SAS® Viya®

The R Perspective

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SAS® Viya®: The R Perspective

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About This Book

What Does This Book Cover?

This book is an introduction to using the R client on the SAS Viya platform. SAS Viya is a high-performance, fault-tolerant analytics architecture that can be deployed on both public and private cloud infrastructures. Although SAS Viya can be used by various SAS applications, it also enables you to access analytic methods from SAS, R, Python, Lua, and Java, as well as through a REST interface using HTTP or HTTPS. Of course, in this book we focus on the perspective of SAS Viya from R.

SAS Viya consists of multiple components. The central piece of this ecosystem is SAS Cloud Analytic Services (CAS). CAS is the cloud-based server that all clients communicate with to run analytical methods. The R client is used to drive the CAS component directly using objects and constructs that are familiar to R programmers.

We assume that you have some knowledge about R before you approach the topics in this book. We do not assume any knowledge of CAS itself. However, you must have a CAS server that is set up and is running in order to execute the examples in this book.

The chapters in the first part of the book cover topics from the installation of R to the basics of connecting, loading data, and getting simple analyses from CAS. Depending on your familiarity with R, after reading the "Ten-Minute Guide to Using CAS from R," you might feel comfortable enough to jump to the chapters later in the book that are dedicated to statistical methods. However, the chapters in the middle of the book cover more detailed information about working with CAS, such as constructing action calls to CAS and processing the results, error handling, managing your data in CAS, and using object interfaces to CAS actions and CAS data tables. Finally, the last chapter about advanced topics covers features and workflows that you might want to take advantage of when you are more experienced with the R client.

This book covers topics that are useful to complete beginners, as well as to experienced CAS users. Its examples extend from creating connections to CAS to simple statistics and machine learning. The book is also useful as a desktop reference.

Is This Book for You?

If you are using the SAS Viya platform in your work and you want to access analytics from SAS Cloud Analytic Services (CAS) using R, then this book is a great starting point. You'll learn about general CAS workflows, as well as the R client that is used to communicate with CAS.

What Are the Prerequisites for This Book?

Some R experience is definitely helpful while reading this book. If you do not know R, there is a multitude of resources on the internet for learning R. The later chapters in the book cover data analysis and modeling topics. Although the examples provide step-by-step code walk-throughs, some training about these topics beforehand is helpful.

What Should You Know about the Examples?

This book includes tutorials for you to follow to gain hands-on experience with SAS.

Software Used to Develop the Book's Content

This book was written using Version 1.3.0 of the SAS Scripting Wrapper for Analytics Transfer (SWAT) package for R. SAS Viya 3.3 was used. Various R resources and packages were used as well. SWAT works with many versions of these packages. The URLs of SWAT and other resources are shown as follows:

SAS Viya
`www.sas.com/en_us/software/viya.html`

SAS Scripting Wrapper for Analytics Transfer (SWAT) – R client to CAS
`github.com/sassoftware/R-swat` **(GitHub repository)**

R
`https://www.r-project.org/`

RStudio – an integrated development environment (IDE) for R
`https://www.rstudio.com/`

Example Code and Data

You can access the example code and data for this book by going to the author page at https://support.sas.com/authors or on GitHub at: https://github.com/sassoftware/sas-viya-the-R-perspective.

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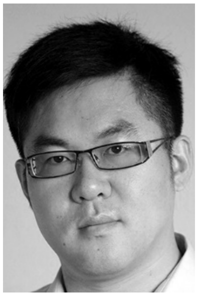

Yue Qi, PhD, is a staff scientist at SAS. He works on automated and adaptive machine learning pipelines, deep learning models on unstructured data, interactive data visualization, and open-source language integration. He has extensive experience in applying these technologies to develop analytics products, build successful models on big data for customers, and help customers solve their most challenging business problems, especially in the finance industry.

Kevin D. Smith has been a software developer at SAS since 1997. He began his career in the development of PROC TEMPLATE and other underlying ODS technologies, including authoring two books on the subjects. He is now heavily involved in client-side work on the SAS® Viya® platform. This includes development of the R, Python, and Lua SWAT packages, as well as higher-level packages built on top of the foundation created by SWAT.

