TCL/TK

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About the Tutorial

Tcl is a general purpose multi-paradigm system programming language. It is a scripting language that aims at providing the ability for applications to communicate with each other.

On the other hand, Tk is a cross platform widget toolkit used for building GUI in many languages.

This tutorial covers various topics ranging from the basics of the Tcl/ Tk to its scope in various applications.

Audience

This tutorial is designed for all those individuals who are looking for a starting point of learning Tcl/ Tk. Therefore, we cover all those topics that are required for a beginner and an advanced user.

Prerequisites

Before proceeding with this tutorial, it is advisable for you to understand the basic concepts of computer programming. This tutorial is self-contained and you will be able to learn various concepts of Tcl/Tk even if you are a beginner. You just need to have a basic understanding of working with a simple text editor and command line.

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1. Tcl – Overview

Tcl is shortened form of **Tool Command Language**. John Ousterhout of the University of California, Berkeley, designed it. It is a combination of a scripting language and its own interpreter that gets embedded to the application, we develop with it.

Tcl was developed initially for Unix. It was then ported to Windows, DOS, OS/2, and Mac OSX. Tcl is much similar to other unix shell languages like Bourne Shell (Sh), the C Shell (csh), the Korn Shell (sh), and Perl.

It aims at providing ability for programs to interact with other programs and also for acting as an embeddable interpreter. Even though, the original aim was to enable programs to interact, you can find full-fledged applications written in Tcl/Tk.

Features of Tcl

The features of Tcl are as follows:

- Reduced development time.
- Powerful and simple user interface kit with integration of TK.
- Write once, run anywhere. It runs on Windows, Mac OS X, and almost on every Unix platform.
- Quite easy to get started for experienced programmers; since, the language is so simple that they can learn Tcl in a few hours or days.
- You can easily extend existing applications with Tcl. Also, it is possible to include Tcl in C, C++, or Java to Tcl or vice versa.
- Have a powerful set of networking functions.
- Finally, it's an open source, free, and can be used for commercial applications without any limit.

Applications

Tcl is a general-purpose language and you can find Tcl everywhere. It includes,

- Scalable websites that are often backed by databases.
- High performance web servers build with TclHttpd.
- Tcl with CGI based websites.
- Desktop GUI applications.
- Embedded applications.

2. Tcl – Environment Setup

Try it Option

You really do not need to set up your own environment to start learning Tcl programming. Reason is very simple, we already have set up Tcl Programming environment online, so that you can execute all the Tcl examples online at the same time when you are doing your theory work. This gives you confidence in what you are reading and to check the result with different options. Feel free to modify any example and execute it online.

Try following example using '**Try it'** option available at the top right corner of the sample code box:

```
#!/usr/bin/tclsh

puts "Hello, World!"
```

For most of the Tcl examples given in this tutorial, you will find **Try it** option, so just make use of it and enjoy your learning. For Tk examples, you will need to have a console to see graphical results; so, we recommend to have your own Tk setup.

Local Environment Setup

If you are willing to set up your environment for Tcl, you need the following two software applications available on your computer:

(a) Text Editor

(b) Tcl Interpreter.

Text Editor

This will be used to type your program. Examples of a few text editors include Windows Notepad, OS Edit command, Brief, Epsilon, EMACS, and vim or vi.

Name and version of a text editor can vary on different operating systems. For example, Notepad will be used on Windows, and vim or vi can be used on windows as well as Linux or UNIX.

The files you create with your text editor are called source files and contain program source code. The source files for Tcl programs are named with the extension **".tcl"**.

Before starting your programming, make sure you have one text editor in place and you have enough experience to write a computer program, save it in a file, build it, and finally execute it.

The Tcl Interpreter

It is just a small program that enables you to type Tcl commands and have them executed line by line. It stops execution of a tcl file, in case, it encounters an error unlike a compiler that executes fully.

Let's have a helloWorld.tcl file as follows. We will use this as a first program, we run on a platform you choose.

```
#!/usr/bin/tclsh


puts "Hello World!"
```

Installation on Windows

Download the latest version for windows **installer** from the list of Active Tcl binaries available. The active Tcl community edition is free for personal use.

Run the downloaded executable to install the Tcl, which can be done by following the on screen instructions.

Now, we can build and run a Tcl file say helloWorld.tcl by switching to folder containing the file using 'cd' command and then execute the program using the following steps

```
C:\Tcl> tclsh helloWorld.tcl
```

We can see the following output.

```
C:\Tcl> helloWorld
```

C:\Tcl is the folder, I am using to save my samples. You can change it to the folder in which you have saved Tcl programs.

Installation on Linux

Most of the Linux operating systems come with Tcl inbuilt and you can get started right away in those systems. In case, it's not available, you can use the following command to download and install Tcl-Tk.

```
$ yum install tcl tk
```

Now, we can build and run a Tcl file say helloWorld.tcl by switching to folder containing the file using 'cd' command and then execute the program using the following steps:

```
$ tclsh helloWorld.tcl
```

We can see the following output:

```
$ hello world
```

Installation on Debian based Systems

In case, it's not available in your OS, you can use the following command to download and install Tcl-Tk:

```
$ sudo apt-get install tcl tk
```

Now, we can build and run a Tcl file say helloWorld.tcl by switching to folder containing the file using 'cd' command and then execute the program using the following steps:

```
$ tclsh helloWorld.tcl
```

We can see the following output:

```
$ hello world
```

Installation on Mac OS X

Download the latest version for Mac OS X **package** from the list of Active Tcl binaries available. The active Tcl community edition is free for personal use.

Run the downloaded executable to install the Active Tcl, which can be done by following the on screen instructions.

Now, we can build and run a Tcl file say helloWorld.tcl by switching to folder containing the file using 'cd' and then execute the program using the following steps:

```
$ tclsh helloWorld.tcl
```

We can see the following output:

```
$ hello world
```

Installation from Source Files

You can use the option of installing from source files when a binary package is not available. It is generally preferred to use Tcl binaries for Windows and Mac OS X, so only compilation of sources on unix based system is shown below.

- Download the **source files.**
- Now, use the following commands to extract, compile, and build after switching to the downloaded folder.

```
$ tar zxf tcl8.6.1-src.tar.gz
$ cd tcl8.6.1
$ cd unix
$ ./configure –prefix=/opt –enable-gcc
$ make
```

```
$ sudo make install
```

Note: Make sure, you change the file name to the version you downloaded on commands 1 and 2 given above.

3. Tcl – Special Variables

In Tcl, we classify some of the variables as special variables and they have a predefined usage/functionality. The list of specials variables is listed below.

Special Variable	Description
argc	Refers to a number of command-line arguments.
argv	Refers to the list containing the command-line arguments.
argv0	Refers to the file name of the file being interpreted or the name by which we invoke the script.
env	Used for representing the array of elements that are environmental variables.
errorCode	Provides the error code for last Tcl error.
errorInfo	Provides the stack trace for last Tcl error.
tcl_interactive	Used to switch between interactive and non-interactive modes by setting this to 1 and 0 respectively.
tcl_library	Used for setting the location of standard Tcl libraries.
tcl_pkgPath	Provides the list of directories where packages are generally installed.
tcl_patchLevel	Refers to the current patch level of the Tcl interpreter.
tcl_platform	Used for representing the array of elements with objects including byteOrder, machine, osVersion, platform, and os.
tcl_precision	Refers to the precision i.e. number of digits to retain when converting to floating-point numbers to strings. The default value is 12.
tcl_prompt1	Refers to the primary prompt.
tcl_prompt2	Refers to the secondary prompt with invalid commands.
tcl_rcFileName	Provides the user specific startup file.
tcl_traceCompile	Used for controlling the tracing of bytecode compilation. Use 0 for no output, 1 for summary, and 2 for detailed.
tcl_traceExec	Used for controlling the tracing of bytecode execution. Use 0 for no output, 1 for summary, and 2 for detailed.
tcl_version	Returns the current version of the Tcl interpreter.

The above special variables have their special meanings for the Tcl interpreter.

Examples for using Tcl Special Variables

Let's see some examples for special variables.

Tcl Version

```
#!/usr/bin/tclsh

puts $tcl_version
```

When you run the program, you will get a similar output as shown below:

```
8.5
```

Tcl Environment Path

```
#!/usr/bin/tclsh

puts $env(PATH)
```

When you run the program, you will get a similar output as shown below:

```
/web/com/GNUstep/Tools:/usr/GNUstep/Local/Tools:/usr/GNUstep/System/Tools:/usr/
local/sml/bin:/usr/local/flex/bin:/usr/local/gcc-
4.8.1/bin:/usr/share/java:.:/usr/share/java:/usr/lib/jvm/java/lib:/usr/lib/jvm/
java/jre/lib:/usr/local/bin:/usr/local/mozart/bin:/usr/local/go/bin:/usr/local/
factor/:/usr/local/groovy-2.1.7/bin:/opt/Pawn/bin/:/usr/local/icon-
v950/bin:/usr/local/lib/mono/4.0:/usr/lib64/qtC.3/bin:/usr/local/bin:/bin:/usr/
bin:/usr/local/sbin:/usr/sbin:/sbin:/opt/Pawn/bin:/usr/local/dart/bin:/usr/loca
l/julia/usr/bin:/usr/local/julia:/usr/local/scriptbasic/bin
```

Tcl Package Path

```
#!/usr/bin/tclsh
puts $tcl_pkgPath
```

When you run the program, you will get a similar output as shown below:

```
/usr/lib64/tcl8.5 /usr/share/tcl8.5 /usr/lib64/tk8.5 /usr/share/tk8.5
```

Tcl Library

```
#!/usr/bin/tclsh

puts $tcl_library
```

When you run the program, you will get a similar output as shown below:

```
/usr/share/tcl8.5
```

Tcl Patch Level

```
#!/usr/bin/tclsh

puts $tcl_patchLevel
```

When you run the program, you will get a similar output as shown below:

```
8.5.7
```

Tcl Precision

```
#!/usr/bin/tclsh

puts $tcl_precision
```

When you run the program, you will get a similar output as shown below:

```
0
```

Tcl Startup File

```
#!/usr/bin/tclsh

puts $tcl_rcFileName
```

When you run the program, you will get a similar output as shown below:

```
~/.tclshrc
```

4. Tcl – Basic Syntax

Tcl is quite simple to learn and let's start creating our first Tcl program!

First Tcl Program

Let us write a simple Tcl program. All Tcl files will have an extension, i.e., .tcl. So, put the following source code in a test.tcl file.

```
#!/usr/bin/tclsh

puts "Hello, World!"
```

Assuming, Tcl environment is setup correctly; let's run the program after switching to file's directory and then execute the program using:

```
$ tclsh test.tcl
```

We will get the following output:

```
Hello, World!
```

Let us now see the basic structure of Tcl program, so that it will be easy for you to understand basic building blocks of the Tcl language. In Tcl, we use new line or semicolon to terminate the previous line of code. But semicolon is not necessary, if you are using newline for each command.

Comments

Comments are like helping text in your Tcl program and the interpreter ignores them. Comments can be written using a hash_(#) sign in the beginning.

```
#!/usr/bin/tclsh

# my first program in Tcl
puts "Hello World!"
```

Multiline or block comment is written using 'if' with condition '0.' An example is shown below.

```
#!/usr/bin/tclsh

if 0 {
my first program in Tcl program
```

```
Its very simple
}
puts "Hello World!"
```

Inline comments use ;#. An example is given below.

```
#!/usr/bin/tclsh

puts "Hello World!" ;# my first print in Tcl program
```

Identifiers

A Tcl identifier is a name used to identify a variable, function, or any other user-defined item. An identifier starts with a letter A to Z or a to z or an underscore (_) followed by zero or more letters, underscores, dollars ($), and digits (0 to 9).

Tcl does not allow punctuation characters such as @, and % within identifiers. Tcl is a **case sensitive**_ language. Thus *Manpower* and *manpower* are two different identifiers in Tcl. Here are some of the examples of acceptable identifiers:

```
mohd       zara    abc   move_name   a_123
myname50   _temp   j     a23b9       retVal
```

Reserved Words

The following list shows a few of the reserved words in Tcl. These reserved words may not be used as constant or variable or any other identifier names.

after	append	array	auto_execok
auto_import	auto_load	auto_load_index	auto_qualify
binary	Bgerror	break	catch
cd	Clock	close	concat
continue	Dde	default	else
elseif	Encoding	eof	error
eval	Exec	exit	expr
fblocked	Fconfigure	fcopy	file
fileevent	Flush	for	foreach
format	Gets	glob	global
history	If	info	interp

join	Lappend	lindex	linsert
list	Llength	load	lrange
lreplace	Lsearch	lsort	namespace
open	Package	pid	pkg_mkIndex
proc	Puts	pwd	read
regexp	Regsub	rename	resource
return	Scan	seek	set
socket	Source	split	string
subst	Switch	tclLog	tell
time	Trace	unknown	unset
update	Uplevel	upvar	variable
vwait	While		

Whitespace in Tcl

A line containing only whitespace, possibly with a comment, is known as a **blank line**, and a Tcl interpreter totally ignores it.

Whitespace is the term used in Tcl to describe blanks, tabs, newline characters, and comments. Whitespace separates one part of a statement from another and enables the interpreter to identify where one element in a statement, such as puts, ends and the next element begins. Therefore, in the following statement:

```
#!/usr/bin/tclsh

puts "Hello World!"
```

There must be at least one whitespace character (usually a space) between “puts” and "Hello World!" for the interpreter to be able to distinguish them. On the other hand, in the following statement:

```
#!/usr/bin/tclsh

puts [expr 3 + 2] ;# print sum of the 3 and 2
```

No whitespace characters are necessary between 3 and +, or between + and 2; although, you are free to include some if you wish for the readability purpose.

When you run the above code, it will produce the following output:

```
5
```

5. Tcl – Commands

As you know, Tcl is a Tool command language, commands are the most vital part of the language. Tcl commands are built in-to the language with each having its own predefined function. These commands form the reserved words of the language and cannot be used for other variable naming. The advantage with these Tcl commands is that, you can define your own implementation for any of these commands to replace the original built-in functionality.

Each of the Tcl commands validates the input and it reduces the work of the interpreter.

Tcl command is actually a list of words, with the first word representing the command to be executed. The next words represent the arguments. In order to group the words into a single argument, we enclose multiple words with "" or {}.

The syntax of Tcl command is as follows:

```
commandName argument1 argument2 ... argumentN
```

Let's see a simple example of Tcl command:

```
#!/usr/bin/tclsh

puts "Hello, world!"
```

When the above code is executed, it produces the following result:

```
Hello, world!
```

In the above code, 'puts' is the Tcl command and "Hello World" is the argument1. As said before, we have used "" to group two words.

Let's see another example of Tcl command with two arguments:

```
#!/usr/bin/tclsh

puts stdout "Hello, world!"
```

When above code is executed, it produces the following result:

```
Hello, world!
```

In the above code, 'puts' is the Tcl command, 'stdout' is argument1, and "Hello World" is argument2. Here, stdout makes the program to print in the standard output device.

Command Substitution

In command substitutions, square brackets are used to evaluate the scripts inside the square brackets. A simple example to add two numbers is shown below:

```
#!/usr/bin/tclsh

puts [expr 1 + 6 + 9]
```

When the above code is executed, it produces following result:

```
16
```

Variable Substitution

In variable substitutions, $ is used before the variable name and this returns the contents of the variable. A simple example to set a value to a variable and print it is shown below.

```
#!/usr/bin/tclsh

set a 3
puts $a
```

When the above code is executed, it produces the following result:

```
3
```

Backslash Substitution

These are commonly called **escape sequences**; with each backslash, followed by a letter having its own meaning. A simple example for newline substitution is shown below:

```
#!/usr/bin/tclsh

puts "Hello\nWorld"
```

When the above code is executed, it produces following result:

```
Hello
World
```

6. Tcl – Data Types

The primitive data-type of Tcl is string and often we can find quotes on Tcl as string only language. These primitive data-types in turn create composite data-types for list and associative array. In Tcl, data-types can represent not only the simple Tcl objects, but also can represent complex objects such as handles, graphic objects (mostly widgets), and I/O channels. Let's look into the details about each of the above.

Simple Tcl Objects

In Tcl, whether it is an integer number, boolean, floating point number, or a string. When you want to use a variable, you can directly assign a value to it, there is no step of declaration in Tcl. There can be internal representations for these different types of objects. It can transform one data-type to another when required. The syntax for assigning value to variable is as follows:

```
#!/usr/bin/tclsh

set myVariable 18
puts $myVariable
```

When the above code is executed, it produces the following result:

```
18
```

The above statement will create a variable name myVariable and stores it as a string even though, we have not used double quotations. Now, if we try to make an arithmetic on the variable, it is automatically turned to an integer. A simple example is shown below:

```
#!/usr/bin/tclsh

set myVariable 18
puts [expr $myVariable + 6 + 9]
```

When the above code is executed, it produces the following result:

```
33
```

One important thing to note is that, these variables don't have any default values and must be assigned value before they are used.

If we try to print using puts, the number is transformed into proper string. Having two representations, internal and external, help Tcl to create complex data structures easily compared to other languages. Also, Tcl is more efficient due to its dynamic object nature.

String Representations

Unlike other languages, in Tcl, you need not include double quotes when it's only a single word. An example can be:

```
#!/usr/bin/tclsh

set myVariable hello
puts $myVariable
```

When the above code is executed, it produces the following result:

```
hello
```

When we want to represent multiple strings, we can use either double quotes or curly braces. It is shown below:

```
#!/usr/bin/tclsh

set myVariable "hello world"
puts $myVariable
set myVariable {hello world}
puts $myVariable
```

When the above code is executed, it produces the following result:

```
hello world
hello world
```

List

List is nothing but a group of elements. A group of words either using double quotes or curly braces can be used to represent a simple list. A simple list is shown below:

```
#!/usr/bin/tclsh

set myVariable {red green blue}
puts [lindex $myVariable 2]
set myVariable "red green blue"
puts [lindex $myVariable 1]
```

When the above code is executed, it produces the following result:

```
blue
```

```
green
```

Associative Array

Associative arrays have an index (key) that is not necessarily an integer. It is generally a string that acts like key value pairs. A simple example is shown below:

```
#!/usr/bin/tclsh

set  marks(english) 80
puts $marks(english)
set  marks(mathematics) 90
puts $marks(mathematics)
```

When the above code is executed, it produces the following result:

```
80
90
```

Handles

Tcl handles are commonly used to represent files and graphics objects. These can include handles to network requests and also other channels like serial port communication, sockets, or I/O devices. The following is an example where a file handle is created.

```
set myfile [open "filename" r]
```

You will see more detail on files in the **Tcl file I/O** chapter.

7. Tcl – Variables

In Tcl, there is no concept of variable declaration. Once, a new variable name is encountered, Tcl will define a new variable.

Variable Naming

The name of variables can contain any characters and length. You can even have white spaces by enclosing the variable in curly braces, but it is not preferred.

The set command is used for assigning value to a variable. The syntax for set command is,

```
set variableName value
```

A few examples of variables are shown below:

```
#!/usr/bin/tclsh

set variableA 10
set {variable B} test
puts $variableA
puts ${variable B}
```

When the above code is executed, it produces the following result:

```
10
test
```

As you can see in the above program, the $variableName is used to get the value of the variable.

Dynamic Typing

Tcl is a dynamically typed language. The value of the variable can be dynamically converted to the required type when required. For example, a number 5 that is stored as string will be converted to number when doing an arithmetic operation. It is shown below:

```
#!/usr/bin/tclsh

set variableA "10"
puts $variableA
set sum [expr $variableA +20];
```

```
puts $sum
```

When the above code is executed, it produces the following result:

```
10
30
```

Mathematical Expressions

As you can see in the above example, expr is used for representing mathematical expression. The default precision of Tcl is 12 digits. In order to get floating point results, we should add at least a single decimal digit. A simple example explains the above.

```
#!/usr/bin/tclsh

set variableA "10"
set result [expr $variableA / 9];
puts $result
set result [expr $variableA / 9.0];
puts $result
set variableA "10.0"
set result [expr $variableA / 9];
puts $result
```

When the above code is executed, it produces the following result:

```
1
1.1111111111111112
1.1111111111111112
```

In the above example, you can see three cases. In the first case, the dividend and the divisor are whole numbers and we get a whole number as result. In the second case, the divisor alone is a decimal number and in the third case, the dividend is a decimal number. In both second and third cases, we get a decimal number as result.

In the above code, you can change the precision by using tcl_precision special variable. It is shown below:

```
#!/usr/bin/tclsh

set variableA "10"
set tcl_precision 5
set result [expr $variableA / 9.0];
```

```
puts $result
```

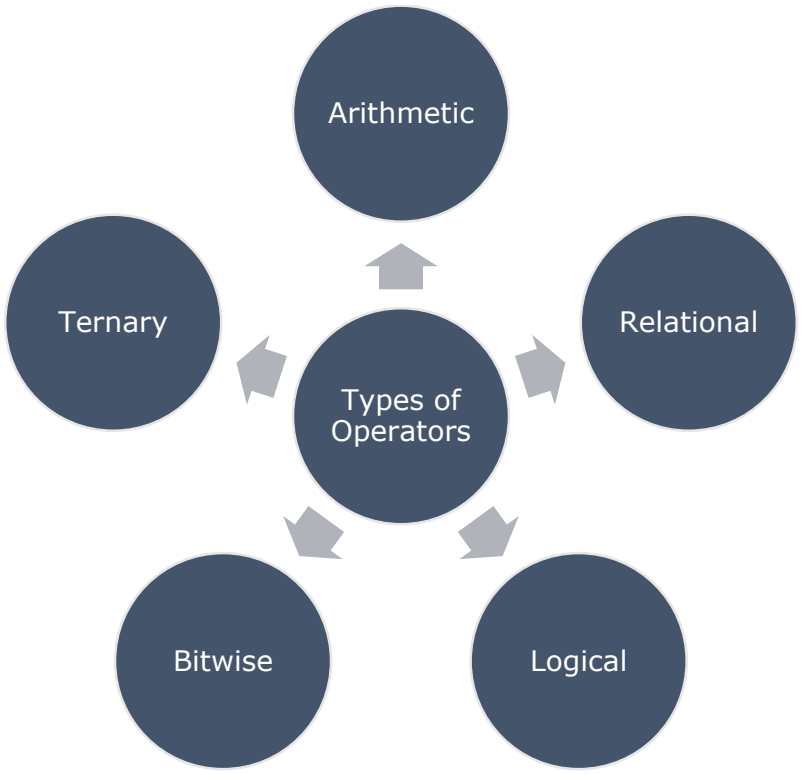
When the above code is executed, it produces the following result:

```
1.1111
```

8. Tcl – Operators

An operator is a symbol that tells the compiler to perform specific mathematical or logical manipulations. Tcl language is rich in built-in operators and provides the following types of operators:

- Arithmetic Operators
- Relational Operators
- Logical Operators
- Bitwise Operators
- Ternary Operator



This chapter will explain the arithmetic, relational, logical, bitwise, and ternary operators one by one.

Arithmetic Operators

Following table shows all the arithmetic operators supported by Tcl language. Assume variable 'A' holds 10 and variable 'B' holds 20, then:

Operator	Description	Example
+	Adds two operands	A + B will give 30
-	Subtracts second operand from the first	A - B will give -10
*	Multiplies both operands	A * B will give 200
/	Divides numerator by de-numerator	B / A will give 2
%	Modulus Operator and remainder of after an integer division	B % A will give 0

Example

Try the following example to understand all the arithmetic operators available in Tcl language:

```
#!/usr/bin/tclsh

set a 21
set b 10
set c [expr $a + $b]
puts "Line 1 - Value of c is $c\n"
set c [expr $a - $b]
puts "Line 2 - Value of c is $c\n"
set c [expr $a * $b]
puts "Line 3 - Value of c is $c\n"
set c [expr $a / $b]
puts "Line 4 - Value of c is $c\n"
set c [expr $a % $b]
puts "Line 5 - Value of c is $c\n"
```

When you compile and execute the above program, it produces the following result:

```
Line 1 - Value of c is 31

Line 2 - Value of c is 11

Line 3 - Value of c is 210
```

```
Line 4 - Value of c is 2


Line 5 - Value of c is 1
```

Relational Operators

Following table shows all the relational operators supported by Tcl language. Assume variable **A** holds 10 and variable **B** holds 20, then:

Operator	Description	Example
==	Checks if the values of two operands are equal or not, if yes then condition becomes true.	(A == B) is not true.
!=	Checks if the values of two operands are equal or not, if values are not equal then condition becomes true.	(A != B) is true.
>	Checks if the value of left operand is greater than the value of right operand, if yes then condition becomes true.	(A > B) is not true.
<	Checks if the value of left operand is less than the value of right operand, if yes then condition becomes true.	(A < B) is true.
>=	Checks if the value of left operand is greater than or equal to the value of right operand, if yes then condition becomes true.	(A >= B) is not true.
<=	Checks if the value of left operand is less than or equal to the value of right operand, if yes then condition becomes true.	(A <= B) is true.

