HBASE PROGRAMMING

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1. Java 之編譯與執行

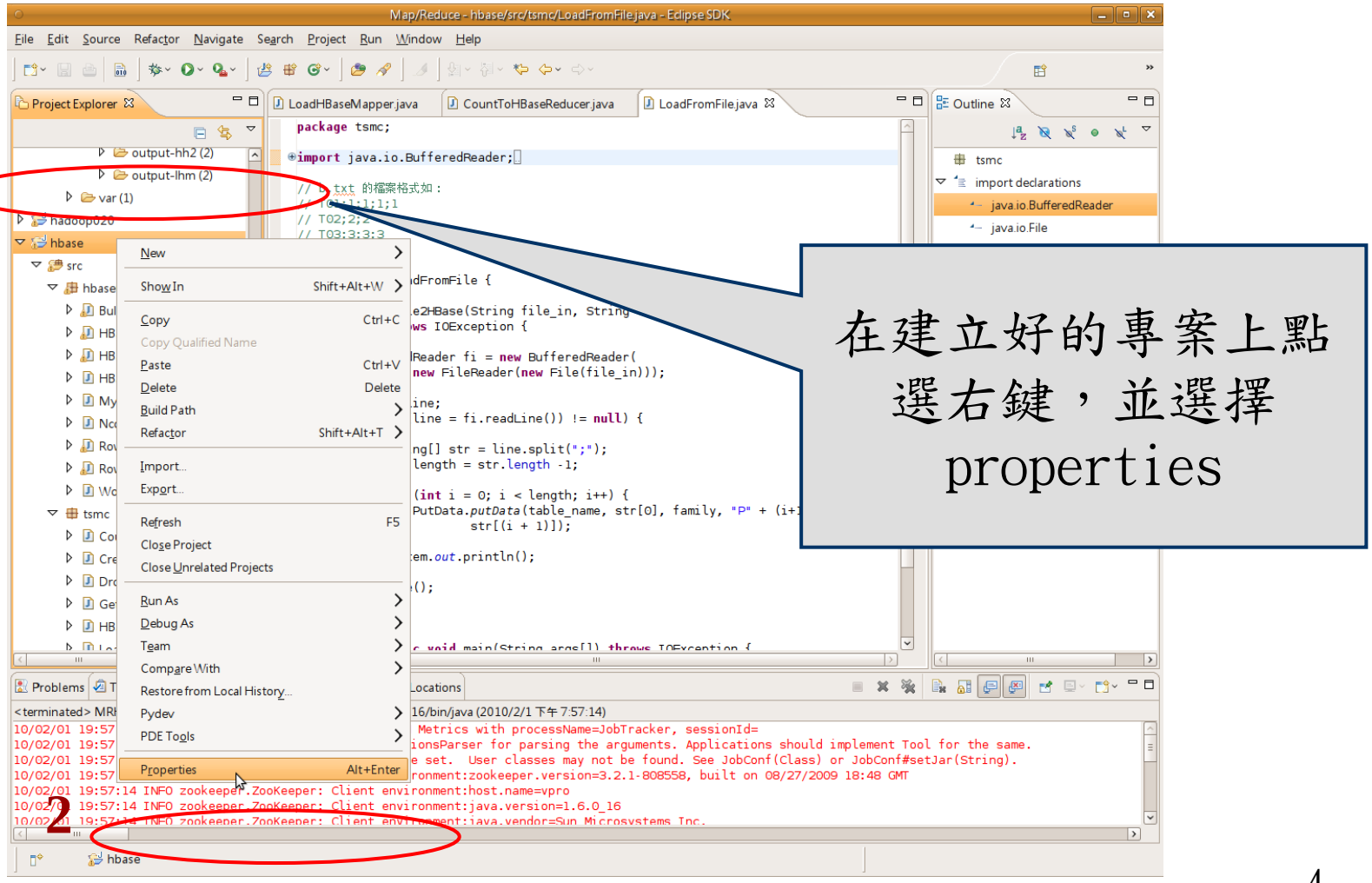
1. 將hbase_home目錄內的 .jar檔全部拷貝至 hadoop_home/lib/ 資料夾內
2. 編譯
   - javac △ -classpath △ **hadoop-*-core.jar:hbase-*.jar** △ -d △ MyJava △ MyCode.java
3. 封裝
   - jar △ -cvf △ MyJar.jar △ -C △ MyJava △ .
4. 執行
   - bin/hadoop △ jar △ MyJar.jar △ MyCode △ {Input/ △ Output/ }

- 所在的執行目錄為Hadoop_Home
- ./MyJava = 編譯後程式碼目錄
- Myjar.jar = 封裝後的編譯檔
- 先放些文件檔到HDFS上的input目錄
- ./input; ./ouput 不一定為 hdfs的輸入、輸出目錄

