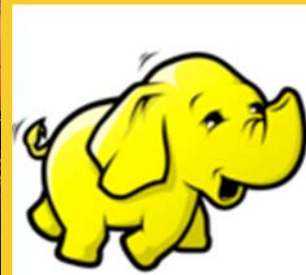




# HBase Installation & Shell

Originals of slides and source code for examples: <http://www.coreservlets.com/hadoop-tutorial/>  
Also see the customized Hadoop training courses (onsite or at public venues) – <http://courses.coreservlets.com/hadoop-training.html>

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Taught by recognized Hadoop expert who spoke on Hadoop several times at JavaOne, and who uses Hadoop daily in real-world apps. Available at public venues, or customized versions can be held on-site at your organization.

- Courses developed and taught by Marty Hall
  - JSF 2.2, PrimeFaces, servlets/JSP, Ajax, jQuery, Android development, Java 7 or 8 programming, custom mix of topics
  - Courses available in any state or country. Maryland/DC area companies can also choose afternoon/evening courses.
- Courses developed and taught by [coreservlets.com](http://coreservlets.com) experts (edited by Marty)
  - Spring, Hibernate/JPA, GWT, Hadoop, HTML5, RESTful Web Services

Contact [info@coreservlets.com](mailto:info@coreservlets.com) for details



# Agenda

- **Learn about installation modes**
- **How to set-up Pseudo-Distributed Mode**
- **HBase Management Console**
- **HBase Shell**
  - Define Schema
  - Create, Read, Update and Delete

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# Runtime Modes

- **Local (Standalone) Mode**
  - Comes Out-of-the-Box, easy to get started
  - Uses local filesystem (not HDFS), NOT for production
  - Runs HBase & Zookeeper in the same JVM
- **Pseudo-Distributed Mode**
  - Requires HDFS
  - Mimics Fully-Distributed but runs on just one host
  - Good for testing, debugging and prototyping
  - Not for production use or performance benchmarking!
  - Development mode used in class
- **Fully-Distributed Mode**
  - Run HBase on many machines
  - Great for production and development clusters

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# Set Up Pseudo-Distributed Mode

- 1. Verify Installation Requirements**
  - Java, password-less SSH
- 2. Configure Java**
- 3. Configure the use of HDFS**
  - Specify the location of Namenode
  - Configure replication
- 4. Make sure HDFS is running**
- 5. Start HBase**
- 6. Verify HBase is running**

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## 1: Verify Installation Requirements

- **Latest release of Java 6 from Oracle**
- **Must have compatible release of Hadoop!**
  - runs on top of HDFS
  - Today runs on Hadoop 0.20.x
  - Can run on top of local FS
    - Will lose data when crashes
    - Needs HDFS's durable sync for data fault-tolerance
      - HDFS provides confirmation that the data has been saved
      - Confirmation is provided after all blocks are successfully replicated to all the required nodes

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## 1: Verify Installation Requirements

- **SSH installed, sshd must be running**
  - Just like Hadoop
  - Need password-less SSH to all the nodes including yourself
  - Required for both pseudo-distributed and fully-distributed modes
- **Windows**
  - Very little testing – for development only
  - Will need Cygwin

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## 2: Configure Java

- **vi <HBASE\_HOME>/conf/hbase-env.sh**

```
export JAVA_HOME=/usr/java/jdk1.6.0
```

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## 3: Configure the use of HDFS

- **Point to HDFS for its filesystem**

- Edit `<hbase_home>/conf/hbase-site.xml`
- `hbase.rootdir` property:
  - Uses HDFS URI
  - Recall URI format: `scheme://namenode/path`
    - Example: `hdfs://localhost:9000/hbase`
  - The location of namenode
  - directory on HDFS where Region Servers will save its data
    - If directory doesn't exist it will be created
- `dfs.replication` property:
  - The number of times data will be replicated across Region Servers (HLog and HFile)
  - Will set to 1 since there is only 1 host

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## 3: Configure the use of HDFS

### `<hbase_home>/conf/hbase-site.xml`

```
<configuration>
...
<property>
  <name>hbase.rootdir</name>
  <value>hdfs://localhost:9000/hbase</value>
  <description>The directory shared by RegionServers.
  </description>
</property>
<property>
  <name>dfs.replication</name>
  <value>1</value>
  <description>The replication count for HLog and HFile
  storage. Should not be greater than HDFS datanode count.
  </description>
</property>
...
</configuration>
```

Will this configuration work on a remote client?