Example

Try the following example to understand all the relational operators available in Tcl language:

```
#!/usr/bin/tclsh

set a 21
set b 10

if { $a == $b } {
     puts "Line 1 - a is equal to b\n"
```

```
} else {
      puts "Line 1 - a is not equal to b\n"
}
if { $a < $b } {
      puts "Line 2 - a is less than b\n"
} else {
      puts "Line 2 - a is not less than b\n"
}
if { $a > $b } {
      puts "Line 3 - a is greater than b\n"
} else {
      puts "Line 3 - a is not greater than b\n"
}
# Lets change value of a and b
set a 5
set b 20
if { $a <= $b } {
      puts "Line 4 - a is either less than or equal to  b\n"
}
if { $b >= $a } {
      puts "Line 5 - b is either greater than  or equal to b\n"
}
```

When you compile and execute the above program it produces the following result:

```
Line 1 - a is not equal to b


Line 2 - a is not less than b


Line 3 - a is greater than b


Line 4 - a is either less than or equal to  -b


Line 5 - b is either greater than  or equal to a
```

Logical Operators

Following table shows all the logical operators supported by Tcl language. Assume variable **A** holds 1 and variable **B** holds 0, then:

Operator	Description	Example
&&	Called Logical AND operator. If both the operands are non-zero, then condition becomes true.	(A && B) is false.
||	Called Logical OR Operator. If any of the two operands is non-zero, then condition becomes true.	(A || B) is true.
!	Called Logical NOT Operator. Use to reverses the logical state of its operand. If a condition is true then Logical NOT operator will make false.	!(A && B) is true.

Example

Try the following example to understand all the logical operators available in Tcl language:

```
#!/usr/bin/tclsh

set a  5
set b 20

if { $a && $b } {
  puts "Line 1 - Condition is true\n"
}
if { $a || $b } {
     puts "Line 2 - Condition is true\n"
}
# lets change the value of  a and b
set a  0
set b 10
if { $a && $b } {
     puts "Line 3 - Condition is true\n"
} else {
     puts "Line 3 - Condition is not true\n"
}
if { !($a && $b) } {
     puts "Line 4 - Condition is true\n"
}
```

When you compile and execute the above program, it produces the following result:

```
Line 1 - Condition is true

Line 2 - Condition is true

Line 3 - Condition is not true

Line 4 - Condition is true
```

Bitwise Operators

Bitwise operator works on bits and perform bit-by-bit operation. The truth tables for &, |, and ^ are as follows:

p	q	p & q	p | q	p ^ q
0	0	0	0	0
0	1	0	1	1
1	1	1	1	0
1	0	0	1	1

Assume if A = 60; and B = 13; now in binary format they will be as follows:

A = 0011 1100

B = 0000 1101

A&B = 0000 1100

A|B = 0011 1101

A^B = 0011 0001

The Bitwise operators supported by Tcl language are listed in the following table. Assume variable **A** holds 60 and variable **B** holds 13, then:

Operator	Description	Example
&	Binary AND Operator copies a bit to the result if it exists in both operands.	(A & B) will give 12, which is 0000 1100

|	Binary OR Operator copies a bit if it exists in either operand.	(A | B) will give 61, which is 0011 1101
^	Binary XOR Operator copies the bit if it is set in one operand but not both.	(A ^ B) will give 49, which is 0011 0001
<<	Binary Left Shift Operator. The left operands value is moved left by the number of bits specified by the right operand.	A << 2 will give 240, which is 1111 0000
>>	Binary Right Shift Operator. The left operands value is moved right by the number of bits specified by the right operand.	A >> 2 will give 15, which is 0000 1111

Example

Try the following example to understand all the bitwise operators available in Tcl language:

```
#!/usr/bin/tclsh

set a 60  ;# 60 = 0011 1100
set b 13  ;# 13 = 0000 1101

set c [expr $a & $b] ;# 12 = 0000 1100
puts "Line 1 - Value of c is $c\n"

set c [expr $a | $b;] ;# 61 = 0011 1101
puts "Line 2 - Value of c is $c\n"

set c [expr $a ^ $b;] ;# 49 = 0011 0001
puts "Line 3 - Value of c is $c\n"

set c [expr $a << 2] ;# 240 = 1111 0000
puts "Line 4 - Value of c is $c\n"

set c [expr $a >> 2] ;# 15 = 0000 1111
puts "Line 5 - Value of c is $c\n"
```

When you compile and execute the above program, it produces the following result:

```
Line 1 - Value of c is 12
```

```
Line 2 - Value of c is 61

Line 3 - Value of c is 49

Line 4 - Value of c is 240

Line 5 - Value of c is 15
```

Ternary Operator

Operator	Description	Example
? :	Ternary	If Condition is true? Then value X : Otherwise value Y

Example

Try the following example to understand ternary operator available in Tcl language:

```
#!/usr/bin/tclsh

set a 10;
set b [expr $a == 1 ? 20: 30]
puts "Value of b is $b\n"
set b [expr $a == 10 ? 20: 30]
puts "Value of b is $b\n"
```

When you compile and execute the above program it produces the following result:

```
Value of b is 30

Value of b is 20
```

Operators Precedence in Tcl

Operator precedence determines the grouping of terms in an expression. This affects how an expression is evaluated. Certain operators have higher precedence than others; for example, the multiplication operator has higher precedence than the addition operator.

For example: x = 7 + 3 * 2; here, x is assigned 13, not 20 because operator * has higher precedence than +, so it first gets multiplied with 3 * 2 and then adds into 7.

Here, operators with the highest precedence appear at the top of the table, those with the lowest appear at the bottom. Within an expression, higher precedence operators will be evaluated first.

Category	Operator	Associativity
Unary	+ -	Right to left
Multiplicative	* / %	Left to right
Additive	+ -	Left to right
Shift	<< >>	Left to right
Relational	< <= > >=	Left to right
Bitwise AND	&	Left to right
Bitwise XOR	^	Left to right
Bitwise OR	|	Left to right
Logical AND	&&	Left to right
Logical OR	||	Left to right
Ternary	?:	Right to left

Example

Try the following example to understand the operator precedence available in Tcl language:

```
#!/usr/bin/tclsh

set a 20
set b 10
set c 15
set d 5

set  e [expr [expr $a + $b] * $c / $d ]     ;# ( 30 * 15 ) / 5
puts "Value of (a + b) * c / d is : $e\n"

set  e [expr  [expr [expr $a + $b] * $c] / $d]   ;#  (30 * 15 ) / 5]
puts "Value of ((a + b) * c) / d is  : $e\n"

set  e  [expr [expr $a + $b] * [expr $c / $d] ]   ;# (30) * (15/5)
puts "Value of (a + b) * (c / d) is  : $e\n"
```

```
set  e  [expr $a + [expr $b * $c ] / $d ] ;#  20 + (150/5)
puts "Value of a + (b * c) / d is  :  $e\n"
```

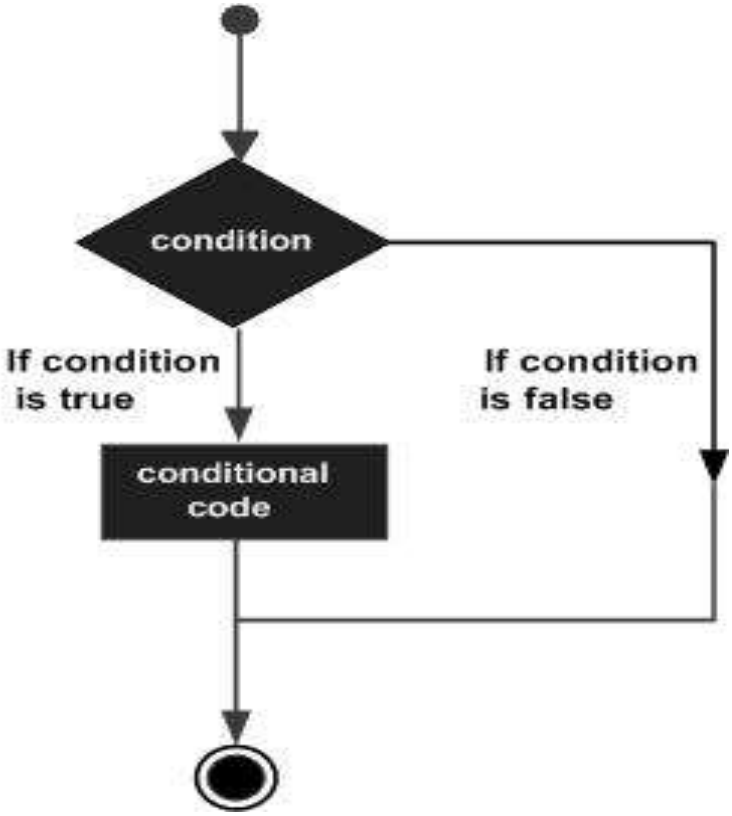
When you compile and execute the above program, it produces the following result:

```
Value of (a + b) * c / d is : 90
Value of ((a + b) * c) / d is  : 90
Value of (a + b) * (c / d) is  : 90
Value of a + (b * c) / d is  :  50
```

9. Tcl – Decisions

Decision making structures require that the programmer specifies one or more conditions to be evaluated or tested by the program, along with a statement or statements to be executed if the condition is determined to be true, and optionally, other statements to be executed if the condition is determined to be false.

Following is the general form of a typical decision making structure found in most of the programming languages:



Tcl language uses the expr command internally and hence it's not required for us to use expr statement explicitly.

Tcl language provides following types of decision making statements:

Statement	Description
if statement	An 'if' statement consists of a Boolean expression followed by one or more statements.
if...else statement	An 'if' statement can be followed by an optional 'else' statement, which executes when the Boolean expression is false.
nested if statements	You can use one 'if' or 'else' if statement inside another 'if' or 'else' if statement(s).

switch statement	A switch statement allows a variable to be tested for equality against a list of values.
nested switch statements	You can use one switch statement inside another switch statement(s).

Tcl - If Statement

An **if** statement consists of a Boolean expression followed by one or more statements.

Syntax

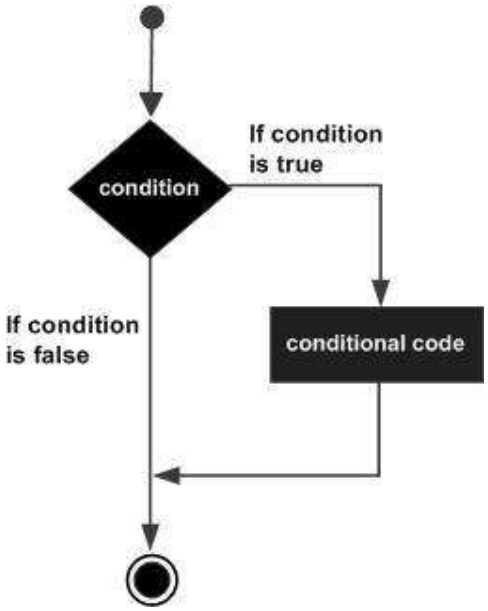
The syntax of an 'if' statement in Tcl language is:

```
if {boolean_expression} {
   # statement(s) will execute if the Boolean expression is true
}
```

If the Boolean expression evaluates to **true**, then the block of code inside the **if** statement will be executed. If Boolean expression evaluates to **false**, then the first set of code after the end of the 'if' statement (after the closing curly brace) will be executed.

Tcl language uses the **expr** command internally and hence it's not required for us to use **expr** statement explicitly.

Flow Diagram



Example

```
#!/usr/bin/tclsh

set a 10

#check the boolean condition using if statement
if { $a < 20 } {
   # if condition is true then print the following
   puts "a is less than 20"
}
puts "value of a is : $a"
```

When the above code is compiled and executed, it produces the following result:

```
a is less than 20
value of a is : 10
```

Tcl – If else Statement

An **if** statement can be followed by an optional **else** statement, which executes when the Boolean expression is false.

Syntax

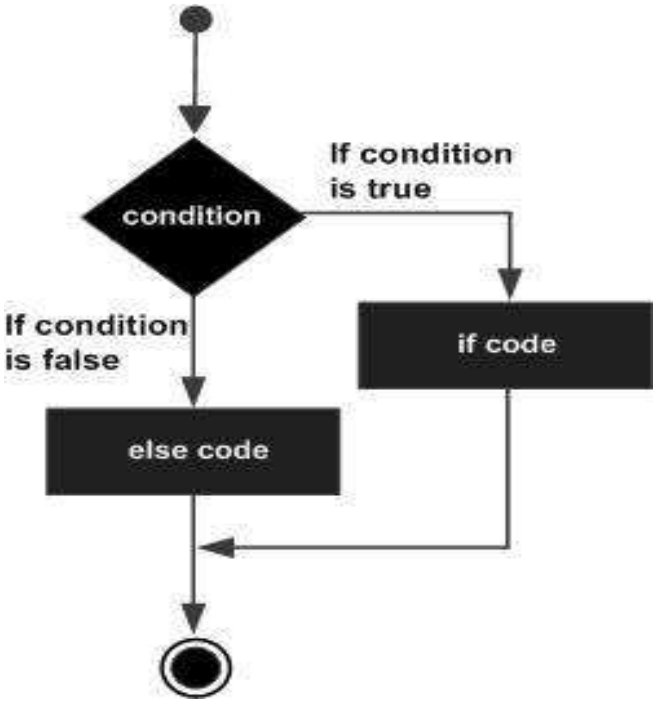
The syntax of an '**if...else'** statement in Tcl language is:

```
if {boolean_expression} {
  # statement(s) will execute if the boolean expression is true
} else {
  # statement(s) will execute if the boolean expression is false
}
```

If the Boolean expression evaluates to **true**, then the **if block** of code will be executed, otherwise **else block** of code will be executed.

Tcl language uses the **expr** command internally and hence it's not required for us to use **expr** statement explicitly.

Flow Diagram



Example

```
#!/usr/bin/tclsh

set a 100

#check the boolean condition
if {$a < 20 } {
   #if condition is true then print the following
   puts "a is less than 20"
} else {
   #if condition is false then print the following
   puts "a is not less than 20"
}
puts "value of a is : $a"
```

When the above code is compiled and executed, it produces the following result:

```
a is not less than 20;
value of a is : 100
```

The if...else if...else Statement

An '**if'** statement can be followed by an optional **else if...else** statement, which is very useful to test various conditions using single if...else if statement.

When using if, else if, else statements there are few points to keep in mind:

- An '**if'** can have zero or one **else's** and it must come after any **else if's.**
- An '**if'** can have zero to many **else if's** and they must come before the **else.**
- Once an '**else if'** succeeds, none of the remaining **else if's** or **else's** will be tested.

Syntax

The syntax of an '**if...else if...else'** statement in Tcl language is:

```
if {boolean_expression 1} {
   # Executes when the boolean expression 1 is true
} elseif {boolean_expression 2} {
   # Executes when the boolean expression 2 is true
} elseif {boolean_expression 3} {
   # Executes when the boolean expression 3 is true
} else {
   # executes when the none of the above condition is true
}
```

Example

```
#!/usr/bin/tclsh

set a 100

#check the boolean condition
if { $a == 10 } {
   # if condition is true then print the following
   puts "Value of a is 10"
} elseif { $a == 20 } {
   # if else if condition is true
   puts "Value of a is 20"
} elseif { $a == 30 } {
   # if else if condition is true
   puts "Value of a is 30"
} else {
```

```
   # if none of the conditions is true
   puts "None of the values is matching"
}

puts "Exact value of a is: $a"
```

When the above code is compiled and executed, it produces the following result:

```
None of the values is matching
Exact value of a is: 100
```

Tcl – Nested If Statement

It is always legal in Tcl to **nest** if-else statements, which means you can use one if or else if statement inside another if or else if statement(s).

Syntax

The syntax for a **nested if** statement is as follows:

```
if { boolean_expression 1 } {
   # Executes when the boolean expression 1 is true
   if {boolean_expression 2} {
      # Executes when the boolean expression 2 is true
   }
}
```

You can nest **else if...else** in the similar way as you have nested **if** statement.

Example

```
#!/usr/bin/tclsh

set a 100
set b 200

# check the boolean condition
if { $a == 100 } {
   # if condition is true then check the following
   if { $b == 200 } {
      #if condition is true then print the following
      puts "Value of a is 100 and b is 200"
```

```
   }
}
puts "Exact value of a is : $a"
puts "Exact value of b is : $b"
```

When the above code is compiled and executed, it produces the following result:

```
Value of a is 100 and b is 200
Exact value of a is : 100
Exact value of b is : 200
```

Tcl – Switch Statement

A **switch** statement allows a variable to be tested for equality against a list of values. Each value is called a case, and the variable being switched on is checked for each **switch case**.

Syntax

The syntax for unquoted **switch** statement in Tcl language is as follows:

```
switch switchingString matchString1 {body1} matchString2 {body2} ...
matchStringn {bodyn}
```

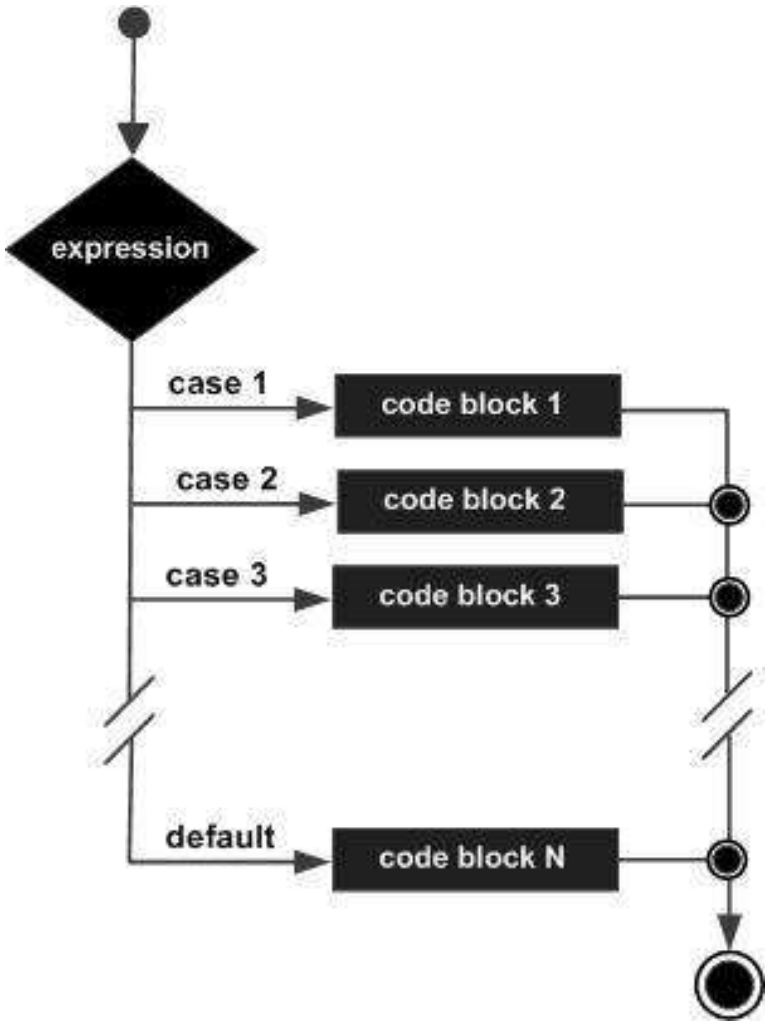
The syntax for unquoted **switch** statement in Tcl language is as follows:

```
switch switchingString {
   matchString1 {
      body1
   }
   matchString2 {
      body2
   }
...
   matchStringn {
      bodyn
   }
}
```

The following rules apply to a **switch** statement:

- The **switchingString** is used in a **switch** statement; used between the different blocks by comparing to the matchString.
- You can have any number of matchString blocks within a switch.
- A **switch** statement can have an optional **default** block, which must appear at the end of the switch. The default case can be used for performing a task when none of the cases is true.

Flow Diagram



Example: Unquoted Version

```
#!/usr/bin/tclsh

set grade C;
```

```
switch $grade  A { puts "Well done!" }  B { puts "Excellent!" }  C { puts "You
passed!"  } F { puts "Better try again"   }   default {     puts "Invalid
grade"   }
puts "Your grade is  $grade"
```

When the above code is compiled and executed, it produces the following result:

```
You passed!
Your grade is  C
```

Example: Quoted Version

```
#!/usr/bin/tclsh

set grade B;

switch $grade {
   A {
     puts "Well done!"
   }
   B {
     puts "Excellent!"
   }

   C {
     puts "You passed!"
   }
   F {
     puts "Better try again"
   }
   default {
     puts "Invalid grade"
   }
}
puts "Your grade is  $grade"
```

When the above code is compiled and executed, it produces the following result:

```
Well done
Your grade is B
```

Tcl – Nested Switch Statement

It is possible to have a **switch** as part of the statement sequence of an outer switch. Even if the case constants of the inner and outer switch contain common values, no conflicts will arise.

Syntax

The syntax for a **nested switch** statement is as follows:

```
switch switchingString {
   matchString1 {
      body1
      switch switchingString {
        matchString1 {
           body1
         }
         matchString2 {
           body2
         }
        ...
         matchStringn {
           bodyn
         }
      }
   }
   matchString2 {
      body2
   }
...
   matchStringn {
      bodyn
   }
}
```

Example

```
#!/usr/bin/tclsh

set a 100
set b 200

switch $a {
   100 {
     puts "This is part of outer switch"
     switch $b {
        200 {
           puts "This is part of inner switch!"
        }
      }
   }
}
puts "Exact value of a is : $a"
puts "Exact value of a is : $b"
```

When the above code is compiled and executed, it produces the following result:

```
This is part of outer switch
This is part of inner switch!
Exact value of a is : 100
Exact value of a is : 200
```

The? : Operator

We have covered **conditional operator?:** in previous chapter, which can be used to replace **if...else** statements. It has the following general form:

```
Exp1 ? Exp2 : Exp3;
```

Where Exp1, Exp2, and Exp3 are expressions. Notice the use and placement of the colon.

The value of a '? expression' is determined like this: Exp1 is evaluated. If it is true, then Exp2 is evaluated and becomes the value of the entire '? expression.' If Exp1 is false, then Exp3 is evaluated and its value becomes the value of the expression. An example is shown below.

```
#!/usr/bin/tclsh
```

```
set a 10;
set b [expr $a == 1 ? 20: 30]
puts "Value of b is $b\n"
set b [expr $a == 10 ? 20: 30]
puts "Value of b is $b\n"
```

When you compile and execute the above program, it produces the following result:

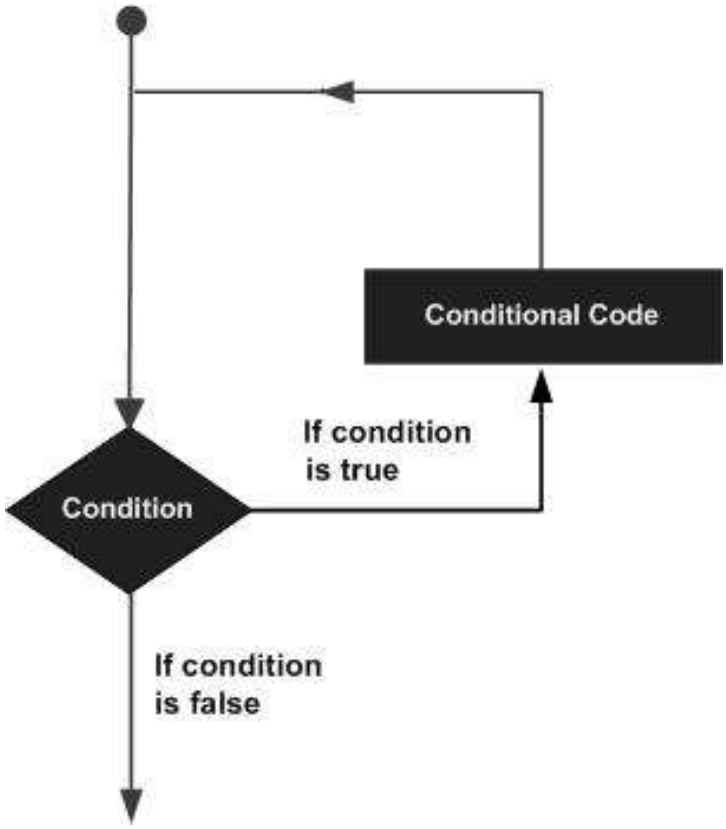
```
Value of b is 30
Value of b is 20
```

10. Tcl – Loops

There may be a situation where you need to execute a block of code several number of times. In general, statements are executed sequentially: The first statement in a function is executed first, followed by the second, and so on.

Programming languages provide various control structures that allow for more complicated execution paths.

A loop statement allows us to execute a statement or group of statements multiple times and following is the general form of a loop statement in most of the programming languages:



Tcl language provides the following types of loops to handle looping requirements.

Loop Type	Description
while loop	Repeats a statement or group of statements while a given condition is true. It tests the condition before executing the loop body.
for loop	Executes a sequence of statements multiple times and abbreviates the code that manages the loop variable.
nested loops	You can use one or more loop inside any another while, for or do..while loop.

Tcl – While Loop

A **while** loop statement in Tcl language repeatedly executes a target statement as long as a given condition is true.

Syntax

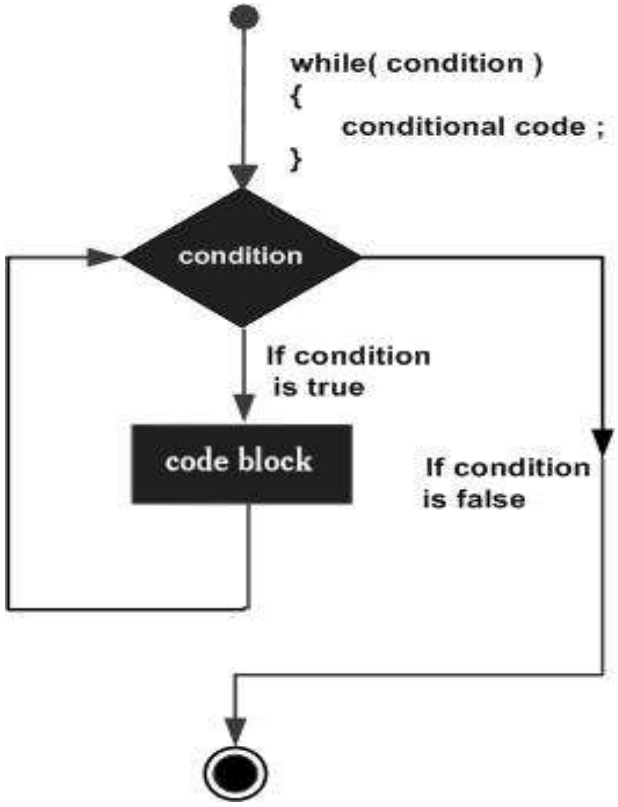
The syntax of a **while** loop in Tcl language is:

```
while {condition} {
   statement(s)
}
```

Here, **statement(s)** may be a single statement or a block of statements. The **condition** may be any expression, and true is any nonzero value. The loop iterates while the condition is true.

