22.   Modularity and the Naming of Symbols

2016-06-27

```
$Version
```

```
10.0 for Mac OS X x86 (64-bit) (September 10, 2014)
```

Mathematica normally assumes that all the variables one introduces are global. There are exceptions in loops. However, in functions definitions, the variables listed at the left hand side of the definition marked by an underscore must be free of assignments;
otherwise the assignmment is taken over into the function definition as for example:

```
x = Pi;
```

```
f[x_] = Sin[a x]
```
Sin[a π]

```
f[y]
```
Sin[a π]

```
Clear[f, x]
f[x_] = Sin[a x]
```
Sin[a x]

```
f[y]
```
Sin[a y]

```
x = Pi;
Sum[x, {x,3}]
```
6

```
x
```
π

```
x
```
π

It is often desirable to have local variables or values in different parts of a *Mathematica* program. This can be accomplished by **Module**, **Block** and **Contexts.**

22.1   Modules and Local Variables

Module[{x,y,...}, *body*]	a module with local variables **x,y** ...

Variables contained in the list at the beginning of **Module** are local. Below the global variable **t** is assigned the value **17**. It keeps this value as the name **t** is used in the **Module.** This **t** is a completely independent variable local to the **Module.**

```
t = 17
```
17

```
Module[{t}, t = 8; Print[t] ]
```
8

```
t
```
17

```
Remove[f,v,a,b]
```

```
f[v_] := Module[{t}, t = (1 + v)^2; Expand[t] ]
```

```
f[a + b]
```

$1 + 2 a + a^2 + 2 b + 2 a b + b^2$

```
t
```

17

```
Expand[ (1 + t)^3 ]
```

5832

```
FullForm[%]
```

5832

```
Head[%%]
```

Integer

```
t
```

17

```
Length[ Expand[ (1 + t)^3 ] ]
```

0

```
Module[ {t},  Length[ Expand[ (1 + t)^3 ] ] ]
```

4

```
fac3[k_] :=
Module[{f,n}, f[1]= 1; f[n_] := k + n f[n -1]; f[3] ]
```

```
fac3[0]
```

6

This value results from the recursion defined above:

f[3] = 0 + 3 f[2] = 3 (0 + 2 f[1]) = 3 2 1 = 6

```
fac3[Pi]
```

$\pi + 3 \ (2 + \pi)$

```
p = 33
```

33

```
Module[ {t},   t = 8 + p; Print[t] ]
```

41

```
Module[ {t,p}, t = 8 + p; Print[t] ]
```

$8 + p\$498$

```
p
```

33

```
Module{ {x = x0, y = y0, ...}, body]
```

a module with initial values for local variables

If any of the variables occuring in left hand parts of the list of has been assigned a global value this may shadow the value at the corresponding right hand side.

```
t = 17
```

17

```
facn[u_] := Module[ {t = u}, f[1] = 1;
                     f[n_] := t + n f[n-1]; f[3] ]
```

```
facn[Pi]
```

$\pi + 3 \ (2 + \pi)$

The following function contains a command in C++. *Mathematica* understands and executes this since *Mathematica* itself is programmed in C.

```
Clear[g]; Remove[g];
g[u_] := Module[ {t = u}, t += t/(1 + u) ]
```

```
g[a]
```

$a + \dfrac{a}{1 + a}$

```
Module[ {t = 6, u = t}, u^2]
```

289

```
17^2
```

289

The global value for **t** is taken as initial value, even though **t** is declared local !

22.1.1 How Modules Work

Modules generate symbols with names of the form **x$nnn** to represent each local variable. **nnn** is increased by unity each time **Module** is called.

```
Module[ {t}, Print[t] ]
```

t$502

```
Module[ {t,u}, Print[t]; Print[u] ]
```

t$503

u$503

```
$ModuleNumber
```

504

```
t
```

17

```
Module[ {t,u}, Print[t]; Print[u] ]
```

t$504

u$504

22.2 Blocks and Local Variables

Modules in *Mathematica* allow one to treat the names as local. When one uses **Block** then the **names** are **global,** but the **values** are **local.**

Block[{x,y,...}, *body*] evaluate *expr* using local values for **x,y,** …

Block[{x=x0,y=y0,...}, *body*] assign initial values to **x,y;** and evaluate … as above

Block[] is automatically used to localize values of iterators in iteration constructs such as **Do**, **Sum** and **Table**.

Block[] may be used to pack several expressions into one unity.

```
Clear[x,t,a]
```

```
x^2 + 3
```

$3 + x^2$

```
Block[ {x = a + 1}, %]
```

$3 + (1 + a)^2$

```
x
```

x

```
t = 17
```

17

```
Module[ {t}, Print[t] ]
```

t$505

```
t
```

17

```
Block[ {t}, Print[t] ]
```

t

```
la = {33, 17};
```

```
Block[ {t}, Print[la[[1]] t^2 + la[[2]] t + 7]]
```

$7 + 17 t + 33 t^2$

```
%
```

```
Block[ {t}, la[[1]] t^2 + la[[2]] t + 7]
```

9833

```
la[[1]] t^2 + la[[2]] t + 7
```

9833

```
Block[ {}, Print[la[[1]] t^2 + la[[2]] t + 7]]
```

9833

```
Block[ {t = 6}, Print[la[[1]] t^2 + la[[2]] t + 7]]
```
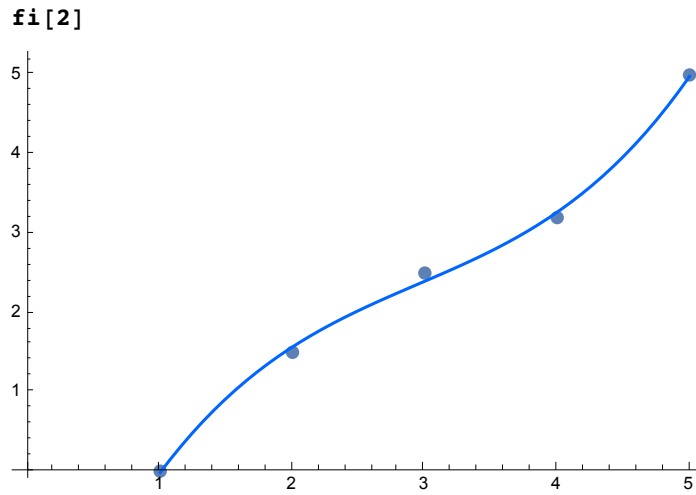
1297

```
t
```

17

```
Block[ {t}, t = 6; la[[1]] t^2 + la[[2]] t + 7]
```

1297

```
t
```

17

```
li1 = {1.1, 2.2, 3.5, 4.3};
li2 = {0, 1.5, 2.5, 3.2, 5};
li = {li1, li2};
```

```
fi[nnn_] := Block[{t}, gr1 = ListPlot[li[[nnn]]];
  gf = Fit[li[[nnn]], {1, t, t^2, t^3}, t];
  gr2 = Plot[gf, {t, 1, 5}, PlotStyle → Hue[nnn 0.3`]];
  Show[gr1, gr2]]
```

fi[2]

t

17

Block   allows to set up "environments" in which the values of variables may be changed temporarily. Expressions being evaluated at any point during the execution of a block will use the values of the variables currently defined for variables in the block. This is true wether the expressions appear directly as part of the body of the block, or are produced at any point in its evaluation.

t

17

Clear[u,x]; u := x^2 + t^2

u

$289 + x^2$

Block[{t = 5}, u + 7]

$32 + x^2$

x^2 + 25 + 7

$32 + x^2$

u

$289 + x^2$

Block[{t = 5, u}, u + 7]

$296 + x^2$

Block[{t = 5}, u + 7]

$32 + x^2$

Block[{t}, u + 7]

$296 + x^2$

x^2 + 17^2 + 7

$296 + x^2$

u

$289 + x^2$

Module[{t = 5}, u + 7]

$296 + x^2$

```
Module[ {t,u}, u + 7 ]
```
7 + u$663

```
Module[ {t = 2, u}, u + 7 ]
```
7 + u$664

```
t = 17
```
17

```
Expand[(1 + t)^3]
```
5832

```
Length[Expand[(1 + t)^3] ]
```
0

```
Expand[(1 + t)^3] //FullForm
```
5832

```
Head[%]
```
Integer

```
Module[ {t}, Length[Expand[(1 + t)^3]]  ]
```
4

```
Expand[ (1 + x)^3] //FullForm
```
Plus[1, Times[3, x], Times[3, Power[x, 2]], Power[x, 3]]

```
Block[ {t}, Length[Expand[(1 + t)^3]] ]
```
4

```
Module[ {t}, Expand[(1 + t)^3]  ] //FullForm
```
Plus[1, Times[3, t$666], Times[3, Power[t$666, 2]], Power[t$666, 3]]

```
Block[ {t}, Expand[(1 + t)^3]  ] //FullForm
```
5832

```
Block[ {x}, Expand[(1 + x)^3]  ] //FullForm
```

Plus[1, Times[3, x], Times[3, Power[x, 2]], Power[x, 3]]

```
Block[{x = t}, Expand[(1 + x)^3]  ] //FullForm
```
5832

22.3   Contexts

The mechanism that *Mathematica* provides for keeping the variables used in a package different from those used in the main session is called contexts. As each symbol is read from the terminal or from a file *Mathematica* checks to see whether this symbol has already been used before. If it has been encountered before, the new instance is made to refer to that previously defined. If the symbol has not been encountered before, a new entry in the symbol table is created.

Each symbol belongs to a certain context. Within one context the names of symbols are unique, but the same name can occur in two differnt contexts. After one has started a *Mathematica* session all new symbols that one defines are put in the context **Global`** (all context names end with `).by default.
The context **Global`**   is that of the main *Mathematica* session.

The full name of a symbol is broken into two parts: a context and a short name:

<div align="center">

context`short

</div>

Contexts in *Mathematica* work somewhat like the directories in many operating systems. One can always specify a particular file by giving its complete name, including its directory. But at any given point, there is usually a current directory, analogous to the current *Mathematica* context. Files that are in this directory can then be specified by giving their short names.

a`x

a`x

aaa`x

aaa`x

%^2 - %

$- \texttt{aaa`x} + \texttt{aaa`x}^2$

a`b`x

a`b`x

$Context

Global`

Clear[x]
{x, Global`x}

{x, x}

$ContextPath

{PacletManager`, System`, Global`}

Context[Pi]

System`

Context[s]	the context of a symbol
$Context	the current context of a *Mathematica* session
$ContextPath	the current context search path
Contexts	a list of all contexts

Contexts[ ]

