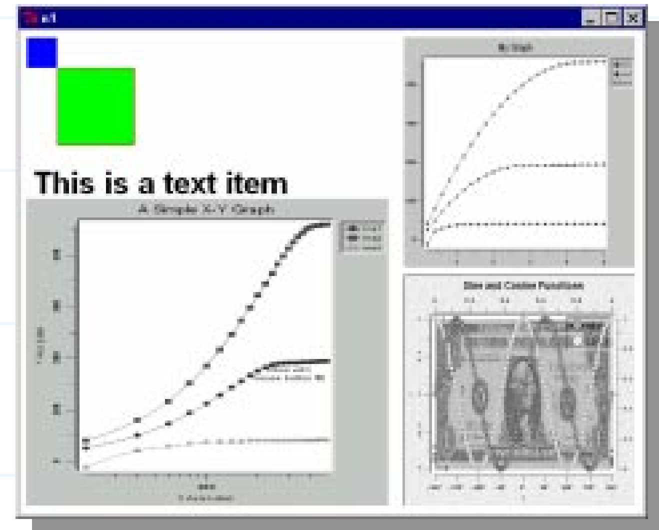
EPS item (cont'd)

eps item usually drawn as filled rectangle on canvas.

- Ok for tiling or page templates.
- Not very good for interactive layout.

But can also display EPSI preview image.

- Poorer quality: bitmap or grayscale (graph only).
- Must generate preview for EPS file.



Better: use Tk photo image.

- Full color image.
- Must supply photo image for **eps** item to display.
- Use graph's **snap** operation to get snapshot of graph.

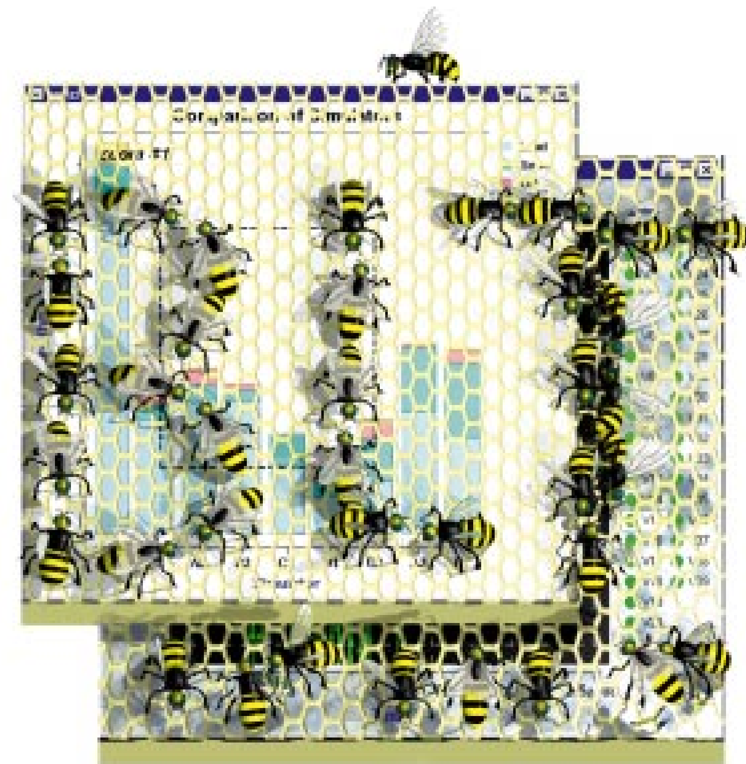
Better than snapping graph window.

```
set image [image create photo]

.g snap $image
.g postscript output myFile.ps
.c create eps 500 10 -file myFile.ps -image $image
```

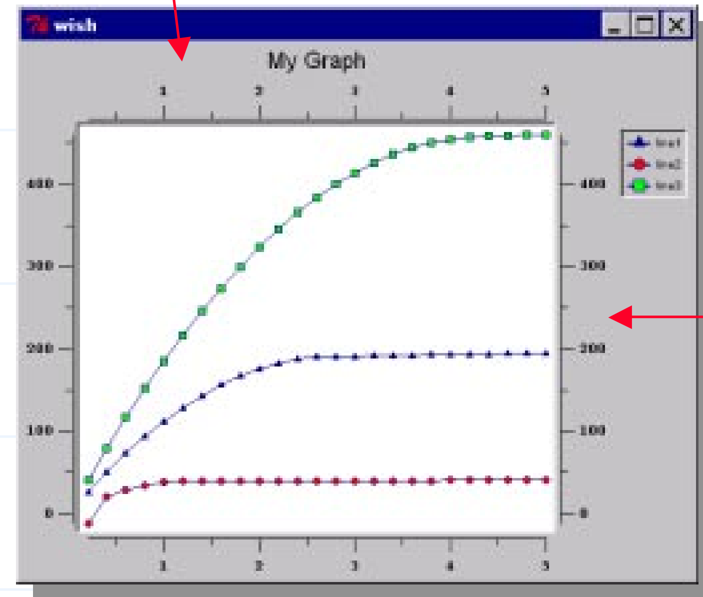
Image of graph drawn into photo.

Graph: advanced features

- Mirror axes.
- Virtual axes.
- Pens and weights.
- Controlling graph margins.



x2



y2

Graph: advanced features

Can display more than 2 axes.

- Axis names are **x**, **y**, **x2**, and **y2**.
- **x2** and **y2** are hidden by default.

Elements, markers, and grids are mapped to specific axes.

- Mapped to **x** and **y** by default.
- **-mapx** and **-mapy** switch axes.

