UNIT 4

TCL/ TK SCRIPTING: Tcl Fundamentals, String and Pattern Matching, Tcl Data Structures ,Control Flow Commands, Procedures and Scope , Evel, Working With UNIX, Reflection and Debugging, Script Libraries, Tk Fundamentals ,Tk by Examples, The Pack Geometry Manager, Binding Commands to X Events, Buttons and Menus, Simple Tk Widgets, Entry and Listbox Widgets Focus, Grabs and Dialogs

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.

Tcl - Environment Setup

Try it Option Online

We have set up the Tcl/Tk Programming environment online, so that you can compile and execute all the available examples online. It gives you confidence in what you are reading and enables you to verify the programs with different options. Feel free to modify any example and execute it online.

Try the following example using our online compiler available at

```
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 −

- Text Editor
- 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.

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.

S.No.	Special Variable & Description
1	**argc** Refers to a number of command-line arguments.
2	**argv** Refers to the list containing the command-line arguments.
3	**argv0** Refers to the file name of the file being interpreted or the name by which we invoke the script.
4	**env** Used for representing the array of elements that are environmental variables.
5	**errorCode** Provides the error code for last Tcl error.
6	**errorInfo** Provides the stack trace for last Tcl error.
7	**tcl_interactive** Used to switch between interactive and non-interactive modes by setting this to 1 and 0 respectively.
8	**tcl_library** Used for setting the location of standard Tcl libraries.
9	**tcl_pkgPath** Provides the list of directories where packages are generally installed.

10	**tcl_patchLevel** Refers to the current patch level of the Tcl interpreter.
11	**tcl_platform** Used for representing the array of elements with objects including byteOrder, machine, osVersion, platform, and os.
12	**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.
13	**tcl_prompt1** Refers to the primary prompt.
14	**tcl_prompt2** Refers to the secondary prompt with invalid commands.
15	**tcl_rcFileName** Provides the user specific startup file.
16	**tcl_traceCompile** Used for controlling the tracing of bytecode compilation. Use 0 for no output, 1 for summary, and 2 for detailed.
17	**tcl_traceExec** Used for controlling the tracing of bytecode execution. Use 0 for no output, 1 for summary, and 2 for detailed.
18	**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 −

```
8.6
```

Tcl Environment Path

```
#!/usr/bin/tclsh

puts $env(PATH)
```

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

```
/home/cg/root/GNUstep/Tools:/usr/GNUstep/Local/Tools:/usr/GNUstep/System/Tools:/usr/local/bin:/usr/bin:/usr/local/sbin:/usr/sbin:/home/webmaster/.local/bin:/home/webmaster/bin:/usr/local/scriba/bin:/usr/local/smlnj/bin:/usr/local/bin/std:/usr/local/bin/extra:/usr/local/fantom/bin:/usr/local/dart/bin:/usr/bin:/usr/local/bin:/usr/local/sbin:/usr/sbin:/opt/mono/bin:/opt/mono/lib/mono/4.5:/usr/local/bin:.:/usr/libexec/sdcc:/usr/local/icon-v950/bin:/usr/local/mozart/bin:/opt/Pawn/bin:/opt/jdk1.7.0_75/bin:/opt/jdk1.7.0_75/jre/bin:/opt/pash/Source/PashConsole/bin/Debug/
```

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/tcl8.6 /usr/share/tcl8.6 /usr/lib64/tk8.6 /usr/share/tk8.6
```

Tcl Library

```
#!/usr/bin/tclsh

puts $tcl_library
```

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

```
/usr/share/tcl8.6
```

Tcl Patch Level

```
#!/usr/bin/tclsh

puts $tcl_patchLevel
```

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

```
8.6.3
```

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
```

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!"
```

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

```
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!"
```

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

```
Hello World!
```

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

```
#!/usr/bin/tclsh

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

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

```
Hello World!
```

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
```

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

```
5
```

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.

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 the 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 the following result −

```
Hello
World
```

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]
```

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
```