When the condition becomes false, program control passes to the line immediately following the loop.

Flow Diagram



The point to note about the **while** loop is that the loop might not ever run. When the condition is tested and the result is false, the loop body will be skipped and the first statement after the while loop will be executed.

Example

```
#!/usr/bin/tclsh

set a 10

#while loop execution
while { $a < 20 } {
   puts "value of a: $a"
   incr a
}
```

When the above code is compiled and executed, it produces the following result:

```
value of a: 10
value of a: 11
value of a: 12
value of a: 13
value of a: 14
value of a: 15
value of a: 16
value of a: 17
value of a: 18
value of a: 19
```

Tcl – For Loops

A **for** loop is a repetition control structure that allows you to efficiently write a code that needs to be executed for a specific number of times.

Syntax

The syntax of a **for** loop in Tcl language is:

```
for {initialization} {condition} {increment} {
   statement(s);
}
```

Here is the flow of control in a **for** loop:

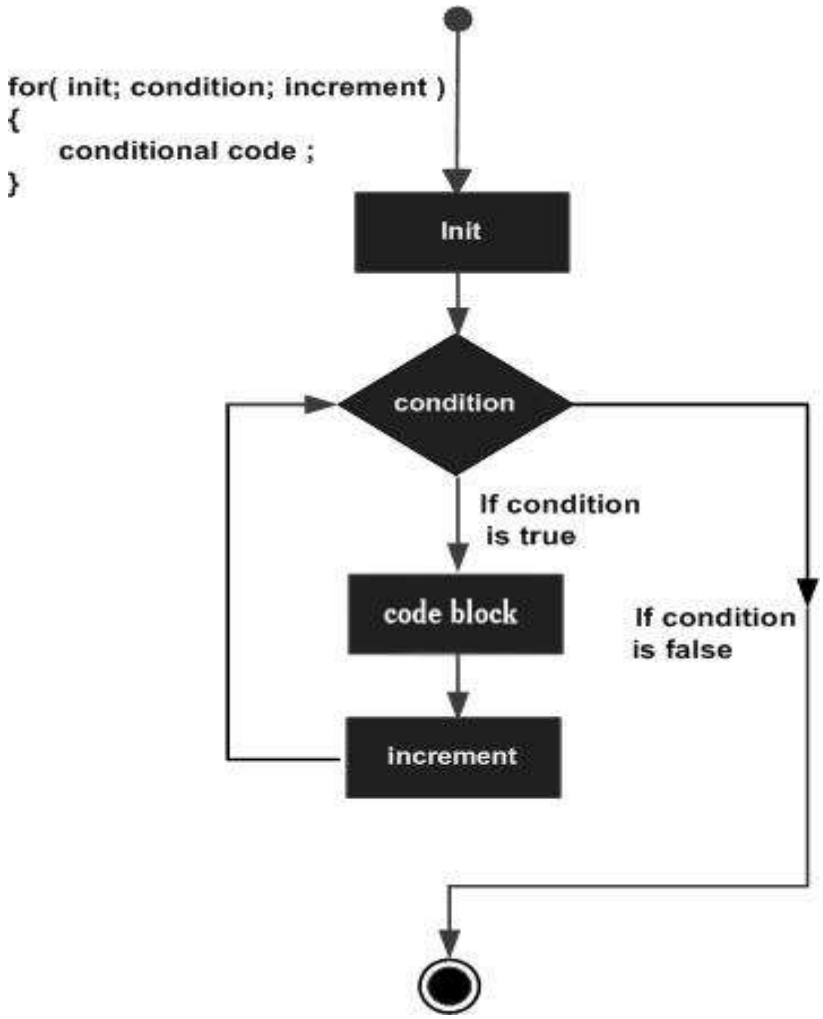
- The **initialization** step is executed first, and only once. This step allows you to declare and initialize any loop control variables. You are not required to put a statement here, as long as a semicolon appears.

- Next, the **condition** is evaluated. If it is true, the body of the loop is executed. If it is false, the body of the loop does not execute and flow of control jumps to the next statement just after the **for** loop.

- After the body of the **for** loop executes, the flow of control jumps back up to the **increment** statement. This statement allows you to update any loop control variables. This statement can be left blank, as long as a semicolon appears after the condition.

- The condition is now evaluated again. If it is true, the loop executes and the process repeats itself (body of loop, then increment step, and then again condition). After the condition becomes false, the **for** loop terminates.

Flow Diagram



Example

```
#!/usr/bin/tclsh

# for loop execution
for { set a 10}  {$a < 20} {incr a} {
   puts "value of a: $a"
}
```

When the above code is compiled and executed, it produces the following result:

```
value of a: 10
value of a: 11
value of a: 12
value of a: 13
value of a: 14
value of a: 15
value of a: 16
value of a: 17
value of a: 18
value of a: 19
```

Tcl – Nested Loops

Tcl allows to use one loop inside another loop. The following section shows a few examples to illustrate the concept.

Syntax

The syntax for a **nested for** loop statement in Tcl language is as follows:

```
for {initialization} {condition} {increment} {
   for {initialization} {condition} {increment} {
      statement(s);
   }
   statement(s);
}
```

The syntax for a **nested while loop** statement in Tcl language is as follows:

```
while {condition} {
   while {condition} {
      statement(s);
   }
   statement(s);
}
```

A final note on loop nesting is that you can put any type of loop inside of any other type of loop. For example, a for loop can be inside a while loop or vice versa.

Example

The following program uses a nested for loop to find the prime numbers from 2 to 100:

```
#!/usr/bin/tclsh

set j 0;
for {set i 2} {$i<100} {incr i} {
   for {set j 2} {$j <= [expr $i/$j] } {incr j} {
      if {  [expr $i%$j] == 0 } {
         break
      }
   }
   if {$j >[expr $i/$j] } {
      puts "$i is prime"
   }
}
```

When the above code is compiled and executed, it produces the following result:

```
2 is prime
3 is prime
5 is prime
7 is prime
11 is prime
13 is prime
17 is prime
19 is prime
23 is prime
```

```
29 is prime
31 is prime
37 is prime
41 is prime
43 is prime
47 is prime
53 is prime
59 is prime
61 is prime
67 is prime
71 is prime
73 is prime
79 is prime
83 is prime
89 is prime
97 is prime
```

Loop Control Statements

Loop control statements change execution from its normal sequence. When execution leaves a scope, all automatic objects that were created in that scope are destroyed.

Tcl supports the following control statements.

Control Statement	Description
break statement	Terminates the loop or switch statement and transfers execution to the statement immediately following the loop or switch.
continue statement	Causes the loop to skip the remainder of its body and immediately retest its condition prior to reiterating.

Tcl – Break Statement

The **break** statement in Tcl language is used for terminating a loop. When the **break** statement is encountered inside a loop, the loop is immediately terminated and program control resumes at the next statement following the loop.

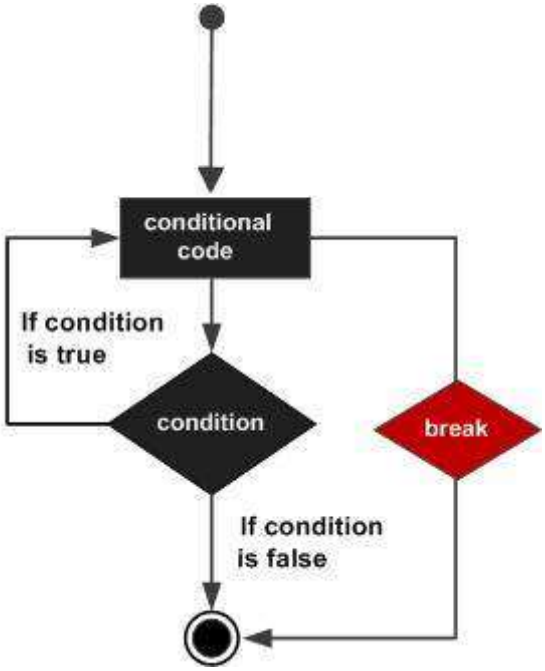
If you are using nested loops (i.e., one loop inside another loop), the break statement will stop the execution of the innermost loop and start executing the next line of code after the block.

Syntax

The syntax for a **break** statement in Tcl is as follows:

```
break;
```

Flow Diagram



Example

```
#!/usr/bin/tclsh

set a 10

# while loop execution
while {$a < 20 } {
   puts "value of a: $a"
   incr a
   if { $a > 15} {
      # terminate the loop using break statement
          break
   }
}
```

When the above code is compiled and executed, it produces the following result:

```
value of a: 10
value of a: 11
value of a: 12
value of a: 13
value of a: 14
value of a: 15
```

Tcl – Continue Statement

The **continue** statement in Tcl language works somewhat like the **break** statement. Instead of forcing termination, however, **continue** forces the next iteration of the loop to take place, skipping any code in between.

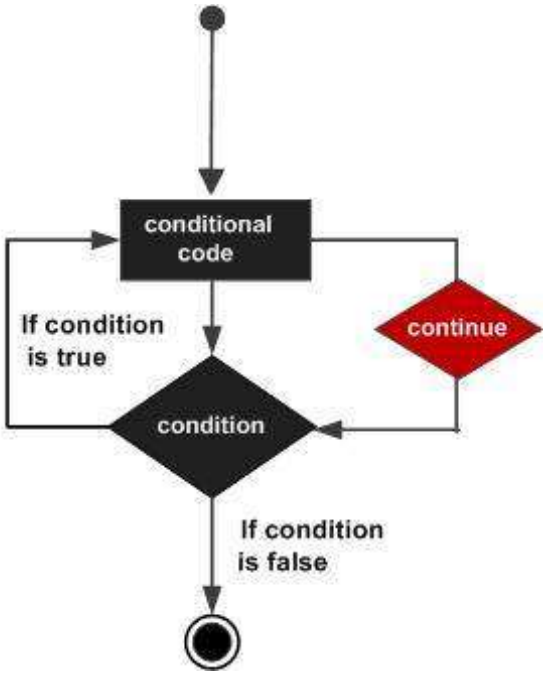
For the **for** loop, **continue** statement causes the conditional test and increment portions of the loop to execute. For the **while** loop, **continue** statement passes the program control to the conditional tests.

Syntax

The syntax for a **continue** statement in Tcl is as follows:

```
continue;
```

Flow Diagram



Example

```
#!/usr/bin/tclsh

set a 10
# do loop execution
while { $a < 20 } {
   if { $a == 15} {
     #skip the iteration
      incr a
     continue
   }
   puts "value of a: $a"
   incr a
}
```

When the above code is compiled and executed, it produces the following result:

```
value of a: 10
value of a: 11
value of a: 12
value of a: 13
value of a: 14
value of a: 16
value of a: 17
value of a: 18
value of a: 19
```

The Infinite Loop

A loop becomes infinite loop if a condition never becomes false. The **while** loop is traditionally used for this purpose. You can make an endless loop by leaving the conditional expression as 1.

```
while {1} {
   puts "This loop will run forever."
}
```

When the conditional expression is absent, it is assumed to be true. Tcl programmers more commonly use the while {1} construct to signify an infinite loop.

NOTE: You can terminate an infinite loop by pressing Ctrl + C keys.

11. Tcl – Arrays

An array is a systematic arrangement of a group of elements using indices. The syntax for the conventional array is shown below.

```
set ArrayName(Index) value
```

An example for creating simple array is shown below.

```
#!/usr/bin/tclsh

set languages(0) Tcl
set languages(1) "C Language"
puts $languages(0)
puts $languages(1)
```

When the above code is executed, it produces the following result:

```
Tcl
C Language
```

Size of Array

The syntax for calculating size array is shown below.

```
[array size variablename]
```

An example for printing the size is shown below.

```
#!/usr/bin/tclsh

set languages(0) Tcl
set languages(1) "C Language"
puts  [array size languages]
```

When the above code is executed, it produces the following result:

```
2
```

Array Iteration

Though, array indices can be non-continuous like values specified for index 1 then index 10 and so on. But, in case they are continuous, we can use array iteration to access

elements of the array. A simple array iteration for printing elements of the array is shown below.

```
#!/usr/bin/tclsh

set languages(0) Tcl
set languages(1) "C Language"
for { set index 0 }  { $index < [array size languages] }  { incr index } {
      puts "languages($index) : $languages($index)"
}
```

When the above code is executed, it produces the following result:

```
languages(0) : Tcl
languages(1) : C Language
```

Associative Arrays

In Tcl, all arrays by nature are associative. Arrays are stored and retrieved without any specific order. Associative arrays have an index that is not necessarily a number, and can be sparsely populated. A simple example for associative array with non-number indices is shown below.

```
#!/usr/bin/tclsh

set personA(Name) "Dave"
set personA(Age) 14
puts  $personA(Name)
puts  $personA(Age)
```

When the above code is executed, it produces the following result:

```
Dave
14
```

Indices of Array

The syntax for retrieving indices of array is shown below.

```
[array names variablename]
```

An example for printing the size is shown below.

```
#!/usr/bin/tclsh

set personA(Name) "Dave"
set personA(Age) 14
puts [array names personA]
```

When the above code is executed, it produces the following result:

```
Age Name
```

Iteration of Associative Array

You can use the indices of array to iterate through the associative array. An example is shown below.

```
#!/usr/bin/tclsh

set personA(Name) "Dave"
set personA(Age) 14
foreach index [array names personA] {
   puts "personA($index): $personA($index)"
}
```

When the above code is executed, it produces the following result:

```
personA(Age): 14
personA(Name): Dave
```

12. Tcl – Strings

The primitive data-type of Tcl is string and often we can find quotes on Tcl as string only language. These strings can contain alphanumeric character, just numbers, Boolean, or even binary data. Tcl uses 16 bit unicode characters and alphanumeric characters can contain letters including non-Latin characters, number or punctuation.

Boolean value can be represented as 1, yes or true for true and 0, no, or false for false.

String Representations

Unlike other languages, in Tcl, you need not include double quotes when it's only a single word. An example can be:

```
#!/usr/bin/tclsh

set myVariable hello
puts $myVariable
```

When the above code is executed, it produces the following result:

```
hello
```

When we want to represent multiple strings, we can use either double quotes or curly braces. It is shown below:

```
#!/usr/bin/tclsh

set myVariable "hello world"
puts $myVariable
set myVariable {hello world}
puts $myVariable
```

When the above code is executed, it produces the following result:

```
hello world
hello world
```

String Escape Sequence

A character literal can be a plain character (e.g., 'x'), an escape sequence (e.g., '\t'), or a universal character (e.g., '\u02C0').

There are certain characters in Tcl when they are preceded by a backslash they will have special meaning and they are used to represent like newline (\n) or tab (\t). Here, you have a list of some of such escape sequence codes:

Escape sequence	Meaning
\\	\ character
\'	' character
\"	" character
\?	? character
\a	Alert or bell
\b	Backspace
\f	Form feed
\n	Newline
\r	Carriage return
\t	Horizontal tab
\v	Vertical tab

Following is the example to show a few escape sequence characters:

```
#!/usr/bin/tclsh

puts("Hello\tWorld\n\nTutorialspoint");
```

When the above code is compiled and executed, it produces the following result:

```
Hello   World

Tutorialspoint
```

String Command

The list of subcommands for string command is listed in the following table:

SN	Methods with Description
1	**compare** string1 string2 Compares string1 and string2 lexographically. Returns 0 if equal, -1 if string1 comes before string2, else 1.
2	string1 string2 Returns the index first occurrence of string1 in string2. If not found, returns -1.

3	**index** string index Returns the character at index.
4	**last** string1 string2 Returns the index last occurrence of string1 in string2. If not found, returns -1.
5	**length** string Returns the length of string.
6	**match** pattern string Returns 1 if the string matches the pattern.
7	**range** string index1 index2 Return the range of characters in string from index1 to index2.
8	**tolower** string Returns the lowercase string.
9	**toupper** string Returns the uppercase string.
10	**trim** string ?trimcharacters? Removes trimcharacters in both ends of string. The default trimcharacters is whitespace.
11	**trimleft** string ?trimcharacters? Removes trimcharacters in left beginning of string. The default trimcharacters is whitespace.
12	**trimright** string ?trimcharacters? Removes trimcharacters in left end of string. The default trimcharacters is whitespace.
13	**wordend** findstring index Return the index in findstring of the character after the word containing the character at index.
14	**wordstart** findstring index Return the index in findstring of the first character in the word containing the character at index.

Examples of some the commonly used Tcl string sub commands are given below.

String Comparison

```
#!/usr/bin/tclsh

set s1 "Hello"
set s2 "World"
set s3 "World"
puts [string compare s1 s2]
if {[string compare s2 s3] == 0} {
puts "String \'s1\' and \'s2\' are same.";
}

if {[string compare s1 s2] == -1} {
puts "String \'s1\' comes before \'s2\'.";
}

if {[string compare s2 s1] == 1} {
puts "String \'s2\' comes before \'s1\'.";
}
```

When the above code is compiled and executed, it produces the following result:

```
-1
String 's1' comes before 's2'.
String 's2' comes before 's1'.
```

Index of String

```
#!/usr/bin/tclsh

set s1 "Hello World"
set s2 "o"
puts "First occurrence of $s2 in s1"
puts [string first $s2 $s1]
puts "Character at index 0 in s1"
puts [string index $s1 0]
puts "Last occurrence of $s2 in s1"
puts [string last $s2 $s1]
puts "Word end index in s1"
```

```
puts [string wordend $s1 20]
puts "Word start index in s1"
puts [string wordstart $s1 20]
```

When the above code is compiled and executed, it produces the following result:

```
First occurrence of o in s1
4
Character at index 0 in s1
H
Last occurrence of o in s1
7
Word end index in s1
11
Word start index in s1
6
```

Length of String

```
#!/usr/bin/tclsh

set s1 "Hello World"
puts "Length of string s1"
puts [string length $s1]
```

When the above code is compiled and executed, it produces the following result:

```
Length of string s1
11
```

Handling Cases

```
#!/usr/bin/tclsh

set s1 "Hello World"
puts "Uppercase string of s1"
puts [string toupper $s1]
puts "Lowercase string of s1"
puts [string tolower $s1]
```

When the above code is compiled and executed, it produces the following result:

```
Uppercase string of s1
HELLO WORLD
Lowercase string of s1
hello world
```

Trimming Characters

```
#!/usr/bin/tclsh

set s1 "Hello World"
set s2 "World"
puts "Trim right $s2 in $s1"
puts [string trimright $s1 $s2]

set s2 "Hello"
puts "Trim left $s2 in $s1"
puts [string trimleft $s1 $s2]

set s1 " Hello World "
set s2 " "
puts "Trim characters s1 on both sides of s2"
puts [string trim $s1 $s2]
```

When the above code is compiled and executed, it produces the following result:

```
Trim right World in Hello World
Hello
Trim left Hello in Hello World
 World
Trim characters s1 on both sides of s2
Hello World
```

Matching Strings

```
#!/usr/bin/tclsh

set s1 "test@test.com"
set s2 "*@*.com"
puts "Matching pattern s2 in s1"
puts [string match "*@*.com" $s1 ]
puts "Matching pattern tcl in s1"
puts [string match {tcl} $s1]
```

When the above code is compiled and executed, it produces the following result:

```
Matching pattern s2 in s1
1
Matching pattern tcl in s1
0
```

Append Command

```
#!/usr/bin/tclsh

set s1 "Hello"
append s1 " World"
puts $s1
```

When the above code is compiled and executed, it produces the following result:

```
Hello World
```

Format Command

The following table shows the list of format specifiers available in Tcl:

Specifier	Use
%s	String representation
%d	Integer representation
%f	Floating point representation
%e	Floating point representation with mantissa-exponent form
%x	Hexa decimal representation

Some simple examples are given below:

```
#!/usr/bin/tclsh

puts [format "%f" 43.5]
puts [format "%e" 43.5]
puts [format "%d %s" 4 tuts]
puts [format "%s" "Tcl Language"]
puts [format "%x" 40]
```

When the above code is compiled and executed, it produces the following result:

```
43.500000
4.350000e+01
4 tuts
Tcl Language
28
```

Scan Command

Scan command is used for parsing a string based to the format specifier. Some examples are shown below.

```
#!/usr/bin/tclsh

puts [scan "90" {%[0-9]} m]
puts [scan "abc" {%[a-z]} m]
puts [scan "abc" {%[A-Z]} m]
puts [scan "ABC" {%[A-Z]} m]
```

When the above code is compiled and executed, it produces the following result:

```
1
1
0
1
```

13. Tcl – Lists

List is one of the basic data-type available in Tcl. It is used for representing an ordered collection of items. It can include different types of items in the same list. Further, a list can contain another list.

An important thing that needs to be noted is that these lists are represented as strings completely and processed to form individual items when required. So, avoid large lists and in such cases; use array.

Creating a List

The general syntax for list is given below:

```
set listName { item1 item2 item3 .. itemn }
# or
set listName [list item1 item2 item3]
# or
set listName [split "items separated by a character" split_character]
```

Some examples are given below:

```
#!/usr/bin/tclsh

set colorList1 {red green blue}
set colorList2 [list red green blue]
set colorList3 [split "red_green_blue" _]
puts $colorList1
puts $colorList2
puts $colorList3
```

When the above code is executed, it produces the following result:

```
red green blue
red green blue
red green blue
```

Appending Item to a List

The syntax for appending item to a list is given below:

```
append listName split_character value
# or
lappend listName value
```

Some examples are given below:

```
#!/usr/bin/tclsh

set var orange
append var " " "blue"
lappend var "red"
lappend var "green"
puts $var
```

When the above code is executed, it produces the following result:

```
orange blue red green
```

Length of List

The syntax for length of list is given below:

```
llength listName
```

Example for length of list is given below:

```
#!/usr/bin/tclsh

set var {orange blue red green}
puts [llength $var]
```

When the above code is executed, it produces the following result:

```
4
```

List Item at Index

The syntax for selecting list item at specific index is given below:

```
lindex listname index
```

Example for list item at index is given below:

```
#!/usr/bin/tclsh

set var {orange blue red green}
puts [lindex $var  1]
```

When the above code is executed, it produces the following result:

```
blue
```

Insert Item at Index

The syntax for inserting list items at specific index is given below.

```
linsert listname index value1 value2..valuen
```

Example for inserting list item at specific index is given below.

```
#!/usr/bin/tclsh

set var {orange blue red green}
set var [linsert  $var 3 black white]
puts $var
```

When the above code is executed, it produces the following result:

```
orange blue red black white green
```

Replace Items at Indices

The syntax for replacing list items at specific indices is given below:

```
lreplace listname firstindex lastindex value1 value2..valuen
```

Example for replacing list items at specific indices is given below.

```
#!/usr/bin/tclsh

set var {orange blue red green}
set var [lreplace $var 2 3 black white]
puts $var
```

When the above code is executed, it produces the following result:

```
orange blue black white
```

Set Item at Index

The syntax for setting list item at specific index is given below:

```
lset listname index value
```

Example for setting list item at specific index is given below:

```
#!/usr/bin/tclsh

set var {orange blue red green}
lset var 0 black
puts $var
```

When the above code is executed, it produces the following result:

```
black blue red green
```

Transform List to Variables

The syntax for copying values to variables is given below:

```
lassign listname variable1 variable2.. variablen
```

Example for transforming list into variables is given below:

```
#!/usr/bin/tclsh

set var {orange blue red green}
lassign $var colour1 colour2
puts $colour1
puts $colour2
```

When the above code is executed, it produces the following result:

```
orange
blue
```

Sorting a List

The syntax for sorting a list is given below:

```
lsort listname
```

An example for sorting a list is given below:

```
#!/usr/bin/tclsh

set var {orange blue red green}
set var [lsort $var]
puts $var
```

When the above code is executed, it produces the following result:

```
blue green orange red
```

14. Tcl – Dictionary

A dictionary is an arrangement for mapping values to keys. The syntax for the conventional dictionary is shown below:

```
dict set dictname key value
# or
dict create dictname key1 value1 key2 value2 .. keyn valuen
```

Some examples for creating a dictionary are shown below:

```
#!/usr/bin/tclsh

dict set colours  colour1 red
puts $colours
dict set colours  colour2 green
puts $colours

set colours [dict create colour1 "black" colour2 "white"]
puts $colours
```

When the above code is executed, it produces the following result:

```
colour1 red
colour1 red colour2 green
colour1 black colour2 white
```

Size of Dict

The syntax for getting size of dict is shown below:

```
[dict size dictname]
```

An example for printing the size is shown below:

```
#!/usr/bin/tclsh

set colours [dict create colour1 "black" colour2 "white"]
puts [dict size $colours]
```

When the above code is executed, it produces the following result:

```
2
```

Dictionary Iteration

A simple dictionary iteration for printing keys and valued of the dictionary is shown below:

```
#!/usr/bin/tclsh

set colours [dict create colour1 "black" colour2 "white"]
foreach item [dict keys $colours] {
    set value [dict get $colours $item]
    puts $value
}
```

When the above code is executed, it produces the following result:

```
black
white
```

Value for Key in Dict

The syntax for retrieving value for key in dict is shown below:

```
[dict get $dictname $keyname]
```

An example for retrieving value for key is given below:

```
#!/usr/bin/tclsh

set colours [dict create colour1 "black" colour2 "white"]
set value [dict get $colours colour1]
puts $value
```

When the above code is executed, it produces the following result:

```
black
```

All Keys in Dict

The syntax for retrieving all keys in dict is shown below:

```
[dict keys $dictname]
```

An example for printing all keys is shown below:

```
#!/usr/bin/tclsh

set colours [dict create colour1 "black" colour2 "white"]
set keys [dict keys $colours]
puts $keys
```

When the above code is executed, it produces the following result:

```
colour1 colour2
```

All Values in Dict

The syntax for retrieving all values in dict is shown below:

```
[dict values $dictname]
```

An example for printing all values is shown below:

```
#!/usr/bin/tclsh

set colours [dict create colour1 "black" colour2 "white"]
set values [dict values $colours]
puts $values
```

When the above code is executed, it produces the following result:

```
black white
```

Key Exists in Dict

The syntax for checking if a key exists in dict is shown below:

```
[dict values $dictname]
```

An example for checking if a key exists in dict is shown below:

```
#!/usr/bin/tclsh

set colours [dict create colour1 "black" colour2 "white"]
set result [dict exists $colours colour1]
puts $result
```

When the above code is executed, it produces the following result:

```
1
```

15. Tcl – Procedures

Procedures are nothing but code blocks with series of commands that provide a specific reusable functionality. It is used to avoid same code being repeated in multiple locations. Procedures are equivalent to the functions used in many programming languages and are made available in Tcl with the help of **proc** command.