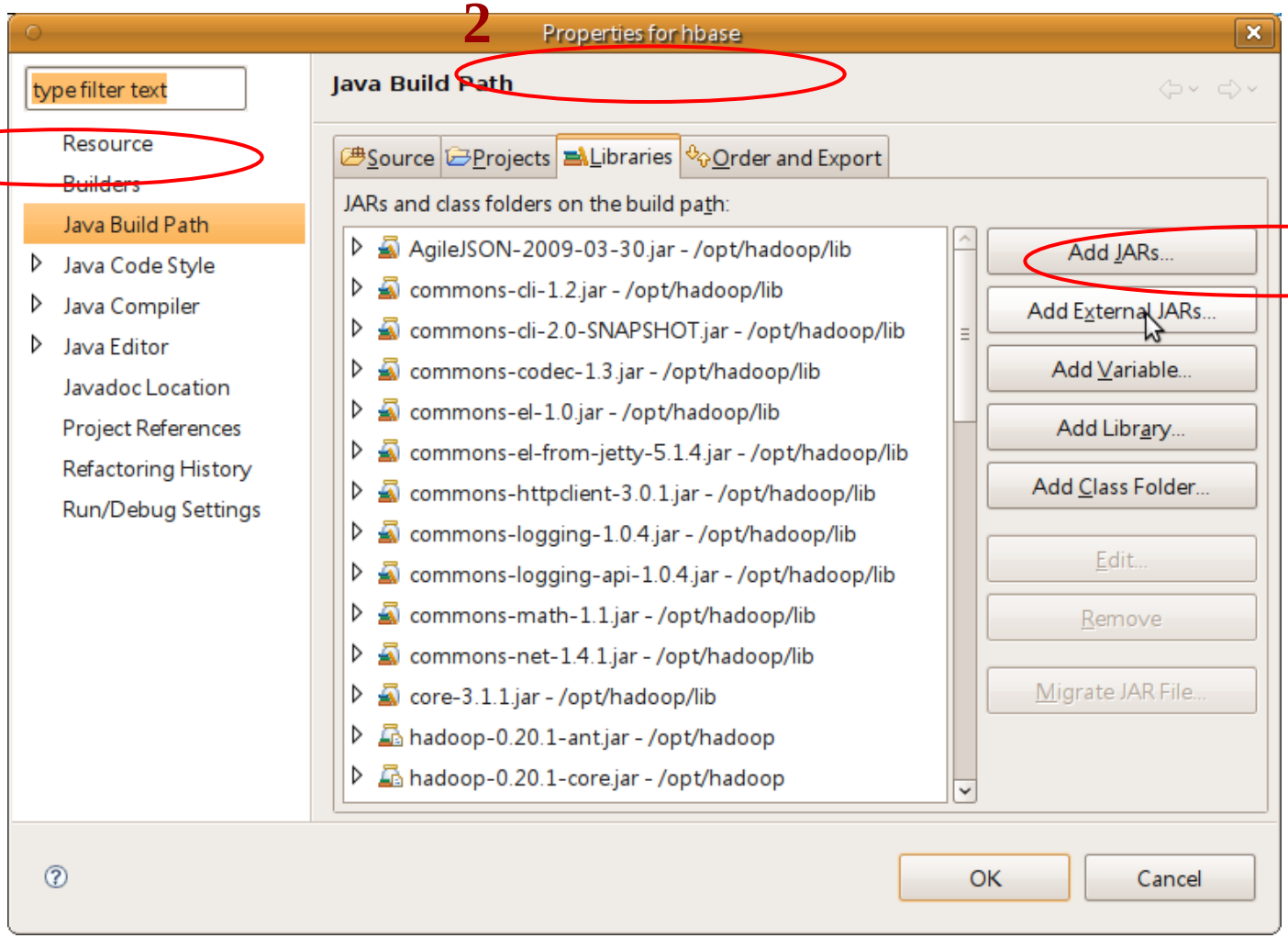
2.0 Eclipse 之編譯與執行

- HBase 已可以於Hadoop上正常運作
- 請先設定好Eclipse 上得 Hadoop 開發環境
- 建立一個hadoop的專案

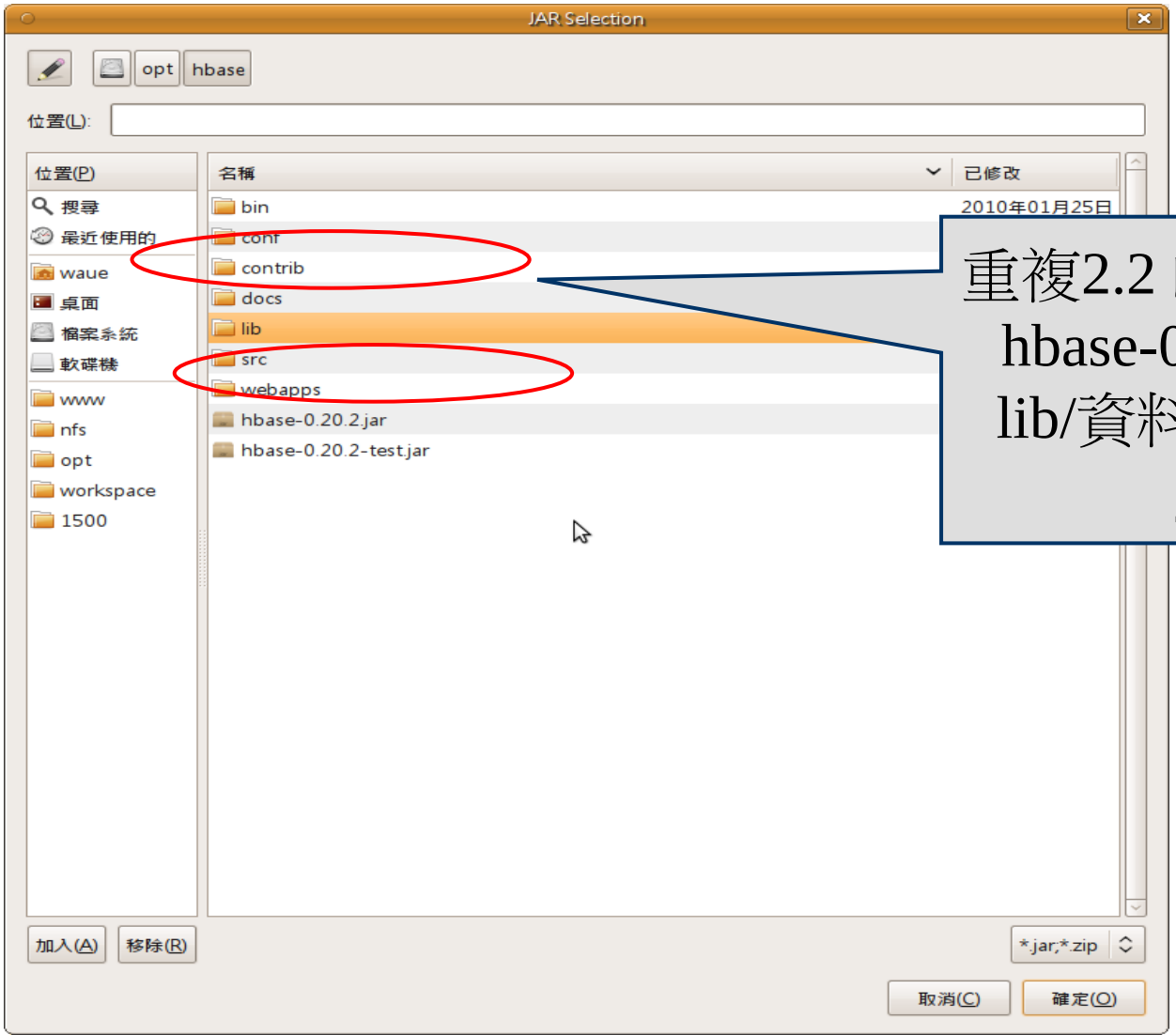
2.1 設定專案的細部屬性



2.2 增加 專案的 Classpath

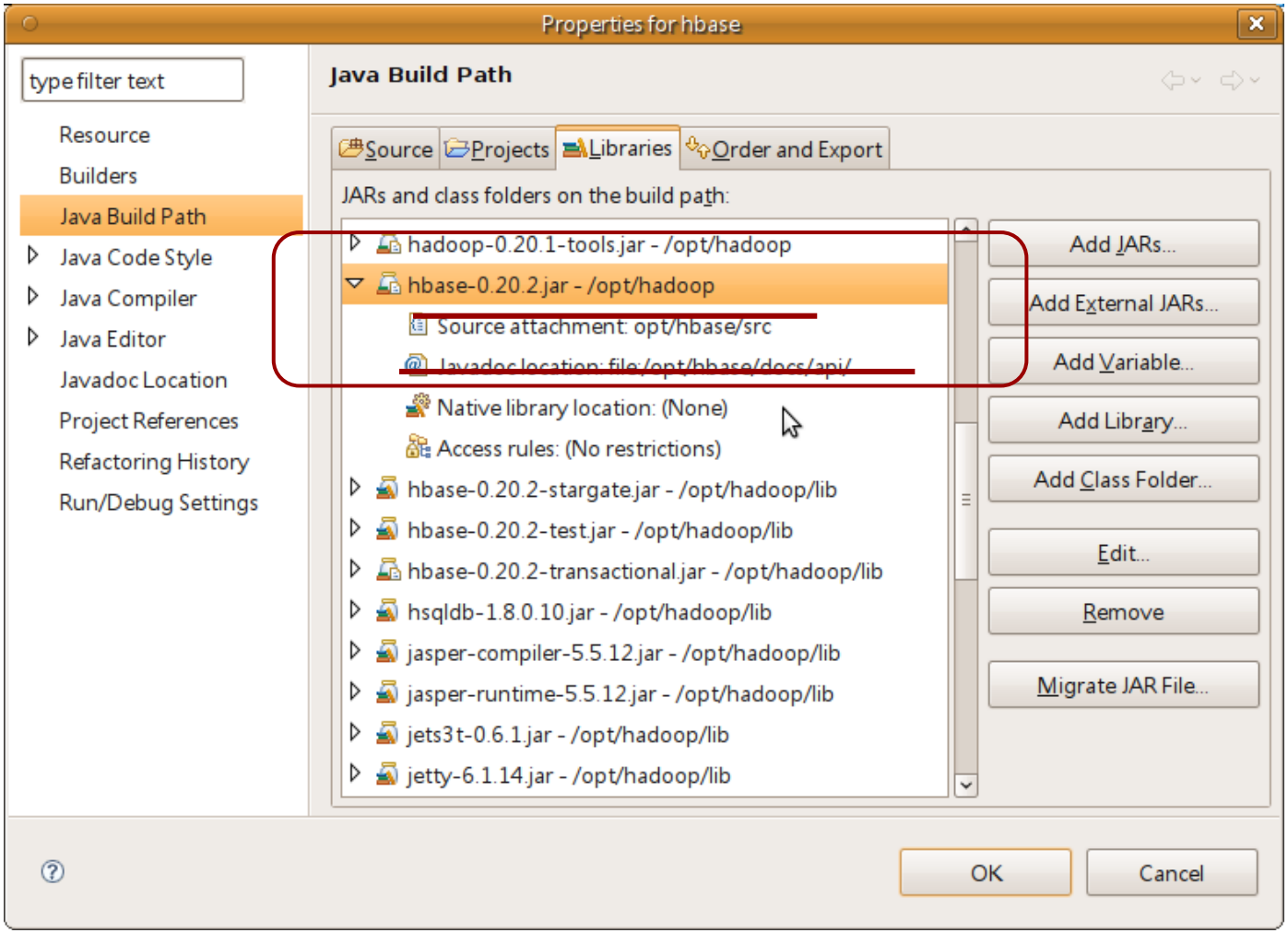


2.3 選擇classpath 的library



重複2.2 的步驟來選取 hbase-0.20.＊.jar 與 lib/資料夾內的所有 jar 檔

2.4 為函式庫增加原始碼、說明檔的配置

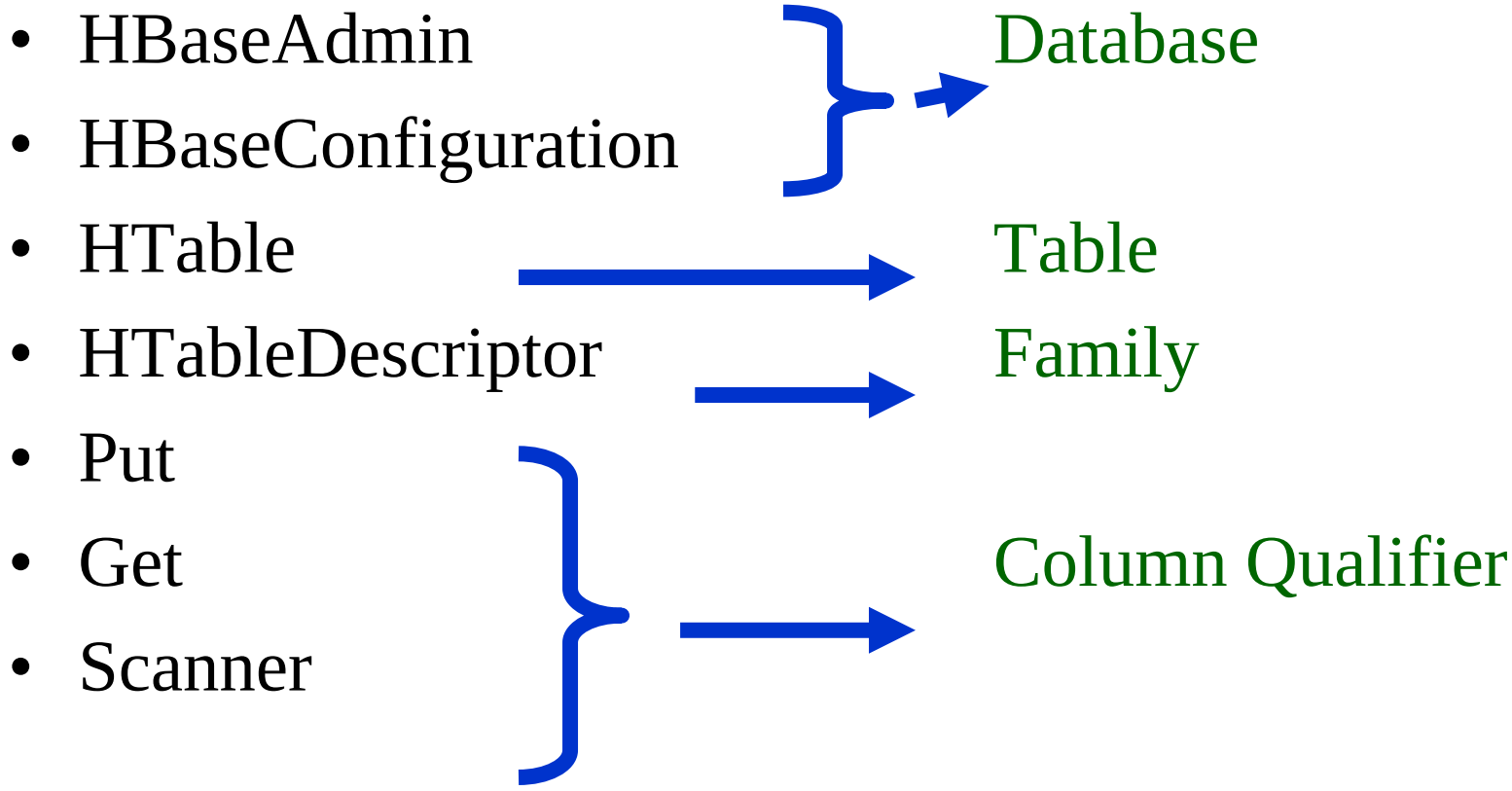


HTable 成員

Table, Family, Column, Qualifier , Row, TimeStamp

		Contents	Department		
			news	bid	sport
t1	com.yahoo.news.tw	“我研發水下6千公尺機器人”	“tech”		
t2		“蚊子怎麼搜尋人肉”	“tech”		
t3		“用腦波「發聲」”	“tech”		
t1	com.yahoo.bid.tw	“… ipad …”		“ 3C ”	
t1	com.yahoo.sport.tw	“… Wang 40…”			“MBA”

HBase 常用函式



HBaseConfiguration

- Adds HBase configuration files to a Configuration
  - = new HBaseConfiguration ( )
  - = new HBaseConfiguration (Configuration c)
- 繼承自 org.apache.hadoop.conf.Configuration

```
<property>
   <name>  name
   </name>
    <value> value
   </value>
</property>
```

回傳值	函數	參數
void	addResource	(Path file)
void	clear	()
String	get	(String name)
String	getBoolean	(String name, boolean defaultValue)
void	set	(String name, String value)
void	setBoolean	(String name, boolean value)

HBaseAdmin

- HBase的管理介面
  - = new HBaseAdmin(HBaseConfiguration conf)
- Ex:

```
HBaseAdmin admin = new HBaseAdmin(config);
admin.disableTable ("tablename");
```

回傳值	函數	參數
void	addColumn	(String tableName, HColumnDescriptor column)
	checkHBaseAvailable	(HBaseConfiguration conf)
	createTable	(HTableDescriptor desc)
	deleteTable	(byte[] tableName)
	deleteColumn	(String tableName, String columnName)
	enableTable	(byte[] tableName)
	disableTable	(String tableName)
HTableDescriptor[]	listTables	()
void	modifyTable	(byte[] tableName, HTableDescriptor htd)
boolean	tableExists	(String tableName)

