reconstructed user manual
by Rob Salgado (version June 17, 2008)

neat tools

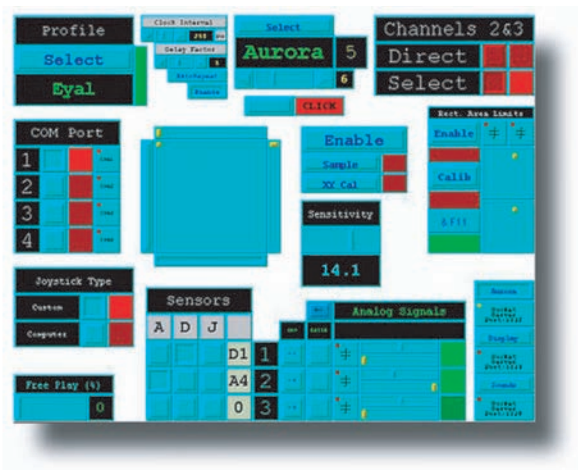
a visual-programming environment for human-computer interfacing

neat

user manual

www.pulsar.org

center for really neat research



We gratefully acknowledge generous support for this NeatTools documentation project and related activities from grants provided by
Microsoft Corporation,
NEC Foundation of America,
and the Institute for Interventional Informatics.

What is NeatTools?

NeatTools is a visual-programming environment, in which users can create programs by direct manipulation of graphical objects called modules. NeatTools can accept input data from devices connected to the PC, such as a keyboard, mouse, joystick and TNG (pronounced “Thing”), a palm-sized serial interface box that accommodates various sensors for human-computer interface applications (see TNG-3B Interface lesson). In creating visual programs, users do not need to know the C++ language that was used to create NeatTools (to the extent of about 54,000 lines of code).

The visual programmer “writes” programs by dragging and dropping modules onto the active desktop area of NeatTools and connecting them to establish a “dataflow network.” NeatTools accommodates various data types, including integers, real numbers, and alphanumeric strings, Musical Instrument Digital Interface (MIDI) events, and wave streams.

NeatTools can be used for many applications: such as using a joystick to control the cursor, entering data through an onscreen keyboard and Web-based communications. Additionally, with suitable electronic devices, NeatTools can be used to control objects in the physical world such as remote-controlled cars, games, lamps and appliances.

NeatTools has been developed in part to serve the needs of people with severe physical disabilities. However, in keeping with modern principles of universal design, features designed for the individuals with disabilities are often of considerable benefit to general users in special situations, where for example, dependence on keyboard and mouse are undesirable. With the advent and spread of wearable computers, the need for this type of design will increase.

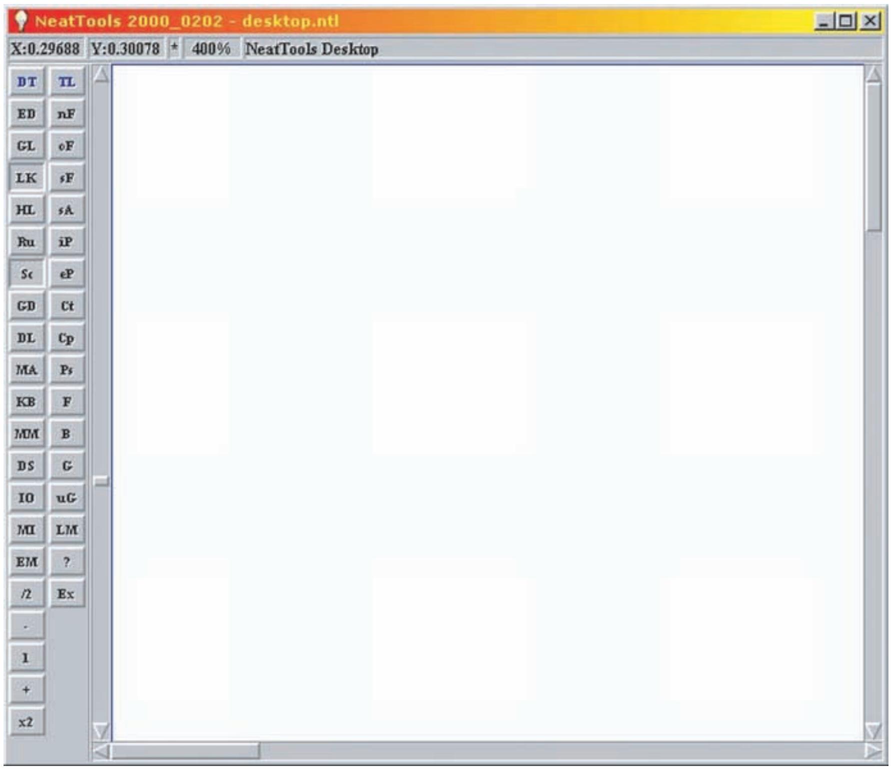
For more information on NeatTools, TNG interface devices, custom sensors, and various applications of these technologies, please visit **www.pulsar.org**. Specifically, click on the NeatTools link. From there you can download the latest version of NeatTools and various collections of (and some individual) program files. In the Documentation section of the NeatTools page, you will find several types of documentation, some of which are animated. NeatTools and the various support resources are freeware. We hope you enjoy using them for worthwhile purposes and hope that you will spread the word so that others can participate and benefit.

System Requirements for NeatTools:

- Pentium PC 133MHz or higher
- Windows 95/98/NT
- 64 MB of RAM (Recommended)
- 800 x 600 monitor resolution

Elementary Techniques

The image below depicts what is seen when NeatTools is first opened.
The components are described below.



Title Bar

The Windows title bar at top shows the name of the current NeatTools file, here desktop.ntl. The title bar also displays the version of NeatTools, here 2000_0202, or February 2, 2000.

Status Bar

The status bar, located just below the title bar displays the mouse X and Y coordinates (relative to the NeatTools desktop), the overall magnification (% zoom level), and particulars on the various modules and/or links associated with the current mouse cursor position.

Tool Bars

Two vertical toolbars are on the left side of the window. The **DT** (**Desktop**) toolbar, at left, contains buttons that directly affect what is happening on the NeatTools desktop. The **ED** (**Edit**) button, for example, turns edit mode on and off (when it is off, a file is protected from accidental change). Other buttons control the presentation of the NeatTools desktop by manipulating the Scale (**SC**) and Grid (**GD**), and specifying whether or not Rulers (**RU**) or Links (**LK**) are visible. This toolbar also features Zoom controls: **/2, -, +, x2, 1**.

The most important buttons on the **DT** toolbar are those for the seven toolboxes: Digital Logic (**DL**), Math (**MA**), Keyboard (**KB**), Multimedia (**MM**), Display (**DS**), Input/Output (**IO**), and Miscellaneous (**MI**). Depressing any of these buttons will open a toolbox from which you can select various NeatTools modules. You can either click on a module to place it at the current position of the NeatTools cursor (different from the Windows mouse cursor) or, as is more commonly done, you can drag the module onto a desired spot on the desktop.

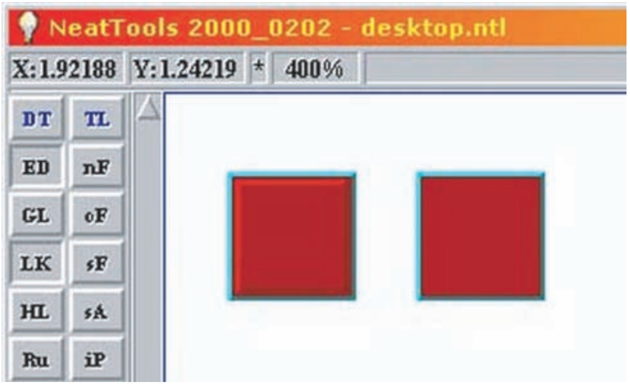
The Tool (**TL**) toolbar contains buttons for common tasks usually found on pull-down menus in other programs. These include opening and saving files; cut, copy, and paste; and grouping and ungrouping sets of objects. For a complete listing, please refer to the reference section of this manual.

NOTE: These toolbars may be floated by depressing the **DT** or **TL** buttons, and then dragging. We recommend keeping the **DT** on the left, when re-docking these toolbars. Indeed, we further recommend simply leaving them docked all the time.

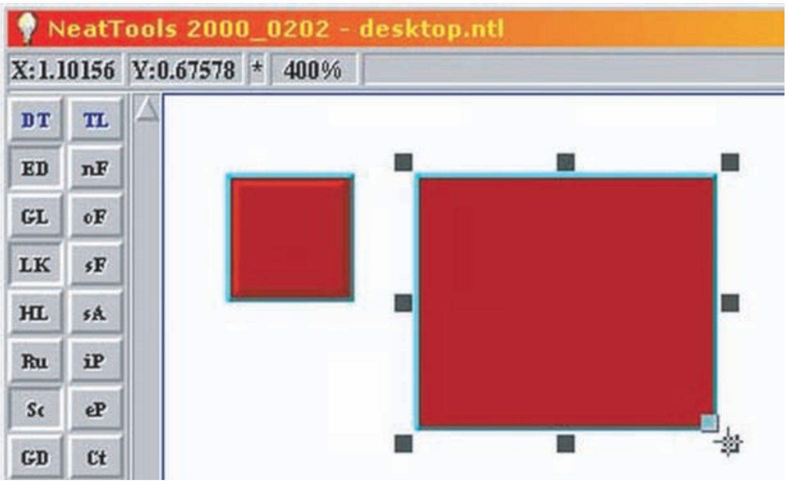
NeatTools programs are created by linking modules. These modules can be found in the various toolboxes on the Desktop (**DT**) toolbar, and can be selected by clicking and dragging them to the desktop. Then links between modules are established by clicking and dragging from the output of one module to the input of another, or vice versa. The links are represented by lines connecting the various modules, and can be removed by clicking on them. Take care not to do that inadvertently! Note that NeatTools will prevent you from making an “illegal” connection.

Try this simple exercise

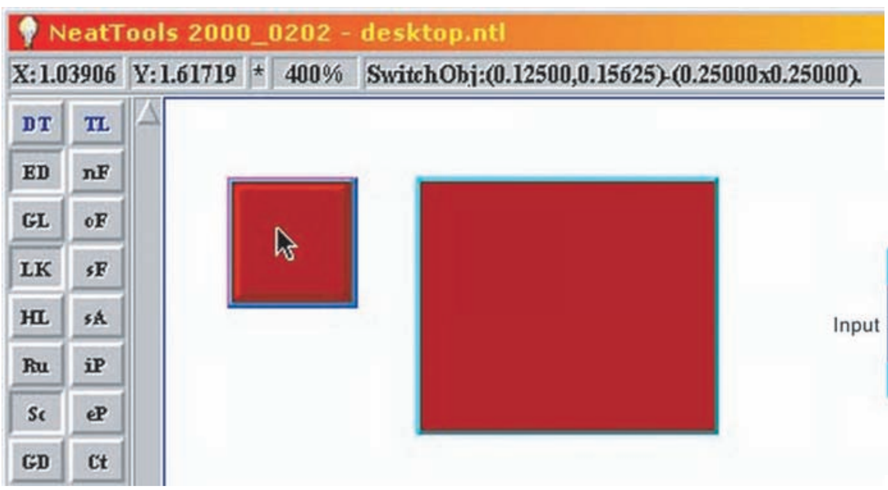
On the **DT** toolbar click the **DS** button. A toolbox of various modules will appear. Drag a **Switch** and an **LED** onto the desktop. Then you may close the **DS** toolbox, or leave it open as you wish.

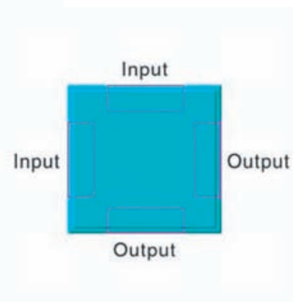


Note: You can click and drag a module to any location on the desktop. You can also resize a module by dragging any of its eight sizing handles (use corners if you want to maintain aspect ratio; use sides to stretch or shrink in one dimension).

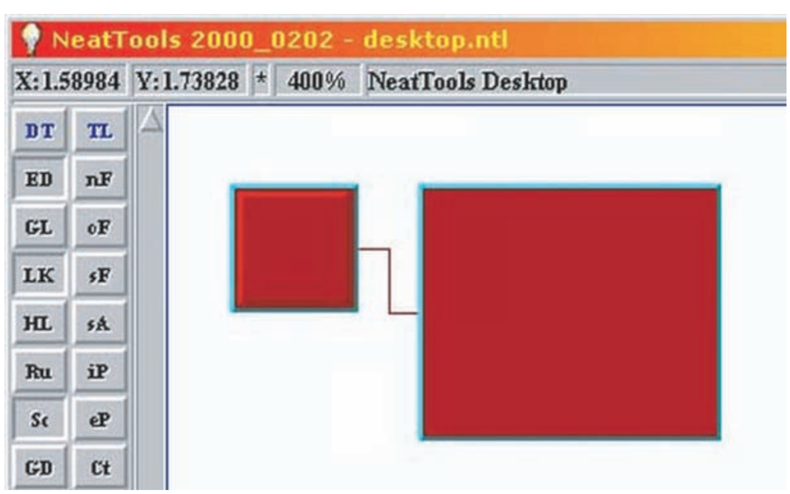


As you move the mouse over each module the status bar will display the name of the module and list its X and Y coordinates. Drag the mouse around the four sides of the object and you will notice that small rectangles appear inside each edge. These are the module's various input, output, and control ports. Although there are many exceptions, inputs are normally on the left, outputs on the right, and control inputs are on the top; sometimes there are special outputs on the bottom. Some modules have multiple input and/or output ports. Sometimes a single input port can accept more then one link. It is common for one output port to link to several other modules.