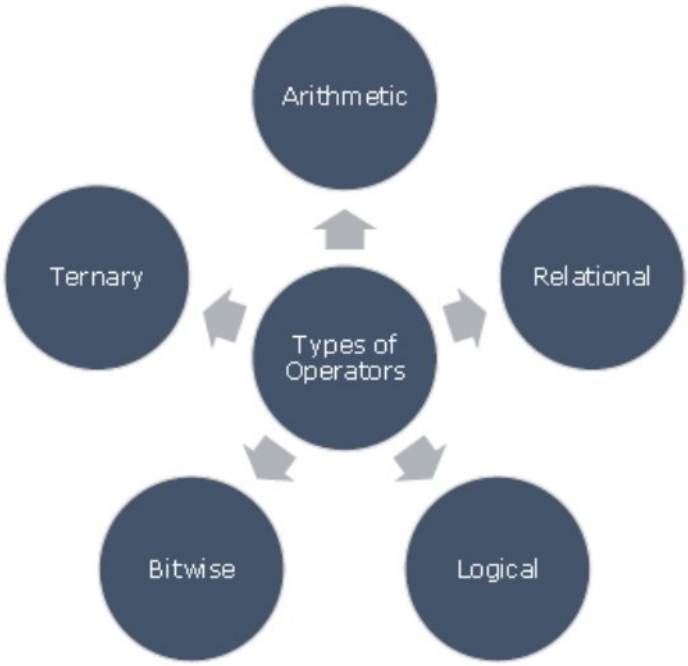
When the above code is executed, it produces the following result −

```
1.1111
```

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 −

Show Examples

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

Relational Operators

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

Show Examples

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.

Logical Operators

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

Show Examples

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.

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 −

Show Examples

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

Ternary Operator

Show Examples

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

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.

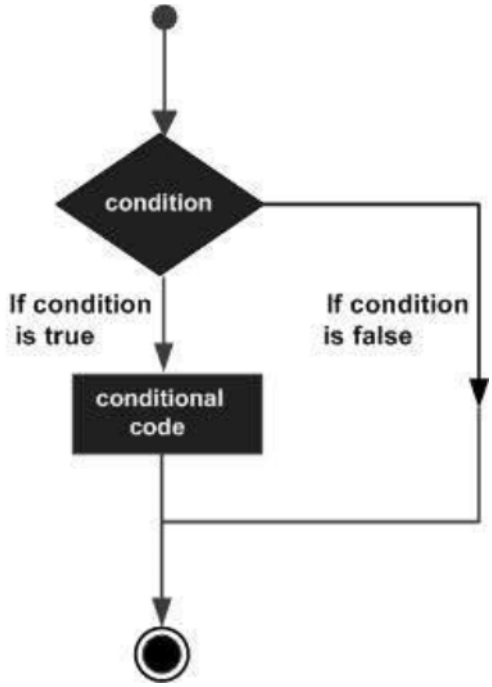
Here, operators with the highest precedence appear at the top of the table, those with the lowest appear at the bottom. Within an expression, higher precedence operators will be evaluated first.

Show Examples

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

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 −

S.No.	Statement & Description
1	**if statement** An 'if' statement consists of a Boolean expression followed by one or more statements.
2	**if...else statement** An 'if' statement can be followed by an optional 'else' statement, which executes when the Boolean expression is false.
3	**nested if statements** You can use one 'if' or 'else if' statement inside another 'if' or 'else if' statement(s).

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

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 −

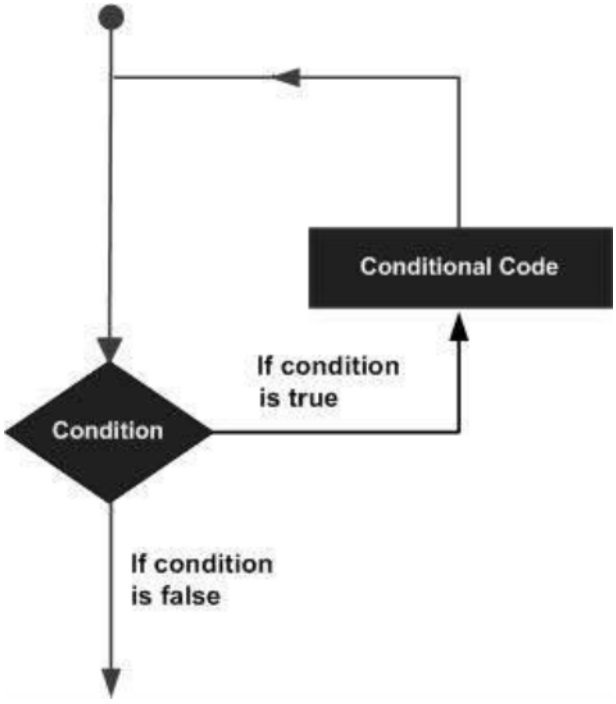
```
Value of b is 30
Value of b is 20
```

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.

S.No.	Loop Type & Description
1	**while loop** Repeats a statement or group of statements while a given condition is true. It tests the condition before executing the loop body.
2	**for loop** Executes a sequence of statements multiple times and abbreviates the code that manages the loop variable.
3	**nested loops** You can use one or more loop inside any another while, for or do..while loop.

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.

S.No.	Control Statement & Description

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

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.