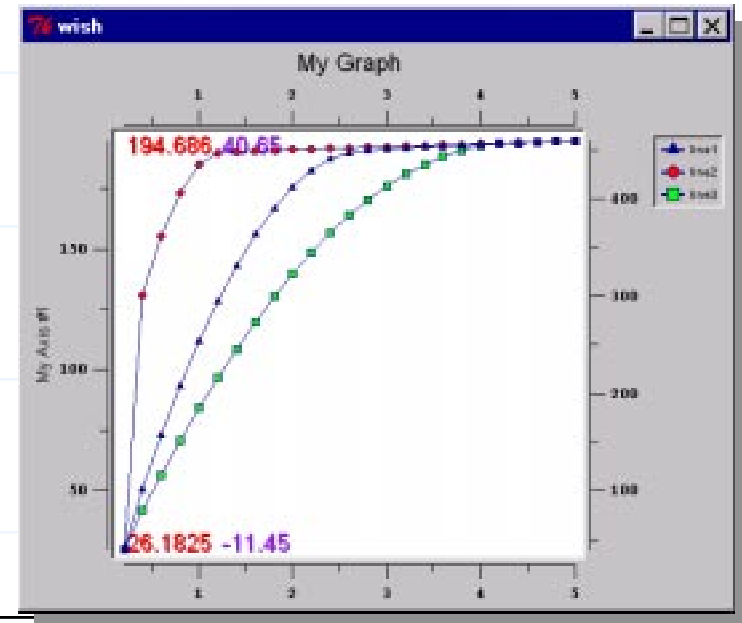
```
.g axis configure x2 y2 -hide no
.g element configure line1 -mapx x2 -mapy y2
.g marker configure myLine -mapx x2 -mapy y2
.g grid configure -mapx x2 -mapy y2
```

Mirror axes: Use **axis limits** operation to get current axis range.

```
set lx [.g axis limits x]
set ly [.g axis limits y]
.g axis configure x2 -min [lindex $lx 0] -max [lindex $lx 1]
.g axis configure y2 -min [lindex $ly 0] -max [lindex $ly 1]
```

Returns list of min and max limits.

Advanced features (cont'd)



Graph also supports **virtual axes**.

- Create any number of new axes.
- Axis minimum and maximum displayed in plotting area.
- Limits string is floating-point format descriptor.
- Can replace normal axes with **xaxis**, **yaxis**, **x2axis**, and **y2axis** operations.
- **use** operation maps one or more axes.

```
.g axis create axis1 -title "My Axis #1" -limits "%g" \
    -limitscolor red -limitsshadow red4
.g axis create axis2 -limits "%4.2f" -limitscolor purple \
    -limitsshadow purple4
.g axis configure axis1 axis2 -limitsfont {Helvetica 12}

.g element configure line1 -mapy axis1
.g element configure line2 -mapy axis2

.g xaxis use axis1
```

Advanced features (cont'd)

Each element has its own default **pen**.

- Represents element's symbol, color, line style, etc.

Can create new pens and swap them in/out of elements.

```
.g pen create pen1 -symbol circle -color blue -linewidth 2
.g pen create pen2 -symbol cross -color red

.g element configure line1 -pen pen1
.g element configure line2 -pen pen2

.g pen configure pen1 -color yellow
```

Element is redrawn with new color.

All elements use a standard "active" pen (`activate` operation).

- `activeLine` graph, stripchart widgets
- `activeBar` barchart

```
.g pen configure activeLine -linewidth 0 -symbol square
.g element configure -activepen pen1
```

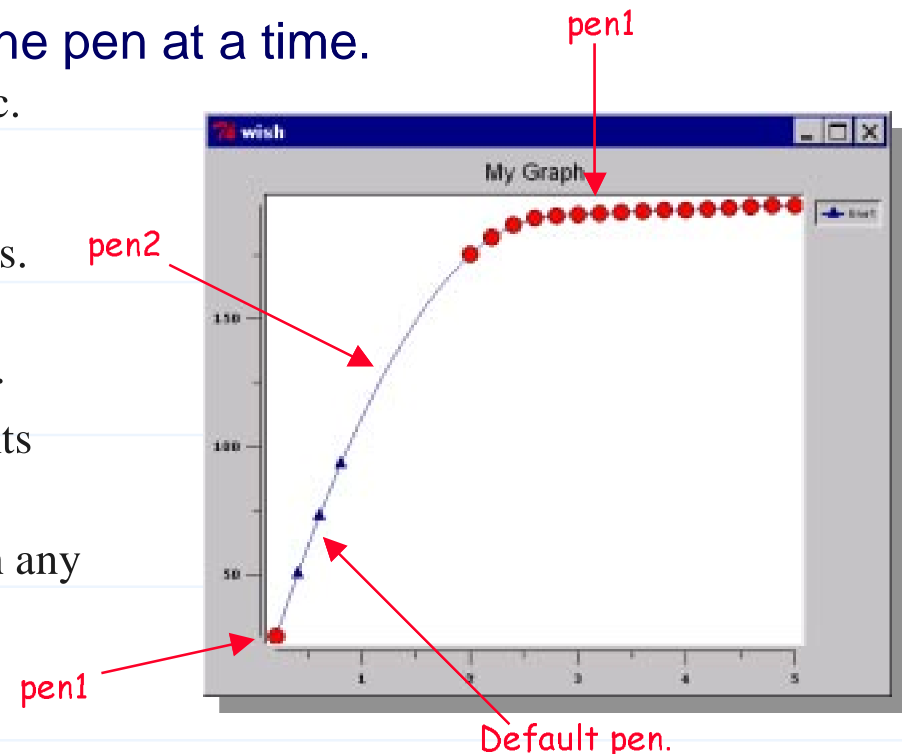
Advanced features (cont'd)

Data elements can use **more** than one pen at a time.