Xiangxiang Meng, PhD, is a Senior Product Manager at SAS. The current focus of his work is on SAS® Visual Statistics, deep learning, reinforcement learning, the Python interface to SAS® Viya®, and other new product initiatives. Previously, Xiangxiang worked on SAS® LASR™ Analytic Server, SAS® In-Memory Statistics for Hadoop, SAS Recommendation Systems, and SAS® Enterprise Miner™. His research interests include deep learning and reinforcement learning, automated and cognitive pipelines for business intelligence and machine learning, and parallelization of machine learning algorithms on distributed data. Xiangxiang received his PhD and MS from the University of Cincinnati.

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http://support.sas.com/Meng

Chapter 2: The Ten-Minute Guide to Using CAS from R

If you are already familiar with R, have a running CAS server, and just can’t wait to get started, we’ve written this chapter just for you. This chapter is a very quick summary of what you can do with CAS from R. We don’t provide a lot of explanation of the examples; that comes in the later chapters. This chapter is here for those who want to dive in and work through the details in the rest of the book as needed.

Loading SWAT and Getting Connected

The only thing that you need to know about the CAS server in order to get connected is the host name, the port number, your user name, and your password. The last two items might even be optional if you are using an Authinfo file, which is explained in detail in Chapter 3. The SWAT package contains the CAS class that is used to talk to the server. The arguments to the CAS class are host name, port, user name, and password, in that order.[1] Note that you can use the REST interface by specifying the HTTP port that is specified by the CAS server. The CAS class can auto detect the port type for the standard CAS port and HTTP. However, if you use HTTPS, you must specify protocol=’https’ as a keyword argument when you start a CAS connection. You can also specify ‘cas’ or ‘http’ to explicitly override auto detection.

```
> library('swat')
```

```
SWAT 0.1.3
```

```
> conn <- CAS('server-name.mycompany.com', 8777, 'username', 'password')
```

```
Connecting to CAS and generating CAS action functions for loaded action sets...
To generate the functions with signatures (for tab completion), add
'genActSyntax=TRUE' to your connection parms.
```

When you connect to CAS, it creates a session on the server. By default, all resources (CAS actions, data tables, options, and so on) are available only to that session. Some resources can be promoted to a global scope, which we discuss later in the book.

To see what CAS actions are available, use the cas.builtins.help method on the CAS connection object, which calls the help action in builtins action set on the CAS server.

```
> out <- cas.builtins.help(conn)
```

```
NOTE: Available Action Sets and Actions:
NOTE:    accessControl
NOTE:       assumeRole - Assumes a role
NOTE:       dropRole - Relinquishes a role
NOTE:       showRolesIn - Shows the currently active role
NOTE:       showRolesAllowed - Shows the roles that a user is a member
                               of
NOTE:       isInRole - Shows whether a role is assumed
NOTE:       isAuthorized - Shows whether access is authorized
NOTE:       isAuthorizedActions - Shows whether access is authorized to
                                  actions
NOTE:       isAuthorizedTables - Shows whether access is authorized to
                                 tables
NOTE:       isAuthorizedColumns - Shows whether access is authorized to
                                  columns
NOTE:       listAllPrincipals - Lists all principals that have explicit
                                access controls
NOTE:       whatIsEffective - Lists effective access and explanations
                              (Origins)
...
NOTE:       partition - Partitions a table
NOTE:       shuffle - Randomly shuffles a table
NOTE:       recordCount - Shows the number of rows in a Cloud Analytic
                          Services table
NOTE:       loadDataSource - Loads one or more data source interfaces
NOTE:       update - Updates rows in a table
```

The return values from all actions are in the form of the R list class. To see a list of names of all of the list members, use the names() function just as you would with any R list. In this case, the object names correspond to the names of the CAS action sets.

```
> names(out)
 [1] "accessControl"  "builtins"       "configuration"
 [4] "dataPreprocess" "dataStep"       "percentile"
 [7] "search"         "session"        "sessionProp"
[10] "simple"         "table"
```