The syntax of creating a simple procedure is shown below:

```
proc procedureName {arguments} {
   body
}
```

A simple example for procedure is given below:

```
#!/usr/bin/tclsh

proc helloWorld {} {
   puts "Hello, World!"
}
helloWorld
```

When the above code is executed, it produces the following result:

```
Hello, World!
```

Procedures with Multiple Arguments

An example for procedure with arguments is shown below:

```
#!/usr/bin/tclsh

proc add {a b} {
   return [expr $a+$b]
}
puts [add 10 30]
```

When the above code is executed, it produces the following result:

```
40
```

Procedures with Variable Arguments

An example for procedure with arguments is shown below:

```
#!/usr/bin/tclsh

proc avg {numbers} {
    set sum 0
    foreach number $numbers {
      set sum  [expr $sum + $number]
     }
    set average [expr $sum/[llength $numbers]]
    return $average
}
puts [avg {70 80 50 60}]
puts [avg {70 80 50 }]
```

When the above code is executed, it produces the following result:

```
65
66
```

Procedures with Default Arguments

Default arguments are used to provide default values that can be used if no value is provided. An example for procedure with default arguments, which is sometimes referred as implicit arguments is shown below:

```
#!/usr/bin/tclsh

proc add {a {b 100} } {
   return [expr $a+$b]
}
puts [add 10 30]
puts [add 10]
```

When the above code is executed, it produces the following result:

```
40
110
```

Recursive Procedures

An example for recursive procedures is shown below:

```
#!/usr/bin/tclsh

proc factorial {number} {
   if {$number <= 1} {
      return 1
   }
   return [expr $number * [factorial [expr $number - 1]]]

}
puts [factorial 3]
puts [factorial 5]
```

When the above code is executed, it produces the following result:

```
6
120
```

16. Tcl – Packages

Packages are used for creating reusable units of code. A package consists of a collection of files that provide specific functionality. This collection of files is identified by a package name and can have multiple versions of same files. The package can be a collection of Tcl scripts, binary library, or a combination of both.

Package uses the concept of namespace to avoid collision of variable names and procedure names. Check out more in our next '**namespace'** tutorial.

Creating Package

A package can be created with the help of minimum two files. One file contains the package code. Other file contains the index package file for declaring your package.

The list of steps for creating and using package is given below.

Step 1: Creating Code

Create code for package inside a folder say HelloWorld. Let the file be named HelloWorld.tcl with the code as shown below:

```
# /Users/rajkumar/Desktop/helloworld/HelloWorld.tcl
# Create the namespace
namespace eval ::HelloWorld {

  # Export MyProcedure
  namespace export MyProcedure

  # My Variables
   set version 1.0
   set MyDescription "HelloWorld"

  # Variable for the path of the script
   variable home [file join [pwd] [file dirname [info script]]]

}

# Definition of the procedure MyProcedure
proc ::HelloWorld::MyProcedure {} {
     puts $HelloWorld::MyDescription
}
```

```
package provide HelloWorld $HelloWorld::version
package require Tcl 8.0
```

Step 2: Creating Package Index

Open tclsh. Switch to HelloWorld directory and use the pkg_mkIndex command to create the index file as shown below:

```
% cd /Users/rajkumar/Desktop/helloworld
% pkg_mkIndex . *.tcl
```

Step 3: Adding Directory to Autopath

Use the lappend command to add the package to the global list as shown below:

```
% lappend auto_path "/Users/rajkumar/Desktop/helloworld"
```

Step 4: Adding Package

Next add package to program using package require statement as shown below:

```
% package require HelloWorld 1.0
```

Step 5: Invoking Procedure

Now, everything being setup, we can invoke our procedure as shown below:

```
% puts [HelloWorld::MyProcedure]
```

You will get the following result:

```
HelloWorld
```

First two steps create the package. Once package is created, you can use it in any Tcl file by adding the last three statements as shown below:

```
lappend auto_path "/Users/rajkumar/Desktop/helloworld"
package require HelloWorld 1.0
puts [HelloWorld::MyProcedure]
```

You will get the following result.

```
HelloWorld
```

17. Tcl – Namespaces

Namespace is a container for set of identifiers that is used to group variables and procedures. Namespaces are available from Tcl version 8.0. Before the introduction of the namespaces, there was single global scope. Now with namespaces, we have additional partitions of global scope.

Creating Namespace

Namespaces are created using the **namespace** command. A simple example for creating namespace is shown below

```
#!/usr/bin/tclsh

namespace eval MyMath {
  # Create a variable inside the namespace
  variable myResult
}

# Create procedures inside the namespace
proc MyMath::Add {a b } {
  set ::MyMath::myResult [expr $a + $b]
}
MyMath::Add 10 23

puts $::MyMath::myResult
```

When the above code is executed, it produces the following result:

```
33
```

In the above program, you can see there is a namespace with a variable **myResult** and a procedure **Add.** This makes it possible to create variables and procedures with the same names under different namespaces.

Nested Namespaces

Tcl allows nesting of namespaces. A simple example for nesting namespaces is given below:

```
#!/usr/bin/tclsh
```

```
namespace eval MyMath {
  # Create a variable inside the namespace
  variable myResult
}

namespace eval extendedMath {
  # Create a variable inside the namespace
   namespace eval MyMath {
     # Create a variable inside the namespace
     variable myResult
   }
}
set ::MyMath::myResult "test1"
puts $::MyMath::myResult
set ::extendedMath::MyMath::myResult "test2"
puts $::extendedMath::MyMath::myResult
```

When the above code is executed, it produces the following result:

```
test1
test2
```

Importing and Exporting Namespace

You can see in the previous namespace examples, we use a lot of scope resolution operator and it's more complex to use. We can avoid this by importing and exporting namespaces. An example is given below:

```
#!/usr/bin/tclsh

namespace eval MyMath {
  # Create a variable inside the namespace
  variable myResult
  namespace export Add
}

# Create procedures inside the namespace
proc MyMath::Add {a b } {
  return [expr $a + $b]
```

```
}

namespace import MyMath::*
puts [Add 10 30]
```

When the above code is executed, it produces the following result:

```
40
```

Forget Namespace

You can remove an imported namespace by using **forget** subcommand. A simple example is shown below:

```
#!/usr/bin/tclsh

namespace eval MyMath {
  # Create a variable inside the namespace
  variable myResult
  namespace export Add
}

# Create procedures inside the namespace
proc MyMath::Add {a b } {
  return [expr $a + $b]
}
namespace import MyMath::*
puts [Add 10 30]
namespace forget MyMath::*
```

When the above code is executed, it produces the following result:

```
40
```

18. Tcl – File I/O

Tcl supports file handling with the help of the built in commands open, read, puts, gets, and close.

A file represents a sequence of bytes, does not matter if it is a text file or binary file.

Opening Files

Tcl uses the open command to open files in Tcl. The syntax for opening a file is as follows:

```
open fileName accessMode
```

Here, **filename** is string literal, which you will use to name your file and **accessMode** can have one of the following values:

Mode	Description
r	Opens an existing text file for reading purpose and the file must exist. This is the default mode used when no accessMode is specified.
w	Opens a text file for writing, if it does not exist, then a new file is created else existing file is truncated.
a	Opens a text file for writing in appending mode and file must exist. Here, your program will start appending content in the existing file content.
r+	Opens a text file for reading and writing both. File must exist already.
w+	Opens a text file for reading and writing both. It first truncate the file to zero length if it exists otherwise create the file if it does not exist.
a+	Opens a text file for reading and writing both. It creates the file if it does not exist. The reading will start from the beginning, but writing can only be appended.

Closing a File

To close a file, use the close command. The syntax for close is as follows:

```
close fileName
```

Any file that has been opened by a program must be closed when the program finishes using that file. In most cases, the files need not be closed explicitly; they are closed automatically when File objects are terminated automatically.

Writing a File

Puts command is used to write to an open file.

```
puts $filename "text to write"
```

A simple example for writing to a file is shown below.

```
#!/usr/bin/tclsh

set fp [open "input.txt" w+]
puts $fp "test"
close $fp
```

When the above code is compiled and executed, it creates a new file **input.txt** in the directory that it has been started under (in the program's working directory).

Reading a File

Following is the simple command to read from a file:

```
set file_data [read $fp]
```

A complete example of read and write is shown below:

```
#!/usr/bin/tclsh

set fp [open "input.txt" w+]
puts $fp "test"
close $fp
set fp [open "input.txt" r]
set file_data [read $fp]
puts $file_data
close $fp
```

When the above code is compiled and executed, it reads the file created in previous section and produces the following result:

```
test
```

Here is another example for reading file till end of file line by line:

```
#!/usr/bin/tclsh

set fp [open "input.txt" w+]
```

```
puts $fp "test\ntest"
close $fp
set fp [open "input.txt" r]

while { [gets $fp data] >= 0 } {
   puts $data
}
close $fp
```

When the above code is compiled and executed, it reads the file created in previous section and produces the following result:

```
test
test
```

19. Tcl – Error Handling

Error handling in Tcl is provided with the help of **error** and **catch** commands. The syntax for each of these commands is shown below.

Error Syntax

```
error message info code
```

In the above error command syntax, message is the error message, info is set in the global variable errorInfo and code is set in the global variable errorCode.

Catch Syntax

```
catch script resultVarName
```

In the above catch command syntax, script is the code to be executed, resultVarName is variable that holds the error or the result. The catch command returns 0 if there is no error, and 1 if there is an error.

An example for simple error handling is shown below:

```
#!/usr/bin/tclsh

proc Div {a b} {
    if {$b == 0} {
  error "Error generated by error" "Info String for error" 401
    } else {
      return [expr $a/$b]
    }
}
if {[catch {puts "Result = [Div 10 0]"} errmsg]} {
   puts "ErrorMsg: $errmsg"
   puts "ErrorCode: $errorCode"
   puts "ErrorInfo:\n$errorInfo\n"
}
```

```
if {[catch {puts "Result = [Div 10 2]"} errmsg]} {
   puts "ErrorMsg: $errmsg"
   puts "ErrorCode: $errorCode"
   puts "ErrorInfo:\n$errorInfo\n"
}
```

When the above code is executed, it produces the following result:

```
ErrorMsg: Error generated by error
ErrorCode: 401
ErrorInfo:
Info String for error
    (procedure "Div" line 1)
    invoked from within
"Div 10 0"

Result = 5
```

As you can see in the above example, we can create our own custom error messages. Similarly, it is possible to catch the error generated by Tcl. An example is shown below:

```
#!/usr/bin/tclsh

catch {set file [open myNonexistingfile.txt]} result
puts "ErrorMsg: $result"
puts "ErrorCode: $errorCode"
puts "ErrorInfo:\n$errorInfo\n"
```

When the above code is executed, it produces the following result:

```
ErrorMsg: couldn't open "myNonexistingfile.txt": no such file or directory
ErrorCode: POSIX ENOENT {no such file or directory}
ErrorInfo:
couldn't open "myNonexistingfile.txt": no such file or directory
    while executing
"open myNonexistingfile.txt"
```

20. Tcl – Built-in Functions

Tcl provides a number of built-in functions (procedures) for various operations. This includes:

- Functions for **list** handling.
- Functions for **string** handling.
- Functions for **array** handling.
- Functions for **dictionary** handling.
- Functions for **File I/O** handling.
- Functions for creating **namespaces** and **packages.**
- Functions for Math operations.
- Functions for System operations.

Each of the above except for math and system functions are covered in earlier chapters. Math and system built-in functions are explained below.

Math Functions

The math functions available in Tcl are listed in the following table:

SN	Method Name	Description
1	abs arg	Calculates the absolute value of arg.
2	acos arg	Calculates the arccosine of arg.
3	asin arg	Calculates the arcsine of arg.
4	atan arg	Calculates the arctangent of arg.
5	atan2 y x	Calculates the arctangent of the quotient of its arguments(y/x).
6	ceil arg	Calculates the smallest integer greater than or equal to a number.
7	cos arg	Calculates the cosine of arg.
8	cosh arg	Calculates the hyperbolic cosine of arg.
9	double arg	Calculates if arg is a floating-point value, returns arg, otherwise converts arg to floating-point, and returns the converted value.

10	exp arg	Calculates an exponential function (e raised to the power of arg).
11	floor arg	Calculates the largest integer less than or equal to arg.
12	fmod x y	Calculates the floating-point remainder of the division of x by y. If y is 0, an error is returned.
13	hypot x y	Calculates the length of the hypotenuse of a right-angled triangle sqrt(x*x+y*y).
14	int arg	Calculates if arg is an integer value of the same width as the machine word, returns arg, otherwise converts arg to an integer.
15	log arg	Calculates the natural logarithm of arg.
16	log10 arg	Calculates the base 10 logarithm of arg.
17	pow x y	Calculates the value of x raised to the power y. If x is negative, y must be an integer value.
18	rand	Calculates a pseudo-random number between 0 and 1.
19	round arg	Calculates the value of arg rounded to the nearest integer.
20	sin arg	Calculates the sine of arg.
21	sinh arg	Calculates the hyperbolic sine of arg.
22	sqrt arg	Calculates the square root of arg. arg must be positive.
23	srand arg	Calculates a pseudo-random number between 0 and 1. The arg, which must be an integer, is used to reset the seed for the random number generator of rand.
24	tan arg	Calculates the tangent of arg.
25	tanh arg	Calculates the hyperbolic tangent of arg.
26	wide arg	Calculates integer value at least 64-bits wide (by sign-extension if arg is a 32-bit number) for arg if it is not one already.

Some examples using math functions are given below.

```
#!/usr/bin/tclsh

namespace import ::tcl::mathfunc::*
puts [tan 10]
puts [pow 10 2]
puts [ceil 10.34]
puts [hypot 10 20]
```

```
puts [srand 45]
puts [log 10]
puts [srand 45]
```

When the above code is executed, it produces the following result.

```
0.6483608274590866
100.0
11.0
22.360679774997898
0.0003521866166741525
2.302585092994046
0.0003521866166741525
```

System Functions

The important system functions in Tcl includes,

- **clock** - seconds function, which returns current time in seconds.
- **clock** - format function, which formats the seconds into date and time.
- **clock** - scan function, which scans the input string and converts it into seconds.
- **open** – function, which is used to open a file.
- **exec** – function, which is used to execute a system command.
- **close** – function, which is used to close a file.

Some examples for the above functions are listed below:

```
#!/usr/bin/tclsh

#get seconds
set currentTime [clock seconds]
puts $currentTime
#get format
puts "The time is: [clock format $currentTime -format %H:%M:%S]"
puts "The date is: [clock format $currentTime -format %D]"

set date "Jun 15, 2014"
puts [clock scan $date -format {%b %d, %Y}]
```

```
puts [exec ls]
puts [exec dir]

set a  [open input.txt]
puts [read $a];
puts $a
close $a
```

When the above code is executed, it produces the following result:

```
1402819756
The time is: 03:09:16
The date is: 06/15/2014
1402808400
input.txt
main.tcl
input.txt  main.tcl
This is the file you can use to provide input to your program and later on open
it inside your program to process the input.


file3
```

The following table provides the list strings that can be used to format the date and time.

SN	Format	Description
1	%a	Day in short form, eg:Sun.
2	%A	Day in full form eg:Sunday.
3	%b	Month in short form.
4	%B	Month in full form.
5	%d	Day of month
6	%j	Julian day of year.
7	%m	Month in number.
8	%y	Year in two digits.
9	%Y	Year in four digits.
10	%H	Hour in 24 hour clock.

11	%I	Hour in 12 hour clock.
12	%M	Minutes.
13	%S	Seconds.
14	%p	AM or PM.
15	%D	Date in number, mm/dd/yy.
16	%r	Time in 12 hour clock.
17	%R	Time in 24 hour clock without seconds.
18	%T	Time in 24 hour clock with seconds.
19	%Z	Time Zone Name like GMT, IST, EST, and so on.

21. Tcl – Regular Expressions

The "regexp" command is used to match a regular expression in Tcl. A regular expression is a sequence of characters that contains a search pattern. It consists of multiple rules and the following table explains these rules and corresponding use.

SN	Rule	Description
1	x	Exact match.
2	[a-z]	Any lowercase letter from a-z.
3	.	Any character.
4	^	Beginning string should match.
5	$	Ending string should match.
6	\^	Backlash sequence to match special character ^.Similarly you can use for other characters.
7	()	Add the above sequences inside parenthesis to make a regular expression.
8	x*	Should match 0 or more occurrences of the preceding x.
9	x+	Should match 1 or more occurrences of the preceding x.
10	[a-z]?	Should match 0 or 1 occurrence of the preceding x.
11	{digit}	Matches exactly digit occurrences of previous regex expression. Digit that contains 0-9.
12	{digit,}	Matches 3 or more digit occurrences of previous regex expression. Digit that contains 0-9.
13	{digit1,digit2}	Occurrences matches the range between digit1 and digit2 occurrences of previous regex expression.

Syntax

The syntax for regex is given below:

```
regexp optionalSwitches patterns searchString fullMatch subMatch1 ... subMatchn
```

Here, regex is the command. We will see about optional switches later. Patterns are the rules as mentioned earlier. Search string is the actual string on which the regex is performed. Full match is any variable to hold the result of matched regex result. Submatch1 to SubMatchn are optional subMatch variable that holds the result of sub match patterns.

Let's look at some simple examples before diving into complex ones. A simple example for a string with any alphabets. When any other character is encountered the regex, search will be stopped and returned.

```
#!/usr/bin/tclsh

regexp {([A-Z,a-z]*)} "Tcl Tutorial" a b
puts "Full Match: $a"
puts "Sub Match1: $b"
```

When the above code is executed, it produces the following result:

```
Full Match: Tcl
Sub Match1: Tcl
```

Multiple Patterns

The following example shows how to search for multiple patterns. This is example pattern for any alphabets followed by any character followed by any alphabets.

```
#!/usr/bin/tclsh

regexp {([A-Z,a-z]*).([A-Z,a-z]*)} "Tcl Tutorial" a b c
puts "Full Match: $a"
puts "Sub Match1: $b"
puts "Sub Match2: $c"
```

When the above code is executed, it produces the following result:

```
Full Match: Tcl Tutorial
Sub Match1: Tcl
Sub Match2: Tutorial
```

A modified version of the above code to show that a sub pattern can contain multiple patterns is shown below:

```
#!/usr/bin/tclsh

regexp {([A-Z,a-z]*.([A-Z,a-z]*))} "Tcl Tutorial" a b c
puts "Full Match: $a"
puts "Sub Match1: $b"
puts "Sub Match2: $c"
```

When the above code is executed, it produces the following result:

```
Full Match: Tcl Tutorial
Sub Match1: Tcl Tutorial
Sub Match2: Tutorial
```

Switches for Regex Command

The list of switches available in Tcl are,

- **nocase:** Used to ignore case.
- **indices:** Store location of matched sub patterns instead of matched characters.
- **line:** New line sensitive matching. Ignores the characters after newline.
- **start index:** Sets the offset of start of search pattern.
- Marks the end of switches

In the above examples, I have deliberately used [A-Z, a-z] for all alphabets, you can easily use -nocase instead of as shown below:

```
#!/usr/bin/tclsh
regexp -nocase {([A-Z]*.([A-Z]*))} "Tcl Tutorial" a b c
puts "Full Match: $a"
puts "Sub Match1: $b"
puts "Sub Match2: $c"
```

When the above code is executed, it produces the following result:

```
Full Match: Tcl Tutorial
Sub Match1: Tcl Tutorial
Sub Match2: Tutorial
```

Another example using switches is shown below:

```
#!/usr/bin/tclsh
regexp -nocase -line -- {([A-Z]*.([A-Z]*))} "Tcl \nTutorial" a b
puts "Full Match: $a"
puts "Sub Match1: $b"
regexp -nocase -start 4 -line -- {([A-Z]*.([A-Z]*))} "Tcl \nTutorial" a b
puts "Full Match: $a"
puts "Sub Match1: $b"
```

When the above code is executed, it produces the following result:

```
Full Match: Tcl
Sub Match1: Tcl
Full Match: Tutorial
Sub Match1: Tutorial
```

22. Tk – Overview

Tk refers to Toolkit and it provides cross platform GUI widgets, which helps you in building a Graphical User Interface. It was developed as an extension to Tcl scripting language by John Ousterhout. Tk remained in development independently from Tcl with version being different to each other, before, it was made in sync with Tcl in v8.0.

Features of Tk

It is cross platform with support for Linux, Mac OS, Unix, and Microsoft Windows operating systems.

- It is an open source.
- It provides high level of extendibility.
- It is customizable.
- It is configurable.
- It provides a large number of widgets.
- It can be used with other dynamic languages and not just Tcl.
- GUI looks identical across platforms.

Applications Built in Tk

Large successful applications have been built in Tcl/Tk.

- Dashboard Soft User Interface
- Forms GUI for Relational DB
- Ad Hoc GUI for Relational DB
- Software/Hardware System Design
- Xtask - Task Management
- Musicology with Tcl and Tk
- Calender app
- Tk mail
- Tk Debugger

23. Tk – Environment

Generally, all Mac and Linux mac come with Tk pre-installed. In case, it's not available or you need the latest version, then you may need to install it. Windows don't come with Tcl/Tk and you may need to use its specific binary to install it.

The Tk Interpreter

It is just a small program that enables you to type Tk commands and have them executed line by line. It stops execution of a tcl file in case, it encounters an error unlike a compiler that executes fully.

Let's have a helloWorld.tcl file as follows. We will use this as first program, we run on the platform you choose.

```
#!/usr/bin/wish

grid [ttk::button .mybutton -text "Hello World"]
```

The following section explains only how to install Tcl/Tk on each of the available platforms.

Installation on Windows

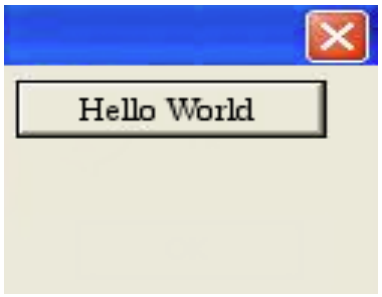
Download the latest version for windows **installer** from the list of Active Tcl/Tk binaries available. Active Tcl/Tk community edition is free for personal use.

Run the downloaded executable to install the Tcl and Tk, which can be done by following the on screen instructions.

Now, we can build and run a Tcl file say helloWorld.tcl by switching to folder containing the file using cd and then using the following step:

```
C:\Tcl> wish helloWorld.tcl
```

Press enter and we will see an output as shown below:



Installation on Linux

Most Linux operating systems comes with Tk inbuilt and you can get started right away in those systems. In case, it's not available, you can use the following command to download and install Tcl-Tk.

```
$ yum install tcl tk
```

Now, we can build and run a Tcl file say helloWorld.tcl by switching to folder containing the file using **cd command** and then using the following step:

```
$ wish helloWorld.tcl
```

Press enter and we will see an output similar to the following:

Installation on Debian Based Systems

In case, it's not available prebuilt in your OS, you can use the following command to download and install Tcl-Tk:

```
$ sudo apt-get install tcl tk
```

Now, we can build and run a Tcl file say helloWorld.tcl by switching to folder containing the file using **cd command** and then using the following steps:

```
$ wish helloWorld.tcl
```

Press enter and we will see an output similar to the following:

Installation on Mac OS X

Download the latest version for Mac OS X **package** from the list of Active Tcl/Tk binaries available. Active Tcl community edition is free for personal use.

Run the downloaded executable to install the Active Tcl, which can be done by following the on screen instructions.

Now, we can build and run a Tcl file say helloWorld.tcl by switching to folder containing the file using **cd command** and then using the following step:

```
$ wish helloWorld.tcl
```

Press enter and we will see an output as shown below:

Installation from Source Files

You can use the option of installing from source files when a binary package is not available. It is generally preferred to use Tk binaries for Windows and Mac OS X, so only compilation of sources on unix based system is shown below:

- Download the source files.
- Now, use the following commands to extract, compile, and build after switching to the downloaded folder.

```
$ tar zxf tk8.6.1-src.tar.gz
$ cd tcl8.6.1
$ cd unix
$ ./configure –with-tcl=../../tcl8.6.1/unix –prefix=/opt –enable-gcc
$ make
$ sudo make install
```

Note: Make sure, you change the file name to the version you downloaded on commands 1 and 2 in the above.