{Algebra`, Algebraics`Private`, Algebra`Polynomial`,
 Algebra`PolynomialPowerMod`, AlphaIntegration`, AlphaIntegration`Dump`,
 ANOVA`, Assumptions`, AssumptionsDump`, AugmentedData`, AugmentedData`Dump`,
 AuthorTools`ExportNotebook`, AuthorTools`MakeIndex`, BarCharts`,
 Benchmarking`, BinningUtilities`, BooleanAlgebra`Private`, BoxForm`,
 BoxFormat`, BrowserCategoryLoad`, CalculateParse`Content`Calculate`,
 CalculateParse`Content`CalculateInternal`, CalculateParse`ExportedFunctions`,

```
CalculateParse`ExportedFunctions`Private`, CalculateParse`GeneralLibrary`,
CalculateParse`GeneralLibrary`Private`, CalculateParse`GlobalTokenizerData`,
CalculateParse`GrammarSyntax`, CalculateScan`CommonFunctions`Private`,
CalculateScan`CommonSymbols`, CalculateScan`CommonSymbols`Private`,
CalculateScan`Data`InternetTimeZoneData`,
CalculateScan`Data`InternetTimeZoneDataLists`,
CalculateScan`Data`InternetTimeZoneDataLists2`,
CalculateScan`Data`InternetTimeZoneDataLists2`Private`,
CalculateScan`Data`InternetTimeZoneDataLists`Private`,
CalculateScan`Data`InternetTimeZoneData`Private`,
CalculateScan`Packages`Get1DPolarPlotRange`,
CalculateScan`Packages`Get1DPolarPlotRange`Private`,
CalculateScan`Packages`Get2DRange`,
CalculateScan`Packages`Get2DRange`Private`,
CalculateScan`Packages`Get3DRange`,
CalculateScan`Packages`Get3DRange`Private`,
CalculateScan`UnitConversionFunctions`,
CalculateScan`UnitConversionFunctions`Private`, CalculateScan`UnitScanner`,
CalculateScan`UnitScanner`Private`, CalculateUnits`UnitCommonSymbols`,
CalculateUnits`UnitCommonSymbols`Private`, CalculateUnits`UnitTable`,
CalculateUnits`UnitTable`Private`, CalculateUtilities`AlgorithmUtilities`,
CalculateUtilities`AlgorithmUtilities`Private`,
CalculateUtilities`DataExposureUtilities`,
CalculateUtilities`DataPaclets`CalculateWebServices`,
CalculateUtilities`FormatUtilities`Private`,
CalculateUtilities`NumberUtilities`Private`,
CalculateUtilities`StringUtilities`Private`,
CalculateUtilities`SuggestPlotRanges`,
CalculateUtilities`SuggestPlotRanges`Private`,
CalculateUtilities`TextUtilities`Private`,
CalculateUtilities`UserVariableUtilities`,
CalculateUtilities`UserVariableUtilities`Private`, Calendar`, Calendar`Legacy`,
CCodeGenerator`, CCompilerDriver`, Charting`, Charting`CommonDump`,
Charting`ParserDump`, Charting`Private`, CloudObject`Private`, CloudSystem`,
CloudSystem`Private`, ClusterAnalysis`FindClusters`, Combinatorica`,
Compile`, CompileDefinition`Private`, CompiledFunctionTools`, Compiler`,
ComplexAnalysis`, ComputationalGeometry`, ComputationalGeometry`Dump`,
ComputationalGeometry`Methods`, ComputationalGeometry`Surface`,
ComputerArithmetic`, Conditional`, Control`, Control`Conxns`, Control`Delay`,
Control`DEqns`, Control`DiffGeom`, Control`Misc`, Control`NCS`,
Control`Patterns`, Control`PCS`, Control`PID`, Control`PlotUtilities`,
Control`PolePlace`, Control`Sim`, ControlSystems`, Control`Typesetting`,
Control`Utilities`, Conversion`, Convert`TeX`, CUDAInformation`,
CUDALink`, Data`, Database`, DatabaseLink`, DatabaseLink`Information`,
DataPaclets`, DataPaclets`CalendarDataDump`, DataPaclets`ColorData`,
DataPaclets`ColorDataDump`, DataPaclets`CommonDump`, DataPaclets`Dictionary`,
DataPaclets`FinancialDataDump`, DataScience`Procedures`Compatibility`,
DataScience`Utils`Lists`, DataScience`Utils`Patterns`,
DataScience`Utils`Predicates`, Dataset`, DateAndTime`, Debug`,
Debugger`, Deconvolve`, Developer`, DeviceAPI`BuildUtilities`,
DeviceFramework`, Devices`, Devices`Audio`, Devices`Developer`,
Devices`DeviceAPI`DeviceDump`, Devices`DeviceAPI`DeviceDump`DumpDump`,
DifferentialEquations`InterpolatingFunctionAnatomy`, Discrete`,
Discrete`DivisorSumDump`, Discrete`FourierFunctionsDump`,
DiscreteMath`DecisionDiagram`, Documentation`, DragAndDrop`,
DrawPolarAxes`, DSolve`, DSolve`DSolveToNDSolveDump`, DynamicChart`,
DynamicDump`, ElisionsDump`, Embedded`, EntityFramework`,
EntityFramework`Private`, EquationalLogic`, EquationalLogic`Private`,
ErrorBarPlots`, Experimental`, Experimental`NumericalFunction`, Explore`,
ExternalService`, ExternalService`MailSettings`, ExternalService`Security`,
ExternalService`URIToolsDump`, ExternalService`Utilities`,
Extras`, Factor`, FE`, FE`PredictiveInterfaceDump`, FE`Private`,
FEPrivate`, FileFormatDump`, Finance`FinancialDerivativeDump`,
Finance`Solvers`, FindMinimum`, FindRoot`, FiniteFields`, FittedModels`,
FittedModels`FittedModelDump`, FittedModels`FittedModelDump`Private`,
FittedModels`FittedModelsCommonDump`, FittedModels`GLMDump`,
FittedModels`LinearFitDump`, FittedModels`NonlinearFitDump`, Format`,
FormulaData`Private`, FourierSeries`, FrontEnd`, FrontEnd`Private`,
```

```
FrontEnd`WolframCloud`, FunctionApproximations`, GenerateConditions`,
GeoGraphics`, GeometricFunctions`, GeometricFunctions`BernsteinBasis`,
GeometricFunctions`BSplineBasis`, GeometricFunctions`CardinalBSplineBasis`,
Geometry`, Geometry`BSPTree`, Geometry`Developer`, Geometry`Mesh`,
Geometry`Spatial`, GIS`, GIS`DMSDump`, Global`, GraphComputation`,
GraphComputation`GraphCoversDump`, Graphics`, GraphicsArray`, Graphics`Glyphs`,
Graphics`Glyphs`GlyphsDump`, Graphics`Legacy`, Graphics`ListParserDump`,
Graphics`MapPlotDump`, Graphics`Mesh`, Graphics`Mesh`Developer`,
Graphics`Mesh`FEM`, Graphics`Mesh`SoS`, Graphics`PerformanceTuningDump`,
Graphics`PolygonUtils`, Graphics`PolygonUtils`Developer`,
Graphics`Region`, Graphics`Units`, GraphUtilities`, GridDump`,
GroebnerBasis`, GroebnerBasis`GroebnerWalk`, GroebnerGCD`,
GroupTheory`GroupCountFunctionsDump`, GroupTheory`PermutationGroups`,
GroupTheory`PermutationGroupsDump`, GroupTheory`PermutationGroups`Private`,
GroupTheory`Symmetries`, GroupTheory`Tools`, HierarchicalClustering`,
Histogram`, Holonomic`, Holonomic`Developer`, Holonomic`Private`,
HTTPClient`, HTTPClient`CURLInfo`, HTTPClient`CURLInfo`Private`,
HTTPClient`CURLLink`, HTTPClient`CURLLink`Private`, HTTPClient`OAuth`Private`,
HTTPClient`Private`, HypergeometricLogDump`, HypothesisTesting`,
Image`, Image`ColorOperationsDump`, Image`CompositionOperationsDump`,
Image`ExternalOCRDump`, Image`FilteringDump`, Image`HDRImageProcessingDump`,
Image`ImageDump`, Image`ImportExportDump`, Image`ITK`,
Image`LocalProcessingDump`, Image`MatricesDump`, Image`MeasurementsDump`,
Image`MorphologicalOperationsDump`, Image`PatternRecognitionDump`,
Image`RegistrationDump`, Image`SegmentationDump`, Image`SpatialOperationsDump`,
Image`StatisticalDescriptionsDump`, ImageTransformation`,
Image`TransformsDump`, IMAQ`, IMAQ`Driver`, IMAQ`Utilities`,
ImportExport`, ImportExport`Encodings`, ImportExport`FileUtilities`,
ImportExport`Private`, Inpaint`, Integrate`, Integrate`Elliptic`,
Integrate`ImproperDump`, Integrate`NLtheoremDump`, Internal`,
Internal`BernoulliB`, Internal`FunctionExpand`, Internal`HypergeometricPFQ`,
Internal`Integrate`, Internal`MWASymbols`, Internal`ProcessEquations`,
java`util`GregorianCalendar`, JLink`, JLink`Information`, JSONTools`, Language`,
Legending`, Legending`LegendDump`, LibraryLink`, Limit`, LinearAlgebra`,
LinearAlgebra`BLAS`, LinearAlgebra`DeconvolveDump`, LinearAlgebra`Fourier`,
LinearAlgebra`Implementations`, LinearAlgebra`Internal`,
LinearAlgebra`LAPACK`, LinearAlgebra`LinearSolve`, LinearAlgebra`MatrixExp`,
LinearAlgebra`Private`, LinearRegression`, Manipulate`,
Manipulate`Dump`, MarkovProcesses`, MathLink`, MathLink`Information`,
MatrixFunction`, MatrixLog`, MatrixPower`, MatrixSqrt`, Method`, MLFS`,
MultivariateResultant`, MUnit`, MUnit`Package`, NDSolve`, NDSolve`Chasing`,
NDSolve`Chasing`Implementation`, NDSolve`EventLocator`, NDSolve`FEM`,
NDSolve`FEM`FEMErrorCheckingDump`, NDSolve`FEM`ShapeFunctionsDump`,
NDSolve`FiniteDifferenceDerivativeFunction`, NDSolve`MethodOfLines`,
NDSolve`MultistepDump`, NDSolve`Newton`, NDSolve`ProcessEquations`,
NDSolve`Shooting`Implementation`, NDSolve`StateData`, NETLink`,
NETLink`Information`, Network`GraphPlot`, NIntegrate`, NIntegrate`OscNInt`,
NMinimize`, NotebookCompatibility`, NotebookTemplating`, NotebookTools`,
NotebookTools`ControlsDump`, NotebookTools`UtilitiesDump`,
NProduct`, NRoots`, NRoots`Private`, NSolve`, NSum`, NumberTheory`,
NumberTheory`AESDump`, NumberTheory`DirichletFunctionsDump`,
NumberTheory`NumberTheoryFunctionsDump`, NumberTheory`PrimePowerQDump`,
NumberTheory`RamanujanTauDump`, NumberTheory`RandomPrimeDump`,
NumberTheory`SquareFreeQDump`, NumberTheory`SquaresRDump`,
NumericalCalculus`, NumericalDifferentialEquationAnalysis`,
NumericalMath`, OpenCLInformation`, OpenCLLink`, Optimization`,
Optimization`FindFit`, Optimization`LinearProgramming`,
Optimization`LinearProgramming`Private`, Optimization`LineSearch`,
Optimization`MPSData`, OutputSizeLimit`, OutputSizeLimit`Dump`,
Package`, PacletManager`, PacletManager`Collection`Private`,
PacletManager`Documentation`Private`, PacletManager`Extension`Private`,
PacletManager`Information`, PacletManager`LayoutDocsCollection`Private`,
PacletManager`Manager`Private`, PacletManager`MemoryCollection`Private`,
PacletManager`Package`, PacletManager`Packer`Private`,
PacletManager`Paclet`Private`, PacletManager`Private`,
PacletManager`Services`Private`, PacletManager`Utils`Private`,
PacletManager`Zip`Private`, PacletTools`, Parallel`Debug`, Parallel`Developer`,
Parallel`Information`, Parallel`Palette`, Parallel`Palette`Private`,
```

```
Parallel`Private`, Parallel`Settings`, Parallel`Static`, Periodic`,
Periodic`PeriodicFunctionDump`, Periodic`PeriodicWavesDump`, Periodic`Private`,
Periodic`Private`PeriodicToolsDump`, PhysicalConstants`, PlanetaryAstronomy`,
PlanetaryAstronomy`Private`, PlotLegends`, Predictions`, Predictions`Private`,
PredictionStartupDump`, PredictiveInterface`, PredictiveInterfaceDump`,
PredictiveInterfaceLoader`Private`, Private`, Product`, Quantifier`,
QuantityUnits`, QuantityUnits`Private`, Random`, Random`Private`,
RandomProcesses`, RandomProcesses`Library`, RandomProcesses`MarkovChainDump`,
RandomProcesses`MarkovProcessUtilities`, RandomProcesses`Simulation`,
RandomProcesses`TimeSeriesCommon`, RandomProcesses`Utilities`,
RandomProcesses`Utilities`BuildTimeUtilitiesDump`, Reduce`, Region`,
Region`Mesh`, Region`Mesh`Utilities`, Region`Private`, RegressionCommon`,
RegularChains`Private`, Reliability`Library`, ResonanceAbsorptionLines`,
ResourceLocator`, ResourceLocator`Private`, RLink`, RomanNumerals`,
RootReduce`Private`, RootsDump`, RSolve`, RuntimeTools`, RuntimeTools`Dump`,
Semantic`AmbiguityDump`, Semantic`PLIDump`, SequenceLimit`,
Series`Private`, Signal`, Signal`FilterDesignDump`, Signal`FilteringDump`,
Signal`FiltersDump`, Signal`Utils`, SimilarityScoreMatrices`, Simplify`,
SimplifyDump`, Simplify`Private`, Solve`, Sound`, SparseArray`,
SparseArray`Private`, SparseArray`SparseBlockArray`, SpecialFunctions`,
SpecialFunctions`Private`, Splines`, StandardAtmosphere`,
StatisticalPlots`, Statistics`, Statistics`Compatibility`,
Statistics`CoxModelFitDump`, Statistics`CoxModelFitDump`Private`,
Statistics`CoxModelFitDump`Private`$ExportedSymbolse`,
Statistics`DataDistributionUtilities`,
Statistics`HypothesisTestingUtilitiesDump`,
Statistics`HypothesisTestingUtilitiesDump`Private`,
Statistics`Library`, Statistics`MomentOperationsDump`,
Statistics`MomentOperationsDump`Private`, Statistics`QuantityUtilities`,
Statistics`SurvivalAnalysisTools`, Statistics`SurvivalDistributionDump`,
Statistics`SurvivalModelFitDump`, Statistics`SurvivalModelFitDump`Private`,
Statistics`SurvivalModelFitDump`Private`$ExportedSymbolse`,
Statistics`Utilities`, StochasticCalculus`, StringPattern`,
StringPattern`Dump`, StringPattern`Lexer`, StructuredArray`,
StructuredArray`StructuredArrayDump`, StructureDetection`, StyleManager`,
Sum`, SurfaceGraphics`, SurfaceGraphics`Methods`, SymbolicC`,
SymbolicTensors`, SymbolicTensors`SymbolicTensorsDump`, System`,
System`BarChartDump`, System`BarnesDump`, System`BarnesDump`Private`,
System`BellDump`, System`BernoulliDump`, System`BesselParamDerivativesDump`,
System`BinaryReadDump`, System`ClebschGordanDump`, System`CompileDump`,
System`ComplexDynamicsDump`, System`ComplexExpand`,
System`ComplexExpandDump`, System`Convert`BitmapDump`,
System`Convert`CommonDump`, System`Convert`CSSDump`,
System`ConvertersDump`, System`ConvertersDump`Utilities`,
System`ConvertersDump`Utilities`Private`, System`Convert`HTMLDump`,
System`Convert`MathMLDump`, System`Convert`MovieDump`,
System`Convert`NewickDump`, System`Convert`TableDump`, System`Convert`TeXDump`,
System`Convert`TeXImportDump`, System`Convert`TextDump`,
System`CrossDump`, System`DateObjectDump`, System`DateStringDump`,
System`Dump`, System`Dump`CommonPatterns`, System`Dump`GeoLocationDump`,
System`Dump`IMAQDump`, System`Dump`ParameterValidation`,
System`EllipticDump`, System`Environment`, System`ErrorBarsDump`,
System`FEDump`, System`FibonacciDump`, System`FibonacciDump`Private`,
System`FileExportListDump`, System`FourierTransformDump`,
System`FunctionInterpolationDump`, System`FunctionZerosDump`,
System`GatherDump`, System`GroebnerBasisDump`, System`HankelDump`,
System`HarmonicNumberDump`, System`HypergeometricDump`,
System`HypergeometricPFQDump`, System`InflationAdjust`Private`,
System`InfoDump`, System`InputOutput`, System`InstanceDump`,
System`IntegerPartitionsDump`, System`InterpolatingFunction`,
System`InverseFunctionDump`, System`KelvinDump`, System`LanguageEnhancements`,
System`LaplaceTransformDump`, System`MeijerGDump`, System`NielsenDump`,
System`NOfOptimizeDump`, System`NSolveDump`, System`Parallel`,
System`PlotThemeDump`, System`PowerReduceDump`, System`PrepElemDump`,
System`Private`, System`Private`charFuns`, System`ProtoPlotDump`,
System`ReduceUtilsDump`, System`SeriesDump`, System`SphericalBesselDump`,
System`StatisticalFunctionsDump`, System`StruveDump`,
System`StruveDump`Private`, System`TransformationFunctionDump`,
```

```
System`TrigToRadicalsDump`, System`TSolveDump`, System`Utilities`,
System`WhittakerDump`, System`ZetaDerivativeDump`, t`, TableView`,
Templating`, TemporalData`, TemporalData`Utilities`, TetGenLink`,
Themes`, TimeZone`, TreeBrowse`, Typeset`, Units`, URLEncoder`,
Utilities`URLTools`, ValueTrack`, VectorAnalysis`, VectorFieldPlots`,
Visualization`, Visualization`Core`, Visualization`DiscontinuityDump`,
Visualization`Interpolation`, Visualization`LegendsDump`,
Visualization`Utilities`, Visualization`Utilities`OptionsDump`,
Visualization`Utilities`ScalingDump`, Visualization`VectorFields`,
Visualization`VectorFields`VectorFieldsDump`, VLFeat`Private`,
Wavelets`, Wavelets`LiftingFilter`, Wavelets`WaveletData`,
Wavelets`WaveletListPlot`, Wavelets`WaveletPlot2D`, Wavelets`WaveletScalogram`,
Wavelets`WaveletUtilities`, WebPredictions`, WebPredictions`Private`,
WebServices`, WebServices`Information`, WolframAlphaClient`Private`,
WorldPlot`, WrappersDump`, WSMLink`, WSTP`ServiceDiscovery`, XML`, XML`MathML`,
XML`MathML`Symbols`, XML`NotebookML`, XML`Parser`, XML`RSS`, XML`SVG`}
```