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
```

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 −

S.No.	Methods & Description
1	**compare** string1 string2 Compares string1 and string2 lexographically. Returns 0 if equal, -1 if string1 comes before string2, else 1.
2	**first** 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 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
```

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
```

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
```

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

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

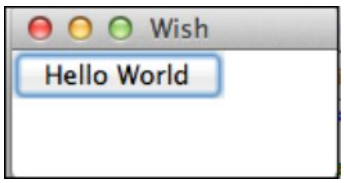
Most Linux operating systems comes with Tk inbuilt and you can get started right away in those systems. In case, it's not available, you can use the following command to download and install Tcl-Tk.

```
$ 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

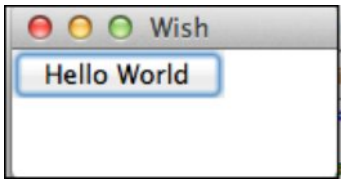
Download the latest version for Mac OS X package from the list of Active Tcl/Tk binaries available. Active Tcl community edition is free for personal use.

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.

Tk - Special Variables

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

S.No.	Special Variable & Description
1	**tk_library** Used for setting the location of standard Tk libraries.

2	**tk_patchLevel** Refers to the current patch level of the Tk interpreter.
3	**tk_strictMotif** When non-zero, Tk tries to adhere to Motif look-and-feel as closely as possible.
4	**tk_version** Displays the Tk version.

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

Examples for using Tk special variables

Lets see the examples for special variables.

TK VERSION

```
#!/usr/bin/wish

puts $tk_version
```

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

```
8.5
```

TK LIBRARY PATH

```
#!/usr/bin/wish

puts $tk_library
```

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

```
/Library/Frameworks/Tk.framework/Versions/8.6/Resources/Scripts
```

TK PATCH LEVEL

```
#!/usr/bin/wish

puts $tk_patchLevel
```

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

```
8.6.1
```

TK STRICTMOTIF

```
#!/usr/bin/wish


puts $tk_strictMotif
```

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

```
0
```

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 −

S.No.	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**

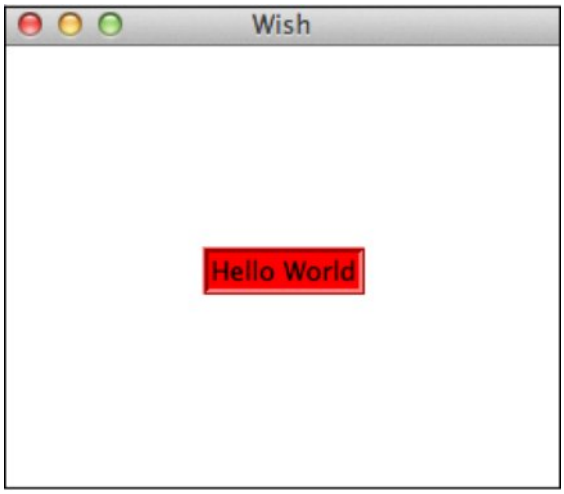
	Used to set the color rectangle to draw around a widget when the widget has input focus.
8	**-padx number** Sets the padx for the widget.
9	**-pady number** Sets the pady for the widget.
10	**-relief condition** Sets the 3D relief for this widget. The condition may be raised, sunken, flat, ridge, solid, 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

S.No.	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

S.N.	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

S.No.	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

S.No.	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

S.No.	Widget & Description
1	**Canvas** Drawing widget for displaying graphics and images..

Tk - Basic Widgets

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

S.No.	Widgets & 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** Widget used to create a frame that is a new top level window.

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 −

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 −

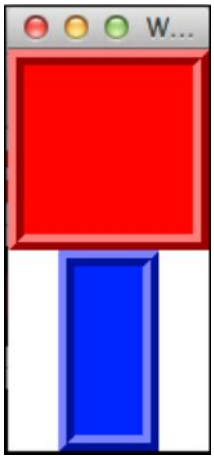
S.No.	Widgets & Description
1	**Frame** Container widget to hold other widgets.
2	**Place** Widget to hold other widgets in specific place with coordinates of its origin and an exact size.
3	**Pack** Simple widget to organize widgets in blocks before placing them in the parent widget.
4	**Grid** Widget to nest widgets packing in different directions.

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 −



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.

S.No.	Widgets & 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.

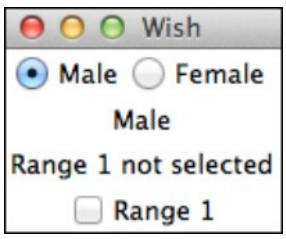
3	**Menu** Widget that acts as holder for menu items.
4	**Listbox** Widget that displays a list of cells, one or more of which may be selected.

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 −



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 −

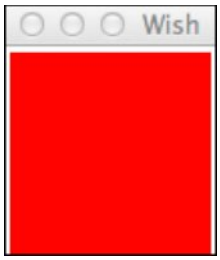
S.No.	Syntax & Description
1	**-background color** Used to set background color for widget.
2	**-closeenough distance** Sets the closeness of mouse cursor to a displayable item. The default is 1.0 pixel. This value may be a fraction and must be positive.
3	**-scrollregion boundingBox** The bounding box 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 −

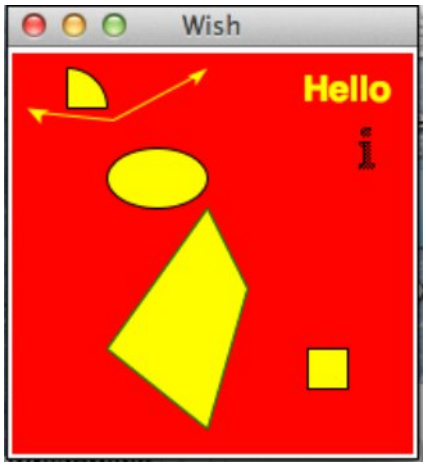
S.No.	Widget & Description
1	**Line** Draws a line.
2	**Arc** Draws an arc.
3	**Rectangle** Draws a rectangle.
4	**Oval** Draws an oval.
5	**Polygon** Draws a polygon.
6	**Text** Draws a text.
7	**Bitmap** Draws a bitmap.
8	**Image** Draws an image.

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 −



Tk - Fonts

here 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 −

S.No.	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}
```