In Tcl, we classify some of the variables as special variables and they have a predefined usage/functionality. The list of specials variables is listed below:

Special Variable	Description
argc	Refers to a number of command-line arguments.
argv	Refers to the list containing the command-line arguments.
argv0	Refers to the file name of the file being interpreted or the name by which we invoke the script.
env	Used for representing the array of elements that are environmental variables.
errorCode	Provides the error code for last Tcl error.
errorInfo	Provides the stack trace for last Tcl error.
tcl_interactive	Used to switch between interactive and non-interactive modes by setting this to 1 and 0 respectively.
tcl_library	Used for setting the location of standard Tcl libraries.
tcl_pkgPath	Provides the list of directories where packages are generally installed.
tcl_patchLevel	Refers to the current patch level of the Tcl interpreter.
tcl_platform	Used for representing the array of elements with objects including byteOrder, machine, osVersion, platform, and os.
tcl_precision	Refers to the precision i.e. number of digits to retain when converting to floating-point numbers to strings. The default value is 12.
tcl_prompt1	Refers to the primary prompt.
tcl_prompt2	Refers to the secondary prompt with invalid commands.
tcl_rcFileName	Provides the user specific startup file.
tcl_traceCompile	Used for controlling the tracing of bytecode compilation. Use 0 for no output, 1 for summary, and 2 for detailed.
tcl_traceExec	Used for controlling the tracing of bytecode execution. Use 0 for no output, 1 for summary, and 2 for detailed.
tcl_version	Returns the current version of the Tcl interpreter.

The above special variables have their special meanings for the Tcl interpreter.

Examples for Using Tcl Special Variables

Let's take some examples to understand the use of special variables.

Tcl Version

```
#!/usr/bin/tclsh


puts $tcl_version
```

When you run the program, you will get a similar output as shown below:

```
8.5
```

Tcl Environment Path

```
#!/usr/bin/tclsh


puts $env(PATH)
```

When you run the program, you will get a similar output as shown below:

```
/web/com/GNUstep/Tools:/usr/GNUstep/Local/Tools:/usr/GNUstep/System/Tools:/usr/
local/sml/bin:/usr/local/flex/bin:/usr/local/gcc-
4.8.1/bin:/usr/share/java:.:/usr/share/java:/usr/lib/jvm/java/lib:/usr/lib/jvm/
java/jre/lib:/usr/local/bin:/usr/local/mozart/bin:/usr/local/go/bin:/usr/local/
factor/:/usr/local/groovy-2.1.7/bin:/opt/Pawn/bin/:/usr/local/icon-
v950/bin:/usr/local/lib/mono/4.0:/usr/lib64/qtC.3/bin:/usr/local/bin:/bin:/usr/
bin:/usr/local/sbin:/usr/sbin:/sbin:/opt/Pawn/bin:/usr/local/dart/bin:/usr/loca
l/julia/usr/bin:/usr/local/julia:/usr/local/scriptbasic/bin
```

Tcl Package Path

```
#!/usr/bin/tclsh


puts $tcl_pkgPath
```

When you run the program, you will get a similar output as shown below:

```
/usr/lib64/tcl8.5 /usr/share/tcl8.5 /usr/lib64/tk8.5 /usr/share/tk8.5
```

Tcl Library

```
#!/usr/bin/tclsh
puts $tcl_library
```

When you run the program, you will get a similar output as shown below:

```
/usr/share/tcl8.5
```

Tcl Patch Level

```
#!/usr/bin/tclsh
puts $tcl_patchLevel
```

When you run the program, you will get a similar output as shown below:

```
8.5.7
```

Tcl Precision

```
#!/usr/bin/tclsh
puts $tcl_precision
```

When you run the program, you will get a similar output as shown below:

```
0
```

Tcl Startup File

```
#!/usr/bin/tclsh


puts $tcl_rcFileName
```

When you run the program, you will get a similar output as shown below:

```
~/.tclshrc
```

24. Tk – Widgets Overview

The basic component of a Tk-based application is called a widget. A component is also sometimes called a window, since, in Tk, "window" and "widget" are often used interchangeably. Tk is a package that provides a rich set of graphical components for creating graphical applications with Tcl.

Tk provides a range of widgets ranging from basic GUI widgets like buttons and menus to data display widgets. The widgets are very configurable as they have default configurations making them easy to use.

Tk applications follow a widget hierarchy where any number of widgets may be placed within another widget, and those widgets within another widget. The main widget in a Tk program is referred to as the root widget and can be created by making a new instance of the TkRoot class.

Creating a Widget

The syntax for creating a widget is given below.

```
type variableName arguments options
```

The type here refers to the widget type like button, label, and so on. Arguments can be optional and required based on individual syntax of each widget. The options range from size to formatting of each component.

Widget Naming Convention

Widget uses a structure similar to naming packages. In Tk, the root window is named with a period (.) and an element in window, for example button is named .myButton1. The variable name should start with a lowercase letter, digit, or punctuation mark (except a period). After the first character, other characters may be uppercase or lowercase letters, numbers, or punctuation marks (except periods). It is recommended to use a lowercase letter to start the label.

Color Naming Convention

The colors can be declared using name like red, green, and so on. It can also use hexadecimal representing with #. The number of hexadecimal digits can be 3, 6, 9, or 12.

Dimension Convention

The default unit is pixels and it is used when we specify no dimension. The other dimensions are i for inches, m for millimeters, c for centimeters and p for points.

Common Options

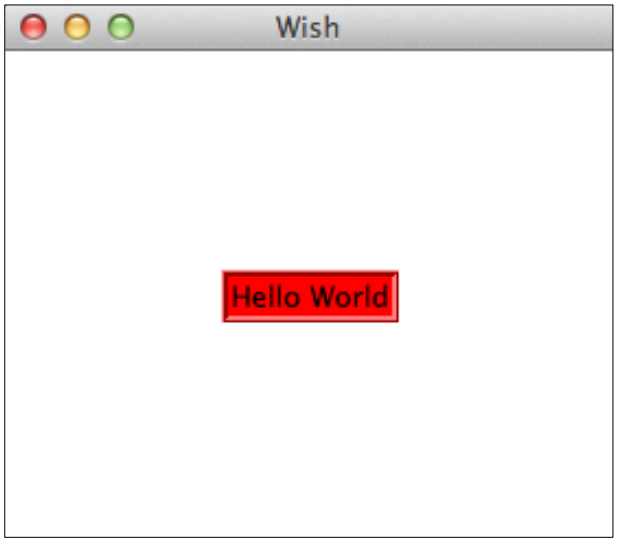
There are so many common options available to all widgets and they are listed below in the following table:

SN	Syntax	Description
1	-background color	Used to set background color for widget.
2	-borderwidth width	Used to draw with border in 3D effects.
3	-font fontDescriptor	Used to set font for widget.
4	-foreground color	Used to set foreground color for widget.
5	-height number	Used to set height for widget.
6	-highlightbackground color	Used to set the color rectangle to draw around a widget when the widget does not have input focus.
7	-highlightcolor color	Used to set the color rectangle to draw around a widget when the widget has input focus.
8	-padx number	Sets the padx for the widget.
9	-pady number	Sets the pady for the widget.
10	-relief condition	Sets the 3D relief for this widget. The condition may be raised, sunken, flat, ridge, solid, or groove.
11	-text text	Sets the text for the widget.
12	-textvariable varName	Variable associated with the widget. When the text of widget changes, the variable is set with text of widget.
13	-width number	Sets the width for widget.

A simple example for options is shown below.

```
#!/usr/bin/wish

grid [label .myLabel -background red -text "Hello World" -relief ridge -
borderwidth 3] -padx 100 -pady 100
```

When we run the above program, we will get the following output.



The list of available widgets are categorized below:

Basic Widgets

SN	Widget	Description
1	Label	Widget for displaying single line of text.
2	Button	Widget that is clickable and triggers an action.
3	Entry	Widget used to accept a single line of text as input.
4	Message	Widget for displaying multiple lines of text.
5	Text	Widget for displaying and optionally edit multiple lines of text.
6	Toplevel	Window with all borders and decorations provided by the Window manager.

Layout Widgets

SN	Widget	Description
1	Frame	Container widget to hold other widgets.
2	Place	Widget to hold other widgets in specific place with coordinates of its origin and an exact size.
3	Pack	Simple widget to organize widgets in blocks before placing them in the parent widget.
4	Grid	Widget to nest widgets packing in different directions.

Selection Widgets

SN	Widget	Description
1	Radiobutton	Widget that has a set of on/off buttons and labels, one of which may be selected.
2	Checkbutton	Widget that has a set of on/off buttons and labels, many of which may be selected.
3	Menu	Widget that acts as holder for menu items.
4	Listbox	Widget that displays a list of cells, one or more of which may be selected.

Mega Widgets

SN	Widget	Description
1	Dialog	Widget for displaying dialog boxes.
2	Spinbox	Widget that allows users to choose numbers.
3	Combobox	Widget that combines an entry with a list of choices available to the use.
4	Notebook	Tabbed widget that helps to switch between one of several pages, using an index tab.
5	Progressbar	Widget to provide visual feedback to the progress of a long operation like file upload.
6	Treeview	Widget to display and allow browsing through a hierarchy of items more in form of tree.
7	Scrollbar	Scrolling widgets without a text or canvas widgets.
8	Scale	Scale widget to choose a numeric value through sliders.

Other Widgets

SN	Widget	Description
1	Canvas	Drawing widget for displaying graphics and images.

We will cover each of these widgets in the upcoming chapters.

25. Tk – Basic Widgets

Basic widgets are common widgets available in almost all Tk applications. The list of available basic widgets is given below:

1	**Label**	Widget for displaying single line of text.
2	**Button**	Widget that is clickable and triggers an action.
3	**Entry**	Widget used to accept a single line of text as input.
4	**Message**	Widget for displaying multiple lines of text.
5	**Text**	Widget for displaying and optionally edit multiple lines of text.
6	**Toplevel**	Widget used to create a frame that is a new top level window.

Tk - Label Widget

A label widget is a common widget used in almost all Tk applications that is used to display simple text. The syntax for label widget is shown below:

```
label labelName options
```

Options

The options available for the label widget are listed below in table:

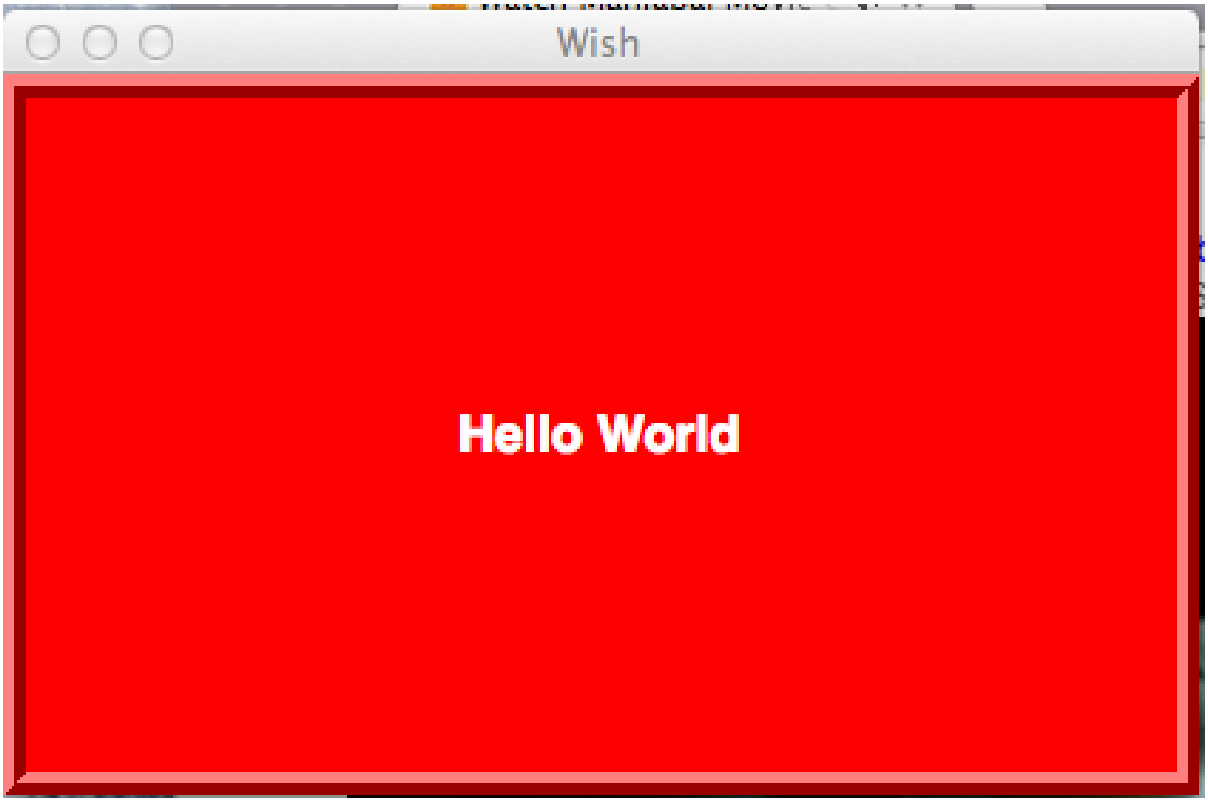
SN	Syntax	Description
1	-background color	Used to set background color for widget.
2	-borderwidth width	Used to draw with border in 3D effects.
3	-font fontDescriptor	Used to set font for widget.
4	-foreground color	Used to set foreground color for widget.
5	-height number	Used to set height for widget.
6	-padx number	Sets the padx for the widget.
7	-pady number	Sets the pady for the widget.
8	-relief condition	Sets the 3D relief for this widget. The condition may be raised, sunken, flat, ridge, solid, or groove.
9	-text text	Sets the text for the widget.
10	-textvariable varName	Variable associated with the widget. When the text of widget changes, the variable is set to text of widget.

11	-width number	Sets the width for widget.
12	-justify alignment	Sets the alignment of text, which can be left, center, or right.

A simple example for label widget is shown below:

```
#!/usr/bin/wish

grid [label .myLabel -background red -foreground white -text "Hello World" -
relief ridge -borderwidth 8 -padx 10 -pady 10 -font {Helvetica -18 bold} -
height 10 -width 35 -textvariable myvariable -justify left -underline 1]

set myvariable "Test Hello"
```

When we run the above program, we will get the following output:



Tk – Button Widget

Tk button widget is a clickable widget that triggers an action. The syntax for button widget is shown below:

```
button buttonName options
```

Options

The options available for the button widget are listed below in table:

SN	Syntax	Description
1	-font fontDescriptor	Used to set font for widget.
2	-height number	Used to set height for widget.
3	-command action	Sets the command action for button.
4	-text text	Sets the text for the widget.
5	-width number	Sets the width for widget.

A simple button widget is shown below:

```
#!/usr/bin/wish


grid [label .myLabel  -text "Click the buttons" -textvariable labelText]

grid [button .myButton1  -text "Button 1" -font {Helvetica -18 bold} -height 5
-width 10  -command "set labelText clicked_top_btn"]

grid [button .myButton2 -text "Button 2" -font {Helvetica -18 bold} -height 5 -
width 10  -command "set labelText clicked_bottom_btn"]
```

When we run the above program, we will get the following output:

When we click the Button1, we will get the following output:

When we click the Button2, we will get the following output:

Tk – Entry Widgets

Entry widgets are used to accept a single line of text as input. Getting user input is almost mandatory in all Tk applications. The syntax for entry widget is shown below:

```
entry entryName options
```

Options

The options available for the entry widget are listed below in the following table:

SN	Syntax	Description
1	-background color	Used to set background color for widget.
2	-borderwidth width	Used to draw with border in 3D effects.
3	-font fontDescriptor	Used to set font for widget.
4	-foreground color	Used to set foreground color for widget.
5	-pady number	Sets the pady for the widget.
6	-relief condition	Sets the 3D relief for this widget. The condition may be raised, sunken, flat, ridge, solid, or groove.
7	-textvariable varName	Variable associated with the widget. When the text of widget changes, the variable is set to text of widget.
8	-width number	Sets the width for widget.
9	-justify side	Sets the justification side. The valid sides are left and right.
10	-show character	Sets the character for secure entry.

A simple example using entry widget is shown below:

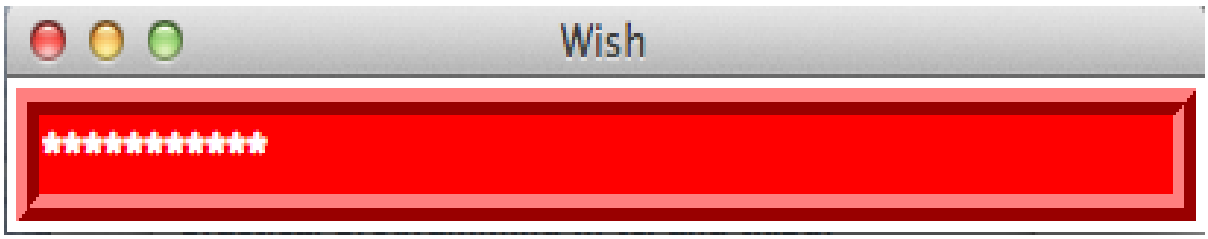
```
#!/usr/bin/wish

grid [entry .myEntry -background red -foreground white -relief ridge -
borderwidth 8 -font {Helvetica -18 bold} -width 35 -textvariable myvariable -
justify right ]

set myvariable "Hello World"
```

When we run the above program, we will get the following output:

An example for secure entry is shown below:

```
#!/usr/bin/wish


grid [entry .myEntry -background red -foreground white  -relief ridge -
borderwidth 8 -font {Helvetica -18 bold} -width 35 -textvariable myvariable -
justify left -show "*"]

set myvariable "Hello World"
```

When we run the above program, we will get the following output:



Tk – Message Widget

A message widget is used for displaying multiple lines of text. The syntax for message widget is shown below:

```
message messageName options
```

Options

The options available for the message widget are listed below in the following table:

SN	Syntax	Description
1	-background color	Used to set background color for widget.
2	-borderwidth width	Used to draw with border in 3D effects.
3	-font fontDescriptor	Used to set font for widget.
4	-foreground color	Used to set foreground color for widget.
5	-padx number	Sets the padx for the widget.
6	-pady number	Sets the pady for the widget.

7	-relief condition	Sets the 3D relief for this widget. The condition may be raised, sunken, flat, ridge, solid, or groove.
8	-text text	Sets the text for the widget.
9	-textvariable varName	Variable associated with the widget. When the text of widget changes, the variable is set to text of widget.
10	-justify alignment	Sets the alignment of text, which can be left, center, or right.
11	-aspect ratio	Sets the aspect ratio in percent. The default is 150. It is available when width option is not used.
12	-width number	Sets the width for widget.

A simple example for message widget is shown below:

```
#!/usr/bin/wish


grid [message .myMessage -background red -foreground white -text "Hello\nWorld"
-relief ridge -borderwidth 8 -padx 10 -pady 10 -font {Helvetica -18 bold} -
textvariable myvariable -justify right -aspect 100 ]
```

When we run the above program, we will get the following output:

Tk – Text Widget

Tk text widget is a general purpose editable text widget with features for multiple options. The syntax for text widget is shown below:

```
text textName options
```

Options

The options available for the text widget are listed below in table:

SN	Syntax	Description
1	-background color	Used to set background color for widget.
2	-borderwidth width	Used to draw with border in 3D effects.
3	-font fontDescriptor	Used to set font for widget.
4	-foreground color	Used to set foreground color for widget.
5	-relief condition	Sets the 3D relief for this widget. The condition may be raised, sunken, flat, ridge, solid, or groove.
6	-width number	Sets the width for widget.
7	-height number	Used to set height for widget.

A simple example for text widget is shown below:

```
#!/usr/bin/wish

grid [text .myText -background red -foreground white -relief ridge -borderwidth
8 -padx 10 -pady 10 -font {Helvetica -18 bold} -width 20 -height 5]
.myText insert 1.0 "Hello\nWorld\n"
.myText insert end "A new line\n"
.myText tag configure para -spacing1 0.15i -spacing2 0.05i \
   -lmargin1 0.25i -lmargin2 0.2i -rmargin 0.25i
.myText tag configure hang -lmargin1 0.30i -lmargin2 0.25i
.myText tag add para 1.0 2.end
.myText tag add hang 3.0 3.end
```

When we run the above program, we will get the following output:

As you can see, text widgets works with the help of procedures like tag, insert, and delete. Most of the tag usages have been covered in the above example.

Tk – Top Level Widgets

Top level widget is used to create a frame that is a new top level window. The syntax for top level widget is shown below:

```
toplevel topLevelName options
```

Options

The options available for the top level widget are listed below in table:

SN	Syntax	Description
1	-background color	Used to set background color for widget.
2	-borderwidth width	Used to draw with border in 3D effects.
3	-height number	Used to set height for widget.
4	-padx number	Sets the padx for the widget.
5	-pady number	Sets the pady for the widget.
6	-relief condition	Sets the 3D relief for this widget. The condition may be raised, sunken, flat, ridge, solid, or groove.
7	-width number	Sets the width for widget.

A simple example for top level widget is shown below:

```
#!/usr/bin/wish

toplevel .top -width 400 -height 100 -background red -relief ridge -borderwidth
8 -padx 10 -pady 10
```

When we run the above program, we will get the following output:

A simple Tk example is shown below using basic widgets:

```
#!/usr/bin/wish

grid [label .myLabel -text "Label Widget" -textvariable labelText]
grid [text .myText -width 20 -height 5]
.myText insert 1.0 "Text\nWidget\n"
grid [entry .myEntry -text "Entry Widget"]
grid [message .myMessage -background red -foreground white -text
"Message\nWidget"]
grid [button .myButton1  -text "Button" -command "set labelText clicked"]
```

When we run the above program, we will get the following output:

26. Tk – Layout Widgets

Layout widgets are used to handle layouts for the Tk application. Frame widget is used group other widgets and place, pack, and grid are layout manager to give you total control over your adding to windows. The list of available layout widgets are as shown below:

1	**Frame**	Container widget to hold other widgets.
2	**Place**	Widget to hold other widgets in specific place with coordinates of its origin and an exact size.
3	**Pack**	Simple widget to organize widgets in blocks before placing them in the parent widget.
4	**Grid**	Widget to nest widgets packing in different directions.

Tk – Frame Widget

The frame widget is a rectangular container widget that groups widgets for designing GUI. The syntax for frame widget is shown below:

```
frame frameName options
```

Options

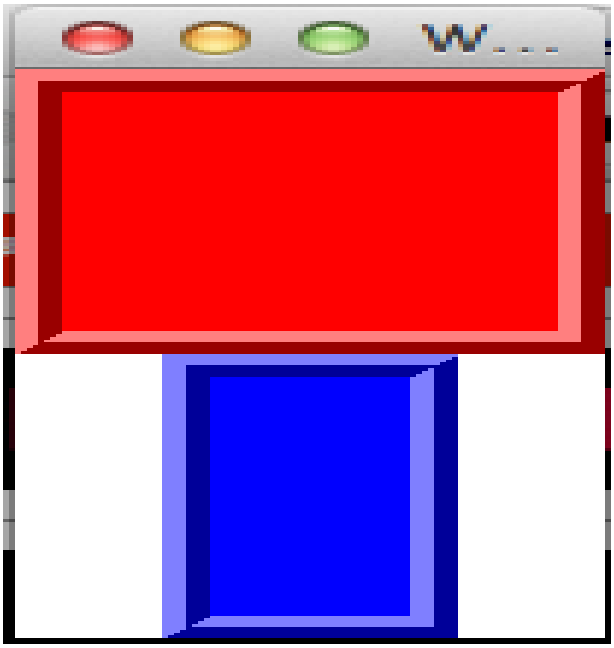
The options available for the frame widget are listed below in table:

SN	Syntax	Description
1	-background color	Used to set background color for widget.
2	-borderwidth width	Used to draw with border in 3D effects.
3	-height number	Used to set height for widget.
4	-padx number	Sets the padx for the widget.
5	-pady number	Sets the pady for the widget.
6	-relief condition	Sets the 3D relief for this widget. The condition may be raised, sunken, flat, ridge, solid, or groove.
7	-width number	Sets the width for widget.

A simple example for frame widget is shown below:

```
#!/usr/bin/wish


frame .myFrame1 -background red  -relief ridge -borderwidth 8 -padx 10 -pady 10
-height 100 -width 100

frame .myFrame2 -background blue  -relief ridge -borderwidth 8 -padx 10 -pady
10  -height 100 -width 50

pack .myFrame1

pack .myFrame2
```

When we run the above program, we will get the following output:



Tk – Place Widget

The place widget is used to locate a widget at an absolute location or a relative location based on the size of the window. The syntax for place widget is shown below:

```
place placeName options
```

Options

The options available for the place widget are listed below in table.