- Highlight outliers, unexpected values, etc.

Each element has a **weight** vector.

- Weight values correspond to a data points.
- Set **`-weight`** option. Like **`-xdata`** or **`-ydata`** options, takes vector or Tcl list.
- **`-styles`** option maps pens to data points according to weight value.
- Default pen used if weight doesn't match any range.



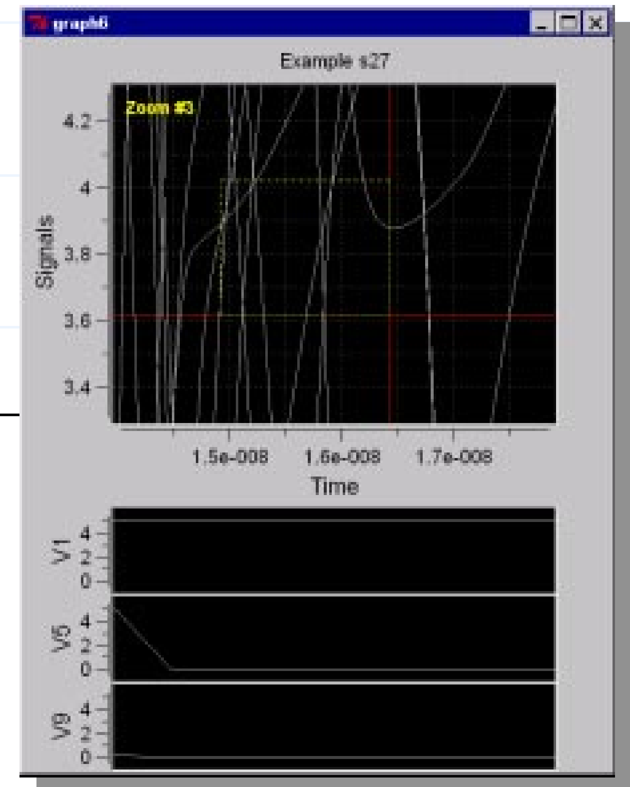

```
.g pen create pen1 -color red -symbol circle -outline black
.g pen create pen2 -symbol none

.g element configure line1 -weight y -styles {
    {pen1 -5 50} {pen2 100 175} {pen1 175 500}
}
```

Advanced features (cont'd)

Margins automatically calculated (based on axis values, etc.)

Sometimes want to override computed values:

- You can reset margins with **-leftmargin**, -**rightmargin**, **-topmargin**, and **-bottommargin** graph configuration options.
- Useful when displaying graphs side-by-side.



To determine current margin:

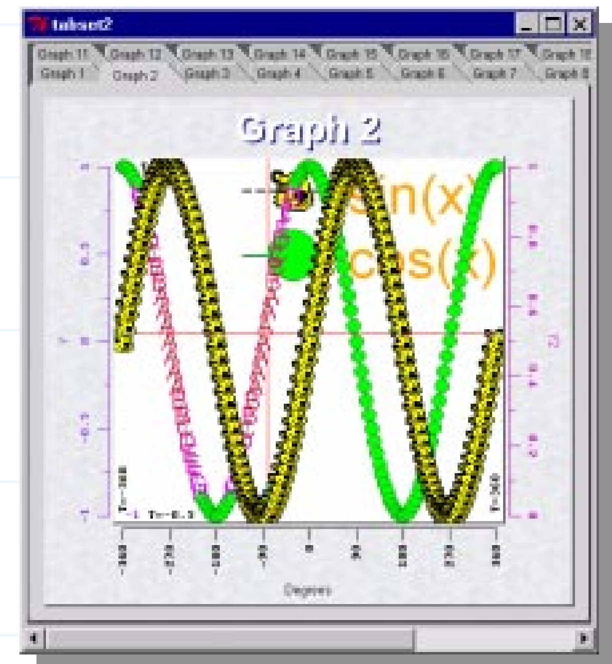
- Graph's **extents** operation reports margin sizes.
- Options **-leftvariable**, **-rightvariable**, **-topvariable**, and **-bottomvariable** specify variables, set when margins are updated.

```
.g1 configure -leftvariable left
trace variable left w UpdateMargins
proc UpdateMargins { p1 p2 how } {
    global left
    .g2 configure -leftmargin $left
    .g3 configure -leftmargin $left
    .g4 configure -leftmargin $left
}
```