context`name**   **c1`c2`..`name	a symbol in an explicitlly specified context
`name	a symbol in the current context
`context`name **`c1`c2`..`name**	a symbol in a specified context relative to the current context
name	a symbol in the current context. or found on the context search path

The following command yields the directory housing the file one is working with:

```
SetDirectory[ToFileName[
  Extract["FileName" /. NotebookInformation[EvaluationNotebook[]],
    {1}, FrontEnd`FileName]]]
```

```
/Users/schnizer/Documents/myfiles/MathematicaLV/lec1510N/CourseFiles
```

22.3.1 Clearing and Removing Symbols

Clear[s]	Clear the values of symbol **s**
Remove[s]	Remove the symbol **s** from the system
Clear["s*"]	Clear the values of all symbols whose names start with the letter **s**
Remove["s*"]	Remove all symbols whose names start with the letter **s** from the system
ClearAll[]	Clears everything

```
ClearAll[]
```

Protected symbols cannot be cleared:

```
x = 5;
```

```
Protect[x]
```

{x}

```
Clear[x]
```

Clear::wrsym : Symbol x is Protected ≫

```
x
```

5

```
Unprotect[x]
Clear[x]
```
{x}

```
x
```
x

```
a = 100; x1 = 2; x2 = 3; x3 = 4; x4 = 5; y = 7; z = 19;
```

```
z
```
19

```
a
```
100

Input	Output / Representation
x1	2
x2	3
y	7
Clear["x*"]	
x1	x1
y	7

```
f[x_] := x^2
```

```
Clear[f]
```

```
Clear["Global`*"]
```

```
N[Pi]
```
3.14159

22.3.2   Removing Packages

Many packages protect the names of their symbols; thus Unprotect[] must be applied before the contexts can be removed.

```
Needs["Combinatorica`"]
```

"Combinatorica Graph and Permutations functionality has been superseded by preloaded functionality. The package now being loaded may conflict with this. Please see the Compatibility Guide for details."

```
V=5
```
5

Clear::"wrsym" : Symbol V is Protected. >>

```
V
```
V

```
Unprotect["Combinatorica`*"];
```

```
Remove["Combinatorica`*"]
```

```
V=5
```
5

22.3.3 Putting Symbols in Contexts

```
Clear[x, y, n, a]
```

```
(* This function returns the first  n  powers of  x  *)
PowerSum[x_, n_] := Sum[ x^i, {i, 1, n} ]
```

```
PowerSum[y,5]
```

$y + y^2 + y^3 + y^4 + y^5$

```
PowerSum[i,5]
```

3413

```
(* this function returns the first  n  terms of the
power series  sum a[i] x^i
              i                                   *)
```

```
SerSum[x_, n_] :=Sum[a[i] x^i, {i, 1, n} ]
```

```
SerSum[y,5]
```

$y\, a[1] + y^2\, a[2] + y^3\, a[3] + y^4\, a[4] + y^5\, a[5]$

```
SerSum[i,5]
```

$a[1] + 4\, a[2] + 27\, a[3] + 256\, a[4] + 3125\, a[5]$

```
SerSum[n,5]
```

$n\, a[1] + n^2\, a[2] + n^3\, a[3] + n^4\, a[4] + n^5\, a[5]$

```
Context[i]
```

Global`

```
$Context
```

Global`

```
$ContextPath
```

{Combinatorica`, PacletManager`, System`, Global`}

The variable **i**   is captured by the variable **i** in the range of the summation. In place of the powers of   **i** one gets numbers.

By default all new symbols that one defines are put in the context Global`. The local variable **i** used in the defintion of the functions **PowerSum** and **BerSum** above is therefore in the same context as the variable **i** used as argument to those functions in the inputs **PowerSum[i,5]** and **SerSum[i,5].**

This is remedied by putting these two symbols having the same name **i** in different contexts. This is done by the command **Module[]** or by the comand **Block[]** :

```
PowerSumm[x_, n_] :=
Module[ {i}, Sum[ x^i, {i, 1, n} ]
]
```

```
PowerSumm[i,5]
```

$i + i^2 + i^3 + i^4 + i^5$

```
PowerSumb[x_,n_] :=
Block[ {i}, Sum[ x^i, {i, 1, n} ]
]
```

```
PowerSumb[i,5]
```

3413

The old definition of **i** is still valid and gets into the way. This does not happen if one used **Module[]**, which command renders the names in the first list local. Remember that **Block[]** ren-

ders local the values but not the names. One must either start a new *Mathematica* session or remove **i** by the following command:

```
Remove[i];
PowerSumb[i,5]
```

$i + i^2 + i^3 + i^4 + i^5$

It is even better to screen off the inner part of a function or a package by giving it its own context. This is done by **Begin["Private`"]** and the corresponding **End** command. This is the common rule for packages.

```
PowerSummi::usage = "this function returns the first    n
    powers of  x .  "
Begin["Private`"]
PowerSummi[x_, n_] :=
Module[ {i}, Sum[ x^i, {i, 1, n} ]
]
End[(* "Private`" *)]
```

```
this function returns the first    n
    powers of  x .
```

```
Private`
```

```
Private`
```