HTableDescriptor

- HTableDescriptor contains the name of an HTable, and its column families.
  - = new HTableDescriptor()
  - = new HTableDescriptor(String name)
- Constant-values
  - org.apache.hadoop.hbase.HTableDescriptor.TABLE_DESCRIPTOR_VERSION
- Ex:

```
HTableDescriptor htd = new HTableDescriptor(tablename);
htd.addFamily ( new HColumnDescriptor (“Family”));
```

回傳值	函數	參數
void	addFamily	(HColumnDescriptor family)
HColumnDescriptor	removeFamily	(byte[] column)
byte[]	getName	( ) = Table name
byte[]	getValue	(byte[] key) = 對應key的value
void	setValue	(String key, String value)

HColumnDescriptor

- An HColumnDescriptor contains information about a column family
  - = new HColumnDescriptor(String familyname)
- Constant-values
  - org.apache.hadoop.hbase.HTableDescriptor.TABLE_DESCRIPTOR_VERSION
- Ex:

```
HTableDescriptor htd = new HTableDescriptor(tablename);
HColumnDescriptor col = new HColumnDescriptor("content:");
htd.addFamily(col);
```

回傳值	函數	參數
byte[]	getName	( ) = Family name
byte[]	getValue	(byte[] key) = 對應key的value
void	setValue	(String key, String value)

HTable

- Used to communicate with a single HBase table.
  - = new HTable(HBaseConfiguration conf, String tableName)
- Ex:

```
HTable table = new HTable (conf, Bytes.toBytes ( tablename ));
ResultScanner scanner = table.getScanner ( family );
```

回傳值	函數	參數
void	checkAndPut	(byte[] row, byte[] family, byte[] qualifier, byte[] value, Put put)
void	close	()
boolean	exists	(Get get)
Result	get	(Get get)
byte[][]	getEndKeys	()
ResultScanner	getScanner	(byte[] family)
HTableDescriptor	getTableDescriptor	()
byte[]	getTableName	()
static boolean	isTableEnabled	(HBaseConfiguration conf, String tableName)
void	put	(Put put)

Put

- Used to perform Put operations for a single row.
  - = new Put(byte[] row)
  - = new Put(byte[] row, RowLock rowLock)
- Ex:

```
HTable table = new HTable (conf, Bytes.toBytes ( tablename ));
Put p = new Put ( brow );
p.add (family, qualifier, value);
table.put ( p );
```

Put	add	(byte[] family, byte[] qualifier, byte[] value)
Put	add	(byte[] column, long ts, byte[] value)
byte[]	getRow	()
RowLock	getRowLock	()
long	getTimeStamp	()
boolean	isEmpty	()
Put	setTimeStamp	(long timestamp)

Get

- Used to perform Get operations on a single row.
  - = new Get (byte[] row)
  - = new Get (byte[] row, RowLock rowLock)
- Ex:

```
HTable table = new HTable(conf, Bytes.toBytes(tablename));
Get g = new Get(Bytes.toBytes(row));
```

Get	addColumn	(byte[] column)
Get	addColumn	(byte[] family, byte[] qualifier)
Get	addColumns	(byte[][] columns)
Get	addFamily	(byte[] family)
TimeRange	getTimeRange	()
Get	setTimeRange	(long minStamp, long maxStamp)
Get	setFilter	(Filter filter)

Result

- Single row result of a Get or Scan query.
  - = new Result()
- Ex:

```
HTable table = new HTable(conf, Bytes.toBytes(tablename));
Get g = new Get(Bytes.toBytes(row));
Result rowResult = table.get(g);
Bytes[] ret = rowResult.getValue( (family + ":"+ column ) );
```

boolean	containsColumn	(byte[] family, byte[] qualifier)
NavigableMap <byte[],byte[]>	getFamilyMap	(byte[] family)
byte[]	getValue	(byte[] column)
byte[]	getValue	(byte[] family, byte[] qualifier)
int	Size	()

Scanner

- All operations are identical to **Get**
  - Rather than specifying a single row, an optional startRow and stopRow may be defined.
- If rows are not specified, the Scanner will iterate over all rows.
  - = new Scan ()
  - = new Scan (byte[] startRow, byte[] stopRow)
  - = new Scan (byte[] startRow, Filter filter)

Get	addColumn	(byte[] column)
Get	addColumn	(byte[] family, byte[] qualifier)
Get	addColumns	(byte[][] columns)
Get	addFamily	(byte[] family)
TimeRange	getTimeRange	()
Get	setTimeRange	(long minStamp, long maxStamp)
Get	setFilter	(Filter filter)

Interface ResultScanner

- Interface for client-side scanning. Go to HTable to obtain instances.
  - HTable.getScanner (Bytes.toBytes(family));
  - Ex:

```
ResultScanner scanner = table.getScanner (Bytes.toBytes(family));
for (Result rowResult : scanner) {
        Bytes[] str = rowResult.getValue ( family , column );
}
```

void	close	()
Result	next	()

HBase Key/Value 的格式

- org.apache.hadoop.hbase.KeyValue
- getRow(), getFamily(), getQualifier(), getTimestamp(), and getValue().
- The KeyValue blob format inside the byte array is:

<keylength> <valuelength> <key> <value>

- Key 的格式:

< row-length >	< row>	< column-family-length >	< column-family >	< column-qualifier >	< time-stamp >	< key-type >

- Rowlength 最大值為 Short.MAX_SIZE,
- column family length 最大值為 Byte.MAX_SIZE,
- column qualifier + key length 必須小於 Integer.MAX_SIZE.

範例一：新增Table

create <表名>, {<family>, ….}

```
$ hbase shell
> create ‘tablename', ‘family1', 'family2', 'family3‘
0 row(s) in 4.0810 seconds
> List
tablename
1 row(s) in 0.0190 seconds
```

範例一：新增Table

```
public static void createHBaseTable ( String tablename, String familyname ) throws
    IOException
  {
    HBaseConfiguration config = new HBaseConfiguration();
    HBaseAdmin admin = new HBaseAdmin(config);
      HTableDescriptor htd = new HTableDescriptor( tablename );
      HColumnDescriptor col = new HColumnDescriptor( familyname );
      htd.addFamily ( col );
      if( admin.tableExists(tablename))
      {     return ()   }
      admin.createTable(htd);
  }
```

範例二：Put資料進Column

put ‘表名’, ‘列’, ‘column’, ‘值’ , [‘時間’]

```
> put 'tablename','row1', 'family1:qua1', 'value'
0 row(s) in 0.0030 seconds
```

範例二： Put資料進Column

```
static public void putData(String tablename, String row, String family,
            String column, String value) throws IOException {
    HBaseConfiguration config = new HBaseConfiguration();
    HTable table = new HTable(config, tablename);
    byte[] brow = Bytes.toBytes(row);
    byte[] bfamily = Bytes.toBytes(family);
    byte[] bcolumn = Bytes.toBytes(column);
    byte[] bvalue = Bytes.toBytes(value);
    Put p = new Put(brow);
    p.add(bfamily, bcolumn, bvalue);
    table.put(p);
    table.close();
}
```

範例三： Get Column Value

get ‘表名’ ,‘列’

```
> get 'tablename', 'row1'
COLUMN                CELL
family1:column1       timestamp=1265169495385,   value=value
1 row(s) in 0.0100 seconds
```