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## 3: Configure the use of HDFS

- Since 'localhost' was specified as the location of the namenode remote clients can't use this configuration

```
...  
<property>  
  <name>hbase.rootdir</name>  
  <value>hdfs://localhost:9000/hbase</value>  
</property>  
...
```



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## 4: Make sure HDFS is running

- **Make sure HDFS is running**
  - Easy way is to check web-based management console
    - <http://localhost:50070/dfshealth.jsp>
  - Or use command line
    - \$ hdfs dfs -ls /

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## 5: Start HBase

```
$ cd <hbase_home>/bin
$ ./start-hbase.sh
starting master, logging to
/home/hadoop/Training/logs/hbase/hbase-hadoop-master-
hadoop-laptop.out
...
```

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## 6: Verify HBase is Running

```
$ hbase shell
HBase Shell; enter 'help<RETURN>' for list of supported commands.
Type "exit<RETURN>" to leave the HBase Shell
Version 0.90.4-cdh3u2, r, Thu Oct 13 20:32:26 PDT 2011
hbase(main):001:0> list
TABLE
0 row(s) in 0.4070 seconds
```

Run a command to verify  
that cluster is actually running

```
$ hadoop fs -ls /hbase
Found 5 items
drwxr-xr-x - hadoop supergroup 0 2011-12-31 13:18 /hbase/-ROOT-
drwxr-xr-x - hadoop supergroup 0 2011-12-31 13:18 /hbase/.META.
drwxr-xr-x - hadoop supergroup 0 2011-12-31 13:18 /hbase/.logs
drwxr-xr-x - hadoop supergroup 0 2011-12-31 13:18 /hbase/.oldlogs
-rw-r--r-- 1 hadoop supergroup 3 2011-12-31 13:18 /hbase/hbase.version
```

HBase data and metadata is stored in HDFS

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## 6: Verify HBase is Running

- **By default HBase manages Zookeeper daemon for you**
- **Logs by default go to <hbase\_home>/logs**
  - Change the default by editing <hbase\_home>/conf/hbase-env.sh
    - export HBASE\_LOG\_DIR=/new/location/logs

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## HBase Management Console

- **HBase comes with web based management**
  - <http://localhost:60010>
- **Both Master and Region servers run web server**
  - Browsing Master will lead you to region servers
    - Regions run on port 60030
- **Firewall considerations**
  - Opening <master\_host>:60010 in firewall is not enough
  - Have to open up <region(s)\_host>:60030 on every slave host
  - An easy option is to open a browser behind the firewall
    - SSH tunneling and Virtual Network Computing (VNC)

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# HBase Management Console

Master: hadoop-laptop:35518

Local logs, Thread dump, Log Level, Debug dump

### Master Attributes

Attribute Name	Value	Description
HBase Version	0.90.4-cdh3u2, r	HBase version and svn revision
HBase Compiled	Thu Oct 13 20:32:26 PDT 2011, jenkins	When HBase version was compiled and by whom
Hadoop Version	0.20.2-cdh3u2, r35a24e4005b2a9461c11f7ef9b4d6072b45c	Hadoop version and svn revision
Hadoop Compiled	Fri Oct 14 01:36:05 PDT 2011, jenkins	When Hadoop version was compiled and by whom
HBase Root Directory	hdfs://localhost:9000/hbase	Location of HBase home directory
Load average	2	Average number of regions per regionserver. Naive computation.
Zookeeper Quorum	localhost:2181	Addresses of all registered ZK servers. For more, see <a href="#">zk.dump</a> .

Currently running tasks

No tasks currently running on this node.

### Catalog Tables

Table	Description
ROOT	The ROOT table holds references to all META regions.
META	The META table holds references to all User Table regions.