Context[i]

```
Global`
```

Contexts[]

```
{Algebra`, Algebraics`Private`, Algebra`Polynomial`,
 Algebra`PolynomialPowerMod`, AlphaIntegration`, AlphaIntegration`Dump`,
 ANOVA`, Assumptions`, AssumptionsDump`, AugmentedData`, AugmentedData`Dump`,
 AuthorTools`ExportNotebook`, AuthorTools`MakeIndex`, AuthorTools`MakeProject`,
 BarCharts`, Benchmarking`, BinningUtilities`, BooleanAlgebra`Private`,
 BoxForm`, BoxFormat`, BrowserCategoryLoad`, CalculateParse`Content`Calculate`,
 CalculateParse`Content`CalculateInternal`, CalculateParse`ExportedFunctions`,
 CalculateParse`ExportedFunctions`Private`, CalculateParse`GeneralLibrary`,
 CalculateParse`GeneralLibrary`Private`, CalculateParse`GlobalTokenizerData`,
 CalculateParse`GrammarSyntax`, CalculateScan`CommonFunctions`Private`,
 CalculateScan`CommonSymbols`, CalculateScan`CommonSymbols`Private`,
 CalculateScan`Data`InternetTimeZoneData`,
 CalculateScan`Data`InternetTimeZoneDataLists`,
 CalculateScan`Data`InternetTimeZoneDataLists2`,
 CalculateScan`Data`InternetTimeZoneDataLists2`Private`,
 CalculateScan`Data`InternetTimeZoneDataLists`Private`,
 CalculateScan`Data`InternetTimeZoneData`Private`,
 CalculateScan`Packages`Get1DPolarPlotRange`,
 CalculateScan`Packages`Get1DPolarPlotRange`Private`,
 CalculateScan`Packages`Get2DRange`,
 CalculateScan`Packages`Get2DRange`Private`,
 CalculateScan`Packages`Get3DRange`,
 CalculateScan`Packages`Get3DRange`Private`,
 CalculateScan`UnitConversionFunctions`,
 CalculateScan`UnitConversionFunctions`Private`, CalculateScan`UnitScanner`,
 CalculateScan`UnitScanner`Private`, CalculateUnits`UnitCommonSymbols`,
 CalculateUnits`UnitCommonSymbols`Private`, CalculateUnits`UnitTable`,
 CalculateUnits`UnitTable`Private`, CalculateUtilities`AlgorithmUtilities`,
 CalculateUtilities`AlgorithmUtilities`Private`,
 CalculateUtilities`DataExposureUtilities`,
 CalculateUtilities`DataPaclets`CalculateWebServices`,
 CalculateUtilities`FormatUtilities`Private`,
 CalculateUtilities`NumberUtilities`Private`,
 CalculateUtilities`StringUtilities`Private`,
 CalculateUtilities`SuggestPlotRanges`,
 CalculateUtilities`SuggestPlotRanges`Private`,
 CalculateUtilities`TextUtilities`Private`,
 CalculateUtilities`UserVariableUtilities`,
 CalculateUtilities`UserVariableUtilities`Private`, Calendar`, Calendar`Legacy`,
```

```
CCodeGenerator`, CCompilerDriver`, Charting`, Charting`CommonDump`,
Charting`ParserDump`, Charting`Private`, CloudObject`Private`, CloudSystem`,
CloudSystem`Private`, ClusterAnalysis`FindClusters`, Combinatorica`Private`,
Compile`, CompileDefinition`Private`, CompiledFunctionTools`, Compiler`,
ComplexAnalysis`, ComputationalGeometry`, ComputationalGeometry`Dump`,
ComputationalGeometry`Methods`, ComputationalGeometry`Surface`,
ComputerArithmetic`, Conditional`, Control`, Control`Conxns`, Control`Delay`,
Control`DEqns`, Control`DiffGeom`, Control`Misc`, Control`NCS`,
Control`Patterns`, Control`PCS`, Control`PID`, Control`PlotUtilities`,
Control`PolePlace`, Control`Sim`, ControlSystems`, Control`Typesetting`,
Control`Utilities`, Conversion`, Convert`TeX`, CUDAInformation`,
CUDALink`, Data`, Database`, DatabaseLink`, DatabaseLink`Information`,
DataPaclets`, DataPaclets`CalendarDataDump`, DataPaclets`ColorData`,
DataPaclets`ColorDataDump`, DataPaclets`CommonDump`, DataPaclets`Dictionary`,
DataPaclets`FinancialDataDump`, DataScience`Procedures`Compatibility`,
DataScience`Utils`Lists`, DataScience`Utils`Patterns`,
DataScience`Utils`Predicates`, Dataset`, DateAndTime`, Debug`,
Debugger`, Deconvolve`, Developer`, DeviceAPI`BuildUtilities`,
DeviceFramework`, Devices`, Devices`Audio`, Devices`Developer`,
Devices`DeviceAPI`DeviceDump`, Devices`DeviceAPI`DeviceDump`DumpDump`,
DifferentialEquations`InterpolatingFunctionAnatomy`, Discrete`,
Discrete`DivisorSumDump`, Discrete`FourierFunctionsDump`,
DiscreteMath`DecisionDiagram`, Documentation`, DragAndDrop`, DrawPolarAxes`,
DSolve`, DSolve`DSolveToNDSolveDump`, DynamicChart`, DynamicDump`,
ElisionsDump`, Embedded`, EntityFramework`, EntityFramework`Private`,
EquationalLogic`, EquationalLogic`Private`, EquationTrekker`,
ErrorBarPlots`, Experimental`, Experimental`NumericalFunction`, Explore`,
ExternalService`, ExternalService`MailSettings`, ExternalService`Security`,
ExternalService`URIToolsDump`, ExternalService`Utilities`,
Extras`, Factor`, FE`, FE`PredictiveInterfaceDump`, FE`Private`,
FEPrivate`, FileFormatDump`, Finance`FinancialDerivativeDump`,
Finance`Solvers`, FindMinimum`, FindRoot`, FiniteFields`, FittedModels`,
FittedModels`FittedModelDump`, FittedModels`FittedModelDump`Private`,
FittedModels`FittedModelsCommonDump`, FittedModels`GLMDump`,
FittedModels`LinearFitDump`, FittedModels`NonlinearFitDump`, Format`,
FormulaData`Private`, FourierSeries`, FrontEnd`, FrontEnd`Private`,
FrontEnd`WolframCloud`, FunctionApproximations`, GenerateConditions`,
GeoGraphics`, GeometricFunctions`, GeometricFunctions`BernsteinBasis`,
GeometricFunctions`BSplineBasis`, GeometricFunctions`CardinalBSplineBasis`,
Geometry`, Geometry`BSPTree`, Geometry`Developer`, Geometry`Mesh`,
Geometry`Spatial`, GIS`, GIS`DMSDump`, Global`, GraphComputation`,
GraphComputation`GraphCoversDump`, Graphics`, GraphicsArray`,
Graphics`Glyphs`, Graphics`Glyphs`GlyphsDump`, Graphics`GraphicsGridDump`,
Graphics`Legacy`, Graphics`ListParserDump`, Graphics`MapPlotDump`,
Graphics`Mesh`, Graphics`Mesh`Developer`, Graphics`Mesh`FEM`,
Graphics`Mesh`SoS`, Graphics`PerformanceTuningDump`, Graphics`PolygonUtils`,
Graphics`PolygonUtils`Developer`, Graphics`Region`, Graphics`Units`,
GraphUtilities`, GridDump`, GroebnerBasis`, GroebnerBasis`GroebnerWalk`,
GroebnerGCD`, GroupTheory`GroupCountFunctionsDump`,
GroupTheory`PermutationGroups`, GroupTheory`PermutationGroupsDump`,
GroupTheory`PermutationGroups`Private`, GroupTheory`Symmetries`,
GroupTheory`Tools`, HierarchicalClustering`, Histogram`, Histograms`,
Holonomic`, Holonomic`Developer`, Holonomic`Private`, HTTPClient`,
HTTPClient`CURLInfo`, HTTPClient`CURLInfo`Private`, HTTPClient`CURLLink`,
HTTPClient`CURLLink`Private`, HTTPClient`OAuth`Private`,
HTTPClient`Private`, HypergeometricLogDump`, HypothesisTesting`,
Image`, Image`ColorOperationsDump`, Image`CompositionOperationsDump`,
Image`ExternalOCRDump`, Image`FilteringDump`, Image`HDRImageProcessingDump`,
Image`ImageDump`, Image`ImportExportDump`, Image`ITK`,
Image`LocalProcessingDump`, Image`MatricesDump`, Image`MeasurementsDump`,
Image`MorphologicalOperationsDump`, Image`PatternRecognitionDump`,
Image`RegistrationDump`, Image`SegmentationDump`, Image`SpatialOperationsDump`,
Image`StatisticalDescriptionsDump`, ImageTransformation`,
Image`TransformsDump`, IMAQ`, IMAQ`Driver`, IMAQ`Utilities`,
ImportExport`, ImportExport`Encodings`, ImportExport`FileUtilities`,
ImportExport`Private`, Inpaint`, Integrate`, Integrate`Elliptic`,
Integrate`ImproperDump`, Integrate`NLtheoremDump`, Internal`,
Internal`BernoulliB`, Internal`FunctionExpand`, Internal`HypergeometricPFQ`,
```

```
Internal`Integrate`, Internal`MWASymbols`, Internal`ProcessEquations`,
java`util`GregorianCalendar`, JLink`, JLink`Information`, JSONTools`, Language`,
Legending`, Legending`LegendDump`, LibraryLink`, Limit`, LinearAlgebra`,
LinearAlgebra`BLAS`, LinearAlgebra`DeconvolveDump`, LinearAlgebra`Fourier`,
LinearAlgebra`Implementations`, LinearAlgebra`Internal`, LinearAlgebra`LAPACK`,
LinearAlgebra`LinearSolve`, LinearAlgebra`MatrixExp`, LinearAlgebra`Private`,
LinearRegression`, Manipulate`, Manipulate`Dump`, MarkovProcesses`,
MathLink`, MathLink`Information`, MatrixFunction`, MatrixLog`,
MatrixPower`, MatrixSqrt`, Method`, MLFS`, MultivariateResultant`,
MUnit`, MUnit`Package`, Music`, NDSolve`, NDSolve`Chasing`,
NDSolve`Chasing`Implementation`, NDSolve`EventLocator`, NDSolve`FEM`,
NDSolve`FEM`FEMErrorCheckingDump`, NDSolve`FEM`ShapeFunctionsDump`,
NDSolve`FiniteDifferenceDerivativeFunction`, NDSolve`MethodOfLines`,
NDSolve`MultistepDump`, NDSolve`Newton`, NDSolve`ProcessEquations`,
NDSolve`Shooting`Implementation`, NDSolve`StateData`, NETLink`,
NETLink`Information`, Network`GraphPlot`, NIntegrate`, NIntegrate`OscNInt`,
NMinimize`, NotebookCompatibility`, NotebookTemplating`, NotebookTools`,
NotebookTools`ControlsDump`, NotebookTools`UtilitiesDump`,
NProduct`, NRoots`, NRoots`Private`, NSolve`, NSum`, NumberTheory`,
NumberTheory`AESDump`, NumberTheory`DirichletFunctionsDump`,
NumberTheory`NumberTheoryFunctionsDump`, NumberTheory`PrimePowerQDump`,
NumberTheory`RamanujanTauDump`, NumberTheory`RandomPrimeDump`,
NumberTheory`SquareFreeQDump`, NumberTheory`SquaresRDump`,
NumericalCalculus`, NumericalDifferentialEquationAnalysis`,
NumericalMath`, OpenCLInformation`, OpenCLLink`, Optimization`,
Optimization`FindFit`, Optimization`LinearProgramming`,
Optimization`LinearProgramming`Private`, Optimization`LineSearch`,
Optimization`MPSData`, OutputSizeLimit`, OutputSizeLimit`Dump`,
Package`, PacletManager`, PacletManager`Collection`Private`,
PacletManager`Documentation`Private`, PacletManager`Extension`Private`,
PacletManager`Information`, PacletManager`LayoutDocsCollection`Private`,
PacletManager`Manager`Private`, PacletManager`MemoryCollection`Private`,
PacletManager`Package`, PacletManager`Packer`Private`,
PacletManager`Paclet`Private`, PacletManager`Private`,
PacletManager`Services`Private`, PacletManager`Utils`Private`,
PacletManager`Zip`Private`, PacletTools`, Parallel`Debug`, Parallel`Developer`,
Parallel`Information`, Parallel`Palette`, Parallel`Palette`Private`,
Parallel`Private`, Parallel`Settings`, Parallel`Static`, Periodic`,
Periodic`PeriodicFunctionDump`, Periodic`PeriodicWavesDump`,
Periodic`Private`, Periodic`Private`PeriodicToolsDump`, PhysicalConstants`,
PlanetaryAstronomy`, PlanetaryAstronomy`Private`, PlotLegends`, Predictions`,
Predictions`Private`, PredictionStartupDump`, PredictiveInterface`,
PredictiveInterfaceDump`, PredictiveInterfaceLoader`Private`, Private`,
Product`, Quantifier`, QuantityUnits`, QuantityUnits`Private`, Quaternions`,
Random`, Random`Private`, RandomProcesses`, RandomProcesses`Library`,
RandomProcesses`MarkovChainDump`, RandomProcesses`MarkovProcessUtilities`,
RandomProcesses`Simulation`, RandomProcesses`TimeSeriesCommon`,
RandomProcesses`Utilities`, RandomProcesses`Utilities`BuildTimeUtilitiesDump`,
Reduce`, Region`, Region`Mesh`, Region`Mesh`Utilities`, Region`Private`,
RegressionCommon`, RegularChains`Private`, Reliability`Library`,
ResonanceAbsorptionLines`, ResourceLocator`, ResourceLocator`Private`,
RLink`, RomanNumerals`, RootReduce`Private`, RootsDump`, RSolve`,
RuntimeTools`, RuntimeTools`Dump`, Semantic`AmbiguityDump`, Semantic`PLIDump`,
SequenceLimit`, Series`Private`, Signal`, Signal`FilterDesignDump`,
Signal`FilteringDump`, Signal`FiltersDump`, Signal`Utils`,
SimilarityScoreMatrices`, Simplify`, SimplifyDump`, Simplify`Private`, Solve`,
Sound`, SparseArray`, SparseArray`Private`, SparseArray`SparseBlockArray`,
SpecialFunctions`, SpecialFunctions`Private`, Splines`, StandardAtmosphere`,
StatisticalPlots`, Statistics`, Statistics`Compatibility`,
Statistics`CoxModelFitDump`, Statistics`CoxModelFitDump`Private`,
Statistics`CoxModelFitDump`Private`$ExportedSymbolse`,
Statistics`DataDistributionUtilities`,
Statistics`HypothesisTestingUtilitiesDump`,
Statistics`HypothesisTestingUtilitiesDump`Private`,
Statistics`Library`, Statistics`MomentOperationsDump`,
Statistics`MomentOperationsDump`Private`, Statistics`QuantityUtilities`,
Statistics`SurvivalAnalysisTools`, Statistics`SurvivalDistributionDump`,
Statistics`SurvivalModelFitDump`, Statistics`SurvivalModelFitDump`Private`,
```

```
       Statistics`SurvivalModelFitDump`Private`$ExportedSymbolse`,
       Statistics`Utilities`, StochasticCalculus`, StringPattern`,
       StringPattern`Dump`, StringPattern`Lexer`, StructuredArray`,
       StructuredArray`StructuredArrayDump`, StructureDetection`, StyleManager`,
       Sum`, SurfaceGraphics`, SurfaceGraphics`Methods`, SymbolicC`,
       SymbolicTensors`, SymbolicTensors`SymbolicTensorsDump`, System`,
       System`BarChartDump`, System`BarnesDump`, System`BarnesDump`Private`,
       System`BellDump`, System`BernoulliDump`, System`BesselParamDerivativesDump`,
       System`BinaryReadDump`, System`ClebschGordanDump`, System`CompileDump`,
       System`ComplexDynamicsDump`, System`ComplexExpand`,
       System`ComplexExpandDump`, System`Convert`BitmapDump`,
       System`Convert`CommonDump`, System`Convert`CSSDump`,
       System`ConvertersDump`, System`ConvertersDump`Utilities`,
       System`ConvertersDump`Utilities`Private`, System`Convert`HTMLDump`,
       System`Convert`MathMLDump`, System`Convert`MovieDump`,
       System`Convert`NewickDump`, System`Convert`TableDump`, System`Convert`TeXDump`,
       System`Convert`TeXImportDump`, System`Convert`TextDump`, System`CrossDump`,
       System`DateObjectDump`, System`DateStringDump`, System`DiscretePlotDump`,
       System`Dump`, System`Dump`CommonPatterns`, System`Dump`GeoLocationDump`,
       System`Dump`IMAQDump`, System`Dump`ParameterValidation`,
       System`EllipticDump`, System`Environment`, System`ErrorBarsDump`,
       System`FEDump`, System`FibonacciDump`, System`FibonacciDump`Private`,
       System`FileExportListDump`, System`FourierTransformDump`,
       System`FunctionInterpolationDump`, System`FunctionZerosDump`,
       System`GatherDump`, System`GroebnerBasisDump`, System`HankelDump`,
       System`HarmonicNumberDump`, System`HypergeometricDump`,
       System`HypergeometricPFQDump`, System`InflationAdjust`Private`,
       System`InfoDump`, System`InputOutput`, System`InstanceDump`,
       System`IntegerPartitionsDump`, System`InterpolatingFunction`,
       System`InverseFunctionDump`, System`KelvinDump`, System`LanguageEnhancements`,
       System`LaplaceTransformDump`, System`MeijerGDump`, System`NielsenDump`,
       System`NOfOptimizeDump`, System`NSolveDump`, System`Parallel`,
       System`PlotThemeDump`, System`PowerReduceDump`, System`PrepElemDump`,
       System`Private`, System`Private`charFuns`, System`ProtoPlotDump`,
       System`ReduceDump`, System`ReduceUtilsDump`, System`SeriesDump`,
       System`SphericalBesselDump`, System`StatisticalFunctionsDump`,
       System`StruveDump`, System`StruveDump`Private`,
       System`TransformationFunctionDump`, System`TrigToRadicalsDump`,
       System`TSolveDump`, System`Utilities`, System`WhittakerDump`,
       System`ZetaDerivativeDump`, t`, TableView`, Templating`, TemporalData`,
       TemporalData`Utilities`, TetGenLink`, Themes`, TimeZone`, TreeBrowse`,
       Typeset`, Units`, URLEncoder`, Utilities`URLTools`, ValueTrack`,
       VectorAnalysis`, VectorFieldPlots`, Visualization`, Visualization`Core`,
       Visualization`DiscontinuityDump`, Visualization`Interpolation`,
       Visualization`LegendsDump`, Visualization`Utilities`,
       Visualization`Utilities`OptionsDump`, Visualization`Utilities`ScalingDump`,
       Visualization`VectorFields`, Visualization`VectorFields`VectorFieldsDump`,
       VLFeat`Private`, Wavelets`, Wavelets`LiftingFilter`, Wavelets`WaveletData`,
       Wavelets`WaveletListPlot`, Wavelets`WaveletPlot2D`, Wavelets`WaveletScalogram`,
       Wavelets`WaveletUtilities`, WebPredictions`, WebPredictions`Private`,
       WebServices`, WebServices`Information`, WolframAlphaClient`Private`,
       WorldPlot`, WrappersDump`, WSMLink`, WSTP`ServiceDiscovery`, XML`, XML`MathML`,
       XML`MathML`Symbols`, XML`NotebookML`, XML`Parser`, XML`RSS`, XML`SVG`}


SerSummp::usage = "    "
Begin["Private`"]
SerSummp[x_, n_] :=
Module[{i},   Sum[ a[i] x^i, {i, 1, n} ]
]
End[]


Private`

Private`
```

```
SerSummp[i,5]
```