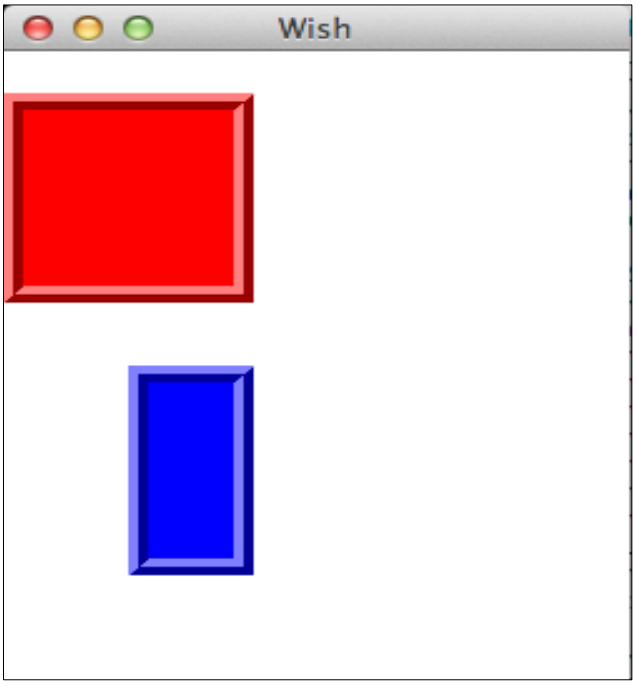
SN	Syntax	Description
1	-x xLocation	Sets the absolute x position for widget.
2	-y yLocation	Sets the absolute y position for widget.
3	-relx xFraction	Sets the relative x position as fraction of width for widget.

4	-rely yFraction	Sets the relative y position as fraction of height for widget.

A simple example for place widget is shown below.

```
#!/usr/bin/wish


 . configure -width 250 -height 300

frame .myFrame1 -background red  -relief ridge -borderwidth 8 -padx 10 -pady 10
-height 100 -width 100

frame .myFrame2 -background blue  -relief ridge -borderwidth 8 -padx 10 -pady
10  -height 100 -width 50

place .myFrame1 -x 0 -y 20

place .myFrame2 -x 50 -y 150
```

When we run the above program, we will get the following output:



Tk – Pack Widget

The pack widget is a rectangular container widget that groups widgets for designing GUI. The syntax for pack widget is shown below.

```
pack packName options
```

Options

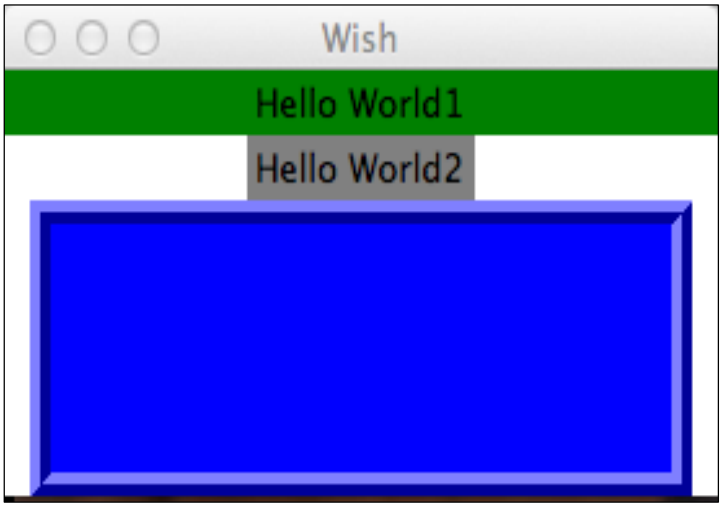
The options available for the pack widget are listed below in the following table:

SN	Syntax	Description
1	-side side	Packs the widget to given side of the parent window. It can be top, bottom, left, and right. The default is top.
2	-anchor edge	Pack widget will be anchored to specific side if the width is less than space is assigned. The valid edges are n, e, w, and s.
3	-expand boolean	Used to make the widget the available space.
4	-padx number	Sets the padx for the widget.
5	-pady number	Sets the pady for the widget.
6	-fill direction	Widget may expand to fill extra space in its parcel. The default is none. The direction may be none, x to fill vertically, y to fill horizontally, and both to fill both ways.
7	-after widgetName	Pack this widget after widgetName, generally on top of it.

A simple pack example for pack widget is shown below:

```
#!/usr/bin/wish

label .label1 -background green -text "Hello World1" -width 30
label .label2 -background gray -text "Hello World2"
frame .myFrame2 -background blue  -relief ridge -borderwidth 8 -padx 10 -pady
10  -height 100 -width 50
pack .label1 -side top -anchor s
pack .label2 -side top -anchor s
pack .myFrame2 -padx 10 -fill x -side bottom -anchor n -after .label2
```

When we run the above program, we will get the following output.



Tk – Grid Widget

The grid widget used to layout widgets in specific rows and columns. The syntax for grid widget is shown below:

```
grid gridName options
```

Options

The options available for the grid widget are listed below in the following table:

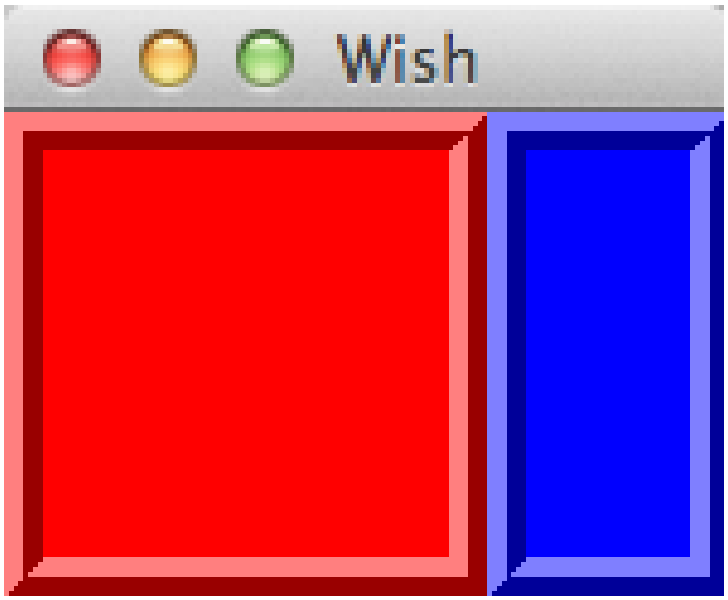
SN	Syntax	Description
1	-column number	Sets the column position for widget.
2	-row number	Sets the row position for widget.
3	-columnspan number	Number of columns to be used for this widget. Defaults to 1.
4	-rowspan number	Number of rows to be used for this widget. Defaults to 1.
5	-sticky side	Sets the edge of the cell to which the widget should stick to. Valid values can be n for top, s for bottom, e for right, w for left, or a combination of these letters.

A simple example for grid widget is shown below:

```
#!/usr/bin/wish
```

```
frame .myFrame1 -background red  -relief ridge -borderwidth 8 -padx 10 -pady 10
-height 100 -width 100

frame .myFrame2 -background blue  -relief ridge -borderwidth 8 -padx 10 -pady
10  -height 100 -width 50

grid .myFrame1 -columnspan 10 -rowspan 10 -sticky w

grid .myFrame2 -column 10 -row 2
```

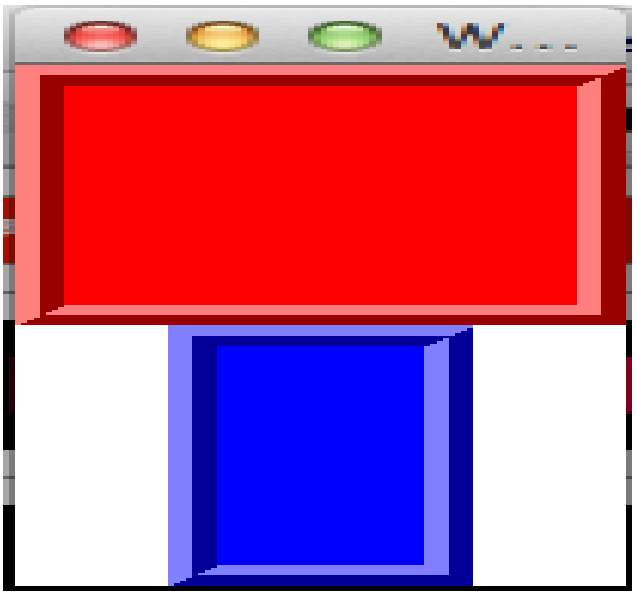
When we run the above program, we will get the following output:



A simple Tk example is shown below for layout widgets:

```
#!/usr/bin/wish


frame .myFrame1 -background red  -relief ridge -borderwidth 8 -padx 10 -pady 10
-height 100 -width 100

frame .myFrame2 -background blue  -relief ridge -borderwidth 8 -padx 10 -pady
10  -height 100 -width 50

pack .myFrame1

pack .myFrame2
```

When we run the above program, we will get the following output:



27. Tk – Selection Widgets

Selection widgets are used to select different options in a Tk application. The list of available selection widgets are as shown below.

1	**Radiobutton**	Widget that has a set of on/off buttons and labels, one of which may be selected.
2	**Checkbutton**	Widget that has a set of on/off buttons and labels, many of which may be selected.
3	**Menu**	Widget that acts as holder for menu items.
4	**Listbox**	Widget that displays a list of cells, one or more of which may be selected.

Tk – Radio Button Widget

Radio button widget implements a multiple-choice button, which is a way to offer many possible selections to the user and lets user choose only one of them. The syntax for radio button widget is shown below:

```
radiobutton radiobuttonName options
```

Options

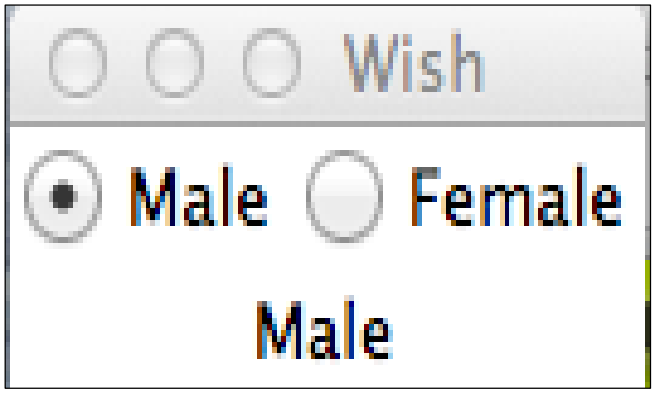
The options available for the radio button widget are listed below in the following table:

SN	Syntax	Description
1	-font fontDescriptor	Used to set font for widget.
2	-height number	Used to set height for widget.
3	-command action	Sets the command action for button.
4	-text text	Sets the text for the widget.
5	-width number	Sets the width for widget.
6	-variable variableName	Sets the variable for widget.
7	-value variableValue	Sets the variable with variable value.

A simple radio button widget example is shown below:

```
#!/usr/bin/wish


grid [frame .gender ]

grid [label .myLabel  -text "Male" -textvariable myLabel1 ]

grid [radiobutton .gender.maleBtn -text "Male"   -variable gender -value "Male"
-command "set  myLabel1 Male"] -row 1 -column 2

grid [radiobutton .gender.femaleBtn -text "Female" -variable gender -value
"Female" -command "set  myLabel1 Female"] -row 1 -column 3

.gender.maleBtn select
```

When we run the above program, we will get the following output:



Tk – Check Button Widget

Tk-check button is used to create multiple selectable items in the form of check boxes. The syntax for check button widget is shown below:

```
checkbutton checkbuttonName options
```

Options

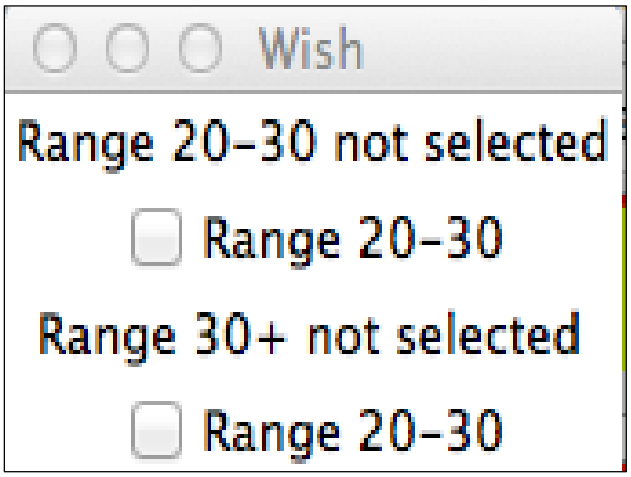
The options available for the check button widget are listed below in the following table:

SN	Syntax	Description
1	-font fontDescriptor	Used to set font for widget.
2	-height number	Used to set height for widget.
3	-command action	Sets the command action for button.
4	-text text	Sets the text for widget.
5	-width number	Sets the width for widget.
6	-variable variableName	Sets the variable for widget.

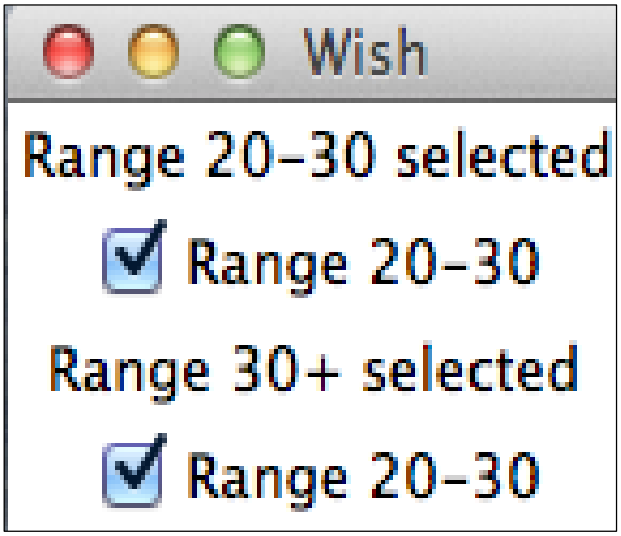
A simple Tk example for check button is shown below:

```
#!/usr/bin/wish


grid [label .myLabel1  -text "Range 20-30 not selected" -textvariable
myLabelValue1 ]

grid [checkbutton .chk1 -text "Range 20-30" -variable occupied1 -command {if
{$occupied1 } {

   set myLabelValue1 {Range 20-30 selected}

} else {

   set myLabelValue1 {Range 20-30 not selected}

} }]

grid [label .myLabel2  -text "Range 30+ not selected" -textvariable
myLabelValue2 ]

grid [checkbutton .chk2 -text "Range 20-30" -variable occupied2 -command {if
{$occupied2 } {

   set myLabelValue2 {Range 30+ selected}

} else {

   set myLabelValue2 {Range 30+ not selected}

} }]
```

When we run the above program, we will get the following output:



When we click the check button1 and check button2, we will get the following output:



Tk – Menu Widget

Tk menu widget is used along with Tk widget menubutton. So, we will see menubutton first. The syntax for menu button widget is shown below:

```
menubutton menubuttonName options
```

Menu Button Options

The options available for the menu button widget are listed below in the following table:

SN	Syntax	Description
1	-command action	Sets the command action for button.
2	-text text	Sets the text for the widget.
3	-textvariable varName	Variable associated with the widget. When the text of widget changes, the variable is set to text of widget.
4	-width number	Sets the width for widget.
5	-menu menuName	Specifies the name of associated menu widget.
6	-underline charPosition	Sets the position for hotkey.

The syntax for menu is shown below.

```
menu menuName options
```

Menu Options

The options available for the menu widget are listed below in the following table:

SN	Syntax	Description
1	-font fontDescriptor	Used to set font for widget.
2	-postcommand action	Sets the command action to be done before a menu is posted.
3	-menu menuName	Specifies the name of associated menu widget.
4	-tearoff boolean	Allows or disallows a menu to be removed from the menubutton and displayed in a permanent window. Default is enabled.

The syntax for adding menubutton is shown below:

```
menuName add type menubuttonType options
```

The type includes separator, cascade, checkbutton, radiobutton, and command.

MenuName Add Options

The options available for the menuName add are listed below in table:

SN	Syntax	Description
1	-command action	Sets the command action for the menubutton.
2	-menu menuName	Specifies the name of associated menu widget.
3	-label string	Set the text of the menu.
4	-variable varName	Sets the variable to be set when this entry is selected.
5	-value string	The value is set for the variable.
6	-underline position	Sets the position for hotkey.

A simple Tk menu is shown below:

```
#!/usr/bin/wish

menubutton .myMenubutton -menu .myMenubutton.myMenu -text "ChangeText"
menu .myMenubutton.myMenu
.myMenubutton.myMenu add command -label Hello -command {set myvariable "Hello"}
.myMenubutton.myMenu add command -label World -command {set myvariable "World"}
pack .myMenubutton
```

```
pack [label .myLabel  -text "Select An option" -font {Helvetica -18 bold} -
height 5 -width 15 -textvariable myvariable]
```

When we run the above program, we will get the following output:

When we select a menu option, we will get an output as shown below:

Tk – Listbox Widget

Tk listbox widgets are scrollable lists that can be selected. The syntax for listbox widget is shown below:

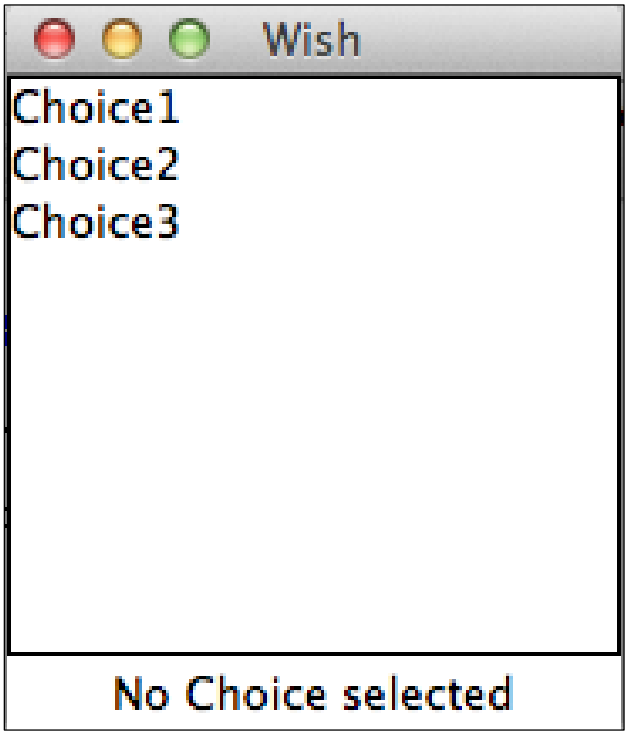
```
listbox buttonName options
```

SN	Syntax	Description
1	-background color	Used to set background color for widget.
2	-borderwidth width	Used to draw with border in 3D effects.
3	-font fontDescriptor	Used to set font for widget.
4	-foreground color	Used to set foreground color for widget.
5	-height numberOfLines	Used to set number of lines for height of widget.
6	-selectmode mode	Mode can be single, browse, multiple and extended.
7	-exportselection bool	To use multiple listbox widgets, set this option to FALSE. The default is TRUE.
8	-width number	Sets the width for widget.

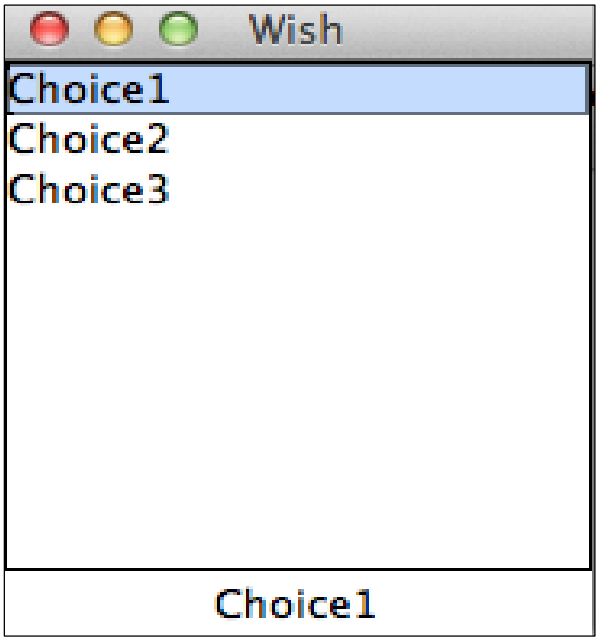
A simple example for listbox is shown below:

```
#!/usr/bin/wish

proc setLabel {text} {
    .label configure -text $text
}
listbox .myList
label .label -text "No Choice selected"
bind .myList  {setLabel [.myList get active]}
grid .myList -row 0 -column 0 -sticky news
grid .label -row 1 -column 0 -columnspan 2
.myList insert 0 Choice1 Choice2 Choice3
```

When we run the above program, we will get the following output:



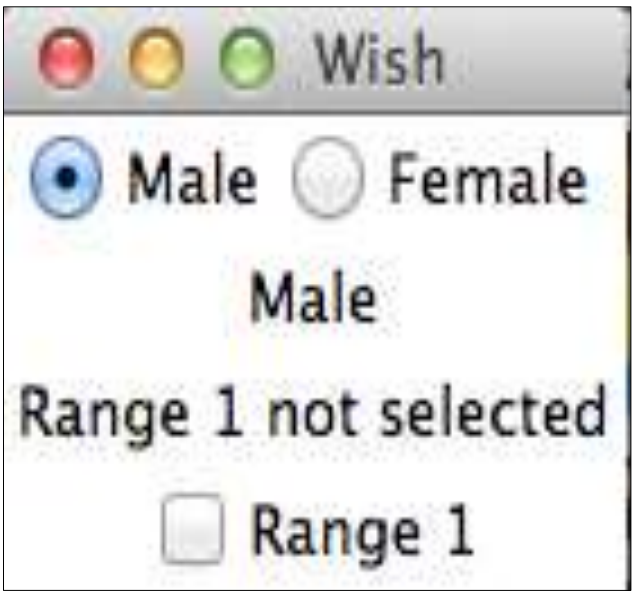
When we select an option, we will get the following output:



A simple Tk example is shown below using selection widgets:

```
#!/usr/bin/wish


grid [frame .gender ]

grid [label .label1  -text "Male" -textvariable myLabel1 ]

grid [radiobutton .gender.maleBtn -text "Male"   -variable gender -value "Male"
-command "set  myLabel1 Male"] -row 1 -column 2

grid [radiobutton .gender.femaleBtn -text "Female" -variable gender -value
"Female" -command "set  myLabel1 Female"] -row 1 -column 3

.gender.maleBtn select

grid [label .myLabel2  -text "Range 1 not selected" -textvariable myLabelValue2
]

grid [checkbutton .chk1 -text "Range 1" -variable occupied1 -command {if
{$occupied1 } {

   set myLabelValue2 {Range 1 selected}

} else {

   set myLabelValue2 {Range 1 not selected}

} }]

proc setLabel {text} {

    .label configure -text $text

}
```

When we run the above program, we will get the following output:



28. Tk – Canvas Widgets

Canvas is used for providing drawing areas. The syntax for canvas widget is shown below:

```
canvas canvasName options
```

Options

The options available for the canvas widget are listed below in the following table:

SN	Syntax	Description
1	-background color	Used to set background color for widget.
2	-closeenough distance	Sets the closeness of mouse cursor to a displayable item. The default is 1.0 pixel. This value may be a fraction and must be positive.
3	-scrollregion boundingBox	The bounding box for the total area of this canvas.
4	-height number	Used to set height for widget.
5	-width number	Sets the width for widget.
6	-xscrollincrement size	The amount to scroll horizontally when scrolling is requested.
7	-yscrollincrement size	The amount to scroll vertically when scrolling is requested.

A simple example for canvas widget is shown below:

```
#!/usr/bin/wish

canvas .myCanvas -background red -width 100 -height 100
pack .myCanvas
```

When we run the above program, we will get the following output:

Widgets for Drawing in Canvas

The list of the available widgets for drawing in canvas is listed below:

SN	Widget	Description
1	**Line**	Draws a line.
2	**Arc**	Draws an arc.
3	**Rectangle**	Draws a rectangle.
4	**Oval**	Draws an oval.
5	**Polygon**	Draws a polygon.
6	**Text**	Draws a text.
7	**Bitmap**	Draws a bitmap.
8	**Image**	Draws an image.

Tk – Canvas Line Widget

Line widget is used to draw a line in canvas. The syntax for line widget is shown below:

```
canvasName create line x1 y1 x2 y2 ... xn yn options
```

x1 y1, x2 y2 ... xn yn are used to determine the end points of line segments.

Options

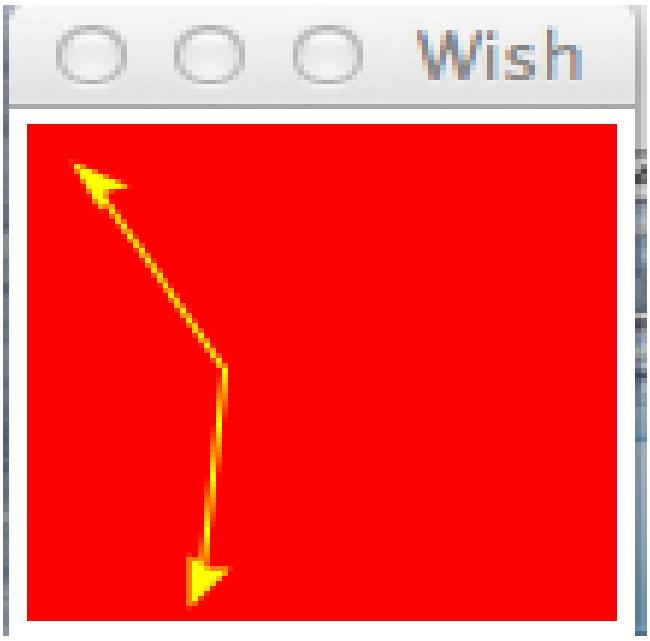
The options available for the line widget are listed below in the following table:

SN	Syntax	Description
1	-arrow end	Determines whether line should have arrow on ends. The end can be both, first, last and none.
2	-fill color	The fill color fills the line segment with the color.
3	-smooth boolean	This can be set to true make the line segments to be rendered with a set of Bezier splines.
4	-splinesteps number	Determines the number of line segment for Bezier splines.