Managing graphs with tabsets

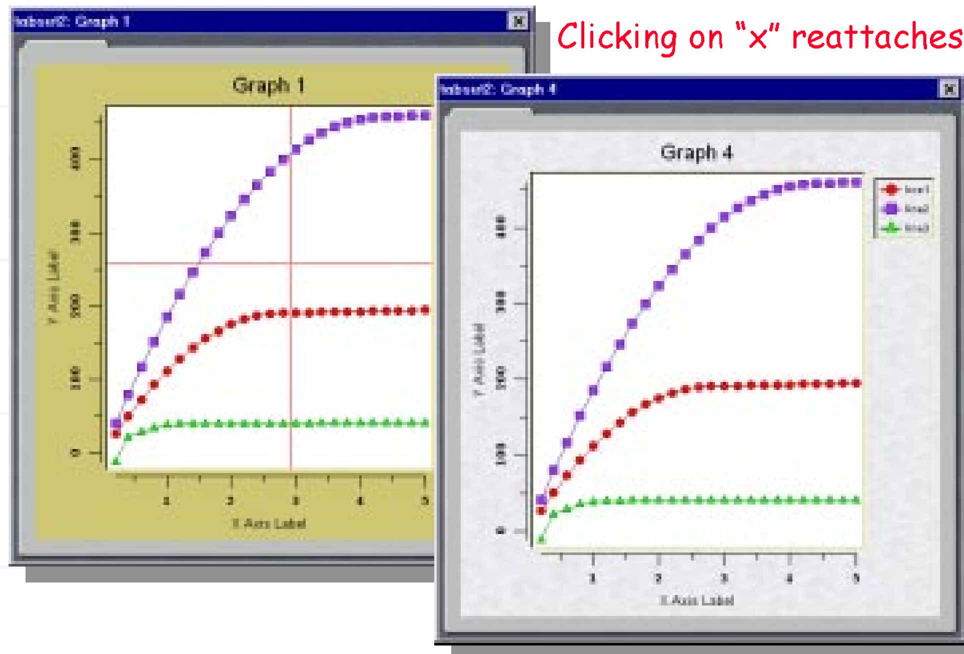
Typical for applications to generate dozens of graphs.

- Clutters screen. Hard to manage.
- Tend to reduce size of graphs.



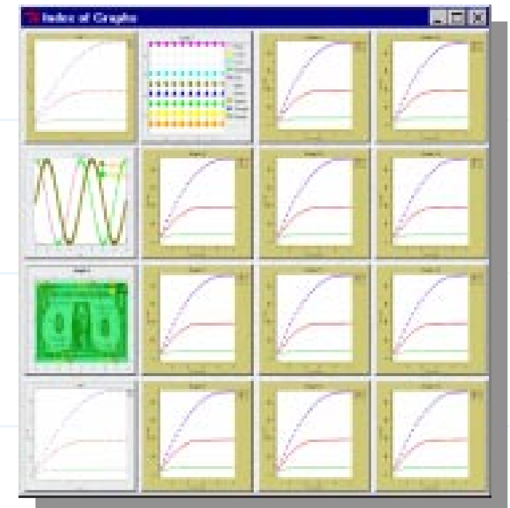
Put graphs in tabbed notebook.

- Tear-off feature lets you compare plots side-by-side.
- Same graph can be shared by different pages.



Clicking on "x" reattaches page.

Managing graphs with tabsets (cont'd)



Idea: Create index for graphs.

- Table of buttons, each contains thumbnail image of a graph.

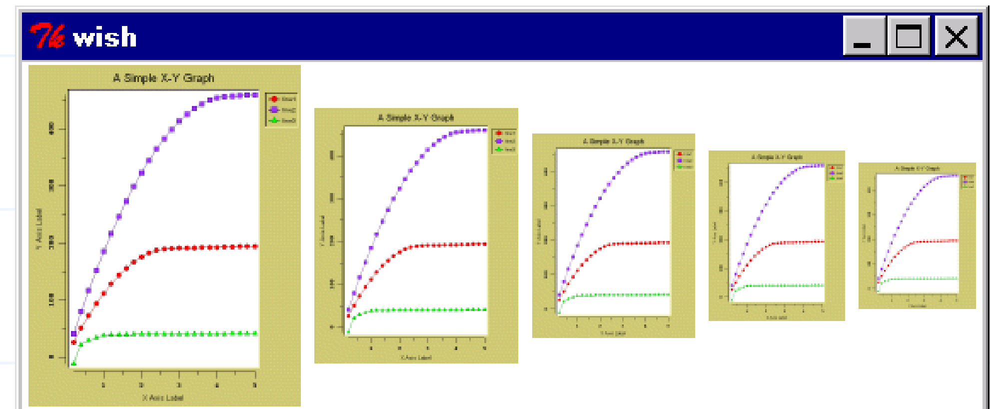
Thumbnails

- Already know how to get snapshot of a graph.

```
set image [image create photo]
.g snap $image
set thumb [image create photo]
$thumb copy $image -subsample 4 4
```

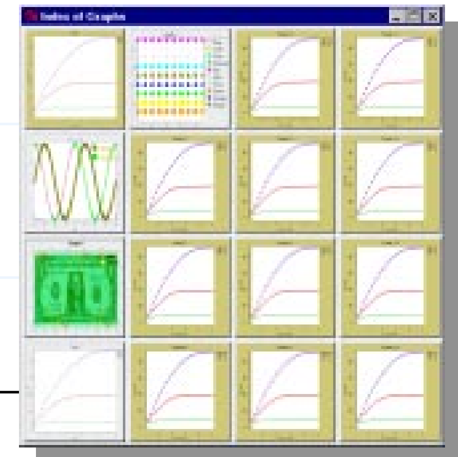
Problem: How do you resize snapshot to arbitrary size?

- Want thumbnails scaled the same.
- Tk image subsample reduces only by integer values.
- Image quality poor. Detail lost.



-subsample 3 through 7.

Managing graphs with tabsets (cont'd)



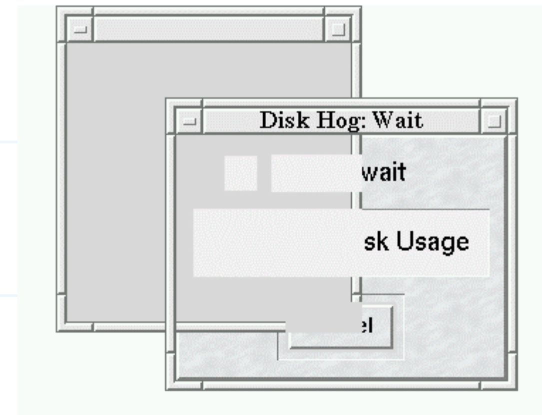
winop resample operation does arbitrary resizing.