$i \, a[1] + i^2 \, a[2] + i^3 \, a[3] + i^4 \, a[4] + i^5 \, a[5]$

```
SerSumbp::usage = "   "
Begin["Private`"]
SerSumbp[x_, n_] :=
Block[{i},    Sum[ a[i] x^i, {i, 1, n} ]
]
End[]
```

```
Private`
```

```
Private`
```

```
Remove[i];
SerSumbp[i,5]
```

$i \, a[1] + i^2 \, a[2] + i^3 \, a[3] + i^4 \, a[4] + i^5 \, a[5]$

```
Contexts[]
```

{Algebra`, Algebraics`Private`, Algebra`Polynomial`,
 Algebra`PolynomialPowerMod`, AlphaIntegration`, AlphaIntegration`Dump`,
 ANOVA`, Assumptions`, AssumptionsDump`, AugmentedData`, AugmentedData`Dump`,
 AuthorTools`ExportNotebook`, AuthorTools`MakeIndex`, AuthorTools`MakeProject`,
 BarCharts`, Benchmarking`, BinningUtilities`, BooleanAlgebra`Private`,
 BoxForm`, BoxFormat`, BrowserCategoryLoad`, CalculateParse`Content`Calculate`,
 CalculateParse`Content`CalculateInternal`, CalculateParse`ExportedFunctions`,
 CalculateParse`ExportedFunctions`Private`, CalculateParse`GeneralLibrary`,
 CalculateParse`GeneralLibrary`Private`, CalculateParse`GlobalTokenizerData`,
 CalculateParse`GrammarSyntax`, CalculateScan`CommonFunctions`Private`,
 CalculateScan`CommonSymbols`, CalculateScan`CommonSymbols`Private`,
 CalculateScan`Data`InternetTimeZoneData`,
 CalculateScan`Data`InternetTimeZoneDataLists`,
 CalculateScan`Data`InternetTimeZoneDataLists2`,
 CalculateScan`Data`InternetTimeZoneDataLists2`Private`,
 CalculateScan`Data`InternetTimeZoneDataLists`Private`,
 CalculateScan`Data`InternetTimeZoneData`Private`,
 CalculateScan`Packages`Get1DPolarPlotRange`,
 CalculateScan`Packages`Get1DPolarPlotRange`Private`,
 CalculateScan`Packages`Get2DRange`,
 CalculateScan`Packages`Get2DRange`Private`,
 CalculateScan`Packages`Get3DRange`,
 CalculateScan`Packages`Get3DRange`Private`,
 CalculateScan`UnitConversionFunctions`,
 CalculateScan`UnitConversionFunctions`Private`, CalculateScan`UnitScanner`,
 CalculateScan`UnitScanner`Private`, CalculateUnits`UnitCommonSymbols`,
 CalculateUnits`UnitCommonSymbols`Private`, CalculateUnits`UnitTable`,
 CalculateUnits`UnitTable`Private`, CalculateUtilities`AlgorithmUtilities`,
 CalculateUtilities`AlgorithmUtilities`Private`,
 CalculateUtilities`DataExposureUtilities`,
 CalculateUtilities`DataPaclets`CalculateWebServices`,
 CalculateUtilities`FormatUtilities`Private`,
 CalculateUtilities`NumberUtilities`Private`,
 CalculateUtilities`StringUtilities`Private`,
 CalculateUtilities`SuggestPlotRanges`,
 CalculateUtilities`SuggestPlotRanges`Private`,
 CalculateUtilities`TextUtilities`Private`,
 CalculateUtilities`UserVariableUtilities`,
 CalculateUtilities`UserVariableUtilities`Private`, Calendar`, Calendar`Legacy`,
 CCodeGenerator`, CCompilerDriver`, Charting`, Charting`CommonDump`,
 Charting`ParserDump`, Charting`Private`, CloudObject`Private`, CloudSystem`,
 CloudSystem`Private`, ClusterAnalysis`FindClusters`, Combinatorica`Private`,
 Compile`, CompileDefinition`Private`, CompiledFunctionTools`, Compiler`,
 ComplexAnalysis`, ComputationalGeometry`, ComputationalGeometry`Dump`,
 ComputationalGeometry`Methods`, ComputationalGeometry`Surface`,
 ComputerArithmetic`, Conditional`, Control`, Control`Conxns`, Control`Delay`,

```
Control`DEqns`, Control`DiffGeom`, Control`Misc`, Control`NCS`,
Control`Patterns`, Control`PCS`, Control`PID`, Control`PlotUtilities`,
Control`PolePlace`, Control`Sim`, ControlSystems`, Control`Typesetting`,
Control`Utilities`, Conversion`, Convert`TeX`, CUDAInformation`,
CUDALink`, Data`, Database`, DatabaseLink`, DatabaseLink`Information`,
DataPaclets`, DataPaclets`CalendarDataDump`, DataPaclets`ColorData`,
DataPaclets`ColorDataDump`, DataPaclets`CommonDump`, DataPaclets`Dictionary`,
DataPaclets`FinancialDataDump`, DataScience`Procedures`Compatibility`,
DataScience`Utils`Lists`, DataScience`Utils`Patterns`,
DataScience`Utils`Predicates`, Dataset`, DateAndTime`, Debug`,
Debugger`, Deconvolve`, Developer`, DeviceAPI`BuildUtilities`,
DeviceFramework`, Devices`, Devices`Audio`, Devices`Developer`,
Devices`DeviceAPI`DeviceDump`, Devices`DeviceAPI`DeviceDump`DumpDump`,
DifferentialEquations`InterpolatingFunctionAnatomy`, Discrete`,
Discrete`DivisorSumDump`, Discrete`FourierFunctionsDump`,
DiscreteMath`DecisionDiagram`, Documentation`, DragAndDrop`, DrawPolarAxes`,
DSolve`, DSolve`DSolveToNDSolveDump`, DynamicChart`, DynamicDump`,
ElisionsDump`, Embedded`, EntityFramework`, EntityFramework`Private`,
EquationalLogic`, EquationalLogic`Private`, EquationTrekker`,
ErrorBarPlots`, Experimental`, Experimental`NumericalFunction`, Explore`,
ExternalService`, ExternalService`MailSettings`, ExternalService`Security`,
ExternalService`URIToolsDump`, ExternalService`Utilities`,
Extras`, Factor`, FE`, FE`PredictiveInterfaceDump`, FE`Private`,
FEPrivate`, FileFormatDump`, Finance`FinancialDerivativeDump`,
Finance`Solvers`, FindMinimum`, FindRoot`, FiniteFields`, FittedModels`,
FittedModels`FittedModelDump`, FittedModels`FittedModelDump`Private`,
FittedModels`FittedModelsCommonDump`, FittedModels`GLMDump`,
FittedModels`LinearFitDump`, FittedModels`NonlinearFitDump`, Format`,
FormulaData`Private`, FourierSeries`, FrontEnd`, FrontEnd`Private`,
FrontEnd`WolframCloud`, FunctionApproximations`, GenerateConditions`,
GeoGraphics`, GeometricFunctions`, GeometricFunctions`BernsteinBasis`,
GeometricFunctions`BSplineBasis`, GeometricFunctions`CardinalBSplineBasis`,
Geometry`, Geometry`BSPTree`, Geometry`Developer`, Geometry`Mesh`,
Geometry`Spatial`, GIS`, GIS`DMSDump`, Global`, GraphComputation`,
GraphComputation`GraphCoversDump`, Graphics`, GraphicsArray`,
Graphics`Glyphs`, Graphics`Glyphs`GlyphsDump`, Graphics`GraphicsGridDump`,
Graphics`Legacy`, Graphics`ListParserDump`, Graphics`MapPlotDump`,
Graphics`Mesh`, Graphics`Mesh`Developer`, Graphics`Mesh`FEM`,
Graphics`Mesh`SoS`, Graphics`PerformanceTuningDump`, Graphics`PolygonUtils`,
Graphics`PolygonUtils`Developer`, Graphics`Region`, Graphics`Units`,
GraphUtilities`, GridDump`, GroebnerBasis`, GroebnerBasis`GroebnerWalk`,
GroebnerGCD`, GroupTheory`GroupCountFunctionsDump`,
GroupTheory`PermutationGroups`, GroupTheory`PermutationGroupsDump`,
GroupTheory`PermutationGroups`Private`, GroupTheory`Symmetries`,
GroupTheory`Tools`, HierarchicalClustering`, Histogram`, Histograms`,
Holonomic`, Holonomic`Developer`, Holonomic`Private`, HTTPClient`,
HTTPClient`CURLInfo`, HTTPClient`CURLInfo`Private`, HTTPClient`CURLLink`,
HTTPClient`CURLLink`Private`, HTTPClient`OAuth`Private`,
HTTPClient`Private`, HypergeometricLogDump`, HypothesisTesting`,
Image`, Image`ColorOperationsDump`, Image`CompositionOperationsDump`,
Image`ExternalOCRDump`, Image`FilteringDump`, Image`HDRImageProcessingDump`,
Image`ImageDump`, Image`ImportExportDump`, Image`ITK`,
Image`LocalProcessingDump`, Image`MatricesDump`, Image`MeasurementsDump`,
Image`MorphologicalOperationsDump`, Image`PatternRecognitionDump`,
Image`RegistrationDump`, Image`SegmentationDump`, Image`SpatialOperationsDump`,
Image`StatisticalDescriptionsDump`, ImageTransformation`,
Image`TransformsDump`, IMAQ`, IMAQ`Driver`, IMAQ`Utilities`,
ImportExport`, ImportExport`Encodings`, ImportExport`FileUtilities`,
ImportExport`Private`, Inpaint`, Integrate`, Integrate`Elliptic`,
Integrate`ImproperDump`, Integrate`NLtheoremDump`, Internal`,
Internal`BernoulliB`, Internal`FunctionExpand`, Internal`HypergeometricPFQ`,
Internal`Integrate`, Internal`MWASymbols`, Internal`ProcessEquations`,
java`util`GregorianCalendar`, JLink`, JLink`Information`, JSONTools`, Language`,
Legending`, Legending`LegendDump`, LibraryLink`, Limit`, LinearAlgebra`,
LinearAlgebra`BLAS`, LinearAlgebra`DeconvolveDump`, LinearAlgebra`Fourier`,
LinearAlgebra`Implementations`, LinearAlgebra`Internal`, LinearAlgebra`LAPACK`,
LinearAlgebra`LinearSolve`, LinearAlgebra`MatrixExp`, LinearAlgebra`Private`,