Printing the contents of the return value shows all of the top-level list members as sections. The builtins.help action returns the information about each action set in a table. These tables are stored in the output as casDataFrames**.**

```
> out
$accessControl
```

	Name	Description
1	assumeRole	Assumes a role
2	dropRole	Relinquishes a role
3	showRolesIn	Shows the currently active role
4	showRolesAllowed	Shows the roles that a user is a member of
5	isInRole	Shows whether a role is assumed

	Name	Description
6	isAuthorized	Shows whether access is authorized
7	isAuthorizedActions	Shows whether access is authorized to actions
8	isAuthorizedTables	Shows whether access is authorized to tables
9	isAuthorizedColumns	Shows whether access is authorized to columns
10	listAllPrincipals	Lists all principals that have explicit access controls
…	…	…
20	partition	Partitions a table
21	shuffle	Randomly shuffles a table
22	recordCount	Shows the number of rows in a Cloud Analytic Services table
23	loadDataSource	Loads one or more data source interfaces
24	update	Updates rows in a table

Since the output is based on R’s list object, you can access each list member individually as well.

```
> out$builtins
```

	Name	Description
1	addNode	Adds a machine to the server
2	removeNode	Remove one or more machines from the server
3	help	Shows the parameters for an action or lists all available actions
4	listNodes	Shows the host names used by the server
5	loadActionSet	Loads an action set for use in this session
6	installActionSet	Loads an action set in new sessions automatically
7	log	Shows and modifies logging levels
8	queryActionSet	Shows whether an action set is loaded
9	queryName	Checks whether a name is an action or action set name
10	reflect	Shows detailed parameter information for an action or all actions in an action set
11	serverStatus	Shows the status of the server
12	about	Shows the status of the server
13	shutdown	Shuts down the server
14	userInfo	Shows the user information for your connection
15	actionSetInfo	Shows the build information from loaded action sets
16	history	Shows the actions that were run in this session
17	casCommon	Provides parameters that are common to many actions
18	ping	Sends a single request to the server to confirm that the connection is working
19	echo	Prints the supplied parameters to the client log
20	modifyQueue	Modifies the action response queue settings
21	getLicenseInfo	Shows the license information for a SAS product
22	refreshLicense	Refresh SAS license information from a file
23	httpAddress	Shows the HTTP address for the server monitor

Running CAS Actions

Just like the builtins.help action, all of the actions are available as R functions. You need to specify the fully qualified name of the action, which includes both the action set name and the action name. For example, the userInfo action is contained in the builtins action set. To call it, you have to use the full name cas.builtins.userinfo. Note that both the action set name and the action name are always written in camelCase.

For example, the userInfo action is called as follows.

```
> cas.builtins.userInfo(conn)
```

```
$userInfo
$userInfo$anonymous
[1] FALSE

$userInfo$groups
$userInfo$groups[[1]]
[1] "users"


$userInfo$hostAccount
[1] TRUE

$userInfo$providedName
[1] "username"

$userInfo$providerName
[1] "Active Directory"

$userInfo$uniqueId
[1] "username"

$userInfo$userId
[1] "username"
```

The result this time is still a list object, and the contents of that object is another list (userInfo) that contains information about your user account. Although all actions return a list object, there are no strict rules about what member names and values are in that object. The returned values are determined by the action and they vary depending on the type of information returned. Analytic actions typically return one or more casDataFrames.