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# HBase Shell

- **JRuby IRB (Interactive Ruby Shell)**
  - HBase commands added
  - If you can do it in IRB you can do it in HBase shell
    - [http://en.wikipedia.org/wiki/Interactive\\_Ruby\\_Shell](http://en.wikipedia.org/wiki/Interactive_Ruby_Shell)
- **To run simply**

```
$ <hbase_install>/bin/hbase shell
```

HBase Shell; enter 'help<RETURN>' for list of supported commands.

Type "exit<RETURN>" to leave the HBase Shell

Version 0.90.4-cdh3u2, r, Thu Oct 13 20:32:26 PDT 2011

```
hbase(main):001:0>
```

- Puts you into IRB
- Type 'help' to get a listing of commands
  - \$ help "command" (quotes are required)
    - > help "get"

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# HBase Shell

- **Quote all names**

- Table and column names
- Single quotes for text
  - `hbase> get 't1', 'myRowId'`
- Double quotes for binary
  - Use hexadecimal representation of that binary value
  - `hbase> get 't1', "key\x03\x3f\xcd"`

- **Uses ruby hashes to specify parameters**

- `{'key1' => 'value1', 'key2' => 'value2', ...}`
- Example:

```
hbase> get 'UserTable', 'userId1', {COLUMN => 'address:str'}
```

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# HBase Shell

- **HBase Shell supports various commands**

- General
  - status, version
- Data Definition Language (DDL)
  - alter, create, describe, disable, drop, enable, exists, is\_disabled, is\_enabled, list
- Data Manipulation Language (DML)
  - count, delete, deleteall, get, get\_counter, incr, put, scan, truncate
- Cluster administration
  - balancer, close\_region, compact, flush, major\_compact, move, split, unassign, zk\_dump, add\_peer, disable\_peer, enable\_peer, remove\_peer, start\_replication, stop\_replication

- **Learn more about each command**

- `hbase> help "<command>"`

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## HBase Shell - Check Status

- **Display cluster's status via status command**
  - hbase> status
  - hbase> status 'detailed'
- **Similar information can be found on HBase Web Management Console**
  - <http://localhost:60010>

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## HBase Shell - Check Status

```
hbase> status
1 servers, 0 dead, 3.0000 average load

hbase> status 'detailed'
version 0.90.4-cdh3u2
0 regionsInTransition
1 live servers
  hadoop-laptop:39679 1326056194009
    requests=0, regions=3, usedHeap=30, maxHeap=998
    .META.,,1
      stores=1, storefiles=0, storefileSizeMB=0, ...
    -ROOT-, ,0
      stores=1, storefiles=1, storefileSizeMB=0, ...
    Blog,,1326059842133.c1b865dd916b64a6228ecb4f743 ...
0 dead servers
```

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# HBase Shell DDL and DML

- **Let's walk through an example**

1. Create a table
  - Define column families
2. Populate table with data records
  - Multiple records
3. Access data
  - Count, get and scan
4. Edit data
5. Delete records
6. Drop table

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## 1: Create Table

- **Create table called 'Blog' with the following schema**

- 2 families
  - 'info' with 3 columns: 'title', 'author', and 'date'
  - 'content' with 1 column family: 'post'

Blog		
Family:	info:	Columns: title, author, date
	content:	Columns: post

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# 1: Create Table

- **Various options to create tables and families**

- hbase> create 't1', {NAME => 'f1', VERSIONS => 5}
- hbase> create 't1', {NAME => 'f1', VERSIONS => 1, TTL => 2592000, BLOCKCACHE => true}
- hbase> create 't1', {NAME => 'f1'}, {NAME => 'f2'}, {NAME => 'f3'}
- hbase> create 't1', 'f1', 'f2', 'f3'

```
hbase> create 'Blog', {NAME=>'info'}, {NAME=>'content'}
0 row(s) in 1.3580 seconds
```

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# 2: Populate Table With Data Records

- **Populate data with multiple records**

Row Id	info:title	info:author	info:date	content:post
Matt-001	Elephant	Matt	2009.05.06	Do elephants like monkeys?
Matt-002	Monkey	Matt	2011.02.14	Do monkeys like elephants?
Bob-003	Dog	Bob	1995.10.20	People own dogs!
Michelle-004	Cat	Michelle	1990.07.06	I have a cat!
John-005	Mouse	John	2012.01.15	Mickey mouse.