範例三： Get Column Value

```
String getColumn ( String tablename, String row, String family,        String column )  throws
    IOException {
    HBaseConfiguration conf = new HBaseConfiguration();
    HTable table;
    table = new HTable( conf, Bytes.toBytes( tablename));
    Get g = new Get(Bytes.toBytes(row));
    Result rowResult = table.get(g);
    return Bytes.toString( rowResult.getValue (
                Bytes.toBytes (family +   ":"   + column)));
    }
```

範例四： Scan all Column

scan ‘表名’

```
> scan 'tablename'
ROW   COLUMN+CELL
row1  column=family1:column1, timestamp=1265169415385, value=value1
row2  column=family1:column1, timestamp=1263534411333, value=value2
row3  column=family1:column1, timestamp=1263645465388, value=value3
row4  column=family1:column1, timestamp=1264654615301, value=value4
row5  column=family1:column1, timestamp=1265146569567, value=value5
5 row(s) in 0.0100 seconds
```

範例四：Scan all Column

```
static void ScanColumn(String tablename, String family, String column)  throws
    IOException {
        HBaseConfiguration conf = new HBaseConfiguration();
        HTable table = new HTable ( conf, Bytes.toBytes(tablename));
        ResultScanner scanner = table.getScanner(
                                                    Bytes.toBytes(family));
        int i = 1;
        for (Result rowResult : scanner) {
                byte[] by = rowResult.getValue(
                        Bytes.toBytes(family), Bytes.toBytes(column) );
                String str = Bytes.toString ( by );
                System.out.println("row " + i + " is \"" + str +"\"");
                i++;
}}}
```

範例五： 刪除資料表

disable ‘表名’
drop ‘表名’

```
> disable 'tablename'
0 row(s) in 6.0890 seconds
> drop 'tablename'
0 row(s) in 0.0090 seconds
0 row(s) in 0.0090 seconds
0 row(s) in 0.0710 seconds
```

範例五： 刪除資料表

```
static void drop ( String tablename ) throws IOExceptions {
   HBaseConfiguration conf = new HBaseConfiguration();
   HBaseAdmin admin = new HBaseAdmin (conf);
   if (admin.tableExists(tablename))
    {
        admin.disableTable(tablename);
        admin.deleteTable(tablename);
   }else{
        System.out.println(" [" + tablename+ "] not found!");
}}
```

MapReduce與HBase的搭配

範例六：WordCountHBase

說明：此程式碼將輸入路徑的檔案內字串取出做字數統計
再將結果塞回HTable內

運算方法：
將此程式運作在hadoop 0.20 平台上，用(參考2)的方法加入hbase參數後，將此程式碼打包成XX.jar

結果： > scan 'wordcount'

```
ROW          COLUMN+CELL
am    column=content:count, timestamp=1264406245488, value=1
chen  column=content:count, timestamp=1264406245488, value=1
hi,          column=content:count, timestamp=1264406245488, value=2
```

注意：

1. 在hdfs 上來源檔案的路徑為 "/user/$YOUR_NAME/input"
   請注意必須先放資料到此hdfs上的資料夾內，且此資料夾內只能放檔案，不可再放資料夾
2. 運算完後，程式將執行結果放在hbase的wordcount資料表內

範例六：WordCountHBase

```
public class WordCountHBase
{
   public static class Map extends
     Mapper<LongWritable,Text,Text,
     IntWritable>
   {
      private IntWritable i = new
     IntWritable(1);
      public void map(LongWritable
     key,Text value,Context context) throws
     IOException, InterruptedException
      {
          String s[] =
     value.toString().trim().split(" ");
          for( String m : s)
          {
              context.write(new Text(m), i);
}}}
```

```
public static class Reduce extends
        TableReducer<Text, IntWritable,
        NullWritable>  {
       public void reduce(Text key,
        Iterable<IntWritable> values, Context
        context) throws IOException,
        InterruptedException  {
          int sum = 0;
          for(IntWritable i : values) {
              sum += i.get(); }
        Put put = new
        Put(Bytes.toBytes(key.toString()));
          put.add(Bytes.toBytes("content"),
        Bytes.toBytes("count"),
        Bytes.toBytes(String.valueOf(sum)));
          context.write(NullWritable.get(),
        put);
} }
```

範例六：WordCountHBase

```
public static void createHBaseTable(String
    tablename)throws IOException
  {
     HTableDescriptor htd = new
    HTableDescriptor(tablename);
     HColumnDescriptor col = new
    HColumnDescriptor("content:");
     htd.addFamily(col);
     HBaseConfiguration config = new
    HBaseConfiguration();
     HBaseAdmin admin = new
    HBaseAdmin(config);
     if(admin.tableExists(tablename))
     {
        admin.disableTable(tablename);
        admin.deleteTable(tablename);
     }
     System.out.println("create new table: " +
    tablename);
     admin.createTable(htd);
  }
```

```
public static void main(String args[]) throws Exception
{
   String tablename = "wordcount";
   Configuration conf = new Configuration();
   conf.set(TableOutputFormat.OUTPUT_TABLE,
       tablename);
   createHBaseTable(tablename);
   String input = args[0];
   Job job = new Job(conf, "WordCount " + input);
   job.setJarByClass(WordCountHBase.class);
   job.setNumReduceTasks(3);
   job.setMapperClass(Map.class);
   job.setReducerClass(Reduce.class);
   job.setMapOutputKeyClass(Text.class);
   job.setMapOutputValueClass(IntWritable.class);
  job.setInputFormatClass(TextInputFormat.class);
  job.setOutputFormatClass(TableOutputFormat.class);
   FileInputFormat.addInputPath(job, new Path(input));
   System.exit(job.waitForCompletion(true)?0:1);
}}
```

範例七：LoadHBaseMapper

說明： 此程式碼將HBase的資料取出來，再將結果塞回hdfs上

運算方法：

將此程式運作在hadoop 0.20 平台上，用(參考2)的方法加入hbase參數後，將此程式碼打包成XX.jar

結果： $ hadoop fs -cat <hdfs_output>/part-r-00000

---

54 30 31 GunLong

54 30 32 Esing

54 30 33 SunDon

54 30 34 StarBucks

注意：

1. 請注意hbase 上必須要有 table, 並且已經有資料
2. 運算完後，程式將執行結果放在指定 hdfs的<hdfs_output> 內
   請注意 沒有 <hdfs_output> 資料夾

範例七：LoadHBaseMapper

```
public class LoadHBaseMapper {
public static class HtMap extends
    TableMapper<Text, Text> {
public void
    map(ImmutableBytesWritable key,
    Result value,
            Context context) throws
    IOException, InterruptedException {
    String res =
    Bytes.toString(value.getValue(Bytes.
    toBytes("Detail"),

            Bytes.toBytes("Name")));
    context.write(new
    Text(key.toString()), new Text(res));
}}
```

```
public static class HtReduce extends
        Reducer<Text, Text, Text, Text> {
public void reduce(Text key, Iterable<Text>
        values, Context context)
            throws IOException,
        InterruptedException {
        String str = new String("");
        Text final_key = new Text(key);
        Text final_value = new Text();
        for (Text tmp : values) {
            str += tmp.toString();        }
        final_value.set(str);
        context.write(final_key, final_value);
}}
```