LinearRegression`, Manipulate`, Manipulate`Dump`, MarkovProcesses`,
```

```
MathLink`, MathLink`Information`, MatrixFunction`, MatrixLog`,
MatrixPower`, MatrixSqrt`, Method`, MLFS`, MultivariateResultant`,
MUnit`, MUnit`Package`, Music`, NDSolve`, NDSolve`Chasing`,
NDSolve`Chasing`Implementation`, NDSolve`EventLocator`, NDSolve`FEM`,
NDSolve`FEM`FEMErrorCheckingDump`, NDSolve`FEM`ShapeFunctionsDump`,
NDSolve`FiniteDifferenceDerivativeFunction`, NDSolve`MethodOfLines`,
NDSolve`MultistepDump`, NDSolve`Newton`, NDSolve`ProcessEquations`,
NDSolve`Shooting`Implementation`, NDSolve`StateData`, NETLink`,
NETLink`Information`, Network`GraphPlot`, NIntegrate`, NIntegrate`OscNInt`,
NMinimize`, NotebookCompatibility`, NotebookTemplating`, NotebookTools`,
NotebookTools`ControlsDump`, NotebookTools`UtilitiesDump`,
NProduct`, NRoots`, NRoots`Private`, NSolve`, NSum`, NumberTheory`,
NumberTheory`AESDump`, NumberTheory`DirichletFunctionsDump`,
NumberTheory`NumberTheoryFunctionsDump`, NumberTheory`PrimePowerQDump`,
NumberTheory`RamanujanTauDump`, NumberTheory`RandomPrimeDump`,
NumberTheory`SquareFreeQDump`, NumberTheory`SquaresRDump`,
NumericalCalculus`, NumericalDifferentialEquationAnalysis`,
NumericalMath`, OpenCLInformation`, OpenCLLink`, Optimization`,
Optimization`FindFit`, Optimization`LinearProgramming`,
Optimization`LinearProgramming`Private`, Optimization`LineSearch`,
Optimization`MPSData`, OutputSizeLimit`, OutputSizeLimit`Dump`,
Package`, PacletManager`, PacletManager`Collection`Private`,
PacletManager`Documentation`Private`, PacletManager`Extension`Private`,
PacletManager`Information`, PacletManager`LayoutDocsCollection`Private`,
PacletManager`Manager`Private`, PacletManager`MemoryCollection`Private`,
PacletManager`Package`, PacletManager`Packer`Private`,
PacletManager`Paclet`Private`, PacletManager`Private`,
PacletManager`Services`Private`, PacletManager`Utils`Private`,
PacletManager`Zip`Private`, PacletTools`, Parallel`Debug`, Parallel`Developer`,
Parallel`Information`, Parallel`Palette`, Parallel`Palette`Private`,
Parallel`Private`, Parallel`Settings`, Parallel`Static`, Periodic`,
Periodic`PeriodicFunctionDump`, Periodic`PeriodicWavesDump`,
Periodic`Private`, Periodic`Private`PeriodicToolsDump`, PhysicalConstants`,
PlanetaryAstronomy`, PlanetaryAstronomy`Private`, PlotLegends`, Predictions`,
Predictions`Private`, PredictionStartupDump`, PredictiveInterface`,
PredictiveInterfaceDump`, PredictiveInterfaceLoader`Private`, Private`,
Product`, Quantifier`, QuantityUnits`, QuantityUnits`Private`, Quaternions`,
Random`, Random`Private`, RandomProcesses`, RandomProcesses`Library`,
RandomProcesses`MarkovChainDump`, RandomProcesses`MarkovProcessUtilities`,
RandomProcesses`Simulation`, RandomProcesses`TimeSeriesCommon`,
RandomProcesses`Utilities`, RandomProcesses`Utilities`BuildTimeUtilitiesDump`,
Reduce`, Region`, Region`Mesh`, Region`Mesh`Utilities`, Region`Private`,
RegressionCommon`, RegularChains`Private`, Reliability`Library`,
ResonanceAbsorptionLines`, ResourceLocator`, ResourceLocator`Private`,
RLink`, RomanNumerals`, RootReduce`Private`, RootsDump`, RSolve`,
RuntimeTools`, RuntimeTools`Dump`, Semantic`AmbiguityDump`, Semantic`PLIDump`,
SequenceLimit`, Series`Private`, Signal`, Signal`FilterDesignDump`,
Signal`FilteringDump`, Signal`FiltersDump`, Signal`Utils`,
SimilarityScoreMatrices`, Simplify`, SimplifyDump`, Simplify`Private`, Solve`,
Sound`, SparseArray`, SparseArray`Private`, SparseArray`SparseBlockArray`,
SpecialFunctions`, SpecialFunctions`Private`, Splines`, StandardAtmosphere`,
StatisticalPlots`, Statistics`, Statistics`Compatibility`,
Statistics`CoxModelFitDump`, Statistics`CoxModelFitDump`Private`,
Statistics`CoxModelFitDump`Private`$ExportedSymbolse`,
Statistics`DataDistributionUtilities`,
Statistics`HypothesisTestingUtilitiesDump`,
Statistics`HypothesisTestingUtilitiesDump`Private`,
Statistics`Library`, Statistics`MomentOperationsDump`,
Statistics`MomentOperationsDump`Private`, Statistics`QuantityUtilities`,
Statistics`SurvivalAnalysisTools`, Statistics`SurvivalDistributionDump`,
Statistics`SurvivalModelFitDump`, Statistics`SurvivalModelFitDump`Private`,
Statistics`SurvivalModelFitDump`Private`$ExportedSymbolse`,
Statistics`Utilities`, StochasticCalculus`, StringPattern`,
StringPattern`Dump`, StringPattern`Lexer`, StructuredArray`,
StructuredArray`StructuredArrayDump`, StructureDetection`, StyleManager`,
Sum`, SurfaceGraphics`, SurfaceGraphics`Methods`, SymbolicC`,
SymbolicTensors`, SymbolicTensors`SymbolicTensorsDump`, System`,
System`BarChartDump`, System`BarnesDump`, System`BarnesDump`Private`,
```

```
System`BellDump`, System`BernoulliDump`, System`BesselParamDerivativesDump`,
System`BinaryReadDump`, System`ClebschGordanDump`, System`CompileDump`,
System`ComplexDynamicsDump`, System`ComplexExpand`,
System`ComplexExpandDump`, System`Convert`BitmapDump`,
System`Convert`CommonDump`, System`Convert`CSSDump`,
System`ConvertersDump`, System`ConvertersDump`Utilities`,
System`ConvertersDump`Utilities`Private`, System`Convert`HTMLDump`,
System`Convert`MathMLDump`, System`Convert`MovieDump`,
System`Convert`NewickDump`, System`Convert`TableDump`, System`Convert`TeXDump`,
System`Convert`TeXImportDump`, System`Convert`TextDump`, System`CrossDump`,
System`DateObjectDump`, System`DateStringDump`, System`DiscretePlotDump`,
System`Dump`, System`Dump`CommonPatterns`, System`Dump`GeoLocationDump`,
System`Dump`IMAQDump`, System`Dump`ParameterValidation`,
System`EllipticDump`, System`Environment`, System`ErrorBarsDump`,
System`FEDump`, System`FibonacciDump`, System`FibonacciDump`Private`,
System`FileExportListDump`, System`FourierTransformDump`,
System`FunctionInterpolationDump`, System`FunctionZerosDump`,
System`GatherDump`, System`GroebnerBasisDump`, System`HankelDump`,
System`HarmonicNumberDump`, System`HypergeometricDump`,
System`HypergeometricPFQDump`, System`InflationAdjust`Private`,
System`InfoDump`, System`InputOutput`, System`InstanceDump`,
System`IntegerPartitionsDump`, System`InterpolatingFunction`,
System`InverseFunctionDump`, System`KelvinDump`, System`LanguageEnhancements`,
System`LaplaceTransformDump`, System`MeijerGDump`, System`NielsenDump`,
System`NOfOptimizeDump`, System`NSolveDump`, System`Parallel`,
System`PlotThemeDump`, System`PowerReduceDump`, System`PrepElemDump`,
System`Private`, System`Private`charFuns`, System`ProtoPlotDump`,
System`ReduceDump`, System`ReduceUtilsDump`, System`SeriesDump`,
System`SphericalBesselDump`, System`StatisticalFunctionsDump`,
System`StruveDump`, System`StruveDump`Private`,
System`TransformationFunctionDump`, System`TrigToRadicalsDump`,
System`TSolveDump`, System`Utilities`, System`WhittakerDump`,
System`ZetaDerivativeDump`, t`, TableView`, Templating`, TemporalData`,
TemporalData`Utilities`, TetGenLink`, Themes`, TimeZone`, TreeBrowse`,
Typeset`, Units`, URLEncoder`, Utilities`URLTools`, ValueTrack`,
VectorAnalysis`, VectorFieldPlots`, Visualization`, Visualization`Core`,
Visualization`DiscontinuityDump`, Visualization`Interpolation`,
Visualization`LegendsDump`, Visualization`Utilities`,
Visualization`Utilities`OptionsDump`, Visualization`Utilities`ScalingDump`,
Visualization`VectorFields`, Visualization`VectorFields`VectorFieldsDump`,
VLFeat`Private`, Wavelets`, Wavelets`LiftingFilter`, Wavelets`WaveletData`,
Wavelets`WaveletListPlot`, Wavelets`WaveletPlot2D`, Wavelets`WaveletScalogram`,
Wavelets`WaveletUtilities`, WebPredictions`, WebPredictions`Private`,
WebServices`, WebServices`Information`, WolframAlphaClient`Private`,
WorldPlot`, WrappersDump`, WSMLink`, WSTP`ServiceDiscovery`, XML`, XML`MathML`,
XML`MathML`Symbols`, XML`NotebookML`, XML`Parser`, XML`RSS`, XML`SVG`}
```