- **Put command format:**

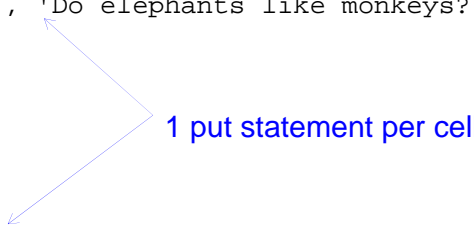
```
hbase> put 'table', 'row_id', 'family:column', 'value'
```

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## 2: Populate Table With Data Records

```
# insert row 1
put 'Blog', 'Matt-001', 'info:title', 'Elephant'
put 'Blog', 'Matt-001', 'info:author', 'Matt'
put 'Blog', 'Matt-001', 'info:date', '2009.05.06'
put 'Blog', 'Matt-001', 'content:post', 'Do elephants like monkeys?'
...
...
... # insert rows 2-4
...
...

# row 5
put 'Blog', 'John-005', 'info:title', 'Mouse'
put 'Blog', 'John-005', 'info:author', 'John'
put 'Blog', 'John-005', 'info:date', '1990.07.06'
put 'Blog', 'John-005', 'content:post', 'Mickey mouse.'
```



1 put statement per cell

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## 3. Access data - count

- **Access Data**
  - count: display the total number of records
  - get: retrieve a single row
  - scan: retrieve a range of rows
- **Count is simple**
  - hbase> count 'table\_name'
  - Will scan the entire table! May be slow for a large table
    - Alternatively can run a MapReduce job (more on this later...)
      - \$ yarn jar hbase.jar rowcount
  - Specify count to display every n rows. Default is 1000
    - hbase> count 't1', INTERVAL => 10

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## 3. Access data - count

```
hbase> count 'Blog', {INTERVAL=>2}
Current count: 2, row: John-005
Current count: 4, row: Matt-002
5 row(s) in 0.0220 seconds
```

```
hbase> count 'Blog', {INTERVAL=>1}
Current count: 1, row: Bob-003
Current count: 2, row: John-005
Current count: 3, row: Matt-001
Current count: 4, row: Matt-002
Current count: 5, row: Michelle-004
```

Affects how often  
count is displayed

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## 3. Access data - get

- **Select single row with 'get' command**
  - hbase> get 'table', 'row\_id'
    - Returns an entire row
  - Requires table name and row id
  - Optional: timestamp or time-range, and versions
- **Select specific columns**
  - hbase> get 't1', 'r1', {COLUMN => 'c1'}
  - hbase> get 't1', 'r1', {COLUMN => ['c1', 'c2', 'c3']}
- **Select specific timestamp or time-range**
  - hbase> get 't1', 'r1', {TIMERANGE => [ts1, ts2]}
  - hbase> get 't1', 'r1', {COLUMN => 'c1', TIMESTAMP => ts1}
- **Select more than one version**
  - hbase> get 't1', 'r1', {VERSIONS => 4}

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## 3. Access data - get

```
hbase> get 'Blog', 'unknownRowId'  
COLUMN          CELL  
0 row(s) in 0.0250 seconds
```

Row Id doesn't exist

```
hbase> get 'Blog', 'Michelle-004'  
COLUMN          CELL  
content:post    timestamp=1326061625690, value=I have a cat!  
info:author     timestamp=1326061625630, value=Michelle  
info:date       timestamp=1326061625653, value=1990.07.06  
info:title      timestamp=1326061625608, value=Cat  
4 row(s) in 0.0420 seconds
```

Returns ALL the columns, displays 1 column per row!!!

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## 3. Access data - get

```
hbase> get 'Blog', 'Michelle-004',  
        {COLUMN=>['info:author','content:post']}  
COLUMN          CELL  
content:post    timestamp=1326061625690, value=I have a cat!  
info:author     timestamp=1326061625630, value=Michelle  
2 row(s) in 0.0100 seconds
```

Narrow down to just two columns

```
hbase> get 'Blog', 'Michelle-004',  
        {COLUMN=>['info:author','content:post'],  
          TIMESTAMP=>1326061625690}  
COLUMN          CELL  
content:post    timestamp=1326061625690, value=I have a cat!  
1 row(s) in 0.0140 seconds
```