Loading Data

The easiest way to load data into a CAS server is by using the as.casTable() function. This function uploads the data from an R data.frame to a CAS table. We use the classic Iris data set in the following data-loading example.

```
> iris_ct <- as.casTable(conn,iris)
> attributes(iris_ct)
```

```
$conn
CAS(hostname=server-name.mycompany.com, port=8777, username=username,
session=60c6e0fc-d690-ea48-9dbc-9692e7205455, protocol=http)

$tname
[1] "iris"

$caslib
[1] ""

$where
[1] ""

$orderby
[1] ""

$groupby
[1] ""

$gbmode
[1] ""

$computedOnDemand
[1] FALSE

$computedVars
[1] ""

$computedVarsProgram
[1] ""

$names
[1] "Sepal.Length" "Sepal.Width"  "Petal.Length" "Petal.Width"  "Species"

$class
[1] "CASTable"
attr(,"package")
[1] "swat"
```

The output from the as.casTable() function is a CASTable object. The CASTable object contains the connection information, name of the created table, the caslib that the table was created in, and other information. The CASTable objects also support many of the operations that are defined by R data.frame so that you can operate on them as if they were local data.[2]

You can use actions such as tableInfo and columnInfo in the table action set to access general information about the table itself and its columns.

```
# Call the tableInfo action on the CASTable object.
> cas.table.tableInfo(conn)
```

```
  Name Rows Columns Encoding CreateTimeFormatted   ModTimeFormatted
1 IRIS  150       5    utf-8  17Apr2017:02:17:40 17Apr2017:02:17:40
  JavaCharSet CreateTime    ModTime Global Repeated View SourceName
1        UTF8 1808014660 1808014660      0        0    0
  SourceCaslib Compressed   Creator Modifier
1                       0  username
```

```
# Call the columninfo action on the CASTable.
> cas.table.columnInfo(iris_ct)
$ColumnInfo
        Column ID    Type RawLength FormattedLength NFL NFD
1 Sepal.Length  1  double         8              12   0   0
2  Sepal.Width  2  double         8              12   0   0
3 Petal.Length  3  double         8              12   0   0
4  Petal.Width  4  double         8              12   0   0
5      Species  5 varchar        10              10   0   0
```

Now that we have some data, let's run some more interesting CAS actions on it.

Executing Actions on CAS Tables

The simple action set that comes with CAS contains some basic analytic actions. Let's run the summary action from the simple action set on our CAS table.

```
> summ <- cas.simple.summary(iris_ct)
> summ
```

```
$Summary
        Column Min Max   N NMiss     Mean   Sum       Std
1 Sepal.Length 4.3 7.9 150     0 5.843333 876.5 0.8280661
2  Sepal.Width 2.0 4.4 150     0 3.057333 458.6 0.4358663
3 Petal.Length 1.0 6.9 150     0 3.758000 563.7 1.7652982
4  Petal.Width 0.1 2.5 150     0 1.199333 179.9 0.7622377
      StdErr       Var     USS       CSS       CV   TValue
1 0.06761132 0.6856935 5223.85 102.16833 14.17113 86.42537
2 0.03558833 0.1899794 1430.40  28.30693 14.25642 85.90830
3 0.14413600 3.1162779 2582.71 464.32540 46.97441 26.07260
4 0.06223645 0.5810063  302.33  86.56993 63.55511 19.27060
         ProbT
1 3.331256e-129
2 8.004458e-129
3  2.166017e-57
4  2.659021e-42
```

The summary action displays summary statistics in a form that is familiar to SAS users. If you want them in a form that is similar to what R users are used to, you can use the summary() method (just like on R data.frame objects).

```
> summary(iris_ct)
```

```
  Sepal.Length    Sepal.Width     Petal.Length    Petal.Width
 Min.   :4.300   Min.   :2.000   Min.   :1.000   Min.   :0.100
 1st Qu.:5.100   1st Qu.:2.800   1st Qu.:1.600   1st Qu.:0.300
 Median :5.800   Median :3.000   Median :4.350   Median :1.300
 Mean   :5.843   Mean   :3.057   Mean   :3.758   Mean   :1.199
 3rd Qu.:6.400   3rd Qu.:3.300   3rd Qu.:5.100   3rd Qu.:1.800
 Max.   :7.900   Max.   :4.400   Max.   :6.900   Max.   :2.500
       Species
 setosa    :50
 versicolor:50
 virginica :50
```

Note that when you call the summary() function on a CASTable object, it calls various CAS actions in the background to do the calculations. This includes the cas.table.columnInfo, cas.simple.summary, cas.percentile.percentile, and cas.fedsql.execDirect actions. The output of those actions is combined into a data.frame in the same form that the real R summary() function returns. This enables you to use CASTable objects and R data.frame objects interchangeably in your workflow to work on the result tables from CAS.