範例七： LoadHBaseMapper <2>

```
public static void main(String args[])
    throws Exception {
String input = args[0];
String tablename = "NTUT";
Configuration conf = new
    Configuration();
Job job = new Job (conf, tablename + "
    hbase data to hdfs");
job.setJarByClass
    (LoadHBaseMapper.class);
TableMapReduceUtil.
    initTableMapperJob
(tablename, myScan,
    HtMap.class,Text.class, Text.class,
    job);
job.setMapperClass (HtMap.class);
job.setReducerClass (HtReduce.class);
job.setMapOutputKeyClass (Text.class);
job.setMapOutputValueClass
        (Text.class);
job.setInputFormatClass (
        TableInputFormat.class);
job.setOutputFormatClass (
        TextOutputFormat.class);
job.setOutputKeyClass( Text.class);
job.setOutputValueClass( Text.class);
FileOutputFormat.setOutputPath ( job,
        new Path(input));
System.exit (job.waitForCompletion
        (true) ? 0 : 1);
}}
```

其他用法

HBase內contrib的項目，如

Trancational

Thrift

1. Transactional HBase

- Indexed Table = Secondary Index = Transactional HBase
- 內容與原本table 相似的另一張table，但key 不同，利於排列內容

Primary Table

	name	price	description
1	apple	10	xx
2	orig	5	ooo
3	banana	15	vvvv
4	tomato	8	uu

Indexed Table

	name	price	description
2	orig	5	ooo
4	tomato	8	uu
1	apple	10	xx
3	banana	15	vvvv

1.1 Transactional HBase環境設定

需在 $HBASE_INSTALL_DIR/conf/hbase-site.xml 檔內增加兩項內容

```
<property>
  <name> hbase.regionserver.class </name>
  <value> org.apache.hadoop.hbase.ipc.IndexedRegionInterface
 </value>
</property>
<property>
  <name> hbase.regionserver.impl </name>
  <value>
org.apache.hadoop.hbase.regionserver.tableindexed.IndexedRegionServer
  </value>
</property>
```

1.a 從一個原有的Table 增加IndexedTable

```
public void addSecondaryIndexToExistingTable
    (String TableName, String IndexID, String IndexColumn)
    throws IOException {
    HBaseConfiguration conf = new HBaseConfiguration();
    IndexedTableAdmin admin = null;
    admin = new IndexedTableAdmin(conf);
    admin.addIndex(Bytes.toBytes(TableName), new
    IndexSpecification(
                IndexID, Bytes.toBytes(IndexColumn)));
}}
```

1.b 建立一個新的Table 附帶IndexedTable

```
public void createTableWithSecondaryIndexes(String TableName,
        String IndexColumn) throws IOException {
    HBaseConfiguration conf = new HBaseConfiguration();
    conf.addResource(new Path("/opt/hbase/conf/hbase-site.xml"));
    HTableDescriptor desc = new HTableDescriptor(TableName);
    desc.addFamily(new HColumnDescriptor("Family1"));
    IndexedTableDescriptor Idxdesc = new
    IndexedTableDescriptor(desc);
    Idxdesc.addIndex(new IndexSpecification(IndexColumn, Bytes
            .toBytes(" Family1 :" + IndexColumn)));
    IndexedTableAdmin admin = new IndexedTableAdmin(conf);
    admin.createIndexedTable(Idxdesc);
}
```

2. Thrift

- 由 Facebook 所開發
- 提供跨語言做資料交換的平台
- 可以用任何 Thrift 有支援的語言來存取 HBase
  - PHP
  - Perl
  - C++
  - Python
  - …..

2.1 Thrift PHP Example

- Insert data into HBase by PHP thrift client

```
$mutations = array(
  new Mutation( array(
    'column' => 'entry:num',
    'value' => array('a','b','c')
  ) ), );
$client->mutateRow( $t, $row, $mutations );
```

案例演練

利用一個虛擬的案例來運用之前的程式碼

NTUT餐廳

- 故事背景：
  - NTUT的餐廳即將開張，預計此廠員工將有200萬人
- 用傳統資料庫可能：
  - 大規模資料、同時讀寫，資料分析運算、...（自行發揮）
- 因此員工餐廳將導入
  - HBase資料庫存放資料
  - 透過 Hadoop進行Map Reduce分析運算

1. 建立商店資料

假設：目前有四間商店進駐NTUT餐廳，分別為位在
第1區的GunLong，品項4項單價為<20,40,30,50>
第2區的ESing,品項1項單價為<50>
第3區的SunDon,品項2項單價為<40,30>
第4區的StarBucks,品項3項單價為<50,50,20>

	Detail		Products				Turnover			
	Name	Locate	P1	P2	P3	P4				
T01	GunLong	01	20	40	30	50				
T02	ESing	02	50							
T03	SunDon	03	40	30						
T04	StarBucks	04	50	50	20					

1.a 建立初始HTable

〈程式碼〉

```
public void createHBaseTable(String tablename, String[] family)
    throws IOException {
HTableDescriptor htd = new HTableDescriptor(tablename);
for (String fa : family) {
    htd.addFamily(new HColumnDescriptor(fa));
}
HBaseConfiguration config = new HBaseConfiguration();
HBaseAdmin admin = new HBaseAdmin(config);
if (admin.tableExists(tablename)) {
    System.out.println("Table: " + tablename + "Existed.");
} else {
    System.out.println("create new table: " + tablename);

    admin.createTable(htd);
}
}
```

1.a 執行結果

Table: NTUT

Family	Detail	Products	Turnover
Qualifier	…	…	…
Row1	value		
Row2			
Row3			
…			

1.b 用讀檔方式把資料匯入HTable

```
void loadFile2HBase(String file_in, String table_name) throws IOException {
BufferedReader fi = new BufferedReader(
            new FileReader(new File(file_in)));
String line;
while ((line = fi.readLine()) != null) {
    String[] str = line.split(";");
    int length = str.length;
    PutData.putData(table_name, str[0].trim(), "Detail", "Name", str[1]
                        .trim());
    PutData.putData(table_name, str[0].trim(), "Detail", "Locate",
                        str[2].trim());
    for (int i = 3; i < length; i++) {
            PutData.putData(table_name, str[0], "Products", "P" + (i - 2),
                                    str[i]);
    }
    System.out.println();
}
fi.close();
}
```

1.b 執行結果

	Detail		Products				Turnover
	Name	Locate	P1	P2	P3	P4	
T01	GunLong	01	20	40	30	50	
T02	ESing	02	50				
T03	SunDon	03	40	30			
T04	StarBucks	04	50	50	20		

1. 螢幕輸出結果

```
create new table: NTUT
Put data :"GunLong" to Table: NTUT's Detail:Name
Put data :"01" to Table: NTUT's Detail:Locate
Put data :"20" to Table: NTUT's Products:P1
Put data :"40" to Table: NTUT's Products:P2
Put data :"30" to Table: NTUT's Products:P3
Put data :"50" to Table: NTUT's Products:P4

Put data :"Esing" to Table: NTUT's Detail:Name
Put data :"02" to Table: NTUT's Detail:Locate
Put data :"50" to Table: NTUT's Products:P1

Put data :"SunDon" to Table: NTUT's Detail:Name
Put data :"03" to Table: NTUT's Detail:Locate
Put data :"40" to Table: NTUT's Products:P1
Put data :"30" to Table: NTUT's Products:P2

Put data :"StarBucks" to Table: NTUT's Detail:Name
Put data :"04" to Table: NTUT's Detail:Locate
Put data :"50" to Table: NTUT's Products:P1
Put data :"50" to Table: NTUT's Products:P2
Put data :"20" to Table: NTUT's Products:P3
```