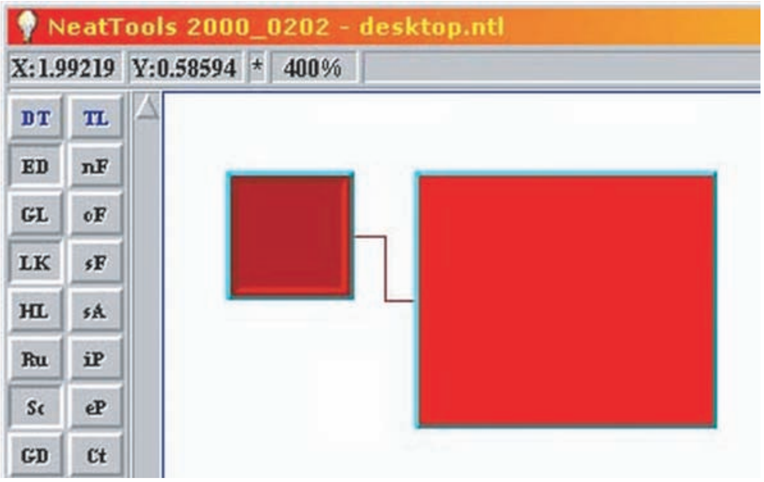




Connect the two modules on the desktop by clicking on the output port of the **Switch** module and dragging it to the input port of the **LED** module.



This is how all modules are connected in NeatTools. Clicking on the **Switch** will light the **LED**, demonstrating the effectiveness of the simple connection. To eliminate the connection, simply click on the link that connects the two pieces.



As you explore the contents of the toolboxes, you will discover that many of the modules look similar except for color or other attributes. For example, in the **DS** toolbox there are four switches/buttons that are graphically identical (beveled edges), except for their colors. The red module is a toggle **Switch** (push on; push off; here, of course, push really means click). The blue and green modules are respectively momentary and autorepeating **Buttons** (i.e.pushbuttons). The yellow **Button** pertains to whether the NeatTools window is in focus (i.e. is the active window) or not; it is for more advanced NeatTools programmers.

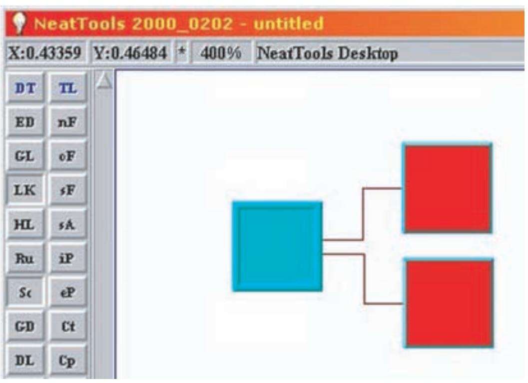
There are several special key combinations in NeatTools. **Ctrl-F4** is a toggle feature that forces a NeatTools program window to remain always on top of any other window, whether it is the active one or not (a subsidiary feature is that clicking on the NeatTools desktop, for example to press buttons or drag sliders, will not force the window into focus; to do so, you should click on the title bar). **Ctrl-F7** allows a user to toggle the NeatTools program in and out of Protected mode, which hides the toolbars and status bar (to save a program this way, click the X button (close window button) at the right end of the title bar and click 'Yes' when prompted about saving). **Ctrl-F9** will shrink the size of the NeatTools desktop area so that it encompasses a selected set of modules on the desktop (selected, for example, by dragging a marquee rectangle around the desired modules). A common key sequence to close a finished program is: a) select a rectangular area of modules that are to remain visible, b) **Ctrl-F9**, and c) **Ctrl-F7**. To return to editing mode, select **Ctrl-F7** again.

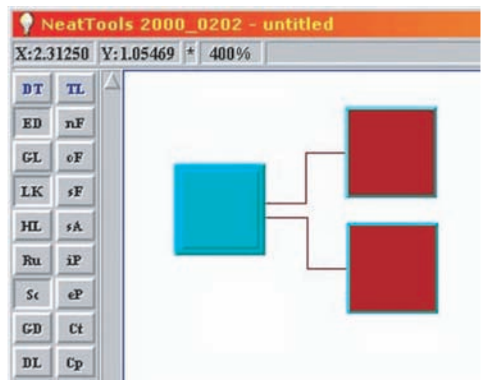
As a final note, modules are grayed out within their toolboxes when the computer running NeatTools does not support the particular functions of those modules.

Module Properties

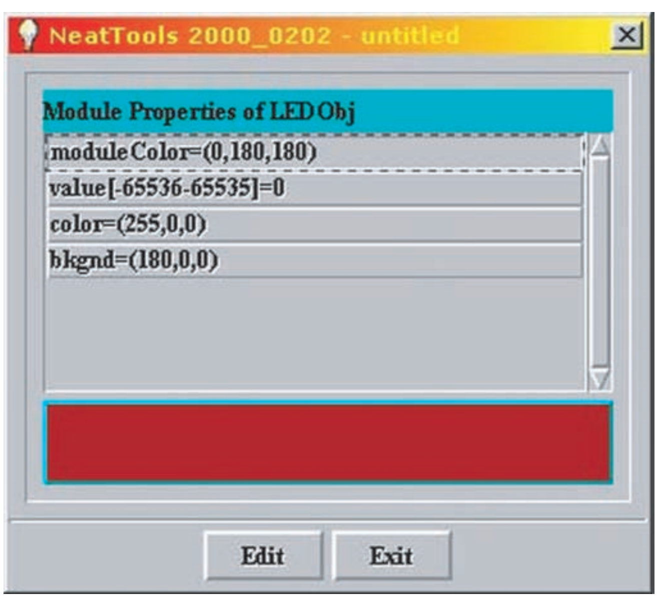
When working in the NeatTools environment, you will often need to change the properties of various modules. The starting point is to right click on the module. Alternatively, you can left click to select the module, and then left click again on the small red square that appears at the lower right corner of the module. Normally, we recommend simply right clicking.

Drag a **Switch** and two **LEDs** from the **DS** toolbox to the desktop. Connect the **Switch** to both **LEDs**. Notice that clicking the **Switch** activates both **LEDs**.



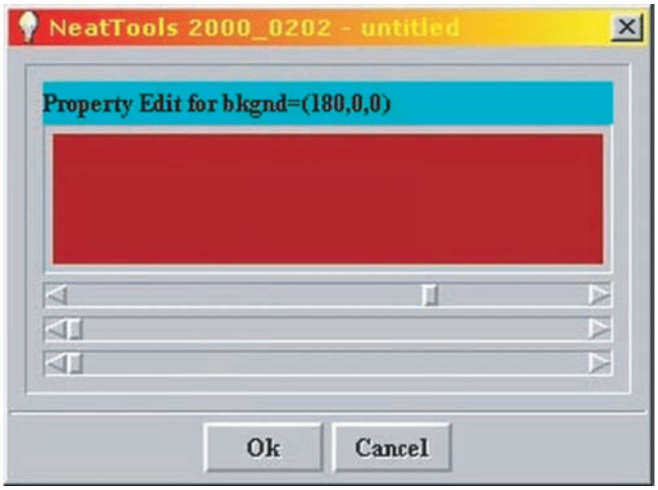


Right click on one of the **LEDs** and a properties menu will appear.



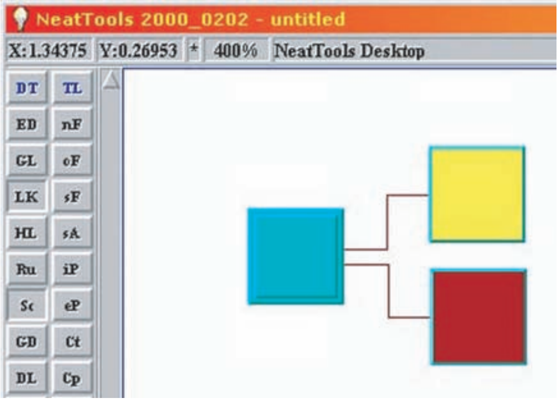
Note: The contents of the properties menus will vary among modules. However, for most modules, the menu will include **moduleColor** (usually left alone), **color** (i.e. foreground color), and **bkgnd** (background color). Other modules will allow you to add labels, change values, change parameters, etc.

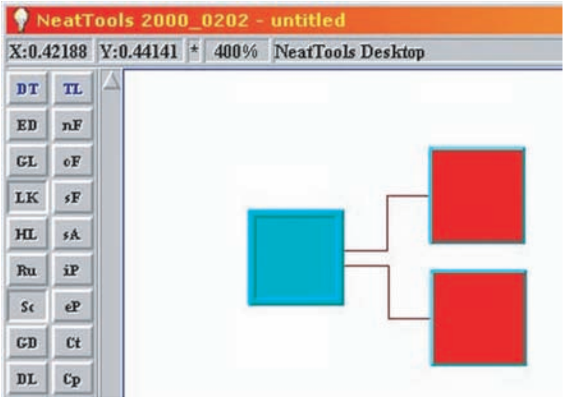
To change the color of the **LED**, click on the background (**bkgnd**) option and click on the **Edit** button or, more simply, just double click on the option. The properties menu will change to display a color rectangle with three sliders below it.



Manipulating the sliders will change the color of the **LED**. When you have found a color combination you like, click **Ok** to return to the properties menu, and then click **Exit** to return to the NeatTools desktop.

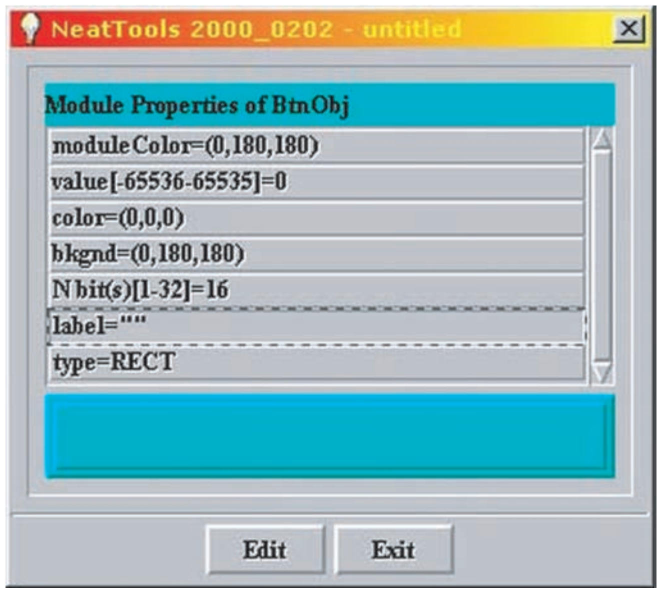
Notice that the background color of the upper **LED** (i.e. color when it is off) has been changed, here to yellow. However when you turn on the **Switch**, the **LED** will show its original foreground color of bright red.





To change its “on” color you will again need to access the properties menu and this time edit the color function. Try this yourself. In the future, you can change the background and foreground colors with the same invocation of the properties menu. Typical slider settings are 255 for one or more foreground color(s) and 180 for background color(s).

Right clicking on the **Switch** module will bring up a different set of options, among which you will notice the option “label=”.



Experiment with this property. It will allow you to add words or numbers to your module.

Changing Properties of Several Modules at Once

A time saving trick, when you need to change common properties of several related modules, select the modules in question and then right click on any of them. This will invoke a properties menu that shows only those properties that are shared among the modules, such as color. Often you can select the desired modules by dragging a marquee rectangle around them. When this does not work or does not suffice, you can always add one more module to the selection group by holding down the Shift key, and then left clicking on that module.

Analog vs. Digital

Many NeatTools programs, particularly those concerned with human computer interfacing, accept signals from external input devices, process these signals, and then produce an output, which may be confined to the computer or may instead control devices in the user's environment.

In such situations, you have a device that provides input (e.g. a mouse, a keyboard, or a TNG with sensors and switches), and you program NeatTools to process that input and produce the output to perform a desired action.

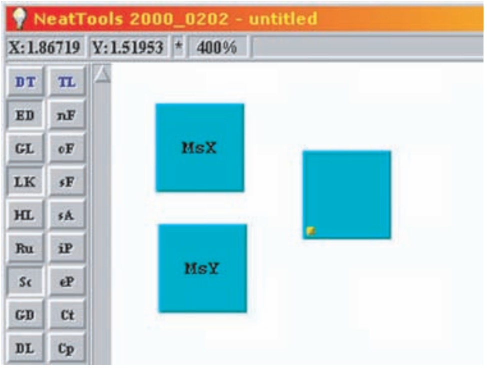
In this lesson, the mouse is used as a representative input device that sends information to the NeatTools program. The mouse motions produce specific results that can be viewed on the monitor.

A digital signal (or variable) is one with discrete states, often just two of them; for example, a light switch can be on or off. In computers, the two common digital states are represented by 0 and 1 (or false and true). In contrast, an analog signal varies continuously, for example the speed of an automobile or the brightness of a light source. Often, analog signals are digitized, and thereby become discrete. For example, an analog voltage accepted by a TNG interface, is converted electronically to a number between 0 and 255 by a process known as analog-to-digital conversion.

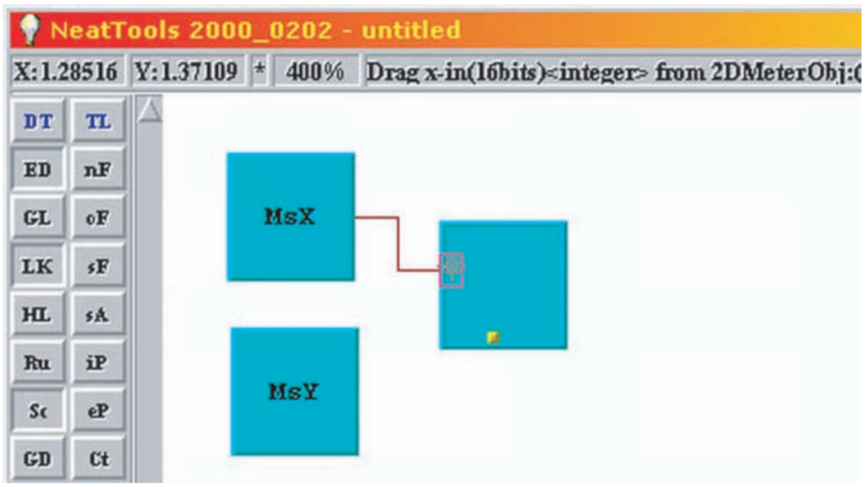
In the following example, the mouse will provide two representative analog signals, namely its X and Y coordinates. Strictly speaking they are represented here by discrete values in the range of 0 to 65535 (16-bit digital representation). It is appropriate, nevertheless, to consider them as analog rather than digital, for they are representing, with fine resolution, the analog X and Y positions of the physical mouse.