Data Visualization

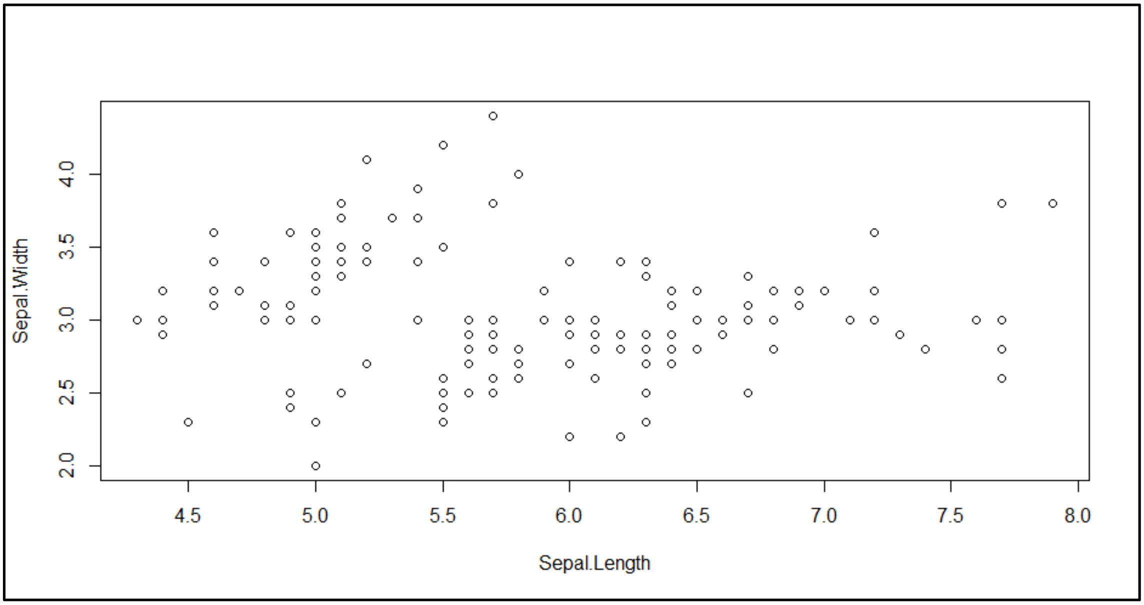
Since the tables that come back from the CAS server are subclasses of an R data.frame, you can do anything to them that works on a data.frame. You can plot the results of your actions using the plot function or use them as input to more advanced packages, such as ggplot2, which are covered in more detail in a later section.

The following example uses the plot method to download the data set and plot it using the default options.[3]

```
> plot(iris_ct$Sepal.Length, iris_ct$Sepal.Width)
```

The output that is created by the plot function is shown in Figure 2.1.

Figure 2.1: Scatter Plot of Sepal.Width versus Sepal.Length



Closing the Connection

As with any network or file resource in R, you should close your CAS connections when you are finished. They time out and disappear eventually if left open, but it's always a good idea to clean them up explicitly.

```
> cas.terminate(conn)
```

Conclusion

Hopefully, this ten-minute guide was enough to give you an idea of the basic workflow and capabilities of the R CAS client. In the following chapters, we dig deeper into the details of the R CAS client and how to blend the power of SAS analytics with the tools that are available in the R environment.

[1] Later in the book, we show you how to store your password so that you do not need to specify it in your programs.

[2] However, until you explicitly fetch the data or call a function that returns data from the table (such as head or tail), all operations are simply combined on the client side (essentially creating a client-side view) until they are needed for the call to the CAS server for data.

[3] To prevent downloading very large data sets to the client, a maximum of only 10,000 rows can be randomly sampled and downloaded when the data set has more than 10,000 rows.