2 計算單月每個品項的購買次數

- 刷卡購餐的系統將每人每次購餐紀錄成檔案，格式如右
- 讀紀錄檔並統計每天每個品項的消費次數
- 將檔案上傳至hdfs
- 使用Hadoop運算
- 計算完後寫入HBase
- Turnover:P1,P2,P3,P4

waue:T01:P1:xx
jazz:T01:P2:xxx
lia:T01:P3:xxxx
hung:T02:P1:xx
lia:T04:P1:xxxx
lia:T04:P1:xxxx
hung:T04:P3:xx
hung:T04:P2:xx

……

2. Map Reduce運算結果匯入HTable

<map 程式碼>

```
public class NTUT2Count {
public static class HtMap extends
    Mapper<LongWritable, Text, Text,
    IntWritable> {
private IntWritable one = new
    IntWritable(1);
public void map(LongWritable key, Text
    value, Context context)
            throws IOException,
    InterruptedException {
    String s[] =
    value.toString().trim().split(":");
    // xxx:T01:P4:oooo => T01@P4
    String str = s[1] + "@" + s[2];
    context.write(new Text(str), one);
}
}
```

<reduce程式碼>

```
public static class HtReduce extends
    TableReducer<Text, IntWritable, LongWritable>
    {
public void reduce(Text key, Iterable<IntWritable>
    values,
            Context context) throws IOException,
    InterruptedException {
    int sum = 0;
    for (IntWritable i : values) sum += i.get();
    String[] str = (key.toString()).split("@");
    byte[] row = (str[0]).getBytes();
    byte[] family = Bytes.toBytes("Turnover");
    byte[] qualifier = (str[1]).getBytes();
    byte[] summary =
    Bytes.toBytes(String.valueOf(sum));
    Put put = new Put(row);
    put.add(family, qualifier, summary );
    context.write(new LongWritable(), put);
}}
```

2. 用Hadoop的Map Reduce運算並把結果匯入HTable

< Main 程式碼>

```
public static void main(String args[]) throws Exception {
String input = "income";
String tablename = "NTUT";
Configuration conf = new Configuration();
conf.set(TableOutputFormat.OUTPUT_TABLE, tablename);
Job job = new Job(conf, "Count to NTUT");
job.setJarByClass(NTUT2Count.class);
job.setMapperClass(HtMap.class);
job.setReducerClass(HtReduce.class);
job.setMapOutputKeyClass(Text.class);
job.setMapOutputValueClass(IntWritable.class);
job.setInputFormatClass(TextInputFormat.class);
job.setOutputFormatClass(TableOutputFormat.class);
FileInputFormat.addInputPath(job, new Path(input));
System.exit(job.waitForCompletion(true) ? 0 : 1);
}
}
```

2 執行結果

	Detail		Products				Turnover			
	Name	Locate	P1	P2	P3	P4	P1	P2	P3	P4
T01	GunLong	01	20	40	30	50	1	1	1	1
T02	ESing	02	50				2			
T03	SunDon	03	40	30			3			
T04	StarBucks	04	50	50	20		2	1	1	

```
> scan 'NTUT'
ROW                    COLUMN+CELL
 T01                   column=Detail:Locate, timestamp=1265184360616, value=01
 T01                   column=Detail:Name, timestamp=1265184360548, value=GunLong
 T01                   column=Products:P1, timestamp=1265184360694, value=20
 T01                   column=Products:P2, timestamp=1265184360758, value=40
 T01                   column=Products:P3, timestamp=1265184360815, value=30
 T01                   column=Products:P4, timestamp=1265184360866, value=50
 T01                   column=Turnover:P1, timestamp=1265187021528, value=1
 T01                   column=Turnover:P2, timestamp=1265187021528, value=1
 T01                   column=Turnover:P3, timestamp=1265187021528, value=1
 T01                   column=Turnover:P4, timestamp=1265187021528, value=1
 T02                   column=Detail:Locate, timestamp=1265184360951, value=02
 T02                   column=Detail:Name, timestamp=1265184360910, value=Esing
 T02                   column=Products:P1, timestamp=1265184361051, value=50
 T02                   column=Turnover:P1, timestamp=1265187021528, value=2
 T03                   column=Detail:Locate, timestamp=1265184361124, value=03
 T03                   column=Detail:Name, timestamp=1265184361098, value=SunDon
 T03                   column=Products:P1, timestamp=1265184361189, value=40
 T03                   column=Products:P2, timestamp=1265184361259, value=30
 T03                   column=Turnover:P1, timestamp=1265187021529, value=3
 T04                   column=Detail:Locate, timestamp=1265184361311, value=04
 T04                   column=Detail:Name, timestamp=1265184361287, value=StarBucks
 T04                   column=Products:P1, timestamp=1265184361343, value=50
 T04                   column=Products:P2, timestamp=1265184361386, value=50
 T04                   column=Products:P3, timestamp=1265184361422, value=20
 T04                   column=Turnover:P1, timestamp=1265187021529, value=2
 T04                   column=Turnover:P2, timestamp=1265187021529, value=1
 T04                   column=Turnover:P3, timestamp=1265187021529, value=1
4 row(s) in 0.0310 seconds
```

3. 計算當天營業額

- 計算每間商店的營業額
  - Σ（<該項商品單價> X <被購買的次數>）
  - 透過 Hadoop 的Map () 從HBase內的 Products:{P1,P2,P3,P4} 與 Turnover:{P1,P2,P3,P4} 調出來
  - 經過計算後由Hadoop 的Reduce () 寫回HBase 內 Turnover:Sum 的Column內
    - 需考慮到表格內每家的商品數量皆不同、有的品項沒有被購買

3. Hadoop 來源與輸出皆為 HBase

〈map 程式碼〉

```
public class NTUT3CalculateMR {
public static class HtMap extends TableMapper<Text, Text> {
public void map(ImmutableBytesWritable key, Result value,
      Context context) throws IOException, InterruptedException {
String row = Bytes.toString(value.getValue(Bytes.toBytes("Detail"),
            Bytes.toBytes("Locate")));
int sum = 0;
for (int i = 0; i < 4; i++) {
      String v = Bytes.toString(value.getValue(Bytes
                        .toBytes("Products"), Bytes.toBytes("P" + (i +
      1))));
      String c = Bytes.toString(value.getValue(Bytes
                        .toBytes("Turnover"), Bytes.toBytes("P" + (i +
      1))));
      if (v != null ) {
            if(c == null) c="0";
            System.err.println("p=" + v);
            System.err.println("c=" + c);
            sum += Integer.parseInt(v) * Integer.parseInt(c);
            System.err.println("T" + row + ":" + "p[" + i + "]*" + "c["
                              + i + "] => " + v + "*" + c + "+="
                              + (sum));    }}
context.write(new Text("T" + row), new Text(String.valueOf(sum))); }}
```

〈reduce程式碼〉

```
public static class HtReduce extends
      TableReducer<Text, Text,
      Text> {
public void reduce(Text key,
      Iterable<Text> values, Context
      context)
      throws IOException,
      InterruptedException {
String sum = "";
for (Text i : values) {
      sum += i.toString();
}
Put put = new
      Put(Bytes.toBytes(key.toString(
      )));
put.add(Bytes.toBytes("Turnover"),
      Bytes.toBytes("Sum"), Bytes
            .toBytes(sum));
context.write(new Text(), put);
}
}
```