Open the I/O toolbox and drag the **MsX** (MouseX) and **MsY** (MouseY) modules, to the desktop. [Note, for future reference, that the **Ms** (Mouse) module, which is a combination of the **MsX** and **MsY** modules, could be used here equally well, but for clarity we are using the two separate modules.]

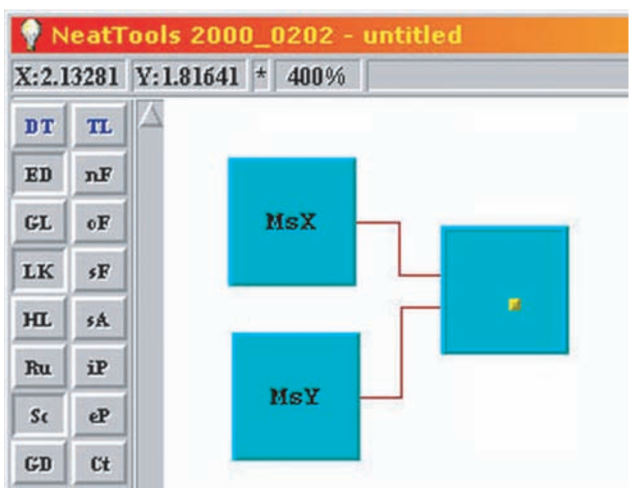
Next drag the **2DMeter** module from the **DS** toolbox to the desktop.



Connect the modules by clicking on the output (right side) of the **MsX** and dragging the connection to the input (left side) of the **2DMeter**.

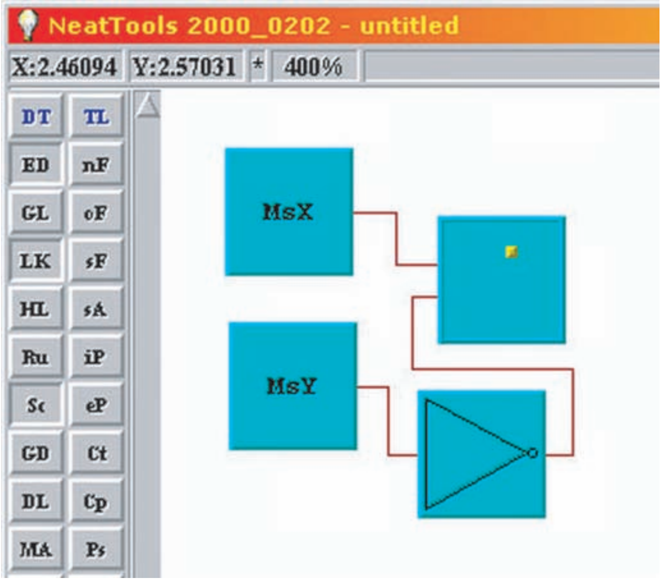


Similarly, connect the **MsY** and the **2DMeter** modules. Note the respective locations of the X and Y input ports of the **2Dmeter** module.



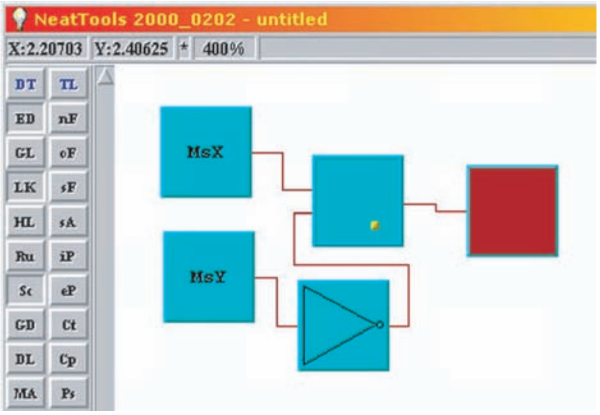
As you move the mouse, the **2Dmeter** will reflect that movement. You will notice however that the Y coordinate on the **2DMeter** moves opposite to the mouse movement that you are performing (mouse goes down; **2DMeter** indicator goes up). This anomaly results from the standard convention by which computer screens use the top left corner as origin (because that is where text typing begins).

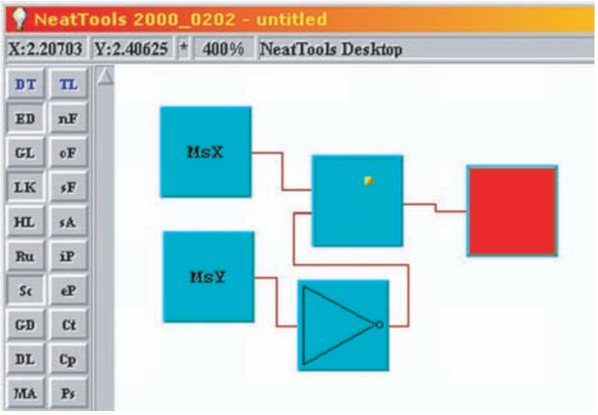
To fix this, you can use the **Not** module from the **DL** (Digital Logic) toolbox to effect the necessary inversion. Remove the link between the **MsY** and the **2DMeter** by clicking on it, and then connect the **MsY** to the **Not** module and the **Not** module to the **2DMeter** as shown. [Alternatively, you can move rather than destroy the original link, by dragging the right end from the **2DMeter** to the **Not**]. The mouse and the module should now appear to move consistently, i.e. up or down together.



Now, let's add a digital component, a binary one that is on or off depending on the value of an analog signal.

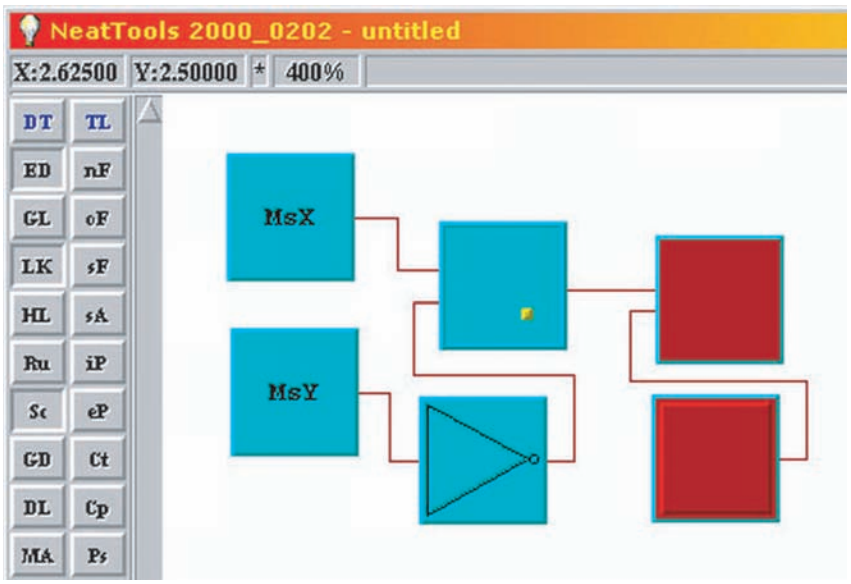
From the **DS** toolbox, select the **LED** module and drag it to the desktop. Connect the output of the **2DMeter** to the **LED** and observe the effect of moving the mouse.





The **LED** illuminates whenever the yellow indicator in the **2DMeter** (representing the mouse Y position) is above the output link that connects to the **LED**. The link at the **2DMeter** output can be placed at any desired vertical position. Try yourself to drag it to another vertical position. This is an example of an adjustable threshold, a topic that will be explored in more depth in later lessons.

Next drag a **Switch** module from the **DS** toolbox and connect that switch directly to the **LED**.



The **LED** can now be turned on either by moving the mouse above the threshold or by depressing the **Switch**. The **LED** represents a binary (two-state) digital signal. [Note: Later we will need to use the **OR** module from the **DL** (digital logic) toolbox, but its logical function is incorporated here implicitly in the **LED** input, so it is not needed here. You may wish to try, at this point, connecting the **2DMeter** and the **Switch** to the input of an **OR** module and the output of that to the **LED**. Verify then that the operation of the program remains unchanged.]

Arithmetic Calculations

As with other programming languages, NeatTools can perform arithmetic operations (addition, subtraction, multiplication and division) on integers and real numbers. NeatTools also includes a number of other mathematical operations.

We will sometimes use the standard mathematical term "operator" to denote any of these mathematical modules. Actually, many other modules in NeatTools qualify for this designation too. The essential idea is that such a module operates on one or more input values to produce an output value or result. Thus, for example, a **Multiply** module operates on two or more input values to produce a result, the product.

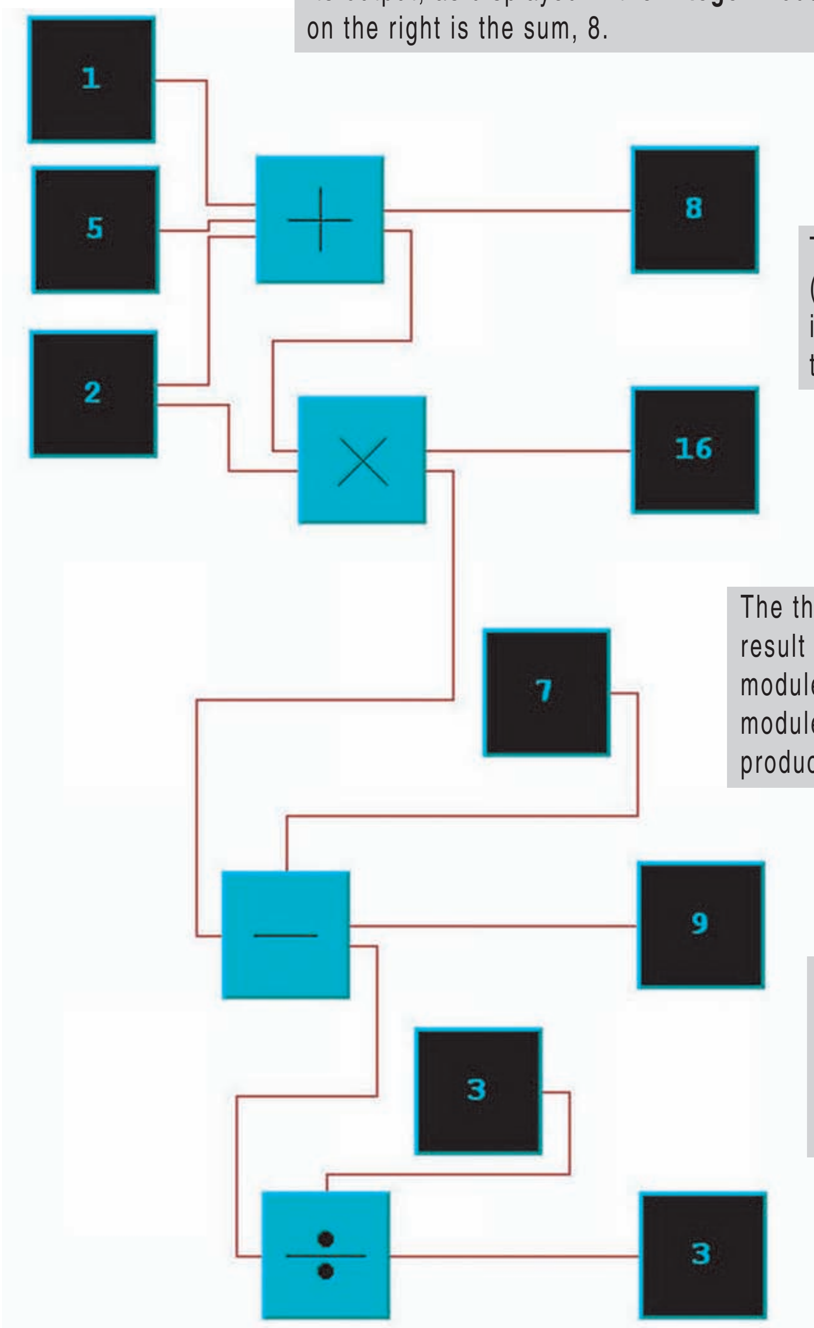
The modules that operate on integers are blue and are found in the **Digital Logic (DL)** toolbox. Those that operate on real numbers (i.e. having a decimal point, unlike integers) are in the **MA** (Math) toolbox, and are colored green. In the **MA** toolbox, there are also gray modules that operate on complex numbers (which have both real and "imaginary" parts); these are beyond the scope of the present lesson and are relevant for more advanced applications such as digital signal processing that are of particular interest to engineers and scientists.

Open the file **Math.ntl**. This program begins with three **Integer** modules, the values of which were arbitrarily chosen for this example. These values can be set or changed by right clicking on the module and entering the value in the "label" property.

The value of an **Integer** module can also be changed by inputting, at the left, an integer value obtained from some other module's output; a common use of **Integer** (or **Real**) modules. In general, they can be used to display the numerical result of other operations or they can serve as an input to another module—or both! Many NeatTools modules have this dual feature that, in a given application, they can accept inputs and/or provide outputs.

Each integer involved in this calculation has a connection from the **Integer** module output to the **Add** module input.

The **Add** module adds the integers 1, 5, and 2. Its output, as displayed in the **Integer** module on the right is the sum, 8.



The result of 8 and the value 2 (used again) are provided as inputs to the **Multiply** module, thereby producing the result, 16.

The third calculation uses the result of 16 from the **Multiply** module and, using the **Subtract** module, subtracts the value 7, producing the output 9.

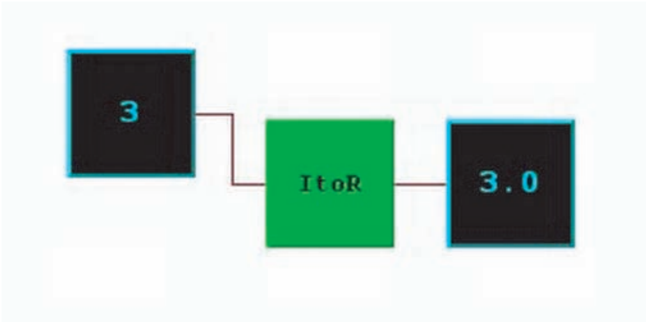
The final calculation uses the **Divide** module to divide the result, 9, from the previous step, by 3, yielding the final result, which is also 3.