Narrow down via columns and timestamp

Only one timestamp matches

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## 3. Access data - get

```
hbase> get 'Blog', 'Michelle-004',  
                {COLUMN=>'info:date', VERSIONS=>2}  
  
COLUMN          CELL  
info:date       timestamp=1326071670471, value=1990.07.08  
info:date       timestamp=1326071670442, value=1990.07.07  
2 row(s) in 0.0300 seconds
```

Asks for the latest two versions

```
hbase> get 'Blog', 'Michelle-004',  
                {COLUMN=>'info:date'}  
  
COLUMN          CELL  
info:date       timestamp=1326071670471, value=1990.07.08  
1 row(s) in 0.0190 seconds
```

By default only the latest version is returned

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## 3. Access data - Scan

- **Scan entire table or a portion of it**
- **Load entire row or explicitly retrieve column families, columns or specific cells**
- **To scan an entire table**
  - hbase> scan 'table\_name'
- **Limit the number of results**
  - hbase> scan 'table\_name', {LIMIT=>1}
- **Scan a range**
  - hbase> scan 'Blog', {STARTROW=>'startRow', STOPROW=>'stopRow'}
  - Start row is inclusive, stop row is exclusive
  - Can provide just start row or just stop row

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## 3. Access data - Scan

- **Limit what columns are retrieved**
  - hbase> scan 'table', {COLUMNS=>['col1', 'col2']}
- **Scan a time range**
  - hbase> scan 'table', {TIMERANGE => [1303, 13036]}
- **Limit results with a filter**
  - hbase> scan 'Blog', {FILTER => org.apache.hadoop.hbase.filter.ColumnPaginationFilter.new(1, 0)}
  - More about filters later

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## 3. Access data - Scan

Scan the entire table, grab ALL the columns

```
hbase(main):014:0> scan 'Blog'
ROW          COLUMN+CELL
Bob-003 column=content:post, timestamp=1326061625569,
           value=People own dogs!
Bob-003 column=info:author, timestamp=1326061625518, value=Bob
Bob-003 column=info:date, timestamp=1326061625546,
           value=1995.10.20
Bob-003 column=info:title, timestamp=1326061625499, value=Dog
John-005     column=content:post, timestamp=1326061625820,
           value=Mickey mouse.
John-005     column=info:author, timestamp=1326061625758,
           value=John
...
Michelle-004 column=info:author, timestamp=1326061625630,
           value=Michelle
Michelle-004 column=info:date, timestamp=1326071670471,
           value=1990.07.08
Michelle-004 column=info:title, timestamp=1326061625608,
           value=Cat

5 row(s) in 0.0670 seconds
```

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## 3. Access data - Scan

Stop row is exclusive, row ids that start with John will not be included

```
hbase> scan 'Blog', {STOPROW=>'John'}
ROW      COLUMN+CELL
Bob-003  column=content:post, timestamp=1326061625569,
          value=People own dogs!
Bob-003  column=info:author, timestamp=1326061625518,
          value=Bob
Bob-003  column=info:date, timestamp=1326061625546,
          value=1995.10.20
Bob-003  column=info:title, timestamp=1326061625499,
          value=Dog
1 row(s) in 0.0410 seconds
```

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## 3. Access data - Scan

Only retrieve 'info:title' column

```
hbase> scan 'Blog', {COLUMNS=>'info:title',
                     STARTROW=>'John', STOPROW=>'Michelle'}
ROW      COLUMN+CELL
John-005  column=info:title, timestamp=1326061625728,
          value=Mouse
Matt-001  column=info:title, timestamp=1326061625214,
          value=Elephant
Matt-002  column=info:title, timestamp=1326061625383,
          value=Monkey
3 row(s) in 0.0290 seconds
```

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## 4: Edit data

- **Put command inserts a new value if row id doesn't exist**
- **Put updates the value if the row does exist**
- **But does it really update?**
  - Inserts a new version for the cell
  - Only the latest version is selected by default
  - N versions are kept per cell
    - configured per family at creation:

```
hbase> create 'table', {NAME => 'family', VERSIONS => 7}
```
    - 3 versions are kept by default