a[1] = Pi

π

```
FunSer[func_, x_, n_] :=
Module[{i}, Sum[ a[i] func[i x], {i,1,n}]]

FunSer[Cos,x,5]
```

$\pi \, \text{Cos}[x] + a[2] \, \text{Cos}[2\, x] + a[3] \, \text{Cos}[3\, x] + a[4] \, \text{Cos}[4\, x] + a[5] \, \text{Cos}[5\, x]$

```
FunSerm[func_, x_, n_] :=
Module[{i, a}, Sum[ a[i] func[i x], {i,1,n}]]

FunSerm[Cos,x,5]
```

$a\$22953[1] \, \text{Cos}[x] + a\$22953[2] \, \text{Cos}[2\, x] +$
$a\$22953[3] \, \text{Cos}[3\, x] + a\$22953[4] \, \text{Cos}[4\, x] + a\$22953[5] \, \text{Cos}[5\, x]$

```
FunSerb[func_, x_, n_] :=
Block[{i, a}, Sum[ a[i] func[i x], {i,1,n}]]
```

```
FunSerb[Cos,x,5]
```

$\pi \text{Cos}[x] + a[2] \text{Cos}[2 x] + a[3] \text{Cos}[3 x] + a[4] \text{Cos}[4 x] + a[5] \text{Cos}[5 x]$

22.3.4 A List of All Mathematica Commands

```
$Version
```

```
10.0 for Mac OS X x86 (64-bit) (December 4, 2014)
```

In view of the above removals one must start the notebook anew !

> **?***   gives a list with all the Mathematica commands

See yourself !

```
? *
```

▼ **System`**

| a |
| b |
| c |
| d |
| e |
| f |
| g |
| h |
| i |
| j |
| k |
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| s |
| t |
| u |
| v |
| w |
| x |
| y |
| z |
| A |
| B |
| C |
| D |
| E |
| F |
| G |
| H |
| I |
| J |
| K |
| L |
| M |
| N |
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P
Σ
T
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Φ
X
Ψ
Ω
α
β
γ
δ
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ζ
η
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κ
λ
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σ
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υ
φ
χ
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ω

AASTriangle
AbelianGroup
Abort
AbortKernels
AbortProtect
Above
Abs
Absolute
AbsoluteCorrelation
AbsoluteCorrelationFunction
AbsoluteCurrentValue
AbsoluteDashing
AbsoluteFileName
AbsoluteOptions
AbsolutePointSize
AbsoluteThickness
AbsoluteTime
AbsoluteTiming
AccountingForm
Accumulate
Accuracy
AccuracyGoal
ActionDelay
ActionMenu
ActionMenuBox
ActionMenuBoxOptions
Activate
Active
ActiveItem
ActiveStyle
AcyclicGraphQ
AddOnHelpPath
AddTo
AddUsers
AdjacencyGraph
AdjacencyList
AdjacencyMatrix
AdjustmentBox
AdjustmentBoxOptions
AdjustTimeSeriesForecast
AdministrativeDivisionData
AffineStateSpaceModel
AffineTransform
After
AircraftData
AirportData
AirPressureData
AirTemperatureData
AiryAi
AiryAiPrime
AiryAiZero
AiryBi
AiryBiPrime
AiryBiZero
AlgebraicIntegerQ
AlgebraicNumber
AlgebraicNumberDenominator
AlgebraicNumberNorm
AlgebraicNumberPolynomial

AlgebraicNumberTrace

AlgebraicRules

AlgebraicRulesData

Algebraics

AlgebraicUnitQ

Alignment

AlignmentMarker

AlignmentPoint

All

AllowedDimensions

AllowedHeads

AllowGroupClose

AllowIncomplete

AllowInlineCells

AllowKernelInitialization

AllowLooseGrammar

AllowReverseGroupClose

AllowScriptLevelChange

AllowTransliteration

AllTrue

AlphaChannel

AlternateImage

AlternatingFactorial

AlternatingGroup

AlternativeHypothesis

Alternatives

AltitudeMethod

AmbientLight

AmbiguityFunction

AmbiguityList

Analytic

AnchoredSearch

And

AndersonDarlingTest

AngerJ

AngleBracket

AngularGauge

Animate

AnimationCycleOffset

AnimationCycleRepetitions

AnimationDirection

AnimationDisplayTime

AnimationRate

AnimationRepetitions

AnimationRunning

AnimationRunTime

AnimationTimeIndex

Animator

AnimatorBox

AnimatorBoxOptions

AnimatorElements

Annotation

Annuity

AnnuityDue

Antialiasing

AntihermitianMatrixQ

Antisymmetric

AntisymmetricMatrixQ

AnyOrder

AnyTrue

Apart

ApartSquareFree

APIFunction

APIFunctionGroup

Appearance

AppearanceElements

AppearanceRules

AppellF1

Append

AppendTo

Apply

ArcCos

ArcCosh

ArcCot

ArcCoth

ArcCsc

ArcCsch

ArcCurvature

ARCHProcess

ArcLength

ArcSec

ArcSech

ArcSin

ArcSinDistribution

ArcSinh

ArcTan

ArcTanh

Area

Arg

ArgMax

ArgMin

ArgumentCountQ

ARIMAProcess

ArithmeticGeometricMean

ARMAProcess

ARProcess

Array

ArrayComponents

ArrayDepth

ArrayFlatten

ArrayPad

ArrayPlot

ArrayQ

ArrayResample

ArrayReshape

ArrayRules

Arrays

Arrow

Arrow3DBox

ArrowBox

Arrowheads

ASATriangle

AspectRatio

AspectRatioFixed

Assert

AssociateTo

Association

AssociationFormat

AssociationMap

AssociationQ

AssociationThread

Assuming

Assumptions

AstronomicalData

AsymptoticOutputTracker

Asynchronous

AsynchronousTaskObject

AsynchronousTasks

AtomQ

Attributes

AugmentedSymmetricPolynomial

AutoAction

AutocorrelationTest

AutoDelete

AutoEvaluateEvents

AutoGeneratedPackage

AutoIndent

AutoIndentSpacings

AutoItalicWords

AutoloadPath

AutoMatch

Automatic

AutomaticImageSize

AutoMultiplicationSymbol

AutoNumberFormatting

AutoOpenNotebooks

AutoOpenPalettes

AutoRemove

AutorunSequencing

AutoScaling

AutoScroll

AutoSpacing

AutoStyleOptions

AutoStyleWords

AutoSubmitting

Axes

AxesEdge

AxesLabel

AxesOrigin

AxesStyle

Axis

BabyMonsterGroupB

Back

Background

BackgroundTasksSettings

Backslash

Backsubstitution

Backward

Ball

Band

BandpassFilter

BandstopFilter

BarabasiAlbertGraphDistribution

BarChart

BarChart3D

BarcodeImage

BarcodeRecognize

BarLegend

BarlowProschanImportance

BarnesG

BarOrigin

BarSpacing

BartlettHannWindow

BartlettWindow

BaseForm

Baseline

BaselinePosition

BaseStyle

BatesDistribution

BattleLemarieWavelet

Because

BeckmannDistribution

Beep

Before

Begin

BeginDialogPacket

BeginFrontEndInteractionPacket

BeginPackage

BellB

BellY

Below

BenfordDistribution

BeniniDistribution

BenktanderGibratDistribution

BenktanderWeibullDistribution

BernoulliB

BernoulliDistribution

BernoulliGraphDistribution

BernoulliProcess

BernsteinBasis

BesselFilterModel

BesselI

BesselJ

BesselJZero

BesselK

BesselY

BesselYZero

Beta

BetaBinomialDistribution

BetaDistribution

BetaNegativeBinomialDistribution

BetaPrimeDistribution

BetaRegularized

BetweennessCentrality

BezierCurve

BezierCurve3DBox

BezierCurve3DBoxOptions

BezierCurveBox

BezierCurveBoxOptions

BezierFunction

BilateralFilter

Binarize

BinaryFormat

BinaryImageQ

BinaryRead

BinaryReadList

BinaryWrite
BinCounts
BinLists
Binomial
BinomialDistribution
BinomialProcess
BinormalDistribution
BiorthogonalSplineWavelet
BipartiteGraphQ
BirnbaumImportance
BirnbaumSaundersDistribution
BitAnd
BitClear
BitGet
BitLength
BitNot
BitOr
BitSet
BitShiftLeft
BitShiftRight
BitXor
Black
BlackmanHarrisWindow
BlackmanNuttallWindow
BlackmanWindow
Blank
BlankForm
BlankNullSequence
BlankSequence
Blend
Block
BlockRandom
BlomqvistBeta
BlomqvistBetaTest
Blue
Blur
BodePlot
BohmanWindow
Bold
Bookmarks
Boole
BooleanConsecutiveFunction
BooleanConvert
BooleanCountingFunction
BooleanFunction
BooleanGraph
BooleanMaxterms
BooleanMinimize
BooleanMinterms
BooleanQ
BooleanRegion
Booleans
BooleanStrings
BooleanTable
BooleanVariables
BorderDimensions
BorelTannerDistribution
Bottom
BottomHatTransform