- 1-D image filters: **box**, **triangle**, **sinc**, etc.
- Eventually function will move to new image type.

```
proc Thumbnail { graph w h } {
    set image [image create photo]
    $graph snap $image
    set thumb [image create photo -width $w -height $h]
    winop resample $image $thumb box box
    image delete $image
    return $thumb
}
set nTabs [.t size]
for { set tab 0 } { $tab < $nTabs } { incr tab } {
    set graph [.t tab cget $tab -window]
    button .f.b$tab -image [Thumbnail $graph 200 200] \
         -command [list .t invoke $tab ]
    table .f .f.b$tab $row,$col
    …
}
```

Makes tab selected.

bgexec



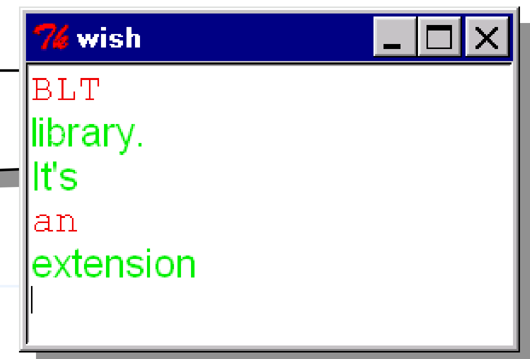
set usage [exec du $dir]

Executes programs while still handling events.

- Same syntax as exec: I/O redirection and pipes.
- Collects *both* stdout and stderr.
- Faster/simpler than **fileevent**.

Example:

```
set info [bgexec myVar du $dir]
```



- Variable **myVar** is set when program finishes.
- Setting **myVar** yourself terminates the program.

Callback proc invoked whenever data is available on stdout or stderr.

```
text .text
.text tag configure outTag -foreground green2
.text tag configure errTag -foreground red2
proc DrawStdout {data} { .text insert end $data outTag }
proc DrawStderr {data} { .text insert end $data errTag }
bgexec myVar -onoutput DrawStdout -onerror DrawStderr \
        myProgram &
```

busy

Makes widgets busy. Widgets ignore user-interactions.

- Mouse, keyboard events etc.
- Creates invisible window. Shields widgets from receiving events.

Better than `grab` for many situations.

- Allow interactions in more than one widget.
- Stopping interactions in specific widgets.
- De-bouncing mouse clicks/key presses.

Configurable cursor.

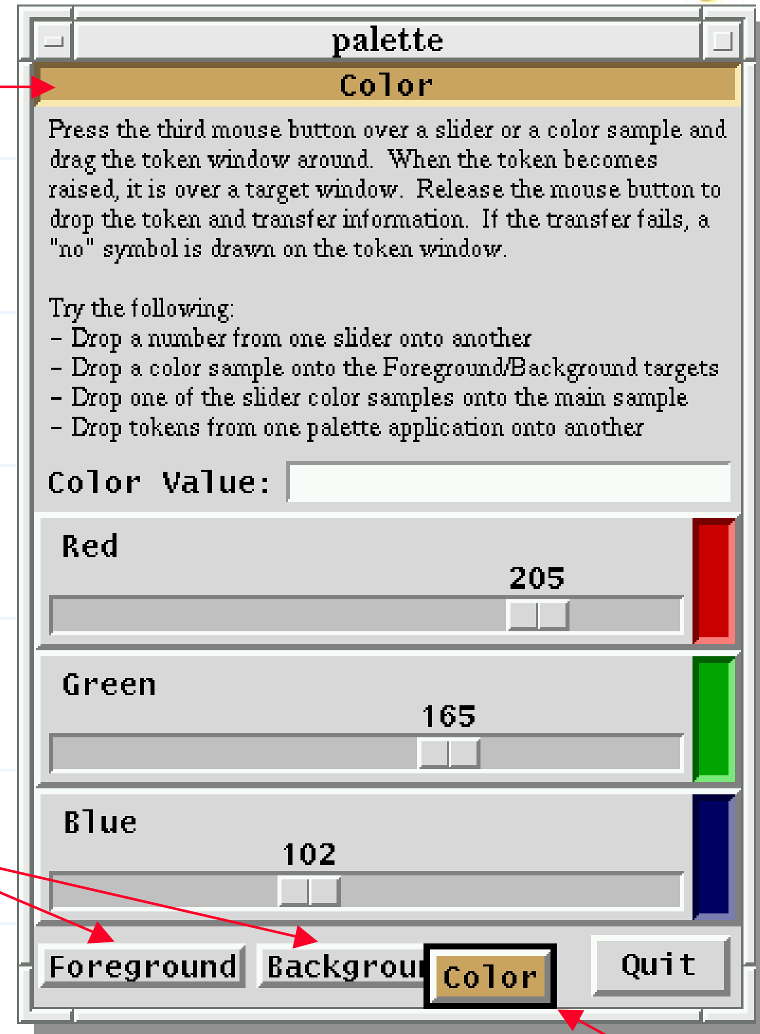
- Defaults to hourglass/watch.

```
busy hold .frame
update
busy release .frame
```

drag&drop

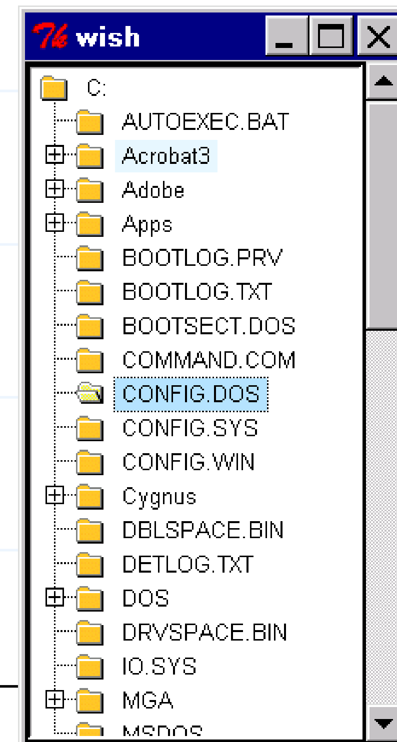
Transfers data between widgets and applications