3. Hadoop 來源與輸出皆為 HBase

< Main 程式碼>

```
public static void main(String args[]) throws
    Exception {
String tablename = "NTUT";
Scan myScan = new Scan();
myScan.addColumn("Detail:Locate".getBytes());
myScan.addColumn("Products:P1".getBytes());
myScan.addColumn("Products:P2".getBytes());
myScan.addColumn("Products:P3".getBytes());
myScan.addColumn("Products:P4".getBytes());
myScan.addColumn("Turnover:P1".getBytes());
myScan.addColumn("Turnover:P2".getBytes());
myScan.addColumn("Turnover:P3".getBytes());
myScan.addColumn("Turnover:P4".getBytes());
Configuration conf = new Configuration();
Job job = new Job(conf, "Calculating ");
job.setJarByClass(NTUT3CalculateMR.class);
job.setMapperClass(HtMap.class);
job.setReducerClass(HtReduce.class);
job.setMapOutputKeyClass(Text.class);
job.setMapOutputValueClass(Text.class);
job.setInputFormatClass(TableInputFormat.class);
job.setOutputFormatClass(TableOutputFormat.class
    );
TableMapReduceUtil.initTableMapperJob(tablena
    me, myScan, HtMap.class,
            Text.class, Text.class, job);
TableMapReduceUtil.initTableReducerJob(tablena
    me, HtReduce.class, job);
System.exit(job.waitForCompletion(true) ? 0 : 1);
}
}
```

```
> scan 'NTUT'
ROW                    COLUMN+CELL
 T01                   column=Detail:Locate, timestamp=1265184360616, value=01
 T01                   column=Detail:Name, timestamp=1265184360548, value=GunLong
 T01                   column=Products:P1, timestamp=1265184360694, value=20
 T01                   column=Products:P2, timestamp=1265184360758, value=40
 T01                   column=Products:P3, timestamp=1265184360815, value=30
 T01                   column=Products:P4, timestamp=1265184360866, value=50
 T01                   column=Turnover:P1, timestamp=1265187021528, value=1
 T01                   column=Turnover:P2, timestamp=1265187021528, value=1
 T01                   column=Turnover:P3, timestamp=1265187021528, value=1
 T01                   column=Turnover:P4, timestamp=1265187021528, value=1
 T01                   column=Turnover:sum, timestamp=1265190421993, value=140
 T02                   column=Detail:Locate, timestamp=1265184360951, value=02
 T02                   column=Detail:Name, timestamp=1265184360910, value=Esing
 T02                   column=Products:P1, timestamp=1265184361051, value=50
 T02                   column=Turnover:P1, timestamp=1265187021528, value=2
 T02                   column=Turnover:sum, timestamp=1265190421993, value=100
 T03                   column=Detail:Locate, timestamp=1265184361124, value=03
 T03                   column=Detail:Name, timestamp=1265184361098, value=SunDon
 T03                   column=Products:P1, timestamp=1265184361189, value=40
 T03                   column=Products:P2, timestamp=1265184361259, value=30
 T03                   column=Turnover:P1, timestamp=1265187021529, value=3
 T03                   column=Turnover:sum, timestamp=1265190421993, value=120
 T04                   column=Detail:Locate, timestamp=1265184361311, value=04
 T04                   column=Detail:Name, timestamp=1265184361287, value=StarBucks
 T04                   column=Products:P1, timestamp=1265184361343, value=50
 T04                   column=Products:P2, timestamp=1265184361386, value=50
 T04                   column=Products:P3, timestamp=1265184361422, value=20
 T04                   column=Turnover:P1, timestamp=1265187021529, value=2
 T04                   column=Turnover:P2, timestamp=1265187021529, value=1
 T04                   column=Turnover:P3, timestamp=1265187021529, value=1
 T04                   column=Turnover:sum, timestamp=1265190421993, value=170
4 row(s) in 0.0460 seconds
```

3. 執行結果

	Detail		Products				Turnover				
	Name	Locate	P1	P2	P3	P4	P1	P2	P3	P4	Sum
T01	GunLong	01	20	40	30	50	1	1	1	1	140
T02	ESing	02	50				2				100
T03	SunDon	03	40	30			3	3			210
T04	StarBucks	04	50	50	20		4	4	4		480

4. 產生最終報表

- NTUT 高層想知道餐廳的營運狀況，因此需要產生出最後的報表
  - 資料由小到大排序
  - 過濾掉營業額 < 130 的資料

4.a 建立Indexed Table

```
public class NTUT4SortTurnover {
public void addIndexToTurnover(String OriTable, String IndexID,
    String OriColumn) throws IOException {
HBaseConfiguration conf = new HBaseConfiguration();
conf.addResource(new Path("/opt/hbase/conf/hbase-site.xml"));
IndexedTableAdmin admin = new IndexedTableAdmin(conf);
admin.addIndex(Bytes.toBytes(OriTable), new IndexSpecification(IndexID,
        Bytes.toBytes(OriColumn)));
}
public static void main(String[] args) throws IOException {
NTUT4SortTurnover tt = new NTUT4SortTurnover();
tt.addIndexToTurnover("NTUT", "Sum", "Turnover:Sum");
tt.readSortedValGreater("130");
}}
```

4.a Indexed Table 輸出結果

```
> scan 'NTUT-Sum'
ROW                  COLUMN+CELL
 100T02              column=Turnover:Sum, timestamp=1265190782127, value=100
 100T02              column=__INDEX__:ROW, timestamp=1265190782127, value=T02
 120T03              column=Turnover:Sum, timestamp=1265190782128, value=120
 120T03              column=__INDEX__:ROW, timestamp=1265190782128, value=T03
 140T01              column=Turnover:Sum, timestamp=1265190782126, value=140
 140T01              column=__INDEX__:ROW, timestamp=1265190782126, value=T01
 170T04              column=Turnover:Sum, timestamp=1265190782129, value=170
 170T04              column=__INDEX__:ROW, timestamp=1265190782129, value=T04
4 row(s) in 0.0140 seconds
```

4.b 產生排序且篩選過的資料

```
public void readSortedValGreater(String filter_val)
    throws IOException {
HBaseConfiguration conf = new
    HBaseConfiguration();
conf.addResource(new
    Path("/opt/hbase/conf/hbase-site.xml"));
// the id of the index to use
String tablename = "NTUT";
String indexId = "Sum";
byte[] column_1 = Bytes.toBytes("Turnover:Sum");
byte[] column_2 = Bytes.toBytes("Detail:Name");
byte[] indexStartRow =
    HConstants.EMPTY_START_ROW;
byte[] indexStopRow = null;
byte[][] indexColumns = null;
SingleColumnValueFilter indexFilter = new
    SingleColumnValueFilter(Bytes
            .toBytes("Turnover"),
    Bytes.toBytes("Sum"),
    CompareFilter.CompareOp.GREATER_OR_E
    QUAL, Bytes.toBytes(filter_val));
byte[][] baseColumns = new byte[][] { column_1,
    column_2 };
IndexedTable table = new IndexedTable(conf,
    Bytes.toBytes(tablename));
ResultScanner scanner =
    table.getIndexedScanner(indexId, indexStartRow,
            indexStopRow, indexColumns, indexFilter,
    baseColumns);
for (Result rowResult : scanner) {
    String sum =
    Bytes.toString(rowResult.getValue(column_1));
    String name =
    Bytes.toString(rowResult.getValue(column_2));
    System.out.println(name + " 's turnover is " + sum
    + " $.");
}
table.close();
}
```

列出最後結果

- 營業額大於130元者

GunLong 's turnover is 140 $.
StarBucks 's turnover is 170 $.