BoundaryDiscretizeGraphics
BoundaryDiscretizeRegion
BoundaryMesh
BoundaryMeshRegion
BoundaryMeshRegionQ
BoundaryStyle
BoundedRegionQ
Bounds
Box
BoxBaselineShift
BoxData
BoxDimensions
Boxed
Boxes
BoxForm
BoxFormFormatTypes
BoxFrame
BoxID
BoxMargins
BoxMatrix
BoxObject
BoxRatios
BoxRotation
BoxRotationPoint
BoxStyle
BoxWhiskerChart
Bra
BracketingBar
BraKet
BrayCurtisDistance
BreadthFirstScan
Break
BridgeData
BroadcastStationData
Brown
BrownForsytheTest
BrownianBridgeProcess
BrowserCategory
BSplineBasis
BSplineCurve
BSplineCurve3DBox
BSplineCurveBox
BSplineCurveBoxOptions
BSplineFunction
BSplineSurface
BSplineSurface3DBox
BubbleChart
BubbleChart3D
BubbleScale
BubbleSizes
BuildingData
BulletGauge
BusinessDayQ
ButterflyGraph
ButterworthFilterModel
Button
ButtonBar
ButtonBox
ButtonBoxOptions

ButtonCell
ButtonContents
ButtonData
ButtonEvaluator
ButtonExpandable
ButtonFrame
ButtonFunction
ButtonMargins
ButtonMinHeight
ButtonNote
ButtonNotebook
ButtonSource
ButtonStyle
ButtonStyleMenuListing
Byte
ByteCount
ByteOrdering
C
CachedValue
CacheGraphics
CalendarConvert
CalendarData
CalendarType
CallPacket
CanberraDistance
Cancel
CancelButton
CandlestickChart
CanonicalGraph
CanonicalName
CantorStaircase
Cap
CapForm
CapitalDifferentialD
CardinalBSplineBasis
CarlemanLinearize
CarmichaelLambda
Cases
CaseSensitive
Cashflow
Casoratian
Catalan
CatalanNumber
Catch
Catenate
CauchyDistribution
CauchyWindow
CayleyGraph
CDF
CDFDeploy
CDFInformation
CDFWavelet
Ceiling
CelestialSystem
Cell
CellAutoOverwrite
CellBaseline
CellBoundingBox
CellBracketOptions

CellChangeTimes
CellContents
CellContext
CellDingbat
CellDynamicExpression
CellEditDuplicate
CellElementsBoundingBox
CellElementSpacings
CellEpilog
CellEvaluationDuplicate
CellEvaluationFunction
CellEventActions
CellFrame
CellFrameColor
CellFrameLabelMargins
CellFrameLabels
CellFrameMargins
CellGroup
CellGroupData
CellGrouping
CellGroupingRules
CellHorizontalScrolling
CellID
CellLabel
CellLabelAutoDelete
CellLabelMargins
CellLabelPositioning
CellMargins
CellObject
CellOpen
CellPrint
CellProlog
Cells
CellSize
CellStyle
CellTags
CellularAutomaton
CensoredDistribution
Censoring
Center
CenterDot
CentralMoment
CentralMomentGeneratingFunction
CForm
ChampernowneNumber
ChanVeseBinarize
Character
CharacterEncoding
CharacterEncodingsPath
CharacteristicFunction
CharacteristicPolynomial
CharacterRange
Characters
ChartBaseStyle
ChartElementData
ChartElementDataFunction
ChartElementFunction
ChartElements
ChartLabels

ChartLayout
ChartLegends
ChartStyle
Chebyshev1FilterModel
Chebyshev2FilterModel
ChebyshevDistance
ChebyshevT
ChebyshevU
Check
CheckAbort
CheckAll
Checkbox
CheckboxBar
CheckboxBox
CheckboxBoxOptions
ChemicalData
ChessboardDistance
ChiDistribution
ChineseRemainder
ChiSquareDistribution
ChoiceButtons
ChoiceDialog
CholeskyDecomposition
Chop
ChromaticityPlot
ChromaticityPlot3D
ChromaticPolynomial
Circle
CircleBox
CircleDot
CircleMinus
CirclePlus
CircleTimes
CirculantGraph
Circumsphere
CityData
ClassifierFunction
ClassifierInformation
ClassifierMeasurements
Classify
ClassPriors
Clear
ClearAll
ClearAttributes
ClearSystemCache
ClebschGordan
ClickPane
Clip
ClipboardNotebook
ClipFill
ClippingStyle
ClipPlanes
ClipPlanesStyle
ClipRange
Clock
ClockGauge
ClockwiseContourIntegral
Close
Closed

CloseKernels
ClosenessCentrality
Closing
ClosingAutoSave
ClosingEvent
CloudAccountData
CloudBase
CloudConnect
CloudDeploy
CloudDirectory
CloudDisconnect
CloudEvaluate
CloudExport
CloudFunction
CloudGet
CloudImport
CloudObject
CloudObjectInformation
CloudObjectInformationData
CloudObjects
CloudPut
CloudSave
CloudSymbol
ClusteringComponents
CMYKColor
Coarse
CodeAssistOptions
Coefficient
CoefficientArrays
CoefficientDomain
CoefficientList
CoefficientRules
CoifletWavelet
Collect
Colon
ColonForm
ColorCombine
ColorConvert
ColorCoverage
ColorData
ColorDataFunction
ColorDistance
ColorFunction
ColorFunctionScaling
Colorize
ColorNegate
ColorOutput
ColorProfileData
ColorQ
ColorQuantize
ColorReplace
ColorRules
ColorSelectorSettings
ColorSeparate
ColorSetter
ColorSetterBox
ColorSetterBoxOptions
ColorSlider
ColorSpace

Column
ColumnAlignments
ColumnBackgrounds
ColumnForm
ColumnLines
ColumnsEqual
ColumnSpacings
ColumnSpans
ColumnWidths
CombinerFunction
CometData
CommonDefaultFormatTypes
Commonest
CommonestFilter
CommonName
CommonUnits
CommunityBoundaryStyle
CommunityGraphPlot
CommunityLabels
CommunityRegionStyle
CompanyData
CompatibleUnitQ
CompilationOptions
CompilationTarget
Compile
Compiled
CompiledFunction
Complement
CompleteGraph
CompleteGraphQ
CompleteKaryTree
CompletionsListPacket
Complex
Complexes
ComplexExpand
ComplexInfinity
ComplexityFunction
ComponentMeasurements
ComponentwiseContextMenu
Compose
ComposeList
ComposeSeries
CompositeQ
Composition
CompoundExpression
CompoundPoissonDistribution
CompoundPoissonProcess
CompoundRenewalProcess
Compress
CompressedData
Condition
ConditionalExpression
Conditioned
Cone
ConeBox
ConfidenceLevel
ConfidenceRange
ConfidenceTransform
ConfigurationPath

ConformImages
Congruent
ConicHullRegion
ConicHullRegion3DBox
ConicHullRegionBox
Conjugate
ConjugateTranspose
Conjunction
Connect
ConnectedComponents
ConnectedGraphQ
ConnectedMeshComponents
ConnectLibraryCallbackFunction
ConnesWindow
ConoverTest
ConsoleMessage
ConsoleMessagePacket
ConsolePrint
Constant
ConstantArray
ConstantImage
ConstantRegionQ
Constants
ConstellationData
ConstrainedMax
ConstrainedMin
ContentPadding
ContentsBoundingBox
ContentSelectable
ContentSize
Context
ContextMenu
Contexts
ContextToFilename
ContextToFileName
Continuation
Continue
ContinuedFraction
ContinuedFractionK
ContinuousAction
ContinuousMarkovProcess
ContinuousTimeModelQ
ContinuousWaveletData
ContinuousWaveletTransform
ContourDetect
ContourGraphics
ContourIntegral
ContourLabels
ContourLines
ContourPlot
ContourPlot3D
Contours
ContourShading
ContourSmoothing
ContourStyle
ContraharmonicMean
Control
ControlActive
ControlAlignment

ControllabilityGramian
ControllabilityMatrix
ControllableDecomposition
ControllableModelQ
ControllerDuration
ControllerInformation
ControllerInformationData
ControllerLinking
ControllerManipulate
ControllerMethod
ControllerPath
ControllerState
ControlPlacement
ControlsRendering
ControlType
Convergents
ConversionOptions
ConversionRules
ConvertToBitmapPacket
ConvertToPostScript
ConvertToPostScriptPacket
ConvexHullMesh
Convolve
ConwayGroupCo1
ConwayGroupCo2
ConwayGroupCo3
CoordinateChartData
CoordinatesToolOptions
CoordinateTransform
CoordinateTransformData
CoprimeQ
Coproduct
CopulaDistribution
Copyable
CopyDirectory
CopyFile
CopyTag
CopyToClipboard
CornerFilter
CornerNeighbors
Correlation
CorrelationDistance
CorrelationFunction
CorrelationTest
Cos
Cosh
CoshIntegral
CosineDistance
CosineWindow
CosIntegral
Cot
Coth
Count
CountDistinct
CountDistinctBy
CounterAssignments
CounterBox
CounterBoxOptions
CounterClockwiseContourIntegral

CounterEvaluator

CounterFunction

CounterIncrements

CounterStyle

CounterStyleMenuListing

CountRoots

CountryData

Counts

CountsBy

Covariance

CovarianceEstimatorFunction

CovarianceFunction

CoxianDistribution

CoxIngersollRossProcess

CoxModel

CoxModelFit

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$UserAgentString

$UserAgentVersion

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$VersionNumber

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$WolframUUID

λ

▼ **PacletManager`**

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GetVirtualCellGroup	PacletSiteRemove
PackPaclet	PacletSites
Paclet	PacletSiteUpdate
PacletCheckUpdate	PacletUninstall
PacletDirectoryAdd	PacletUpdate
PacletDirectoryRemove	RebuildPacletData
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PacletEnable	SetInternetProxy
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PacletFindRemote	UseInternetProxy
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The number of *Mathematica* commands is found in the following way:

```
$Version
cmdList = Names["*"];
Length[cmdList]
```

5369

10.0 for Mac OS X x86 (64-bit) (December 4, 2014)

5406

10.0 for Mac OS X x86 (64-bit) (September 10, 2014)

4672

9.0 for Mac OS X x86 (64-bit) (January 24, 2013)

Above is the list contained in the file .

```
$Version
cmdList = Names["*"];
Length[cmdList]
```