- Data transferred with **send** command.
- Any widget can be registered as drag source, drop target, or both.
- Configurable drop token.
- Soon: interoperation with Windows CDE drag-and-drop.




```
drag&drop source .sample \
        -packagecmd {PackageColor %t}
drag&drop source .sample handler Color
drag&drop target .sample handler Color {ReceiveColor %v}
```

hierbox



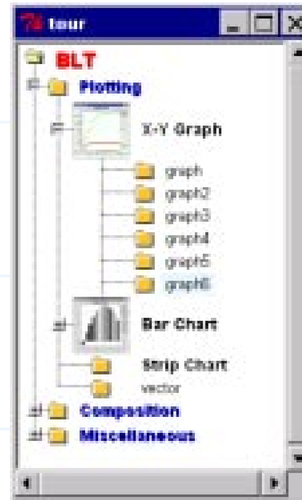
Hierarchical listbox widget.

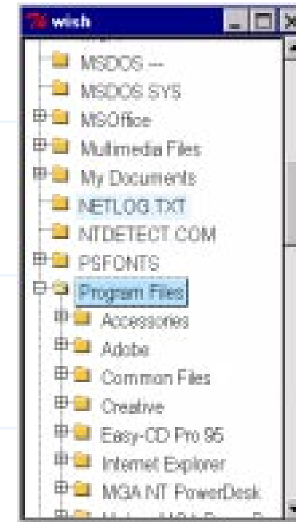
- Displays tree of data.
- Incremental (lazy) insertions.
- Much faster than Tcl-based versions.
- Designed to work with companion widget.
  - Canvas, listbox, etc.
  - Example: **-selectcommand** callback proc.
- Multi-mode selection: single, multiple, non-contiguous.

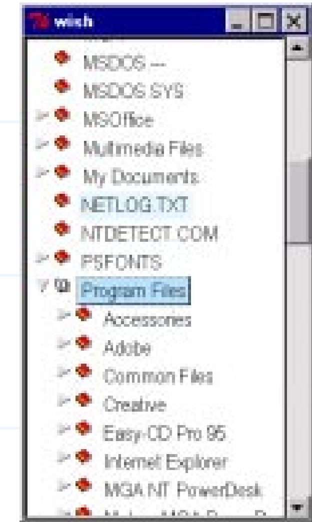
```
hierbox .h -opencommand {AddEntries %P} \
        -closecommand {.h delete %n 0 end}
proc AddEntries { dir } {
    if { [file isdirectory $dir] } {
        eval .h insert end [lsort [glob $dir/*]]
        eval .h entry configure [lsort [glob $dir/*/*] \
           -button yes
    }
}
.h configure root -label "C:"
```

%P Pathname of entry.
%n Node index of entry.

hierbox (cont'd)







Variety of styles supported.

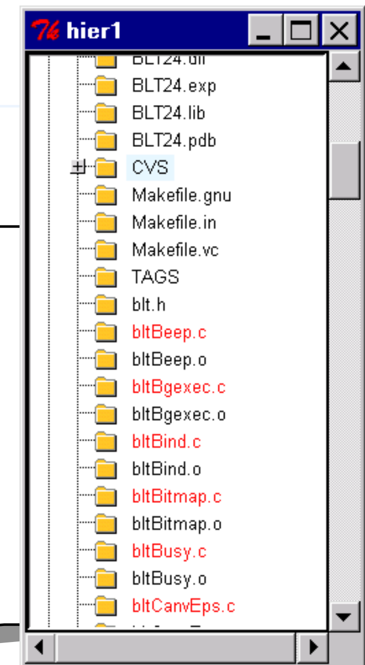
- Read-only/editable entries.
- Bind to individual entries (e.g. tool tips).
- Font, color, icons, images configurable for single entries.
- Auxiliary text and/or images displayed for entries.

Built-in search and selection functions.

- Search on name, data, entry attributes, etc.
- **hiertable** widget uses new tree data object.

Returns list of matching nodes.

```
set nodes [.h find -glob -name *.c]
eval .h entry configure $nodes -labelcolor red

.h find -glob -name *.gif -exec {
  .h entry configure %n \
        -image [image create photo -file %P]
}
```