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 −

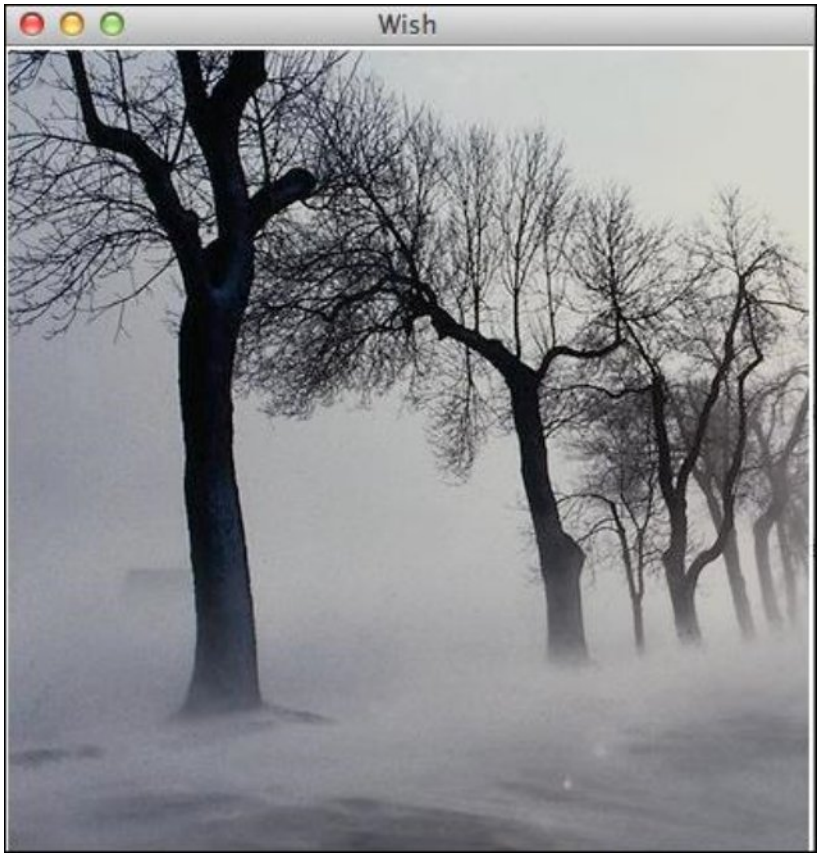
S.No.	Syntax & Description
1	**-file fileName** The name of the image file name.
2	**-height number** Used to set height for widget.
3	**-width number** Sets the width for widget.
4	**-data string** Image in base 64 encoded string.

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 −

S.No.	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::question
```

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 −

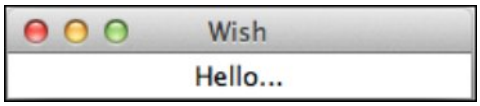
A simple program to show delay text animation event is shown below −

```
#!/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
```

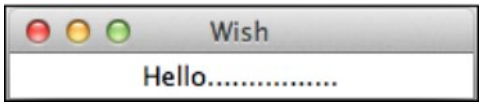
A simple program to show after delay event is shown below −

```
#!/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
```