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## 4: Edit data

```
hbase> put 'Blog', 'Michelle-004', 'info:date', '1990.07.06'  
0 row(s) in 0.0520 seconds  
hbase> put 'Blog', 'Michelle-004', 'info:date', '1990.07.07'  
0 row(s) in 0.0080 seconds  
hbase> put 'Blog', 'Michelle-004', 'info:date', '1990.07.08'  
0 row(s) in 0.0060 seconds
```

Update the same exact row with a different value

```
hbase> get 'Blog', 'Michelle-004',  
          {COLUMN=>'info:date', VERSIONS=>3}  
COLUMN      CELL  
info:date   timestamp=1326071670471, value=1990.07.08  
info:date   timestamp=1326071670442, value=1990.07.07  
info:date   timestamp=1326071670382, value=1990.07.06  
3 row(s) in 0.0170 seconds
```

Keeps three versions of each cell by default

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## 4: Edit data

```
hbase> get 'Blog', 'Michelle-004',  
          {COLUMN=>'info:date', VERSIONS=>2}  
  
COLUMN      CELL  
info:date   timestamp=1326071670471, value=1990.07.08  
info:date   timestamp=1326071670442, value=1990.07.07  
2 row(s) in 0.0300 seconds
```

Asks for the latest two versions

```
hbase> get 'Blog', 'Michelle-004',  
          {COLUMN=>'info:date'}  
  
COLUMN      CELL  
info:date   timestamp=1326071670471, value=1990.07.08  
1 row(s) in 0.0190 seconds
```

By default only the latest version is returned

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## 5: Delete records

- **Delete cell by providing table, row id and column coordinates**
  - delete 'table', 'rowId', 'column'
  - Deletes all the versions of that cell
- **Optionally add timestamp to only delete versions before the provided timestamp**
  - delete 'table', 'rowId', 'column', timestamp

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## 5: Delete records

```
hbase> get 'Blog', 'Bob-003', 'info:date'  
COLUMN      CELL  
info:date   timestamp=1326061625546, value=1995.10.20  
1 row(s) in 0.0200 seconds
```

```
hbase> delete 'Blog', 'Bob-003', 'info:date'  
0 row(s) in 0.0180 seconds
```

```
hbase> get 'Blog', 'Bob-003', 'info:date'  
COLUMN      CELL  
0 row(s) in 0.0170 seconds
```

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## 5: Delete records

```
hbase> get 'Blog', 'Michelle-004',  
          {COLUMN=>'info:date', VERSIONS=>3}  
COLUMN      CELL  
info:date   timestamp=1326254742846, value=1990.07.08  
info:date   timestamp=1326254739790, value=1990.07.07  
info:date   timestamp=1326254736564, value=1990.07.06  
3 row(s) in 0.0120 seconds
```

3 versions

```
hbase> delete 'Blog', 'Michelle-004', 'info:date', 1326254739791  
0 row(s) in 0.0150 seconds
```

1 millisecond after the second version

```
hbase> get 'Blog', 'Michelle-004',  
          {COLUMN=>'info:date', VERSIONS=>3}  
COLUMN      CELL  
info:date   timestamp=1326254742846, value=1990.07.08  
1 row(s) in 0.0090 seconds
```

After the timestamp provided at delete statement

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## 6: Drop table

- **Must disable before dropping**
  - puts the table “offline” so schema based operations can be performed
  - hbase> disable 'table\_name'
  - hbase> drop 'table\_name'
- **For a large table it may take a long time....**

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## 6: Drop table

```
hbase> list
TABLE
Blog
1 row(s) in 0.0120 seconds
```

```
hbase> disable 'Blog'
0 row(s) in 2.0510 seconds
```

```
hbase> drop 'Blog'
0 row(s) in 0.0940 seconds
```

```
hbase> list
TABLE
0 row(s) in 0.0200 seconds
```

Take the table offline for  
schema modifications

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# Wrap-Up

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## Summary

- **We learned**
  - How to install HBase in Pseudo-Distributed Mode
  - How to use HBase Shell
  - HBase Shell commands





# Questions?

More info:

<http://www.coreservlets.com/hadoop-tutorial/> – Hadoop programming tutorial

<http://courses.coreservlets.com/hadoop-training.html> – Customized Hadoop training courses, at public venues or onsite at *your* organization

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