A simple example for line widget is shown below:

```
#!/usr/bin/wish

canvas .myCanvas -background red -width 100 -height 100
pack .myCanvas
.myCanvas create line 10 10 50 50 30 100 -arrow both -fill yellow -smooth true
-splinesteps 2
```

When we run the above program, we will get the following output:



Tk - Canvas Arc Widget

Arc widget is used to draw an arc in canvas. The syntax for arc widget is shown below:

```
canvasName create arc x1 y1 x2 y2 options
```

x1 y1 and x2 y2 are the end points of an arc.

Options

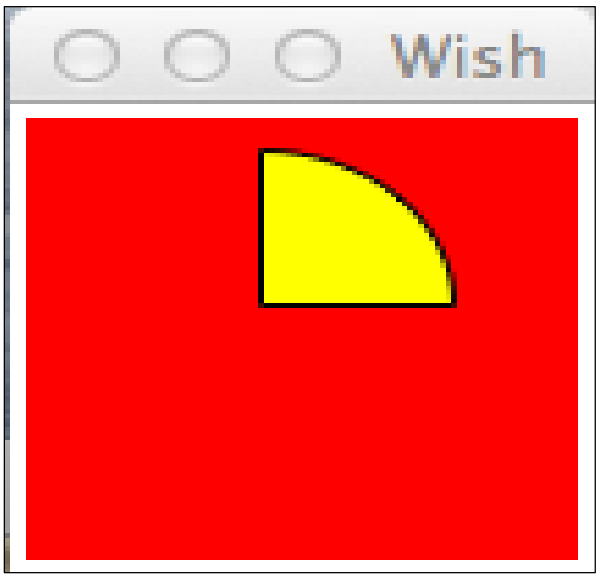
The options available for the arc widget are listed below in the following table:

SN	Syntax	Description
1	-fill color	The fill color fills the arc with the color.
2	-start angle	The start location in degrees for this arc. The default is 0.
3	-extent angle	The number of degrees to extend the arc from the start position. The default is 90 degrees.
4	-style styleType	The style of arc to draw. The options are pieslice, chord, and arc.

A simple example for arc widget is shown below:

```
#!/usr/bin/wish

canvas .myCanvas -background red -width 100 -height 100
pack .myCanvas
.myCanvas create arc 10 10 80 80 -fill yellow
```

When we run the above program, we will get the following output:



Tk – Canvas Rectangle Widget

Rectangle widget is used to draw a rectangle shape in canvas. The syntax for rectangle widget is shown below:

```
canvasName create rectangle x1 y1 x2 y2 options
```

x1 y1 and x2 y2 are the end points of rectangle.

Options

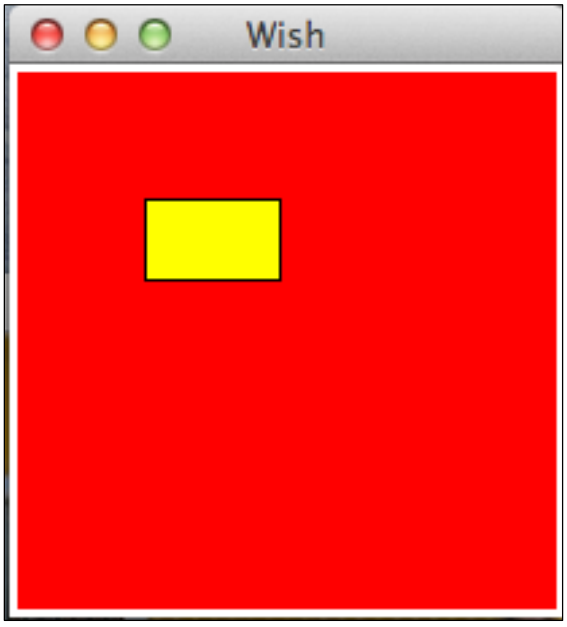
The options available for the rectangle widget are listed below in the following table:

SN	Syntax	Description
1	-outline color	Determines the outline color.
2	-fill color	The fill color fills the oval with the color.
3	-stipple bitmap	The stipple pattern to use if the -fill option is being used.
4	-width number	Determines the width.

A simple example for rectangle widget is shown below:

```
#!/usr/bin/wish

canvas .myCanvas -background red -width 200 -height 200
pack .myCanvas
.myCanvas create rectangle 50 50 100 80  -fill yellow
```

When we run the above program, we will get the following output:



Tk – Canvas Oval Widget

Oval widget is used to draw an oval shape in canvas. The syntax for oval widget is shown below:

```
canvasName create oval x1 y1 x2 y2 options
```

x1 y1 and x2 y2 are the end points of oval.

Options

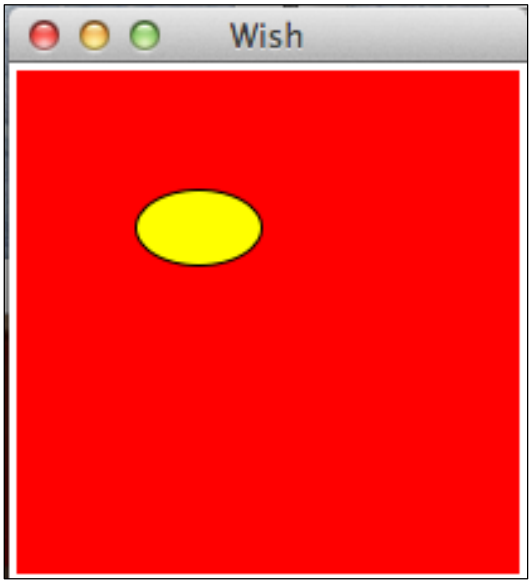
The options available for the oval widget are listed below in the following table:

SN	Syntax	Description
1	-outline color	Determines the outline color.
2	-fill color	The fill color fills the oval with the color.
3	-stipple bitmap	The stipple pattern to use if the -fill option is being used.
4	-width number	Determines the width.

A simple example for oval widget is shown below:

```
#!/usr/bin/wish

canvas .myCanvas -background red -width 200 -height 200
pack .myCanvas
.myCanvas create oval 50 50 100 80 -fill yellow
```

When we run the above program, we will get the following output:



Tk – Canvas Polygon Widget

Polygon widget is used to draw a polygon shape in canvas. The syntax for polygon widget is shown below:

```
canvasName create polygon x1 y1 x2 y2 ... xn yn options
```

x1 y1 and x2 y2 ... xn yn are used to determine the end points of a polygon.

Options

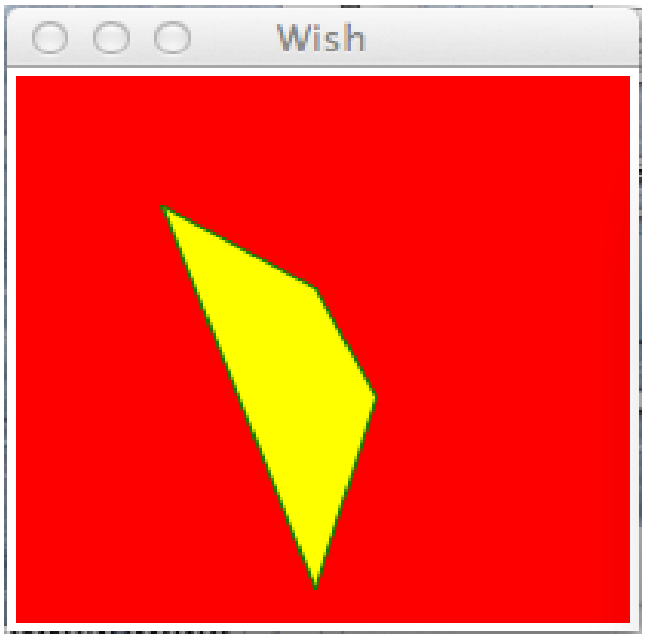
The options available for the polygon widget are listed below in the following table:

SN	Syntax	Description
1	-outline color	Determines the outline color.
2	-fill color	The fill color fills the oval with the color.
3	-stipple bitmap	The stipple pattern to use if the -fill option is being used.
4	-width number	Determines the width.
5	-smooth boolean	This can be set to true make the line segments to be rendered with a set of Bezier splines.
6	-splinesteps number	Determines the number of line segment for bezier splines.

A simple example for polygon widget is shown below:

```
#!/usr/bin/wish

canvas .myCanvas -background red -width 200 -height 200
pack .myCanvas
.myCanvas create polygon 50 50 100 80 120 120 100 190 -fill yellow -outline
green
```

When we run the above program, we will get the following output:



Tk - Canvas Text Widget

Canvas text widget is used to draw text in canvas. The syntax for canvas text widget is shown below:

```
canvasName create text x y options
```

x and y are used to determine the position of text:

Options

The options available for the canvas text widget are listed below in the following table:

SN	Syntax	Description
1	-anchor position	The text will be positioned relative to the x and y locations. Center is default and other options are n, s, e, w, ne, se, sw, and nw.
2	-justify style	Determines the multiline, should be right justified, left justified, or center justified. The default is left.
3	-fill color	The fill color fills the oval with the color.
4	-text text	The text for text widget.
5	-font fontStyle	The font to use for this text.

A simple example for canvas text widget is shown below:

```
#!/usr/bin/wish


canvas .myCanvas -background red -width 200 -height 200

pack .myCanvas

.myCanvas create text 100 100 -fill yellow -justify center -text "Hello
World.\n How are you?" -font {Helvetica -18 bold}
```

When we run the above program, we will get the following output:

Tk – Canvas Bitmap Widget

Bitmap widget is used to add bitmap to canvas. The syntax for bitmap widget is shown below:

```
canvasName create bitmap x y options
```

x and y set the location of bitmap.

Options

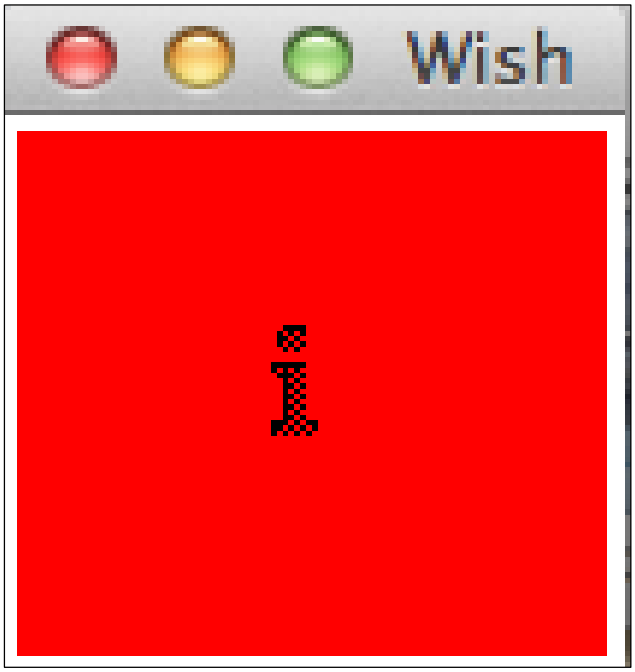
The options available for the bitmap widget are listed below in the following table:

SN	Syntax	Description
1	-anchor position	The bitmap will be positioned relative to the x and y locations. Center is default an other options are n, s, e, w, ne, se, sw, and nw.
2	-bitmap name	Defines the bitmap to display. The available bitmaps in Tk include warning, question, questhead, info, hourglass, error, gray12, gray25, gray50, and gray75.

A simple example for bitmap widget is shown below:

```
#!/usr/bin/wish

canvas .myCanvas -background red -width 100 -height 100
pack .myCanvas
.myCanvas create bitmap 50 50 -bitmap info
```

When we run the above program, we will get the following output:



Tk – Canvas Image Widget

Image widget is used to create a displayed image item. An image can be created from a GIF, PNG, PPM, PGM, or X-Bitmap image. The syntax for image widget is shown below.

```
canvasName create image x y options
```

x and y set the location of a bitmap.

Option

The option available for the image widget are listed below in the following table:

SN	Syntax	Description
1	-image imageName	The variable that holds image to display.

A simple example for image widget is shown below:

```
#!/usr/bin/wish

canvas .myCanvas -background red -width 100 -height 100
pack .myCanvas
set myImage [image create photo]
$myImage read "/Users/myImages/myImage1.png"
.myCanvas create image 50 50 -image $myImage
```

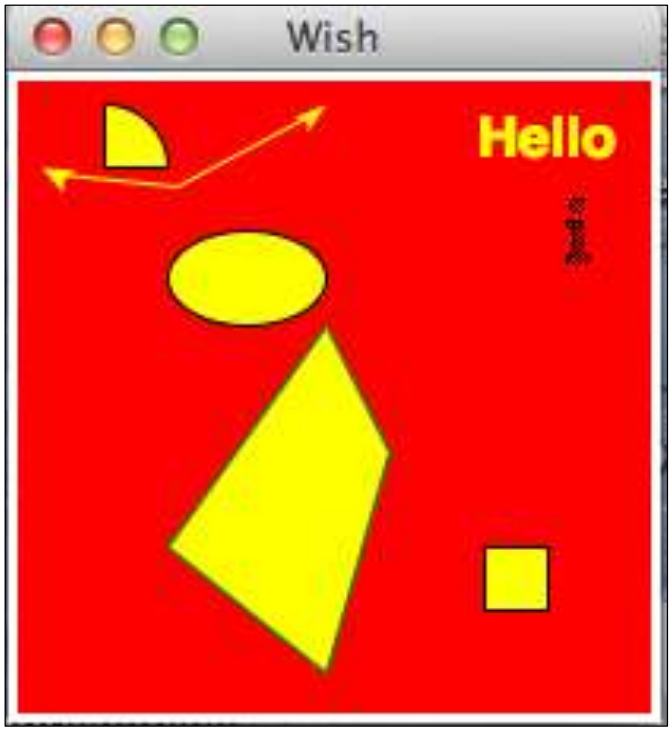
When we run the above program, we will get the following output:

An example using different canvas widgets is shown below:

```
#!/usr/bin/wish

canvas .myCanvas -background red -width 200 -height 200
pack .myCanvas
.myCanvas create arc 10 10 50 50 -fill yellow
.myCanvas create line 10 30 50 50 100 10 -arrow both -fill yellow -smooth true
-splinesteps 2
.myCanvas create oval 50 50 100 80 -fill yellow
```

```
.myCanvas create polygon 50 150 100 80 120 120 100 190 -fill yellow -outline
green

.myCanvas create rectangle 150 150 170 170  -fill yellow

.myCanvas create text 170 20 -fill yellow -text "Hello" -font {Helvetica -18
bold}

.myCanvas create bitmap 180 50 -bitmap info
```

When we run the above program, we will get the following output:



29. Tk – Mega Widgets

Mega widgets include many complex widgets which is often required in some large scale Tk applications. The list of available mega widgets are as shown below:

SN	Widget	Description
1	Dialog	Widget for displaying dialog boxes.
2	Spinbox	Widget that allows users to choose numbers.
3	Combobox	Widget that combines an entry with a list of choices available to the use.
4	Notebook	Tabbed widget that helps to switch between one of several pages, using an index tab.
5	Progressbar	Widget to provide visual feedback to the progress of a long operation like file upload.
6	Treeview	Widget to display and allow browsing through a hierarchy of items more in form of tree.
7	Scrollbar	Scrolling widgets without a text or canvas widgets.
8	Scale	Scale widget to choose a numeric value through sliders.

Tk – Dialog Widget

A dialog widget is used for displaying dialog boxes:

```
tk_dialog window title detailText bitmap default string1 ... stringn
```

The use of each of the above option of the widget is listed below in the following table and they need to be used in the same order:

SN	Syntax	Description
1	window	Determines the name of the top level window for dialog and any existing window by this name is destroyed.
2	title	Title for the widget.
3	detailText	Detail text for the widget.
4	bitmap	Bitmap (in the form suitable for Tk_GetBitmap) to display in the top portion of the dialog, to the left of the text. If this is an empty string then no bitmap is displayed in the dialog. The available bitmaps in Tk include warning, question, questhead, info, hourglass, error, gray12, gray25, gray50, and gray75.
5	default	The index of button to be selected.

6	string1 ... stringn	The strings for buttons and it determines the number of buttons.

A simple example for dialog widget is shown below:

```
#!/usr/bin/wish

set a [tk_dialog .myDialog "myTitle" "myDetail Text" questhead 0 "Yes" "No"]
```

When we run the above program, we will get the following output:

Tk – Spinbox Widget

Spinbox widget allows users to choose numbers or arbitrary values. The syntax for spinbox widget is shown below.

```
spinbox spinboxName options
```

Options

The options available for the spinbox widget are listed below in table.

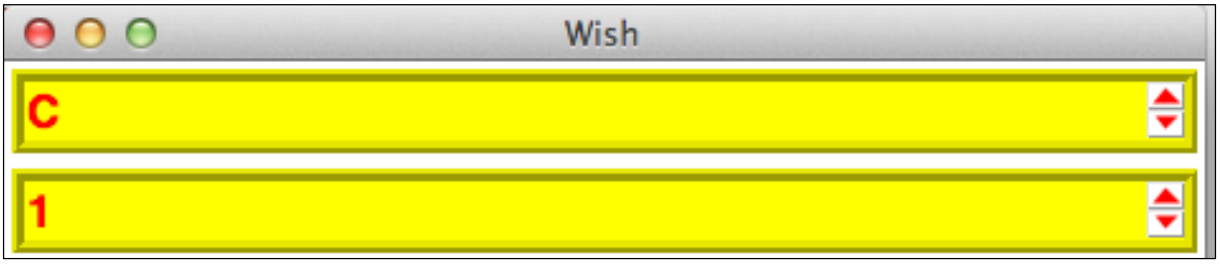
SN	Syntax	Description
1	-background color	Used to set background color for widget.
2	-borderwidth width	Used to draw with border in 3D effects.
3	-font fontDescriptor	Used to set font for widget.
4	-foreground color	Used to set foreground color for widget.
5	-from number	Range start value for spinbox.
6	-increment number	Range increment value for spinbox.
7	-relief condition	Sets the 3D relief for this widget. The condition may be raised, sunken, flat, ridge, solid, or groove.

8	-textvariable varName	Variable associated with the widget. When the text of widget changes, the variable is set to text of widget.
9	-to number	Range end value for spinbox.
10	-values array	Arbitrary values for spinbox widget.
11	-width number	Sets the width for widget.

A simple example for spinbox widget is shown below:

```
#!/usr/bin/wish


set mylist [list C C++ Lua Tcl]

pack [spinbox .s1  -textvariable spinval1 -values $mylist -background yellow -
borderwidth 5 -font {Helvetica -18 bold} -foreground red -width 40  -relief
ridge]

pack [spinbox .s2  -textvariable spinval2 -from 1.0 -to 100.0 -increment 5 -
background yellow -borderwidth 5 -font {Helvetica -18 bold} -foreground red -
width 40  -relief ridge]
```

When we run the above program, we will get the following output:



Tk – Combobox Widget

Combobox widget is a widget that combines an entry with a list of choices available to the use. The syntax for combobox widget is shown below:

```
combobox comboboxName options
```

Options

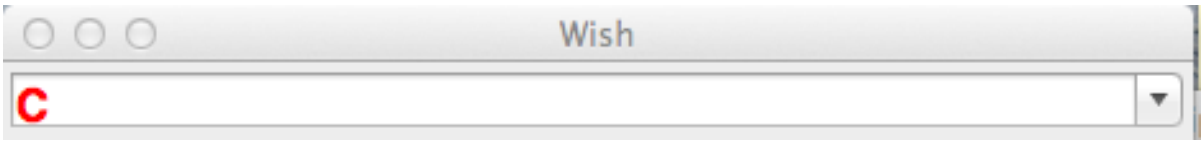
The options available for the combobox widget are listed below in table.

SN	Syntax	Description
1	-background color	Used to set background color for widget.
2	-borderwidth width	Used to draw with border in 3D effects.
3	-font fontDescriptor	Used to set font for widget.
4	-foreground color	Used to set foreground color for widget.
5	-textvariable varName	Variable associated with the widget. When the text of widget changes, the variable is set to text of widget.
6	-values array	Arbitrary values for combobox widget.
7	-width number	Sets the width for widget.
8	-justify alignment	Sets the alignment of text, which can be left, center, or right.
9	-state requiredState	Sets the state, which can be read only, disabled, or normal.
10	-postcommand command	Procedure to be executed post action.

A simple example for combobox widget is shown below:

```
#!/usr/bin/wish


set mylist [list C C++ Lua Tcl]

pack [ttk::combobox .s1  -textvariable combovalue -values $mylist -background
yellow -font {Helvetica -18 bold} -foreground red -width 40 -justify left -
state normal]

set combovalue "C"
```

When we run the above program, we will get the following output:



Tk – Notebook Widget

A tabbed widget that helps to switch between one of several pages, using an index tab. The syntax for notebook widget is shown below.

```
ttk::notebook notebookName options
```

Options

The options available for the notebook widget are listed below in the following table:

SN	Syntax	Description
1	-height number	Used to set height for widget.
2	-width number	Sets the width for widget.

A simple example for notebook widget is shown below:

```
#!/usr/bin/wish

ttk::notebook .n  -width 100 -height 100
ttk::frame .n.f1;
ttk::frame .n.f2;
.n add .n.f1 -text "TabOne"
.n add .n.f2 -text "TabTwo"
pack [label .n.f1.f2 -background red -foreground white -text "TabOne"]
pack [label .n.f2.f2 -background red -foreground white -text "TabTwo"]
pack .n
```

When we run the above program, we will get the following output:

Tk – Progressbar Widget

Progressbar widget is used to provide visual feedback of the progress of a long operation like file upload. The syntax for progressbar widget is shown below:

```
progressbar progressbarName options
```

Options

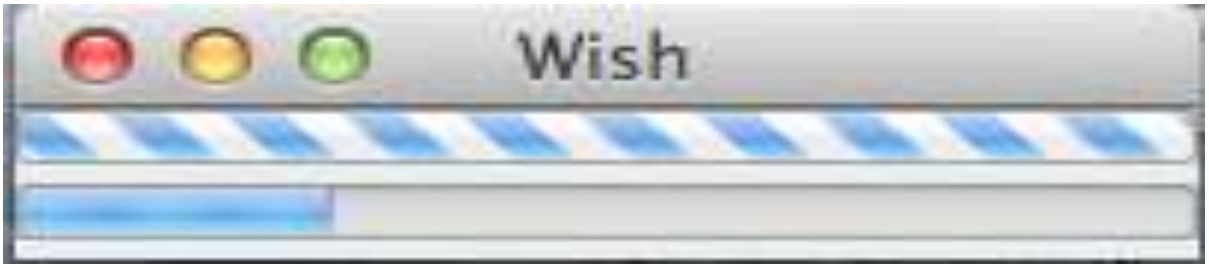
The options available to progressbar widget is listed below in the following table:

SN	Syntax	Description
1	-length number	Sets the length for widget.
2	-maximum number	Set the maximum possible -value. Default is 100.
3	-mode mode	Mode can be indeterminate or determinate.
4	-orien orientation	Sets the orientation for widget. It can be either horizontal or vertical.
5	-value number	The current progress of the progress bar.
6	-variable varName	Variable associated with the widget. When the text of widget changes, the variable is set to text of widget.

A simple example for progressbar widget is shown below.

```
#!/usr/bin/wish


pack [ttk::progressbar .p1 -orient horizontal -length 200 -mode indeterminate -
value 90]
pack [ttk::progressbar .p2 -orient horizontal -length 200 -mode determinate -
variable a -maximum 75 -value 20]
```

When we run the above program, we will get the following output.



Tk – Treeview Widget

Treeview widget is used to choose a numeric value through sliders. The syntax for treeview widget is shown below.

```
treeview treeviewName options
```

Options

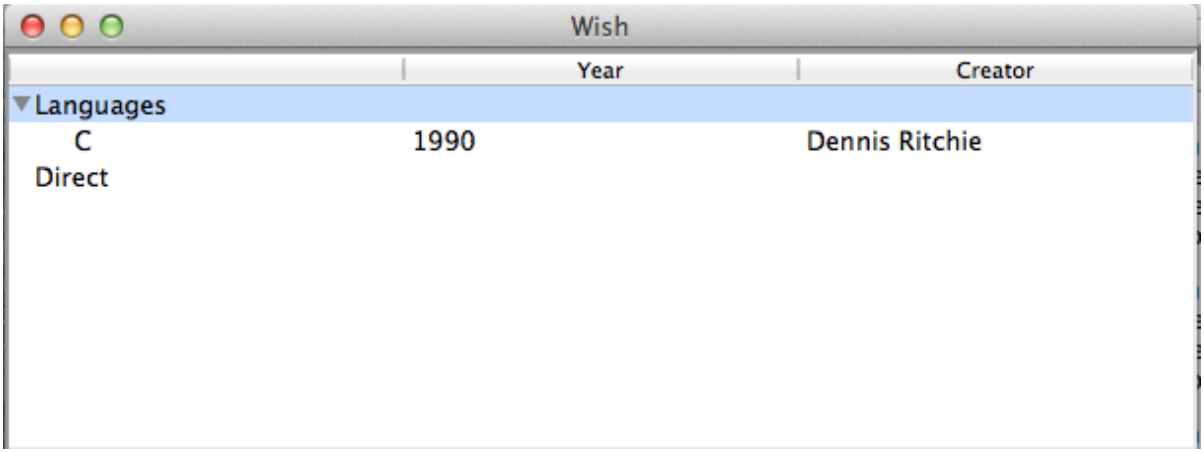
The options available for the treeview widget are listed below in table.