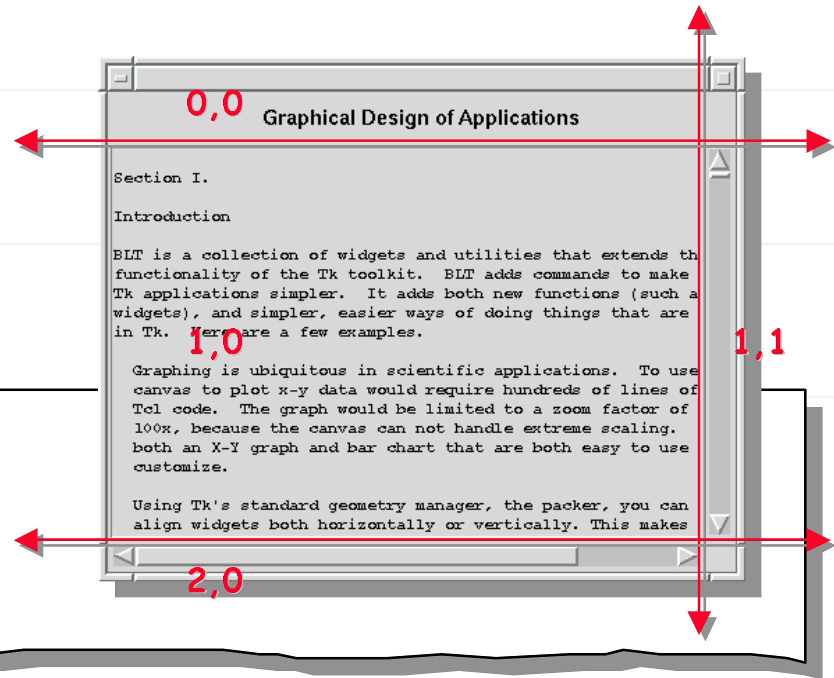


table

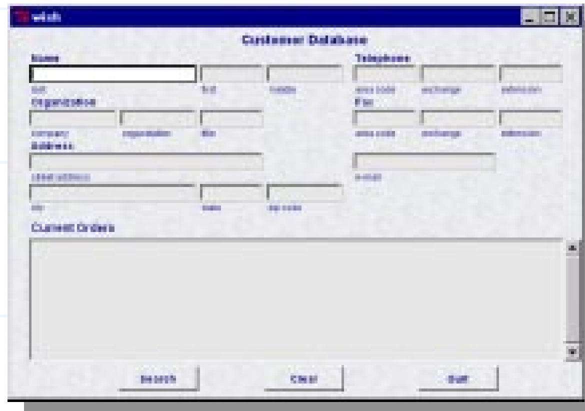
Grid-based geometry manager.

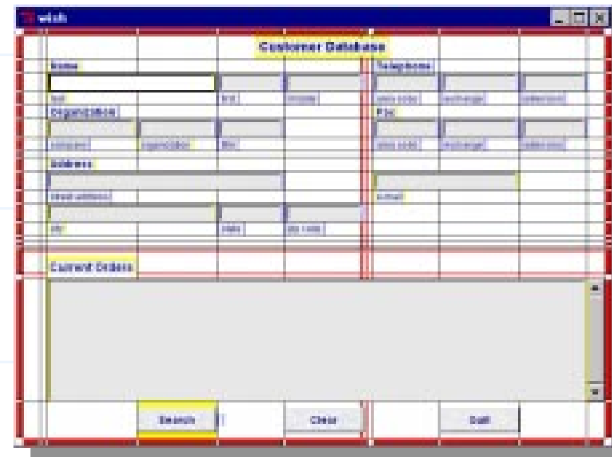
- Position widgets by row/column.
- Father of Tk grid.
- Can bound row/column sizes.

```
table . \
     0,0 .label -cspan 2 \
     1,0 .text -fill both \
     1,1 .vs -fill y \
     2,0 .hs -fill x
```

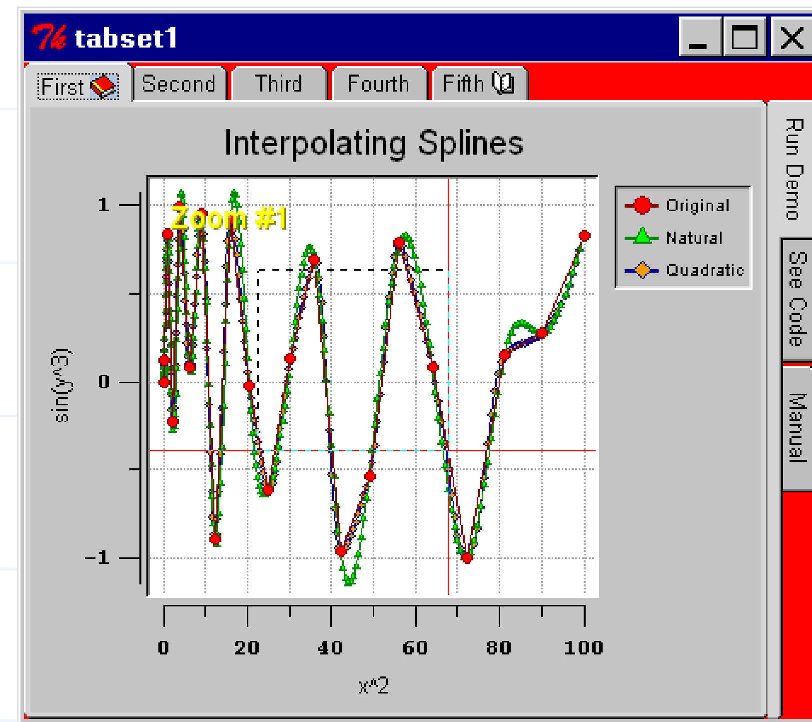


- Insert/delete rows and columns.
- Debugging mode.



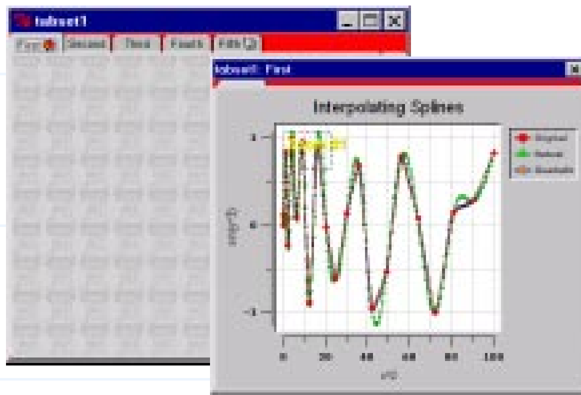


tabset



Tabbed notebook widget.

- Single or multi-tiered tabs.
- Scrollable (with/without scrollbar).
- Bind to individual tabs (tool tips)
- Tear off and re-attach pages.



Can use tabset without pages.

```
tabset .t -bg red -scrollcommand {.s set}
scrollbar .s -command {.t view} -orient horizontal
.t insert end First -window .t.graph \
    -selectcommand { SelectTab "First" } \
    -image [image create photo -file book.gif]
.t bind First <Enter> {ToolTips "Graph of Interpolating Splines"}
.t bind First <Leave> {ToolTips ""}
```

tabset (cont'd)

Variety of styles supported.

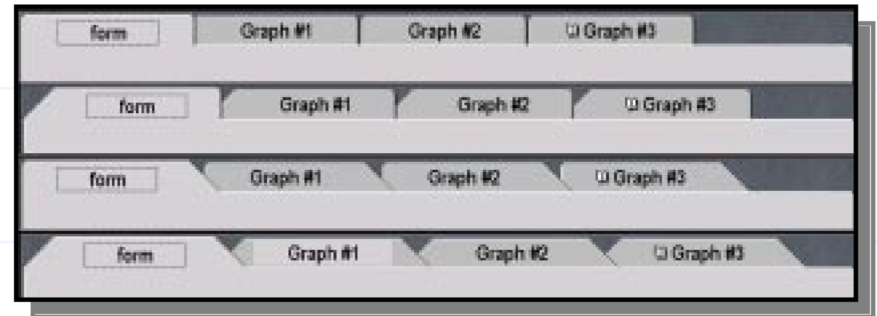
- Controlled via tabset's configuration options.

-slant none

-slant left

-slant right

-slant both

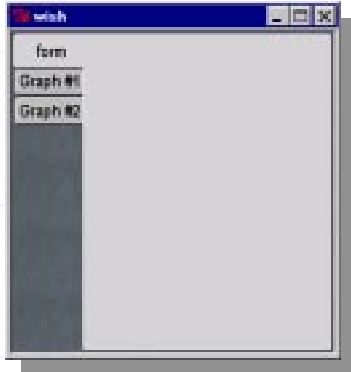


-side top

-side right

-side bottom

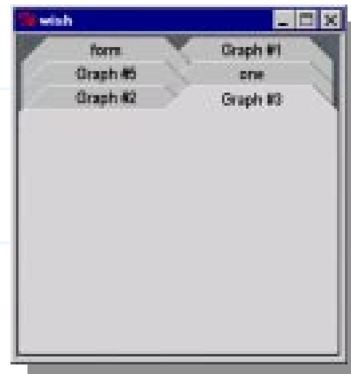
-side left



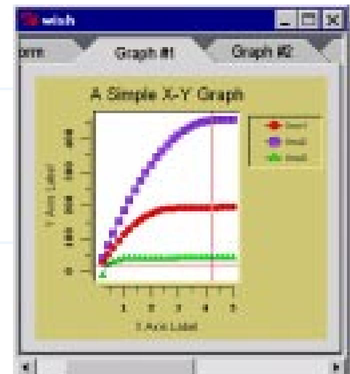
-rotate 0

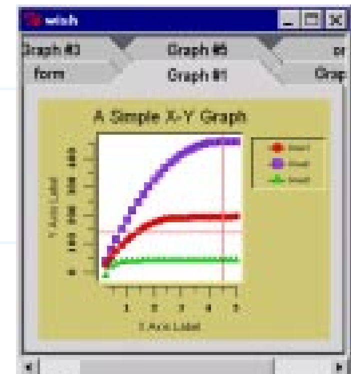
-tiers 1

-tiers 2



-tiers 3





Attach scrollbar to single or multi-tiered tabs.

General Information

What version of Tcl/Tk is required?

- Tcl 7.5, Tk 4.1 through Tcl/Tk 8.3.0 (latest release) all work.

Can I use BLT in a commercial product?

- Free to copy and use. No royalties.

Where do I get the latest version?

- `http://www.tcltk.com/blt`
- Sources for latest version.
- Windows binaries available.

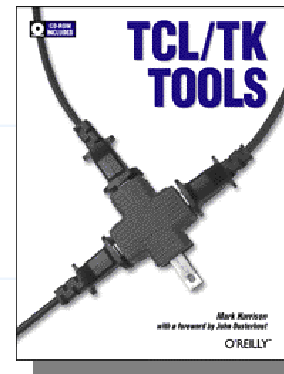
Where do I send bug reports and requests?

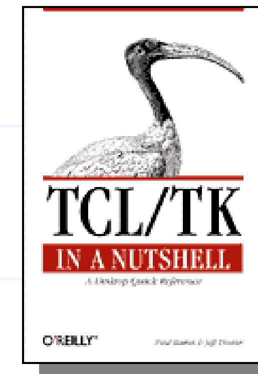
- Send to both addresses. Put "BLT" in the subject line:

  ghowlett@fast.net

  gah@cadence.com

General Information (cont'd)





Books

- **Tcl/Tk Tools**
  edited by Mark Harrison.
- **Tcl/Tk in a Nutshell**
  by Paul Raines and Jeff Trantor.

What does BLT stand for?

- *Bell Labs Toolkit*
  Bacon, Lettuce, and Tomato
  Better Luck Tomorrow
- Whatever you want it to…