The **Add** module can accept multiple values at its one input on the left side (so you can add several numbers at once); the same holds for the **Multiply** module. However, the **Subtract** and **Divide** modules have two input locations, one (#1) to the left and the other (#2) at the top, each of which can accept only a single value. For subtraction, the order is #1 minus #2 (left minus top), and for division it is #1 divided by #2. Verify that this is the case for the example calculations shown above, and then try this yourself with a new program, using your own choices of numbers.

Similar calculations can be performed using real numbers or, through the use of the **RtoI** (Real to Integer) or **ItoR** (Integer to Real) converter modules, these calculations can be performed with a mixture of integer and real numbers.

Using the file we just finished studying, drag an **ItoR** module from the **MI** (Miscellaneous) toolbox onto the desktop, as well as a **Real** module, distinguished in the **DI** (Display) toolbox by its default display value of 0.0. The **Real** module, whatever its numerical value, will always display a decimal point.

Connect the result of the previous calculation, 3, to the **ItoR** module, the output of which should go into the **Real** module.

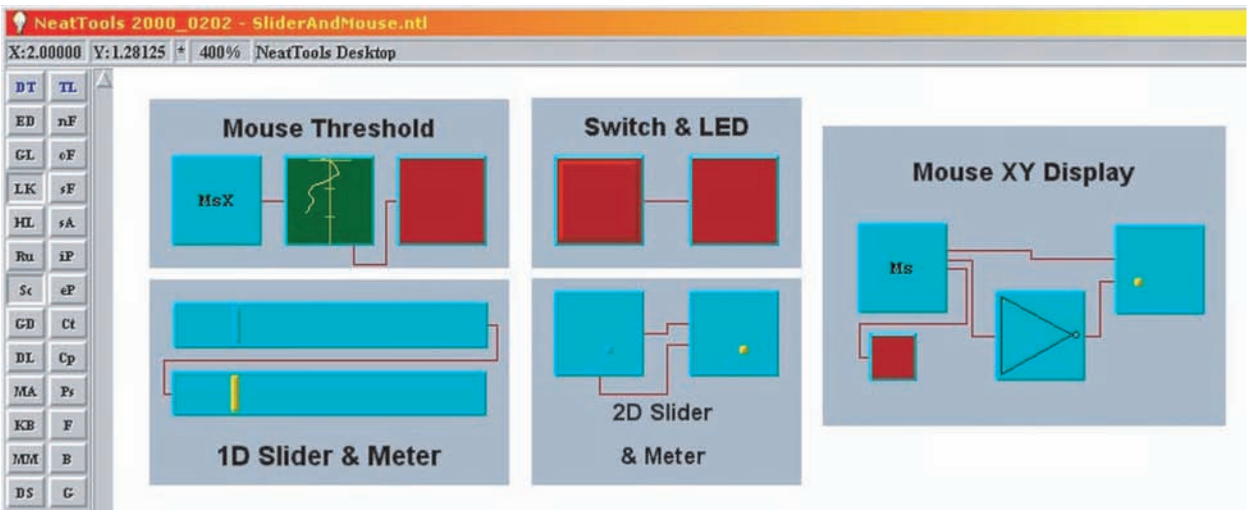


Notice how the answer is now displayed as a real number, with decimal point. In this sort of way, you can perform calculations with a combination of integers and real numbers.

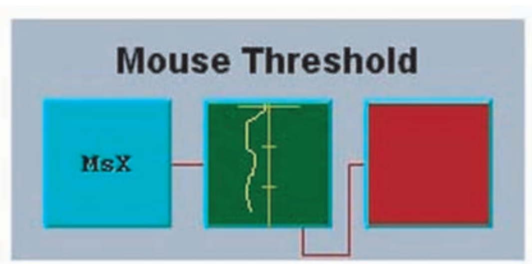
Experiment with some of the other mathematical operators in the **DL** and **MA** toolboxes. For example, try raising a number to a power (using the **Pow** (^) module), and try converting real numbers back into integers. Remember that, depending on the type of numbers you are working with, you will need to use either or both of the groups of mathematical modules in the **DL** and **MA** toolboxes.

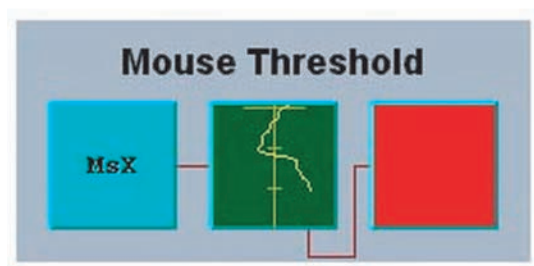
Slider & Mouse

Open the “SliderAndMouse.ntl” file by pressing the Open File (**OF**) button on the **TL** toolbar (or by pressing "Ctrl-O") and selecting the file name. Your screen will display several programs, which we will describe briefly before teaching you to modify them.



Mouse Threshold





This simple network connects three modules: **MsX** (Mouse X; from the **IO** toolbox); and **1DViewer** and **LED** (both from **DS** toolbox). The program displays mouse position on the viewer and turns on the **LED**, when the viewer signal display crosses the threshold. Thus, the **LED** turns on whenever the yellow display signal is to the right of where the link connects to the bottom edge of the **1DViewer** module. The same type of direct thresholding is available in the other **1DViewer**, which has a horizontal axis, as well as in the two **1Dmeter** modules and the **2DMeter** module (see below).

A problem with this direct thresholding is that one can change the threshold level only by adjusting the link position while in **Edit** mode. Although this offers the advantage of rapid programming, it can become a disadvantage if one needs later to adjust the threshold level, especially if the program has been saved in Protected Mode. An alternative method, which avoids this problem, is to use a **1DSlider** to set the threshold, and a **GreaterThan** module (from **DL** toolbox) to do the comparison.

In this example, as you move the mouse to the right (X direction), the **1DViewer** display signal shifts to the right, while it also progresses continuously downward as a function of time (and periodically returns to the top after it reaches the bottom). The display here depends only on the mouse X position, and is unaffected by its vertical Y position.

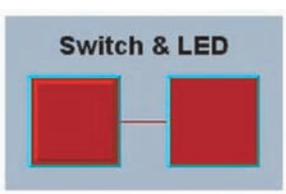
As you move the mouse to the right, note that the **LED** turns on once the **1DViewer** signal crosses the threshold value. You can turn the **LED** on and off by crossing this threshold back and forth.

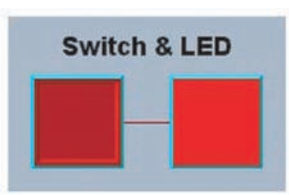
Practice changing the threshold value by dragging the existing link to a new position along the edge of the 1DViewer module. You should depress the Edit (ED) button on the DT toolbar to be able to make these changes, or else type Ctrl-E (this key combination toggles Edit mode on and off).

Now try connecting different colored **LED**s. Remember that, in order to change the color of a module, you have to access its property menu by right clicking that module. You will normally want to change the background (dim) and foreground (bright) colors. Notice the default settings before making your changes.

As an exercise, construct a similar program, using the other **1DViewer** module (with horizontal axis) in the **IO** toolbox, the module that displays mouse Y movement instead of X.

Switch & LED

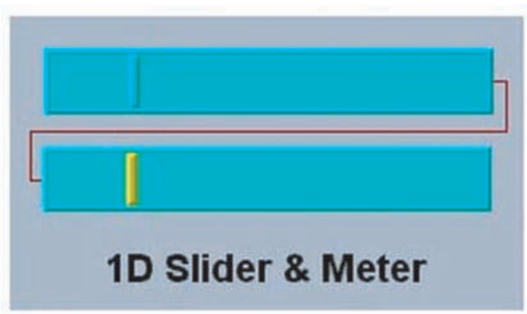


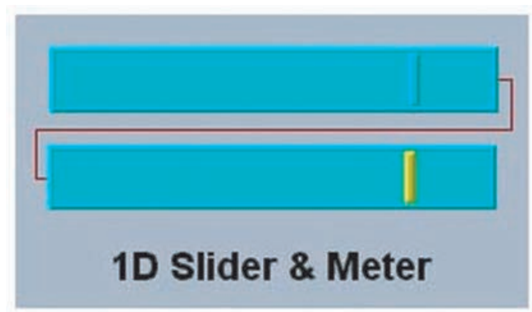


This simple program involves a **Switch** and an **LED**, both from the **DS** toolbar. When the **Switch** is depressed, the **LED** turns on. Pressing the **Switch** again turns off both the **Switch** and the **LED**. This is among the simplest NeatTools programs one can write, and is thus a good one to show first when demonstrating NeatTools.

1D Slider and Meter

This program employs the modules for the **1DSlider** (top) and the **1DMeter** (bottom), both from the **DS** Toolbox.

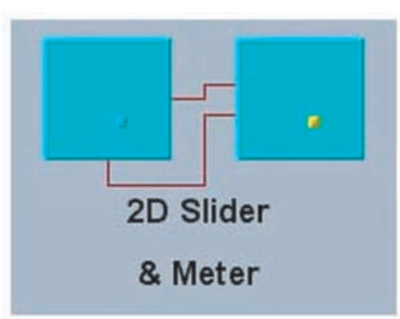


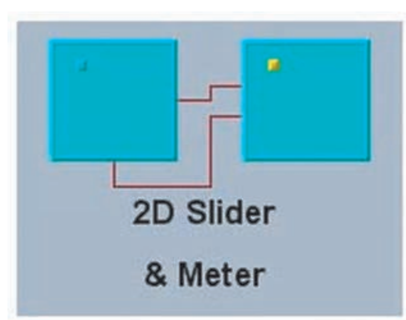


Note that you cannot directly adjust the position of the yellow bar on the **1DMeter** by dragging, whereas you can freely drag the bar of the **1DSlider**. The **1DMeter** is for display purposes only. The same distinction applies between the **2DMeter** and **2DSlider**.

When you drag the **1Dslider** bar, the **1DMeter** bar moves identically. Note that the editing mode (**ED**) should first be disabled; otherwise, clicking on the slider bar will select the Slider and cause it to drag around the desktop when you move the mouse. Try this yourself both ways, so you will be prepared to avoid this problem in the future.

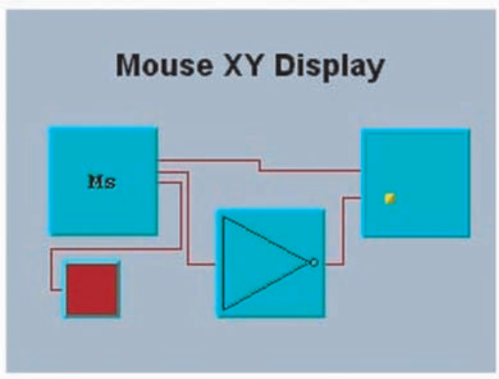
2D Slider and Meter

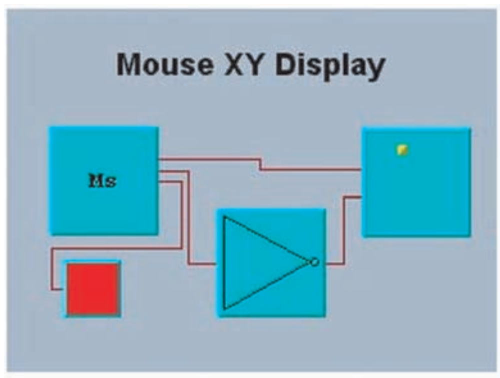




This program connects the modules for the **2DSlider** and the **2DMeter** (both from the **DS** toolbox). When you alter the position of the **Slider** with the mouse, the **Meter** moves identically. Note how the X (upper) and Y (lower) connections are made.

Mouse XY Display



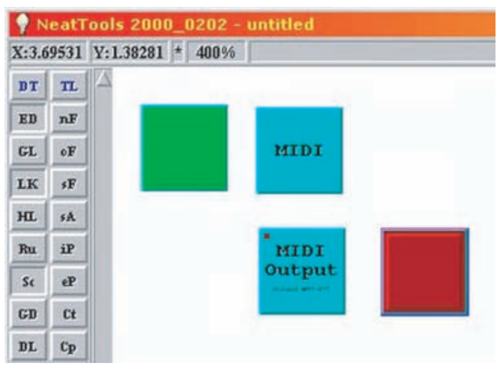


This program combines a variety of modules from previous programs (**Ms**, **LED**, **NOT**, and **2DMeter**). Note that the position of the mouse cursor is indicated by the **2DMeter**, and that left-clicking the mouse turns on the **LED**. The action of the **NOT** module is to invert the Y direction, because the conventional origin of a computer display screen is the top left corner rather than the bottom left (as it would be in a conventional XY graph), Y increases downward. After the **NOT** inversion, Y increases upward as desired. An explanation of why the logical **NOT** operator takes care of this inversion is beyond the present scope. Suffice it to say that it works, and that it is the simplest way to accomplish this action; another way is to use the **Subtract** module from the **DL** toolbox and set up a subtraction of the Y output of **Ms** from the maximum value of 65535 (provided the **Ms** module's "N bit(s)" property is set at the default of 16 bits). You might want to try this both ways, and see that the two methods give the same result.

Introduction to MIDI

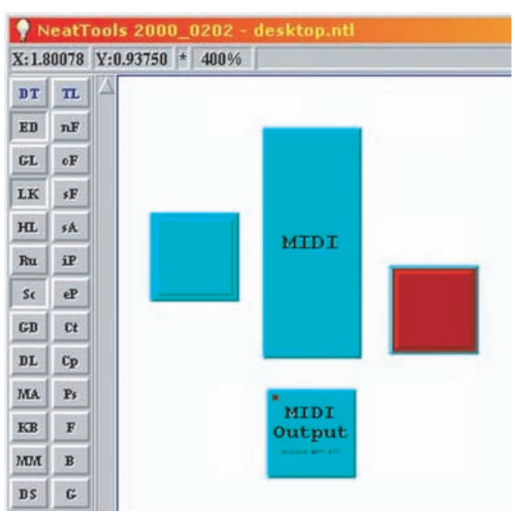
MIDI is short for Musical Instrument Digital Interface. It is commonly incorporated, for example, into electronic keyboards, guitars, and drum machines so they can be interfaced to computers. For more information, visit www.midi.org. NeatTools has a substantial set of MIDI and other modules in the **MM** (Multimedia) toolbox.

Drag a green **PushButton** and a red **Switch** from the **DS** toolbox to the desktop. Then from the **MM** toolbox, drag a **MIDI** module and a **MIDI Output** module.

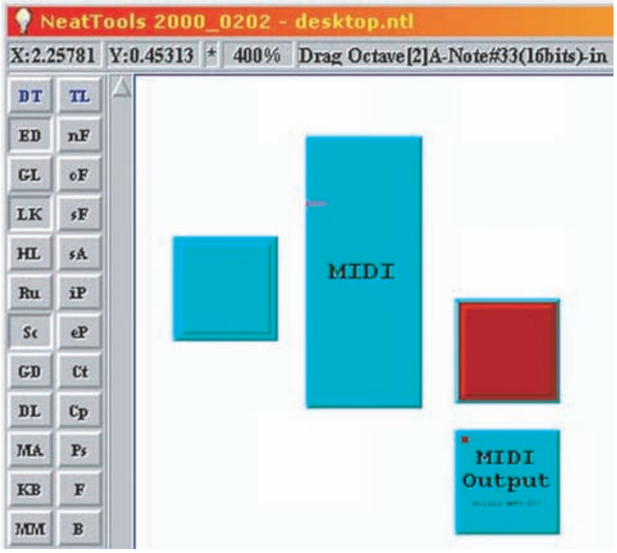


When creating MIDI events, the particular note that will be produced depends upon where the input is connected to the **MIDI** module. Because there are many such inputs on the left side, it is appropriate to elongate the **MIDI** module as shown below.

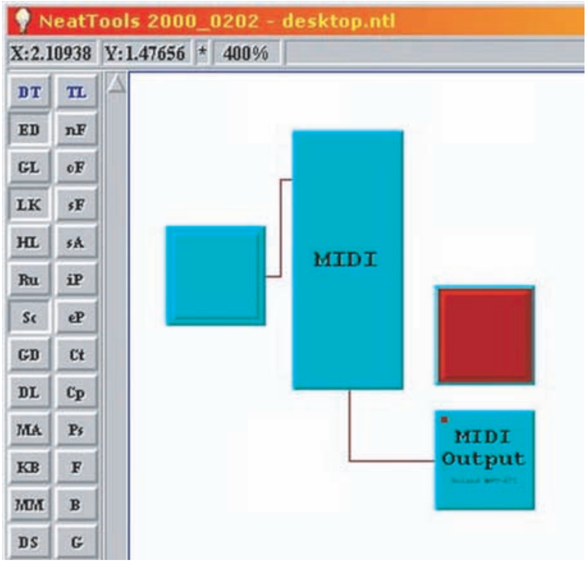
Drag the mouse along the inside of the left edge of the **MIDI** module and watch the status bar to see where on the module the ports for the desired individual notes are located.



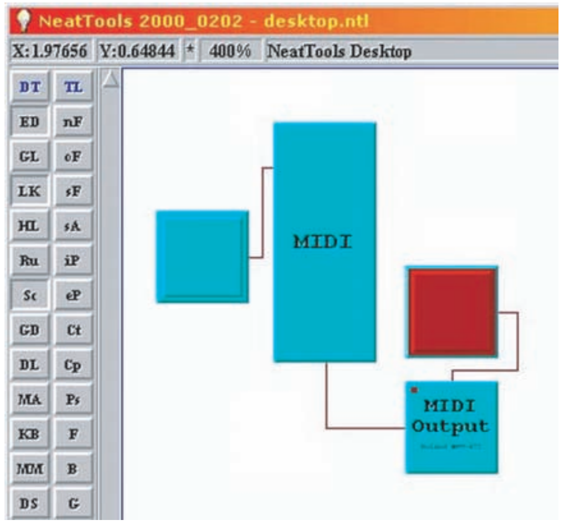
Choose a note on the left side of **MIDI** and drag a link from there back to the output of the green **PushButton** (or proceed from the **PushButton** output the **MIDI** input, if you prefer).



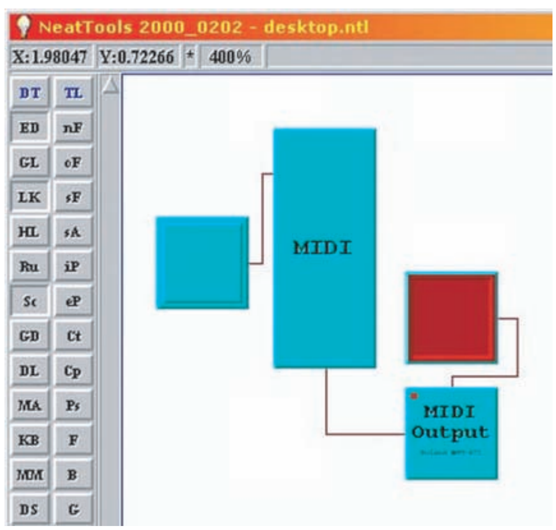
Next, link the bottom output of the **MIDI** module to the left input of the **MIDI** Output module.



Note: The **MIDI Output** module has a small red LED indicator in its upper left-hand corner that shows whether the module is active or not. Normally, it is activated by a red **Switch** module. Connect the output of the **Switch** to the top input of the **MIDI Out** module.



Make sure the **Switch** is depressed and then press the green **PushButton** to hear your note.

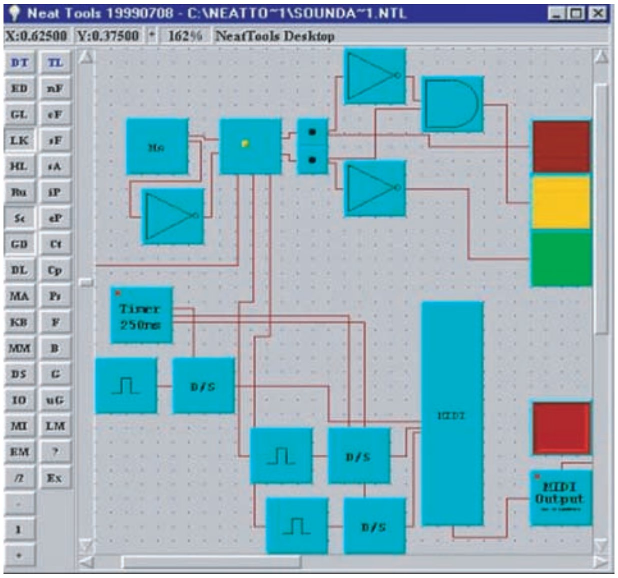


Note: If you are unable to hear the note, you may need to change to a different MIDI output device. To do so, right click on the **MIDI Output** module. On the property menu that appears, select the line that begins “device=” and then click Edit. Chose the alternate device and click Exit. Test for sound. You may need to do this more than once, depending how many MIDI device drivers are installed on your computer. If there is still no sound, make sure your speakers are operating by using another sound source, such as a music CD. You may actually want to do that system test first.

Sound & Light

This program demonstrates mouse control of a) Musical Instrument Digital Interface (MIDI)-generated sound and b) color changes on three different **LED**s. Modules featured in this program include **MIDI**, **2Dmeter**, And and **Not** logic operators, and **DelaySustain**.

Open the file **soundandlight.ntl**. The NeatTools window will display the program shown below.



Make sure **Edit** mode (**ED** button on **DT** toolbar) is off, in order to avoid inadvertent alterations of the program. Then, place the mouse cursor over each module (without clicking) and read its name from the Status Bar.

Slowly move the mouse cursor from the left to the right side of the screen. Note that your speakers will produce three successive tones of increasing pitch. The sound can be disabled by turning off the red **Switch** attached to **MIDI Out.** If you fail to obtain sound, consult the MIDI lesson for troubleshooting tips.

Slowly move the mouse cursor from the bottom to the top of the screen. Note that the three **LED**s sequentially illuminate.

How the Program Works

Examine the overall flow of information (connections of modules) to understand in general how this program functions. Note that the modules for sound are near the bottom,and the modules for light are near the top. The modules with the black dots are Node modules that are used here simply for fanout, i.e. to allow one link expand into two (or more), without having to make multiple connections at the special edge of the 2DMeter, where the specific link position matters.

Optional: Temporarily turn off the **LK** (Link) button on the **DT** (Desktop) toolbar, so the links among icons disappear. Now move the cursor over each module to see which other modules it is connected to.

The green **LED** (connected to **NOT**) illuminates, if the yellow indicator on the **2DMeter** remain within the lowest zone (defined by where, along the right edge of the **2DViewer**, the output links are connected). The yellow **LED** (connected to **AND** and **NOT**) illuminates, if the yellow indicator is in the middle zone. The red **LED** illuminates, if the cursor is in the upper zone.

The **2DMeter** connects to three **Pulse** modules (one for each note), each of which connects in turn to a **D/S** (Delay/Sustain) module. The **D/S** modules connect to the **MIDI** module and the **Timer** module.

Try the following exercises:

1. Make the frequency of the three tones decrease as the cursor moves from left to right.

2. Make all three tones sound off for a shorter period time.

3. Add a fourth note of higher pitch than the others.

4. Make the three tones sound off as the cursor moves up, instead of to the right.

5. Make the green **LED** stay on as the cursor moves up.

6. Change the thresholds of the **LED**s.

7. Add a switch to enable input to the **Timer** and observe the effect.

TNG-3B Interface

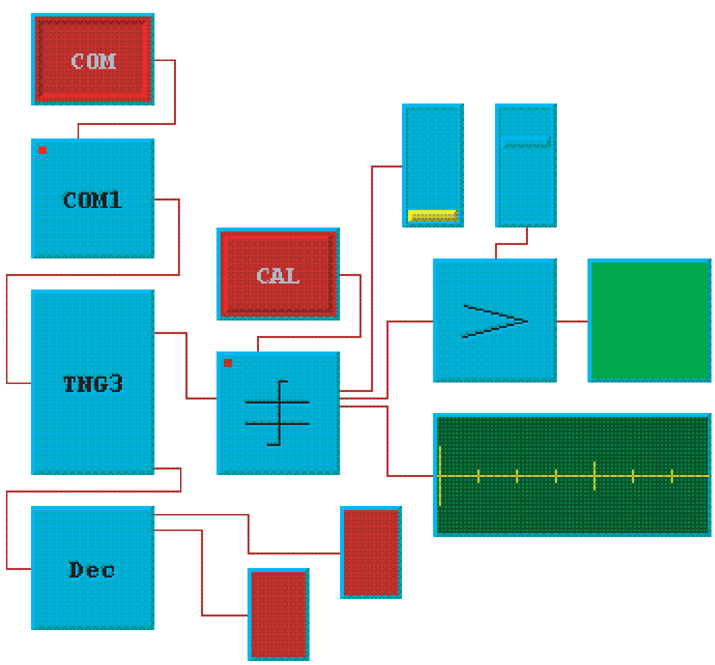
TNG-3B

TNG-3B is a general purpose interface device that accepts 8 analog and 8 digital inputs and streams data to the PC through a DB9 serial-port connector. Together with appropriate sensors, transducers, and switches, it provides a flexible system for human-computer interface applications, notably for persons with severe disabilities.

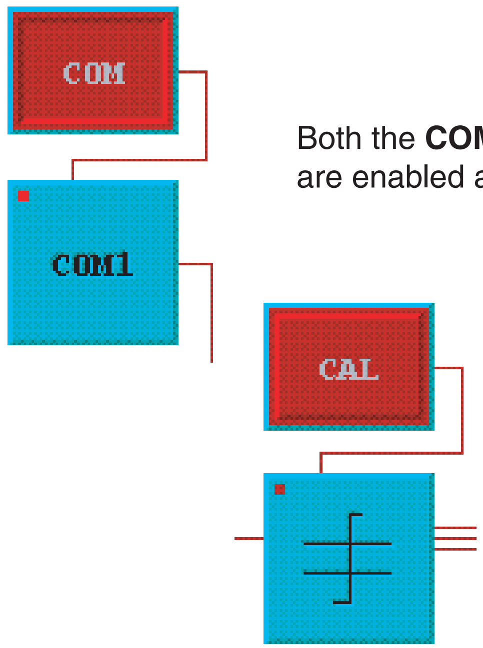
8 Analog Inputs

8 Digital Inputs

The illustration below demonstrates how to develop a network using the TNG-3B serial interface. It shows the use of a calibrator, and displays one analog and two digital outputs.



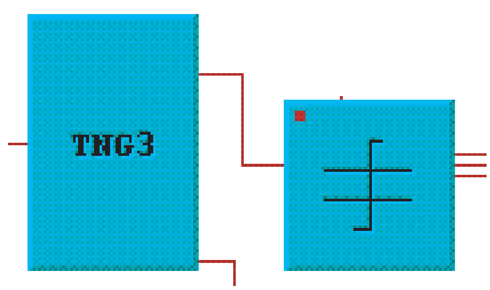
Turning on the **Switch** modules labeled **COM** and **CAL** illuminates the **LED** indicator at the top left corner of the **COM** and **Calibrate** modules respectively.



Both the **COM** and **Calibrate** modules are enabled at the top left port.

Note: The COM port number of this module and the computer COM port number that the TNG-3B interface is plugged into should match. If the COM port does not work, check whether the port is being used by another device, such as a modem, or by another program.

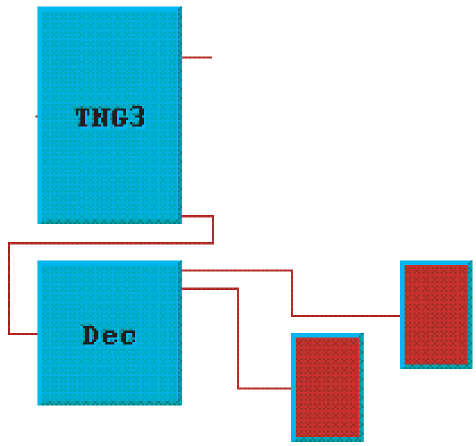
The **TNG3** module has 9 output ports. Channels 1-8 correspond to the eight analog inputs on the TNG-3B Interface. Channel 9 carries all 8 digital inputs.



Analog channel connection to calibrator. When an analog sensor is used, depending on the channel the sensor is plugged into, the output is linked from that channel to the input of the **Calibrate** module; i.e., if the sensor is in Analog channel 1, the output from channel 1 on the **TNG3** module is linked to the input of the **Calibrate** module.

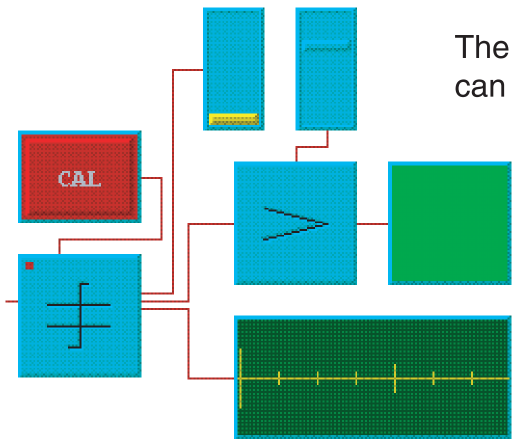
Note: The **TNG3** module is set here for 8 bits, as is the **Decoder**, **Calibrate**, and **GreaterThan** module. The default for all of these modules is 16 bits. These properties can be changed by right clicking on the module. The eight digital inputs are transmitted together as one byte (as are each of the analog channels) from the **TNG3** module. The **Decoder** extracts the individual bits, informing of the current state of the eight digital inputs.

When Digital sensors are plugged into Digital Inputs 1 and 2 on the TNG3B Interface, the **Decoder** module is linked from channel 0 to the input of an **LED** module and from channel 1 to the input of another **LED** module. The **LED** modules become illuminated when the sensor is activated in the TNG-3B Interface.



Note: Channel numbers on the **Decoder** module are numbered 0-7 instead of 1-8 as on the TNG3 module (to correspond with numbering on the TNG-3B device).

The output from the **Calibrator** module links into three other modules. The **1D Meter**, and **1D Viewer** modules record the signals from the sensor. When the sensor's signal shown on the **1D Meter** exceeds the limit set on the **1D Slider**, the green **LED** threshold is illuminated showing that the signal is greater than the set threshold.

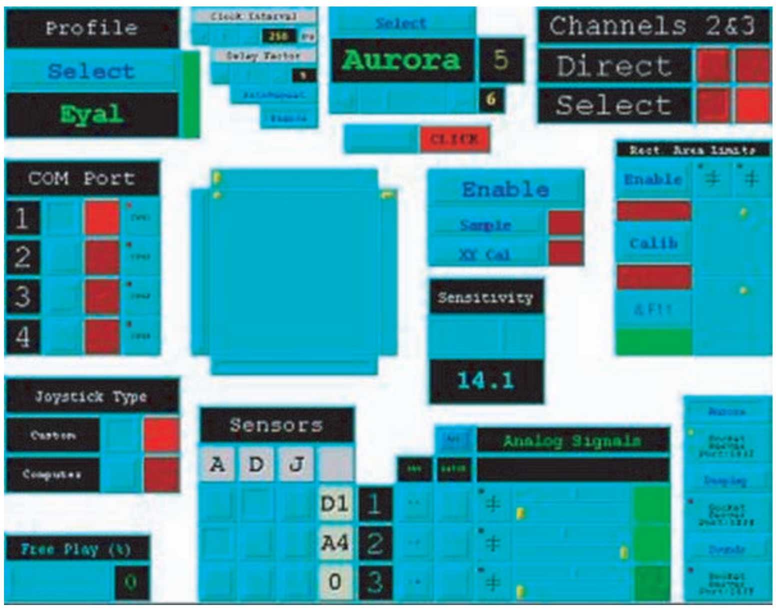


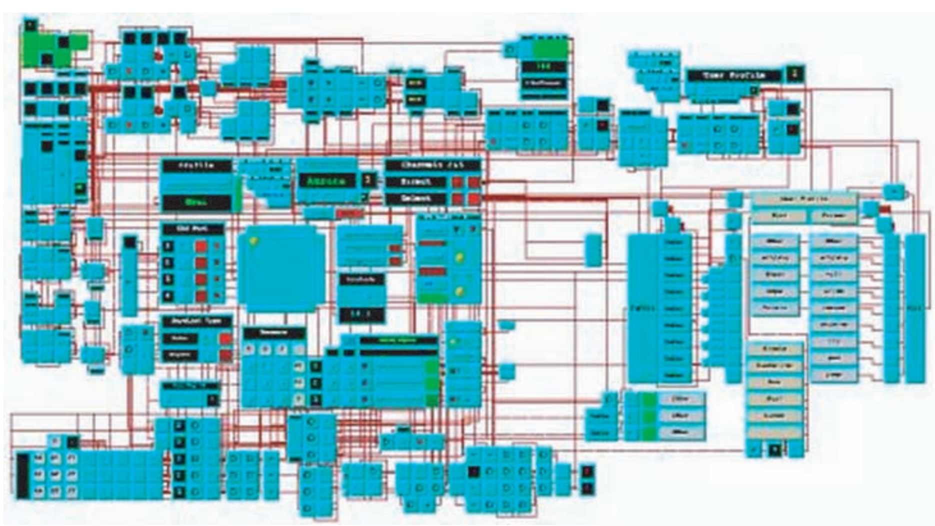
The level of the **1D Slider** can be changed.

The **1D Viewer** module displays signals from the sensor with respect to time.

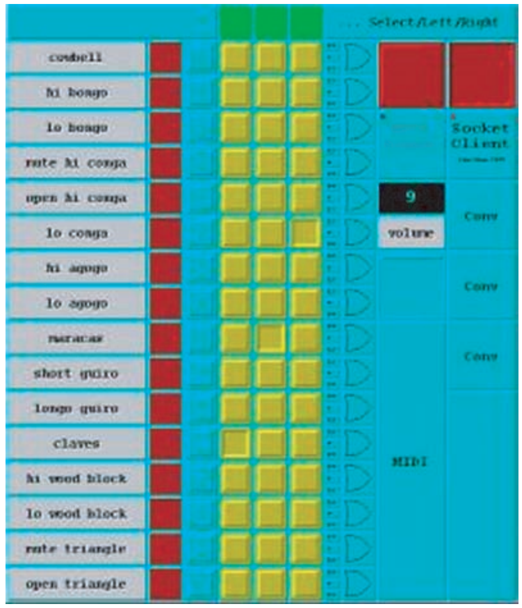
JoyMouse

A complex set of module connections, joymouse provides the user with a relatively user-friendly interface and allows for the use of a custom made joystick and switches to replace traditional joystick and mouse. Given the complexity of the program, this lesson will focus specifically on running and using the joymouse program.





Used in conjunction with LatinSounds.ntl, a signal received by the joymouse.ntl program is assigned audio feedback for each switch mounted.



Use of the jm123sh.ntl program with joymouse will allow the third digital switch to choose the second digital switch's function on the fly from a list of pre-programmed functions. Both of these additional modules will be discussed in this lesson.

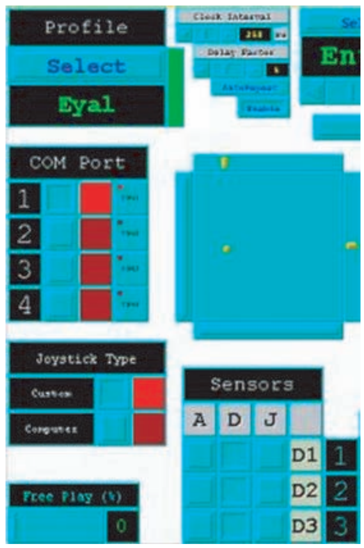
Hardware Setup

Connect a serial cable to the top of the TNG interface box. Connect the opposite end to the com port on the CPU. When a NeatTools program is running, TNG can be tested by depressing the yellow button to the right of the serial cable connection. A red light on the face of the box will illuminate if the proper connections have been made and the box is working.

Running the Program

1. From the center left hand side of the joymouse program, select the com port on the CPU that TNG is plugged into.

2. Below the Com Port selection, identify the type of joystick that will be used; custom made joystick, or standard unaltered computer joystick



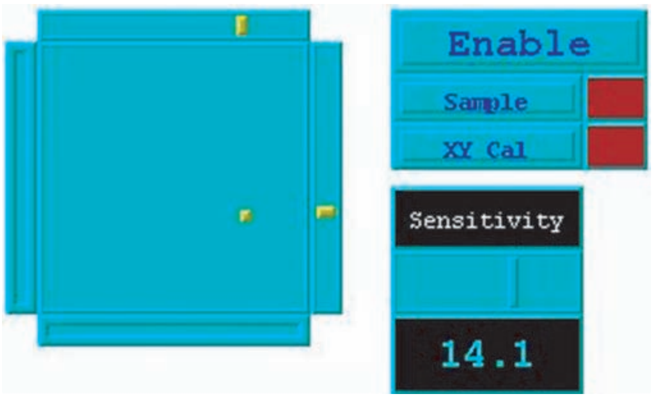
3. In the upper right hand corner of the joymouse program note a section titled Channels 2 &3. The existence of this function is relevant to another application that will be discussed in a later lesson. For now simply choose Select mode.

Joystick Setup & Calibration

What are we going to do about profiles? Create a generic?

Plug the analog and digital sensors into TNG reserving analog 1 & 2 inputs for the joystick X and Y plugs.

1. Move the joystick in a circular motion. With the appropriate com port having been selected, the motion should be visible on the **2DMeter** at the center of the program.



2. Move the joystick in a vertical motion. If the motion in the **2DMeter** is opposite that of the actual joystick motion, click on the vertical bar to the left of the **2DMeter** to invert the on-screen vertical motion.

3. Similarly, move the joystick in a horizontal motion. If the motion on the **2Dmeter** is opposite of the actual joystick motion, click on the horizontal bar at the bottom of the **2DMeter** to invert the on-screen horizontal motion.

For the first session in which a joystick is used with the joymouse program, it must be calibrated. Saving the joymouse program after calibration will save the settings and will therefore not require recalibration each time the joystick is used. Calibrating the joystick teaches the program the user's range of motion.

4. To calibrate the joystick click **XY Cal** button to the right of the **2DMeter.** Move the joystick vertically and horizontally a few times, then move it in a wide circular motion to establish the extent of the joystick's range. Click the **XY** button again to turn off the range of motion test.

The second step in calibration is to establish the center point of the joystick, or the position at which the cursor on the screen is at rest.

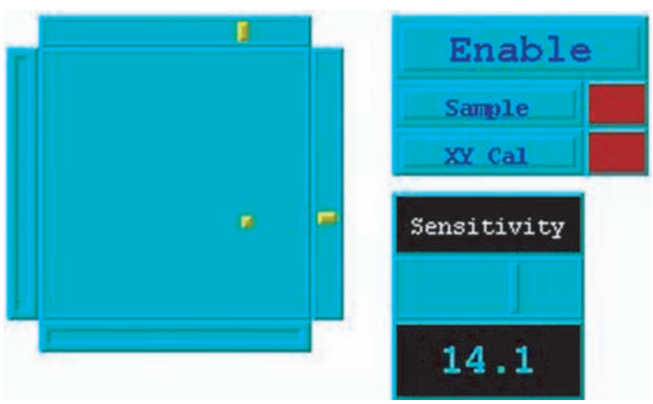
5. Remove your hands from the joystick to allow it to return to its rest position. Click the **SAMPLE** button to the right of the **2DMeter**.

6. To use the joystick click the **ENABLE** button to the right of the **2DMeter**.

Adjustments

The sensitivity of the joystick refers to the speed with which the cursor will move across the screen. To determine the level, set it near the center of the range and test the speed.

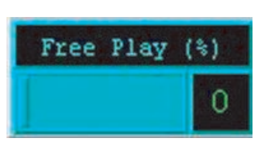
To increase or decrease the sensitivity of the joystick move the 1Dslider located to the right of the 2DMeter, and below the calibration buttons.



Similarly, the joymouse program allows the user to set the free play of the joystick, or a "dead zone". Free play refers to a range around the joystick in which movement of the joystick will not result in movement of the cursor.

The benefit of this feature is that a user who is not able to hold the joystick still at its rest position will not inadvertently move the cursor. In addition, a user with less dexterity in releasing the joystick will have better command of where the cursor stops on the screen.

It is recommended that free play be set at or near zero and increased as needed.



To this point, this lesson has dealt only with using the joymouse program to move the cursor around within the X and Y axis. The remainder of this program will address adding switches to the TNG interface box and the joymouse program to perform mouse clicking functions.

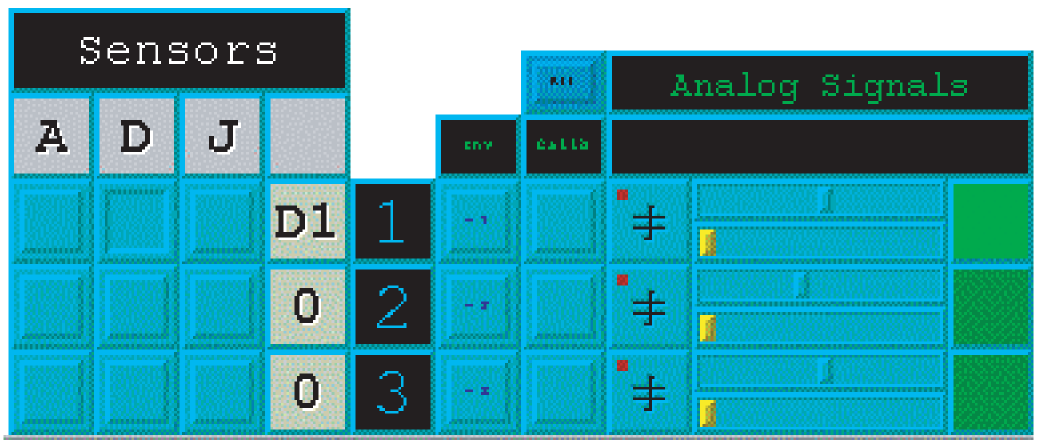
Sensors & Peripheral Programs

Frequently users use the left mouse button function to select items, drag and drop, and launch programs.

TNG and joymouse accept both analog and digital switches. Where each is inserted into the TNG box depends on what its function will be. For example, the switch intended for the left mouse click should always be plugged into the digital input 1.

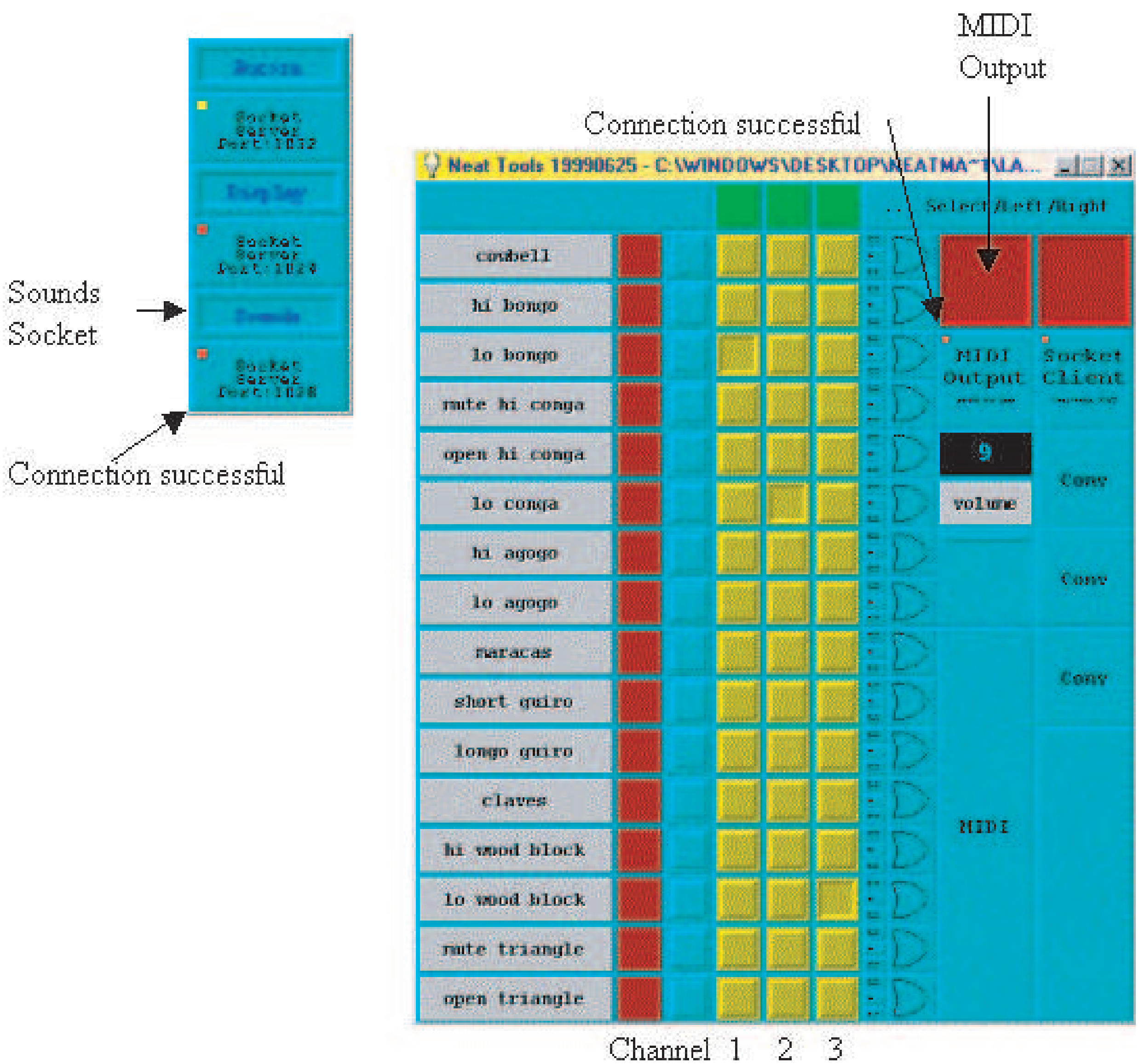
1. Within the joymouse program, and in the section labeled Sensors, indicate whether the switch in each input is analog or digital.

Since the joystick X and Y axis are plugged into the number one and two inputs in the analog section of TNG, the number one and two slots for sensors will always be digital with the option for either an analog or digital switch as the third sensor.



Latin Sounds

Sound can be added to switches and other modules used with NeatTools. To link joymouse to the latin sounds program open both programs. A connection is established by clicking on the socket button labeled Sounds. This button can be found in the bottom right hand corner of the joymouse program. Additionally, click the button above the MIDI Output module in the Latin Sounds program. Verify the connection is made by observing the illuminated red button in the upper left hand corner of the sounds socket module and the MIDI Output module. Broken connections are depicted as a yellow light.



Test each sound by clicking the blue buttons to the right of the names.
To select a sound, click the yellow button corresponding with the channel in the joymouse program.

Troubleshooting

If you are unable to hear the sound by clicking the blue buttons, perform the following steps.

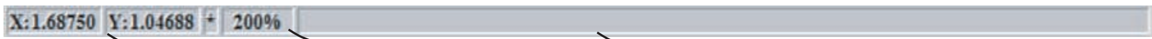
1. On the keyboard hit Ctrl+F7
2. Right click the MIDI Output module
3. Click Devices
4. Click Edit
5. Choose the alternate device
6. Click Exit
7. Hit Ctrl+F7
8. Test for sound by clicking the blue buttons.

The Title Bar:

Version of NeatTools in use

Name of current NeatTools file

The Status Bar:



X and Y coordinates of mouse

Current zoom factor

Description of currently selected module

The Tool Bars:

Desktop Toolbar Toggle
Detaches or anchors the Desktop toolbar

Edit Mode Toggle
Enables or disables the ability to edit a program

Guide Toggle
Enables or disables the ability to snap to grid

Link Toggle
Displays or hides the links (connection lines)

Hidden Line Toggle
Displays or hides links hidden behind modules

Ruler Toggle
Displays or hides the ruler toolbar

Scaler Toggle
Displays zoom slider on left side of screen

Grid Toggle
Displays or hides the grid lines

Digital Logic Toolbox Toggle
Displays or hides the Digital Logic toolbox

Math Toolbox Toggle
Displays or hides the Math toolbox

Keyboard Toolbox Toggle
Displays or hides the Keyboard toolbox

Multimedia Toolbox Toggle
Displays or hides the Multimedia toolbox

Display Toolbox Toggle
Displays or hides the Keyboard toolbox

Input/Output Toolbox Toggle
Displays or hides the I/O toolbox

Miscellaneous Toolbox Toggle
Displays or hides the Miscellaneous toolbox

External Toolbox Toggle
Displays or hides an External (Module) toolbox

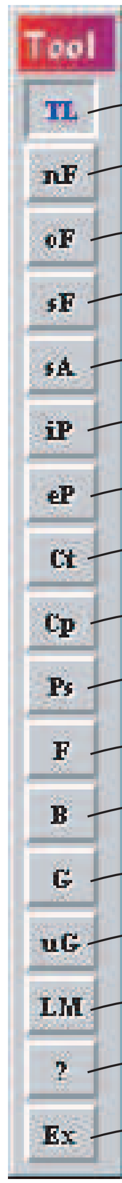
Zoom-Out by 2
Zooms out by 2

Zoom-Out
Zooms out

Original Scale
Returns the display to the original size

Zoom-In
Zooms in

Zoom-In by 2
Zooms in by 2



Tool Toolbar Toggle
Detaches or anchors the Tool toolbar

New File
Starts a new NeatTools application file

Open File
Opens a NeatTools application file

Save File
Saves the NeatTools application

Save File As
Saves the NeatTools file as a specific filename

Import Component
Imports a module file into this NeatTools application

Export Component
Exports a grouped module to a NeatTools file

Cut
Cuts selected items to the NeatTools clipboard

Copy
Copy selected items to the NeatTools clipboard

Paste
Pastes a highlighted group from NeatTools clipboard

To Front
Brings the module to the front

To Back
Sends the object to the back

Group
Groups a highlighted section together

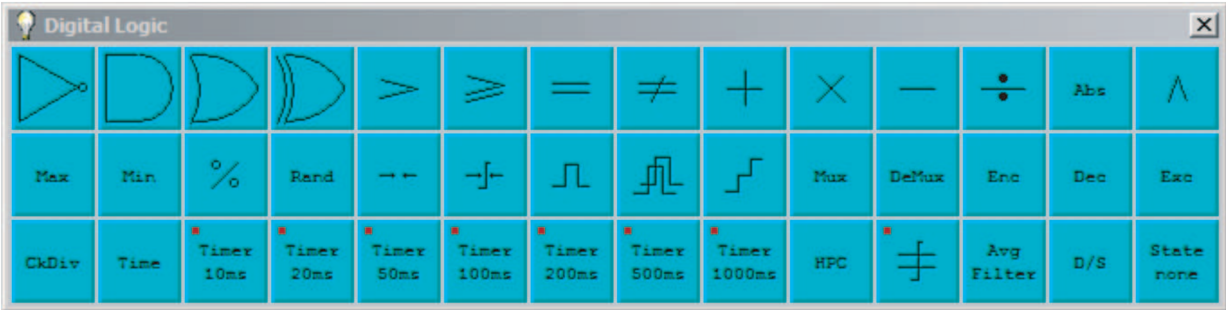
Ungroup
Ungroups a highlighted section

Load External Module
Loads an External Module for use in current application

About NeatTools
Displays the NeatTools splash screen

Exit NeatTools
Exit the NeatTools application

The Digital Logic Toolbox:



Not
Logical Negate (bitwise)

And
Logical And

Or
Logical Or

Exclusive Or
Logic Xor

Integer Greater Than
Greater than (for use with integers)

Integer Greater Than or Equal
Greater than or equal (for use with integers)

Integer Equal
Equal (for use with integers)

Integer Not Equal
Not Equal (for use with integers)

Integer Add
Addition (for use with integers)

Integer Multiply
Multiplication (for use with integers)

Integer Subtract
Subtract (for use with integers)

Integer Divide
Divide (for use with integers)

Integer Absolute Value
Calculates absolute value

Integer Power
Raise integer to a power

Integer Maximum
Outputs the maximum integer value

Integer Minimum
Outputs minimum integer value

Integer Percent
Calculates remainder (for use with integers)

Integer Random
Generates a random integer value

Control
Opens and closes a switch in series

Sample
Sample input values on demand

Pulse
Event production shaped pulse

Delay
Delays sending current value until next event is received

Accumulator
Counts events

Multiplexer
Selects one input to be current output

DeMultiplexer
Sends single input to selected output

Encoder
Converts bytes to integers

Decoder
Decodes the byte values of integers

Exclusive
(For radio buttons)

Clock Divider
Cycling clock

Time
Provides current time (use with date module)

High Performance Counter
(For fast timing)

Calibrate
Accommodates signal range (min to max)

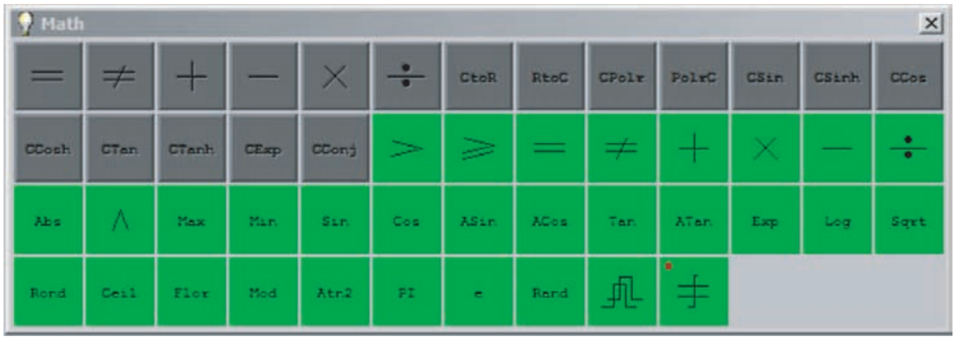
Average Filter
Running average

Delay Sustain
(As in music)

State Object
State machine element (advanced)

Timers
Activates at regular specified time intervals

The Math Toolbox:



Complex Equal
Equal (for use with complex numbers)

Complex Not Equal
Not equal (for use with complex numbers)

Complex Addition
Addition (for use with complex numbers)

Complex Subtract
Subtract (for use with complex numbers)

Complex Multiplication
Multiplication (for use with complex numbers)

Complex Division
Division (for use with complex numbers)

Complex to Real
Converts complex numbers to real numbers

Real to Complex
Converts real numbers to complex numbers

Complex to Polar
Converts complex numbers to polar coordinates

Polar to Complex
Converts polar coordinates to complex numbers

Complex Sine
Calculates the sine of complex numbers

Complex Hyperbolic Sine
Calculates the hyperbolic sine of complex numbers

Complex Cosine
Calculates the cosine of complex numbers

Complex Hyperbolic Cosine
Calculates hyperbolic cosine of complex numbers

Complex Tangent
Calculates the tangent of complex numbers

Complex Hyperbolic Tangent
Calculates the hyperbolic tangent of complex numbers

Complex Natural Antilog
Calculates natural antilog of complex numbers e^2

Complex Conjugate
Outputs the conjugate of complex numbers

Real Greater Than
Greater than (for use with real numbers)

Real Greater than or Equal
Greater than or equal (for use with real numbers)

Real Equal
Equal to (for use with real numbers)

Real Not Equal
Not equal to (for use with real numbers)

Real Addition
Addition (for use with real numbers)

Real Multiplication
Multiplication (for use with real numbers)

Real Subtract
Subtract (for use with real numbers)

Real Division
Division (for use with real numbers)

Real Absolute Value
Calculates the absolute value of real numbers

Real Power
Raises a real number to a power

Real Maximum
Outputs the maximum real value

Real Minimum
Outputs the minimum real value

Real Sine
Calculates the sine of real numbers

Real Cosine
Calculates the cosine of real numbers

Real Tangent
Calculates the tangent of real numbers

Real Arc Tangent
Calculates the arc tangent of real numbers

Natural Antilog e^x
Calculates the antilog of real numbers

Real Logarithm
Calculates the logarithm of real numbers

Real Square Root
Calculates the square root of real numbers

Real Round
Rounds real numbers

Real Ceiling
Calculates ceiling value of real numbers

Floor
Calculates floor value of real numbers

Modulus
Calculates remainder of a real number

Arc Tangent 2
Determines the four-quadrant arc tangent

(PI)
3.14...

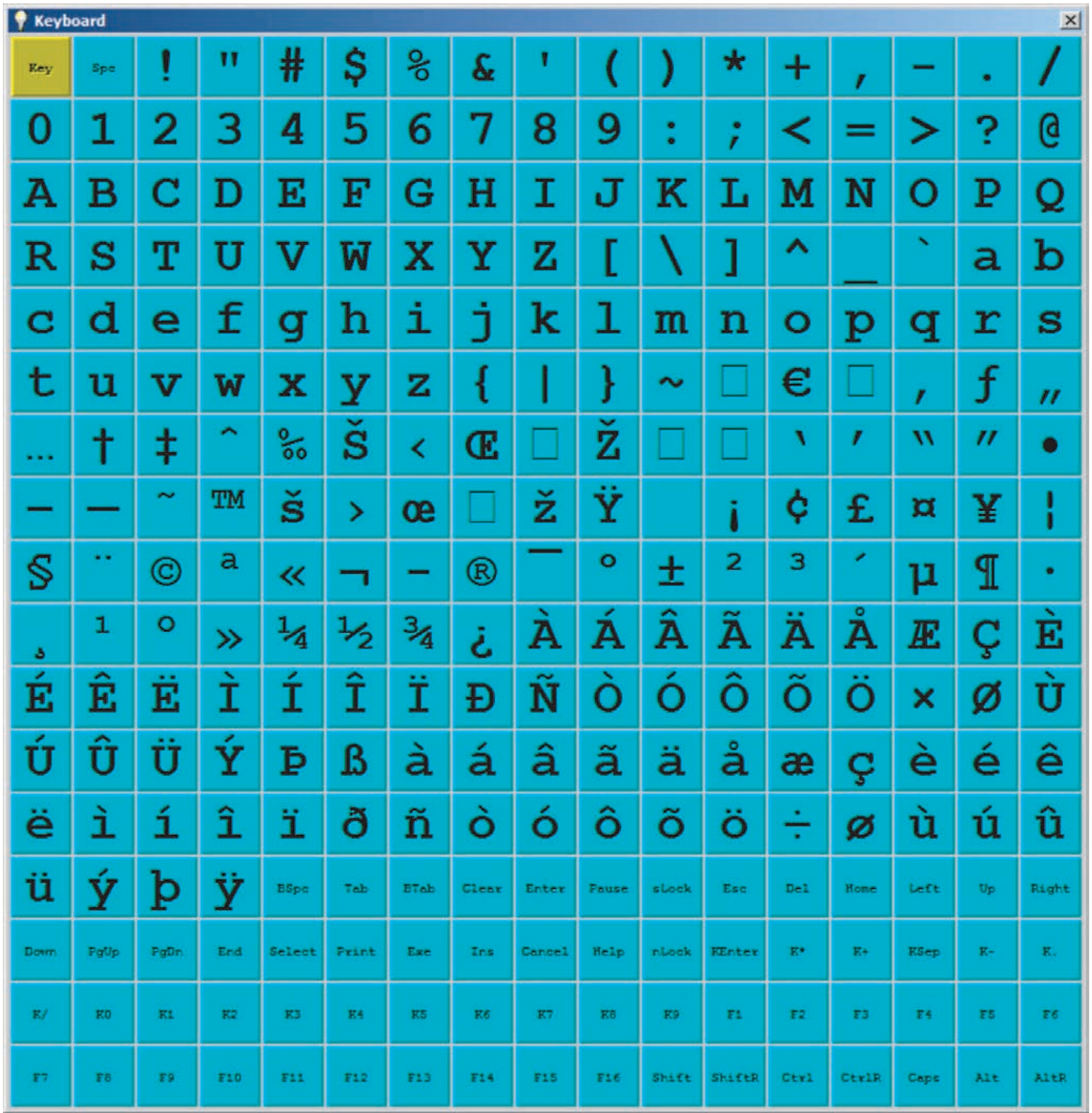
Natural number e
2.71828...

Real Random
Generates random real numbers

Real Calibrate
Calibrates real numbers

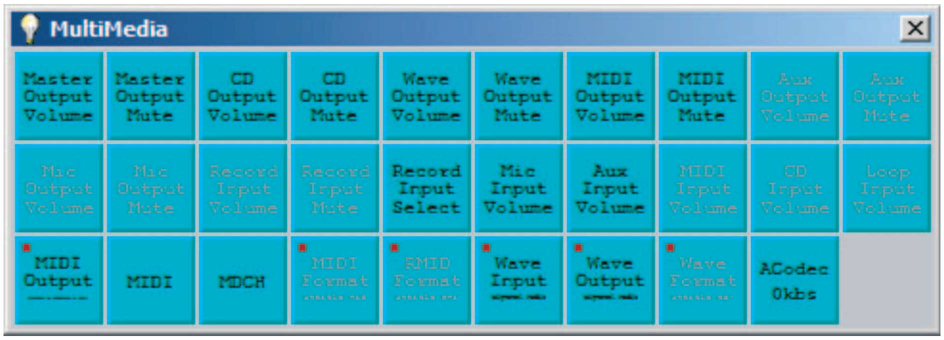
The Keyboard Toolbox:

These modules are relatively self explanatory and function in the same way that they do when found on a traditional keyboard.



Key
Generates string events from keyboard input

The Multimedia Toolbox:



Master Output Volume
Master volume control

Master Output Mute
Master toggle of output mute

CD Output Volume
Controls CD volume

CD Output Mute
Toggles mute on and off for CD volume

WAV Output Volume
Controls WAV volume

WAV Output Mute
Toggles mute on and off for WAV volume

MIDI Output Volume
Controls volume of MIDI output

MIDI Output Mute
Toggles mute on and off for MIDI volume

Auxiliary Output Volume
Controls volume of auxiliary output

Auxiliary Output Mute
Toggles mute on and off for mixer

Microphone Output Volume
Controls volume of microphone

Microphone Output Mute
Toggles mute on and off for microphone volume

Record Input Volume
Controls input volume for recording

Record Input Mute
Toggles mute on and off for recording

Record Input Select
Selects input type to be recorded

Microphone Input Volume
Controls microphone volume

Auxiliary Input Volume
Controls mixer volume

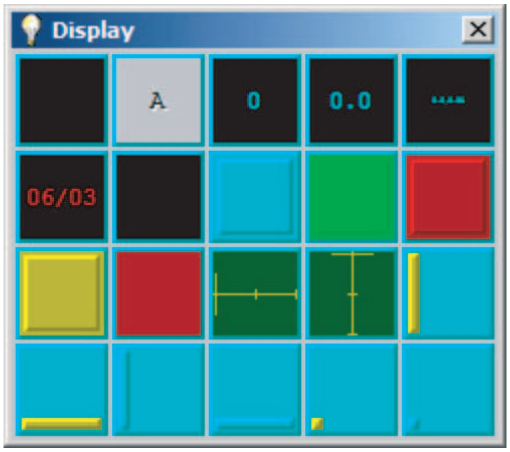
MIDI Input Volume
Controls volume of MIDI input

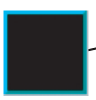
CD Input Volume
Controls volume of CD input

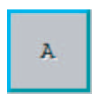
MIDI Output
Outputs MIDI events

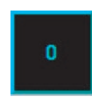
MIDI
Produces MIDI sound by adjusting MIDI channel

The Display Toolbox:




Color
Outputs color values to other modules


Label
Displays labels

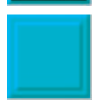

Integer
Displays integers


Real
Displays real numbers

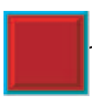

Real Complex
Displays complex numbers in floating point (real)


Date
Displays date


Bytes
Displays bytes

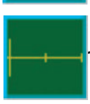

Button (Blue)
Momentary

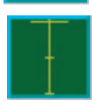

Push Button (Green)
Momentary and auto repeating


Switch (Red)
Push on, push off


Focus (Yellow)
Turns on if program is in the active window


LED
(Light Emitting Diode)
Illuminates


1DViewer
Displays 1D signal over time

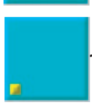

1DViewer
Displays 1D signal over time


1DMeter
Displays 1D movement


1DMeter
Displays 1D signal level

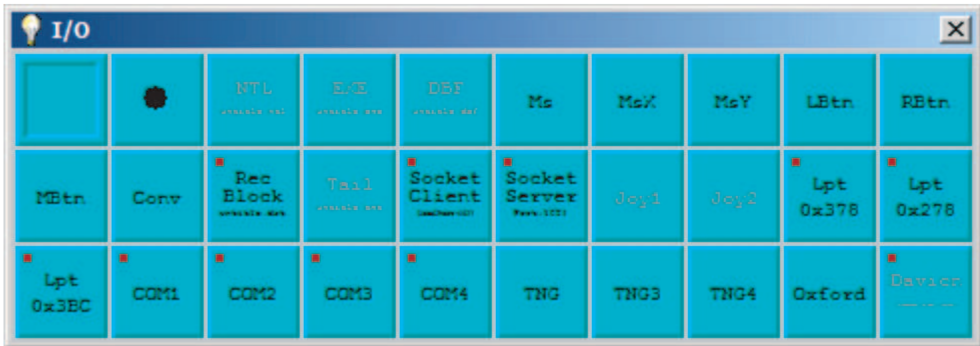

1DSlider
Adjusts 1D signal level


1DSlider
Adjusts 1D signal level


2DMeter
Displays 2D signal level


2DSlider
Adjusts 2D signal level

The Input/Output Toolbox:



Complex Object
Container for reusable data flow networks

Node
Pass through and fan out (event detector on bottom)

NeatTools Program Executable
NeatTools program executable

Executable
Opens an EXE file

Data Base Module

Complete Mouse
Receives full mouse I/O

Mouse X
Receives and transmits i/o for mouse x motion

Mouse Y
Receives and transmits i/o for mouse y motion

Left Mouse Button
I/O for left mouse button

Right Mouse Button
I/O for right mouse button

Middle Mouse Button
I/O for middle mouse button

Converter
Converts data types to block data and vise versa

Record Block
Records and plays back block type data (use with converter module)

Client Socket
Provides client socket connection

Server Socket Connection
Provides server socket connection

Joymouse 1
Joystick I/O on port 1

Joymouse 2
Joystick I/O on port 2

Line Printer 0x378
LPT I/O for 0x378 print port

Line Printer 0x278
LPT I/O for 0x278 print port

Line Printer 0x3BC
LPT I/O for 0x3BC print port

TNG-2
Receives input from TNG-2 serial interface

TNG-3
Receives input from TNG-3 serial interface

TNG-4
Receives input from TNG-4 serial interface

Oxford Pulse Oximeter
Instrument interface

Davicon EMG
Instrument interface

Com Port / Serial Port
Serial port I/O for ports 1-4

The Miscellaneous Toolbox:

Real to Integer Object
Converts real numbers to integers

Integer to Real Object
Converts integers to real numbers

Byte to Integer
Converts bytes to integers

Integer to Byte
Converts integers to bytes

WAV to integer
Converts WAVs to integers

Integer to WAV
Converts Integers to WAV

String to Integer
Converts strings to integers

Integer to String
Converts integers to strings

String to Byte
Converts strings to bytes

Byte to String
Converts bytes to strings

Date to Real
Converts dates to real

Real to Date
Converts real to date

Date Greater Than
Greater than (for use with dates)

Date Greater Than or Equal
Greater than or equal to (for use with dates)

Date Equal
Equal (for use with dates)

Date Not Equal
Not equal to (for use with dates)

String Greater Than
Greater than (for use with strings)

String Greater Than or Equal
Greater than or equal to (for use with strings)

String Equal
Equal (for use with strings)

String Not Equal
Not equal (for use with strings)

String Addition
Addition (for use with strings)

String Subtract
Subtract (for use with strings)

String Delete
Delete (for use with strings)

String Insert
Insert (for use with strings)

String Length
Length of string

String Position
Position (for use with strings)

String Upper Case
Upper case (for use with strings)

String Lower Case
Lower case (for use with strings)

Byte Addition
Addition (for use with bytes)

Byte Subtract
Subtract (for use with bytes)

Byte Delete
Delete (for use with bytes)

Byte Insert
Insert (for use with bytes)

Byte Length
Length (for use with bytes)

Byte Position
Position (for use with bytes)

Credits

The following individuals (in alphabetic order) have contributed to the NeatTools documentation project:

Matthew Carbone, Owner IDeations and Manager of the Center for Really Neat Research
Peter Ensminger, Ph.D., free-lance science writer based in Syracuse, NY
Taviare Hawkins, doctoral student in Physics at Syracuse University
Sarah Leadbeater, undergraduate student in Industrial Design at Syracuse University
Edward Lipson, Professor of Physics at Syracuse University. and CEO, Mindtel LLC
Jill Rajunas, doctoral student in Information Studies at Syracuse University

NeatTools Historical Credits

Dave Warner and Joh Johannsen developed the first generation versions of Neat software, with Joh doing the actual programming, based on design concepts and specifications by Dave. Similarly Dave and Yuh-Jye Chang codeveloped NeatTools, with Yuh-Jye doing the detailed architecture and coding. This work was the basis of his Ph.D. work in Computer Science at Syracuse University. Yuh-Jye is now employed by Lucent Bell Laboratories in New Jersey. Joh is a principal of Trapezium Development in Southern California. Dave is director of the Institute for Interventional Informatics and CIO of Mindtel, LLC. Joh remains active on the project; specifically, he is among those developing external modules (loadable at runtime) for NeatTools.

Software

neat

t o o l s

f o r   u p d a t e s

~~w w w . p u l s a r . o r g / n e a t t o o l s~~ → www.pulsar.org/2k/neattools

beta version