SN	Syntax	Description
1	-columns columnNames	An array of column names for widget.
2	-displaycolumns columns	An array of column names or indices specifying columns to be displayed. Use #all for all.
3	-height number	Height for widget.
4	-selectmode mode	Selection mode which can be extended, browse, or none.

A simple example for treeview widget is shown below.

```
#!/usr/bin/wish

ttk::treeview .tree -columns "Creator Year" -displaycolumns "Year Creator"
.tree heading Creator -text "Creator" -anchor center
.tree heading Year -text "Year" -anchor center
pack .tree
.tree insert {} end -id Languages -text "Languages"
.tree insert Languages end -text C -values [list "Dennis Ritchie" "1990"]
.tree insert "" end -id Direct -text "Direct"
```

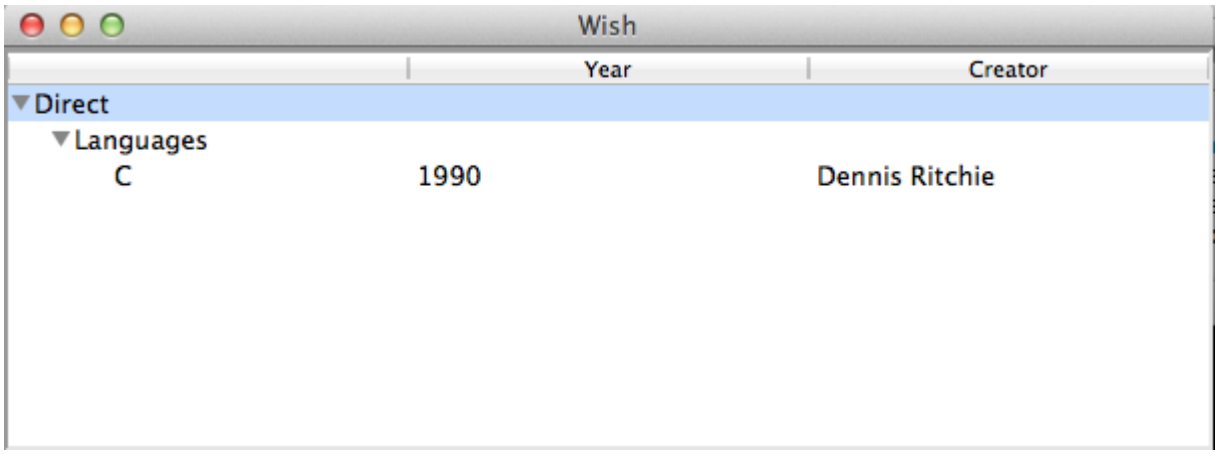
When we run the above program, we will get the following output.



To move the elements, we can use the following command.

```
.tree move Languages Direct end
```

We will get the following output when the above command is executed.



Similarly, we can use the delete command to delete a values from treeview.

Tk – Scrollbar Widget

Scrollbar widget is a scrolling widget that can work without a text or canvas widgets. The syntax for scrollbar widget is shown below.

```
scrollbar scrollbarName options
```

Options

The options available for the scrollbar widget are listed below in table.

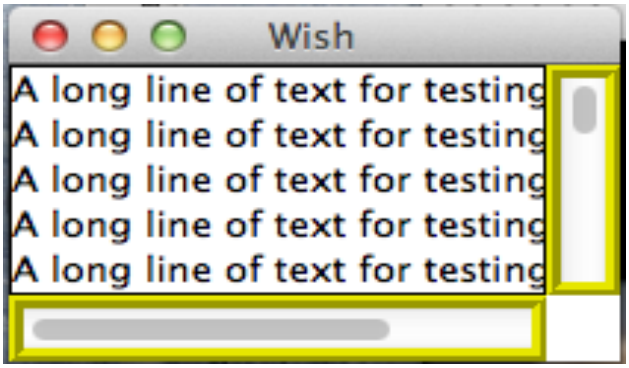
SN	Syntax	Description
1	-background color	Used to set background color for widget.
2	-borderwidth width	Used to draw with border in 3D effects.
3	-orien orientation	Sets the orientation for widget. It can be either horizontal or vertical.
4	-relief condition	Sets the 3D relief for this widget. The condition may be raised, sunken, flat, ridge, solid, or groove.
5	-command command	Command links view to scrollbar widget.

A simple example for scrollbar widget is shown below:

```
#!/usr/bin/wish


grid [tk::listbox .l -yscrollcommand ".s1 set" -xscrollcommand ".s2 set" -
height 5 -width 20] -column 0 -row 0 -sticky nwes

grid [ttk::scrollbar .s1 -command ".l yview" -orient vertical -background
yellow -borderwidth 5 -relief ridge] -column 1 -row 0 -sticky ns
```

```
grid [ttk::scrollbar .s2 -command ".l xview" -orient horizontal -background
yellow -borderwidth 5 -relief ridge] -column 0 -row 1 -sticky ew


for {set index 0} {$index<100} {incr index} {
   .l insert end "A long line of text for testing scrollbar."
}
```

When we run the above program, we will get the following output:



Tk – Scale Widget

Scale widget is used to choose a numeric value through sliders. The syntax for scale widget is shown below:

```
scale scaleName options
```

Options

The options available for the scale widget are listed below in the following table:

SN	Syntax	Description
1	-background color	Used to set background color for widget.
2	-borderwidth width	Used to draw with border in 3D effects.
3	-font fontDescriptor	Used to set font for widget.
4	-foreground color	Used to set foreground color for widget.
5	-from number	Range start value for widget.
6	-variable varName	Variable associated with the widget. When the text of widget changes, the variable is set to text of widget.
7	-length number	Sets the length for widget.
8	-orien orientation	Sets the orientation for widget. It can be either horizontal or vertical.

9	-relief condition	Sets the 3D relief for this widget. The condition may be raised, sunken, flat, ridge, solid, or groove.
10	-to number	Range end value for widget.
11	-command command	Procedure to be executed on action.

A simple example for scale widget is shown below:

```
#!/usr/bin/wish


proc scaleMe {mywidget scaleValue} {
      $mywidget configure -length $scaleValue
}
pack [scale .s2  -from 100.0 -to 200.0 -length 100 -background yellow -
borderwidth 5 -font {Helvetica -18 bold} -foreground red -width 40 -relief
ridge -orien horizontal -variable a -command "scaleMe .s2" ]
```

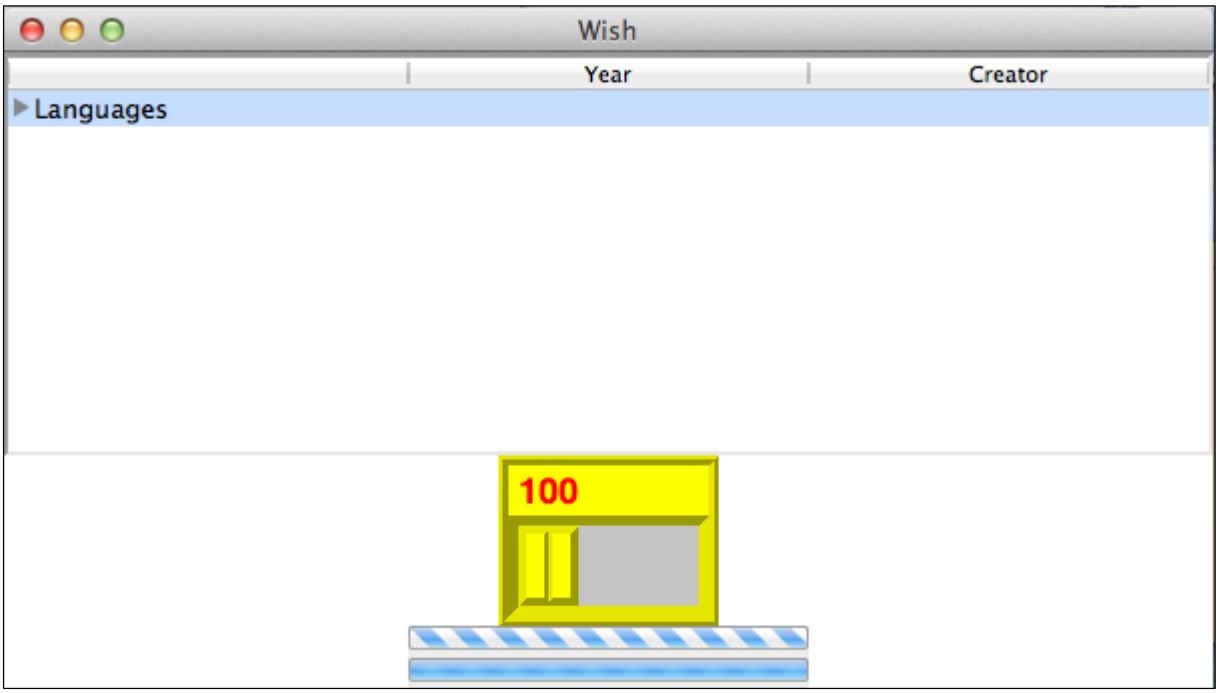
When we run the above program, we will get the following output.

When we scroll the scale to maximum, we will get the following output.

A simple Tk example is shown below using some mega widgets.

```
#!/usr/bin/wish

ttk::treeview .tree -columns "Creator Year" -displaycolumns "Year Creator"
.tree heading Creator -text "Creator" -anchor center
.tree heading Year -text "Year" -anchor center
pack .tree
.tree insert {} end -id Languages -text "Languages"
.tree insert Languages end -text C -values [list "Dennis Ritchie" "1990"]
proc scaleMe {mywidget scaleValue} {
     $mywidget configure -length $scaleValue
}
pack [scale .s2  -from 100.0 -to 200.0 -length 100 -background yellow -
borderwidth 5 -font {Helvetica -18 bold} -foreground red -width 40 -relief
ridge -orien horizontal -variable a -command "scaleMe .s2" ]
pack [ttk::progressbar .p1 -orient horizontal -length 200 -mode indeterminate -
value 90]
pack [ttk::progressbar .p2 -orient horizontal -length 200 -mode determinate -
variable a -maximum 75 -value 20]
```

When we run the above program, we will get the following output:



30. Tk – Fonts

There are a number of widgets that supports displaying text. Most of these provides the option of font attribute. The syntax for creating a font is shown below:

```
font create fontName options
```

Options

The options available for the font create are listed below in the following table:

SN	Syntax	Description
1	-family familyName	The name of font family.
2	-size number	The size of font.
3	-weight level	The weight for font.

A simple example for a font creation is shown below:

```
#!/usr/bin/wish

font create myFont -family Helvetica -size 18 -weight bold
pack [label .myLabel -font myFont -text "Hello World"]
```

When we run the above program, we will get the following output:

To get all the fonts available, we can use the following command:

```
#!/usr/bin/wish

puts [font families]
```

When we run the above command, we will get the following output:

```
{Abadi MT Condensed Extra Bold} {Abadi MT Condensed Light} {Al Bayan} {Al Nile} {Al
Tarikh} {American Typewriter} {Andale Mono} Arial {Arial Black} {Arial Hebrew}
{Arial Narrow} {Arial Rounded MT Bold} {Arial Unicode MS} Athelas Avenir {Avenir
Next} {Avenir Next Condensed} Ayuthaya Baghdad {Bangla MN} {Bangla Sangam MN}
{Baoli SC} Baskerville {Baskerville Old Face} Batang {Bauhaus 93} Beirut {Bell MT}
{Bernard MT Condensed} BiauKai {Big Caslon} {Book Antiqua} {Bookman Old Style}
{Bookshelf Symbol 7} Braggadocio {Britannic Bold} {Brush Script MT} Calibri
{Calisto MT} Cambria {Cambria Math} Candara Century {Century Gothic} {Century
Schoolbook} Chalkboard {Chalkboard SE} Chalkduster {Charcoal CY} Charter Cochin
{Colonna MT} {Comic Sans MS} Consolas Constantia {Cooper Black} Copperplate
{Copperplate Gothic Bold} {Copperplate Gothic Light} Corbel {Corsiva Hebrew}
Courier {Courier New} {Curlz MT} Damascus {DecoType Naskh} Desdemona {Devanagari
MT} {Devanagari Sangam MN} Didot {DIN Alternate} {DIN Condensed} {Diwan Kufi}
{Diwan Thuluth} {Edwardian Script ITC} {Engravers MT} {Euphemia UCAS} Eurostile
Farah Farisi {Footlight MT Light} {Franklin Gothic Book} {Franklin Gothic Medium}
Futura Gabriola Garamond {GB18030 Bitmap} {Geeza Pro} Geneva {Geneva CY} Georgia
{Gill Sans} {Gill Sans MT} {Gloucester MT Extra Condensed} {Goudy Old Style}
{Gujarati MT} {Gujarati Sangam MN} Gulim GungSeo {Gurmukhi MN} {Gurmukhi MT}
{Gurmukhi Sangam MN} Haettenschweiler {Hannotate SC} {Hannotate TC} {HanziPen SC}
{HanziPen TC} Harrington HeadLineA Hei {Heiti SC} {Heiti TC} Helvetica {Helvetica
CY} {Helvetica Neue} Herculanum {Hiragino Kaku Gothic Pro} {Hiragino Kaku Gothic
ProN} {Hiragino Kaku Gothic Std} {Hiragino Kaku Gothic StdN} {Hiragino Maru Gothic
Pro} {Hiragino Maru Gothic ProN} {Hiragino Mincho Pro} {Hiragino Mincho ProN}
{Hiragino Sans GB} {Hoefler Text} Impact {Imprint MT Shadow} InaiMathi {Iowan Old
Style} Kai Kailasa {Kaiti SC} {Kaiti TC} {Kannada MN} {Kannada Sangam MN} Kefa
{Khmer MN} {Khmer Sangam MN} {Kino MT} Kokonor Krungthep KufiStandardGK {Lantinghei
SC} {Lantinghei TC} {Lao MN} {Lao Sangam MN} {Libian SC} {LiHei Pro} {LiSong Pro}
{Lucida Blackletter} {Lucida Bright} {Lucida Calligraphy} {Lucida Console} {Lucida
Fax} {Lucida Grande} {Lucida Handwriting} {Lucida Sans} {Lucida Sans Typewriter}
{Lucida Sans Unicode} {Malayalam MN} {Malayalam Sangam MN} Marion {Marker Felt}
Marlett {Matura MT Script Capitals} Meiryo Menlo {Microsoft Sans Serif} Mishafi
Mistral {Modern No. 20} Monaco {MS Gothic} {MS Mincho} {MS PGothic} {MS PMincho}
{MS Reference Sans Serif} {MS Reference Specialty} Mshtakan {MT Extra} Muna
{Myanmar MN} {Myanmar Sangam MN} Nadeem {Nanum Brush Script} {Nanum Gothic} {Nanum
Myeongjo} {Nanum Pen Script} {New Peninim MT} {News Gothic MT} Noteworthy Onyx
Optima {Oriya MN} {Oriya Sangam MN} Osaka Palatino {Palatino Linotype} Papyrus
PCMyungjo Perpetua {Perpetua Titling MT} PilGi {Plantagenet Cherokee} Playbill
PMingLiU {PT Mono} {PT Sans} {PT Sans Caption} {PT Sans Narrow} {PT Serif} {PT
Serif Caption} Raanana Rockwell {Rockwell Extra Bold} Sana Sathu {Savoye LET}
Seravek Silom SimSun {Sinhala MN} {Sinhala Sangam MN} Skia {Snell Roundhand}
{Songti SC} {Songti TC} Stencil STFangsong STHeiti STIXGeneral STIXIntegralsD
STIXIntegralsSm STIXIntegralsUp STIXIntegralsUpD STIXIntegralsUpSm STIXNonUnicode
STIXSizeFiveSym STIXSizeFourSym STIXSizeOneSym STIXSizeThreeSym STIXSizeTwoSym
STIXVariants STKaiti STSong Superclarendon Symbol Tahoma {Tamil MN} {Tamil Sangam
MN} TeamViewer8 {Telugu MN} {Telugu Sangam MN} Thonburi Times {Times New Roman}
{Trebuchet MS} {Tw Cen MT} Verdana Waseem {Wawati SC} {Wawati TC} Webdings {Weibei
SC} {Weibei TC} {Wide Latin} Wingdings {Wingdings 2} {Wingdings 3} {Xingkai SC}
{Yuanti SC} YuGothic YuMincho {Yuppy SC} {Yuppy TC} {Zapf Dingbats} Zapfino {Apple
Braille} {Apple Chancery} {Apple Color Emoji} {Apple LiGothic} {Apple LiSung}
{Apple SD Gothic Neo} {Apple Symbols} AppleGothic AppleMyungjo {Monotype Corsiva}
{Monotype Sorts}
```

31. Tk – Images

The image widget is used to create and manipulate images. The syntax for creating image is as follows:

```
image create type name options
```

In the above syntax type is photo or bitmap and name is the image identifier.

Options

The options available for image create are listed below in the following table:

SN	Syntax	Description
1	-file fileName	The name of the image file name.
2	-height number	Used to set height for widget.
3	-width number	Sets the width for widget.
4	-data string	Image in base 64 encoded string.

A simple example for image widget is shown below:

```
#!/usr/bin/wish


image create photo imgobj -file "/Users/rajkumar/Desktop/F
Drive/pictur/vb/Forests/680049.png" -width 400 -height 400

pack [label .myLabel]

.myLabel configure -image imgobj
```

When we run the above program, we will get the following output:

The available function for image are listed below in the following table:

SN	Syntax	Description
1	image delete imageName	Deletes the image from memory and related widgets visually.
2	image height imageName	Returns the height for image.
3	image width imageName	Returns the width for image.
4	image type imageName	Returns the type for image.
5	image names	Returns the list of images live in memory.

A simple example for using the above image widget commands is shown below:

```
#!/usr/bin/wish


image create photo imgobj -file "/Users/rajkumar/images/680049.png" -width 400
-height 400

pack [label .myLabel]

.myLabel configure -image imgobj

puts [image height imgobj]

puts [image width imgobj]

puts [image type imgobj]

puts [image names]

image delete imgobj
```

The image will be deleted visually and from memory once "image delete imgobj" command executes. In console, the output will be like the following:

```
400

400

photo

imgobj ::tk::icons::information ::tk::icons::error ::tk::icons::warning
::tk::icons::questi
```

32. Tk – Events

Events in its simplest form is handled with the help of commands. A simple example for event handling is event handling with button and is shown below:

```
#!/usr/bin/wish

proc myEvent { } {
puts "Event triggered"
}
pack [button .myButton1  -text "Button 1"   -command myEvent]
```

When we run the above program, we will get the following output:

A simple program to show delay text animation event is shown below:

```
#!/usr/bin/wish

proc delay {} {
 for {set j 0} {$j < 100000} {incr j} {
   }
}
label .myLabel -text "Hello................" -width 25
pack .myLabel
set str "Hello................"
for {set i [string length $str]} {$i > -2} {set i [expr $i-1]} {
   .myLabel configure -text [string range $str 0 $i]
   update
   delay
}
```

When we run the program, we will get the following output in animated way:

Event after Delay

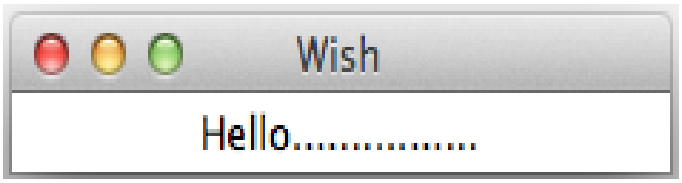
The syntax for event after delay is shown below:

```
after milliseconds number command
```

A simple program to show after delay event is shown below:

```
#!/usr/bin/wish

proc addText {} {
 label .myLabel -text "Hello.............." -width 25
 pack .myLabel
}
after 1000 addText
```

When we run the program, we will get the following output after one second:



You can cancel an event using the after cancel command as shown below:

```
#!/usr/bin/wish

proc addText {} {
 label .myLabel -text "Hello.............." -width 25
 pack .myLabel
}
after 1000 addText
after cancel addText
```

Event Binding

The syntax for event binding is as shown below:

```
bind arguments
```

Keyboard Events Example

```
#!/usr/bin/wish

bind .  {puts "Key Pressed: %K "}
```

When we run the program and press a letter X, we will get the following output:

```
Key Pressed: X
```

Mouse Events Example

```
#!/usr/bin/wish

bind .  {puts "Button %b Pressed : %x %y "}
```

When we run the program and press the left mouse button, we will get an output similar to the following:

```
Button 1 Pressed : 89 90
```

Linking Events with Button Example

```
#!/usr/bin/wish

proc myEvent { } {
puts "Event triggered"
}
pack [button .myButton1  -text "Button 1"   -command myEvent]
bind .  ".myButton1 invoke"
```

When we run the program and press enter, we will get the following output:

```
Event triggered
```

33. Tk – Windows Manager

Window manager is used to handle the top level window. It helps in controlling the size, position, and other attributes of the window. In Tk, . is used to refer the main window. The syntax for window command is shown below:

```
wm option window arguments
```

The list of options available for Tk wm command is shown in the following table:

SN	Syntax	Description
1	aspect windowName a b c d	Tries to maintain the ratio of width/height to be between a/b and c/d.
2	geometry windowName geometryParams	Use to set geometry for window.
3	grid windowName w h dx dy	Sets the grid size.
4	group windowName leaderName	leaderName gives the leader of a group of related windows.
5	deiconify windowName	Brings the screen to normal if minimized.
6	iconify windowName	Minimizes the window.
7	state windowName	Returns the current state of window.
8	withdraw windowName	Unmaps the window and removes its details in memory.
9	iconbitmap windowName image	Sets or returns the icon bitmap.
10	iconPhoto windowName image	Sets or returns the icon photo.
11	command windowName commandString	Records the startup command in the WM_COMMAND property.
12	protocol windowName arguments	Register a command to handle the protocol request name, which can be WM_DELETE_WINDOW, WM_SAVE_YOURSELF, WM_TAKE_FOCUS. Eg: wm protocol . WM_DELETE_WINDOW Quit.
13	minsize windowName size	Determines the minimum window size.
14	maxsize windowName size	Determines the maximum window size.

15	title windowName titleText	Determines the title for window.
16	attributes subOptions	There are lots of attributes available like alpha, full screen and so on.

Some of the above commands are used in the following example:

```
#!/usr/bin/wish

wm maxsize . 800 800
wm minsize . 300 300
wm title . "Hello"
wm attributes . -alpha ".90"
wm geometry . 300x200+100+100
```

When we run the above program, we will get the following output:

As you can see alpha is one of the attributes available. The list of commonly used subcommands are listed below:

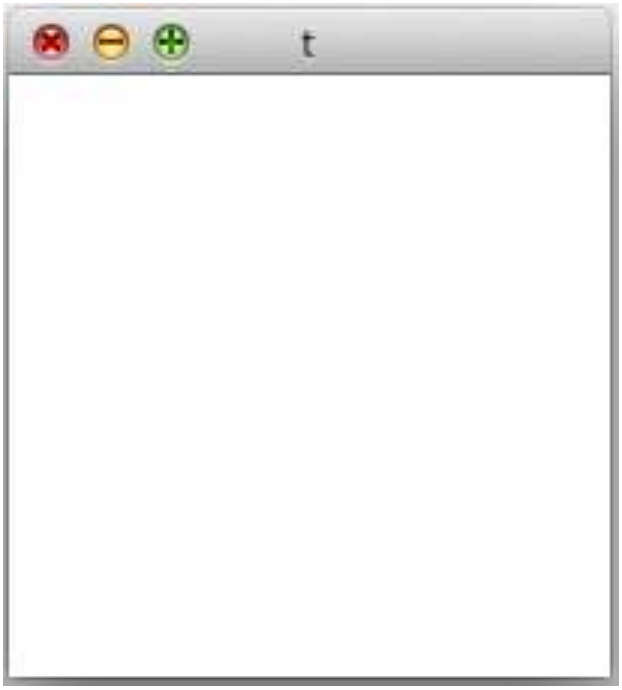
SN	Syntax	Description
1	-alpha number	Sets the alpha for window.
2	-fullscreen number	Number can be 0 for normal screen or 1 for full screen.
3	-topmost number	Sets or returns whether window is topmost.Value can be 0 or 1.

Creating Window

We can use top level command to create a window and an example is shown below:

```
#!/usr/bin/wish

toplevel .t
```

When we run the above program, we will get the following output:



Destroying Window

We can use destroy command to destroy a window and an example is shown below:

```
#!/usr/bin/wish

destroy .t
```

The above command will destroy window named **.t.**

34. Tk – Geometry Manager

The geometry manager is used to manage the geometry of the window and other frames. We can use it to handle the position and size of the window and frames. The **layout widgets** are used for this purpose.

Positioning and Sizing

The syntax for positioning and sizing window is shown below:

```
wm geometry . wxh+/-x+/-y
```

Here, w refers to width and h refers to height. It is followed by a '+' or '−' sign with number next referring to the x position on screen. Similarly the following '+' or '−' sign with number refers to the y position on screen

A simple example is shown below for the above statement:

```
#!/usr/bin/wish

wm geometry . 300x200+100+100
```

When we run the above program, we will get the following output:

Grid Geometry

The syntax for grid geometry is shown below:

```
grid gridName -column number -row number -columnspan number -rowspan number
```

The column, row, columnspan, or rowspan helps in providing the grid geometry.

A simple example is shown below for the above statement:

```
#!/usr/bin/wish

frame .myFrame1 -background red  -height 100 -width 100
frame .myFrame2 -background blue -height 100 -width 50
grid .myFrame1 -columnspan 10 -rowspan 10 -sticky w
grid .myFrame2 -column 10 -row 2
```

When we run the above program, we will get the following output: