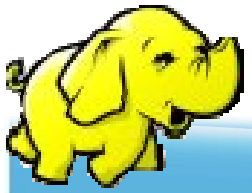
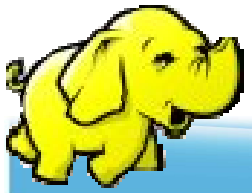
# 學員背景調查

- Java 語言 ??
- PHP 語言 ?? MySQL 資料庫 ??
- Linux 操作 ?? 電腦叢集維護 ??
- 安裝過 Hadoop ??
- 參加過 Hadoop 基礎課程 ??



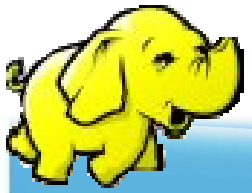
# It’s Show Time

- 名稱
- 服務公司/就讀學校
- 報名原因
- 預期收穫



# 引言

雲端運算這個名詞雖然紅，
但我一定需要雲端運算嗎？
他用在什麼場合？又或非它不可嗎？



# Computing with big datasets

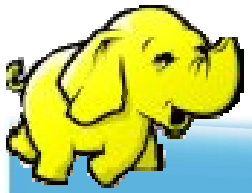
is a fundamentally different challenge than doing “big compute” over a small dataset

# 平行分散式運算

- 格網運算(網格運算, Grid computing)
  - MPI, PVM, Condor…
- 著重於: 分散工作量
- 目前的問題在於：如何分散資料量
  - Reading 100 GB off a single filer would leave nodes starved – just store data locally

# 分散大量資料： Slow and Tricky

- 交換資料需同步處理
  - **Deadlock** becomes a problem
- 有限的頻寬
  - Failovers can cause **cascading failure**



# 數字會說話

- Data processed by Google every month: 400 PB … in 2007
  - ◆Max data in memory: 32 GB
  - ◆Max data per computer: 12 TB
  - ◆Average job size: 180 GB
- 光一個device的讀取時間= 45 minutes

# 所以 …

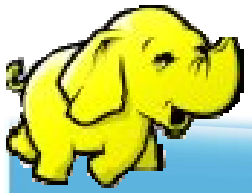
- 運算資料可以很快速，但瓶頸在於硬碟的 I/O
  - 1 HDD = 75 MB/sec
- 解法: parallel reads
  - 1000 HDDs = 75 GB/sec

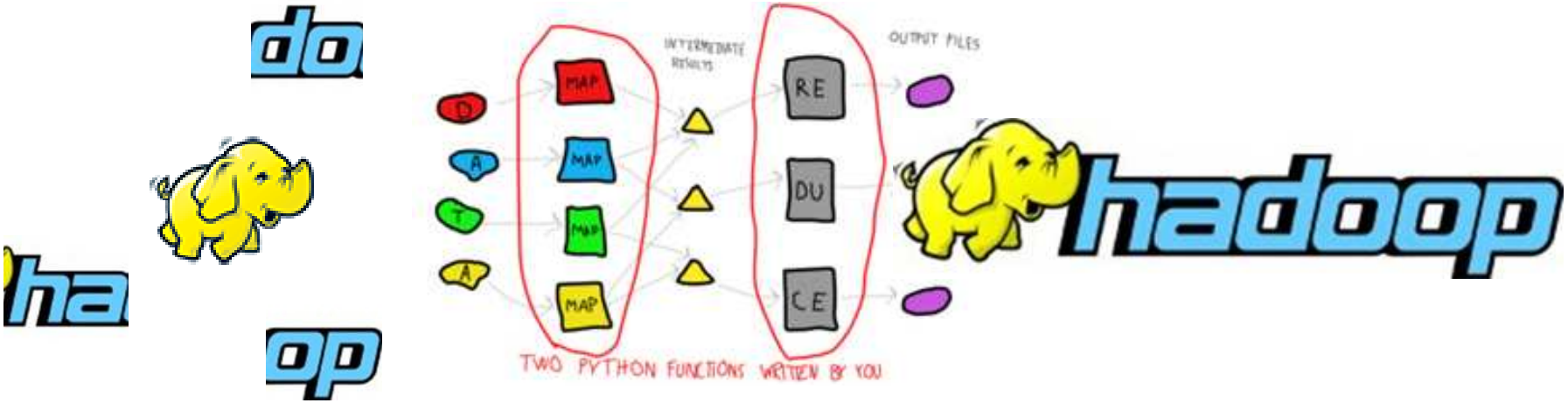
# MapReduce 的動機

- Data > 1 TB
- 交互運算於大量的CPU
- 容易開發與使用
  - High-level applications written in MapReduce
  - Programmers don’t worry about socket(), etc.

# Conclusions

- “大資料集的運算”與“小資料集的高速運算”，兩者是迥然不同的挑戰。
- 大資料量的解決方法將需要：
  - 提供囊括所有解決之道的新工具
  - MapReduce 與 HDFS 等工具是其中之一



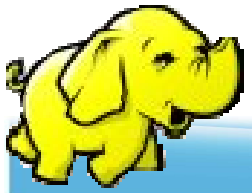



# 一、Hadoop 簡介

Hadoop 是一套儲存並處理
petabytes 等級資訊的
雲端運算技術

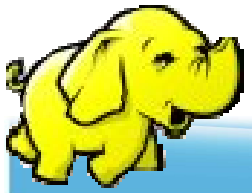
# Hadoop

- 以Java開發
- 自由軟體
- 上千個節點
- Petabyte等級的資料量
- 創始者 Doug Cutting
- 為Apache 軟體基金會的 top level project



# 特色

- 巨量
  - 擁有儲存與處理大量資料的能力
- 經濟
  - 由一般個人電腦所架設的叢集環境
- 效率
  - 藉由平行分散檔案以致得到快速的回應
- 可靠
  - 當某個節點發生錯誤，系統能即時自動的取得備份資料以及佈署運算資源



實用案例

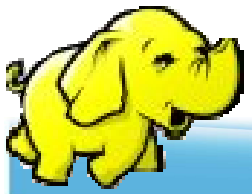
# Hadoop於Yahoo的運作資訊

| 年份 | 日期 | 節點數 | 耗時（小時） |
|---|---|---|---|
| 2006 | 四月 | 188 | 47.9 |
| 2006 | 五月 | 500 | 42 |
| 2006 | 十一月 | 20 | 1.8 |
| 2006 | 十一月 | 100 | 3.3 |
| 2006 | 十一月 | 500 | 5.2 |
| 2006 | 十一月 | 900 | 7.8 |
| 2007 | 七月 | 20 | 1.2 |
| 2007 | 七月 | 100 | 1.3 |
| 2007 | 七月 | 500 | 2 |
| 2007 | 七月 | 900 | 2.5 |

Sort benchmark, every nodes with terabytes data.

# 誰在用Hadoop ？(1)

- Facebook
  - 處理 internal log and dimension data sources
  - for reporting/analytics and machine learning.
- IBM
  - Blue Cloud Computing Clusters
- Journey Dynamics
  - 用 Hadoop MapReduce 分析 billions of lines of GPS data 並產生交通路線資訊.
- Krugle
  - 用 Hadoop and Nutch 建構 原始碼搜尋引擎

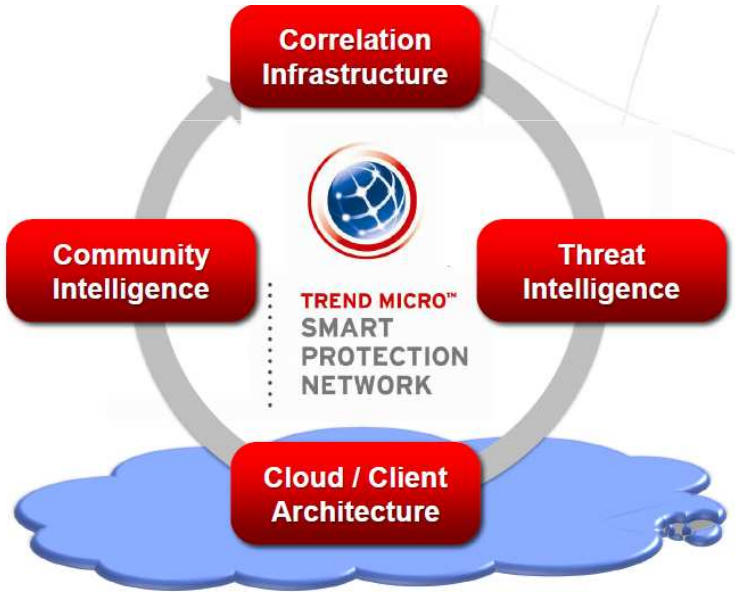


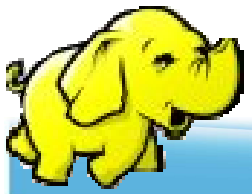
# 誰在用Hadoop ？(2)

- SEDNS - Security Enhanced DNS Group
  - 收集全世界的 DNS 以探索網路分散式內容.
- Technical analysis and Stock Research
  - 分析股票資訊
- University of Nebraska Lincoln, Research Computing Facility
  - 用Hadoop跑約200TB的CMS經驗分析
  - **緊湊渺子線圈**（**CMS**，**C**ompact **M**uon **S**olenoid）為瑞士歐洲核子研究組織CERN的大型強子對撞器計劃的兩大通用型粒子偵測器中的一個。

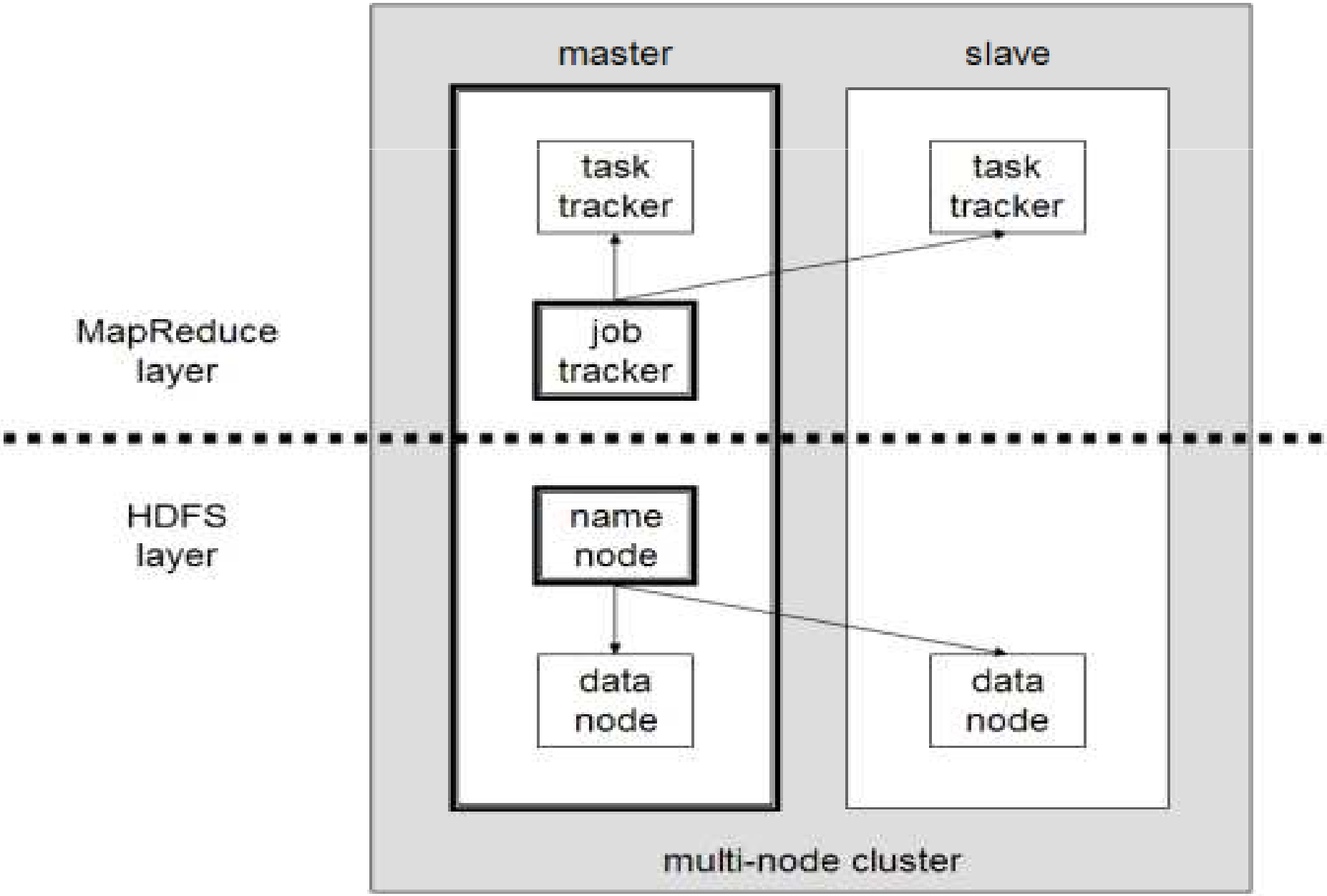
# 誰在用Hadoop？(3)

- Yahoo!
  - Used to support research for Ad Systems and Web Search
  - 使用Hadoop平台來發現發送垃圾郵件的殭屍網絡
- 趨勢科技
  - 過濾像是釣魚網站或惡意連結的網頁內容

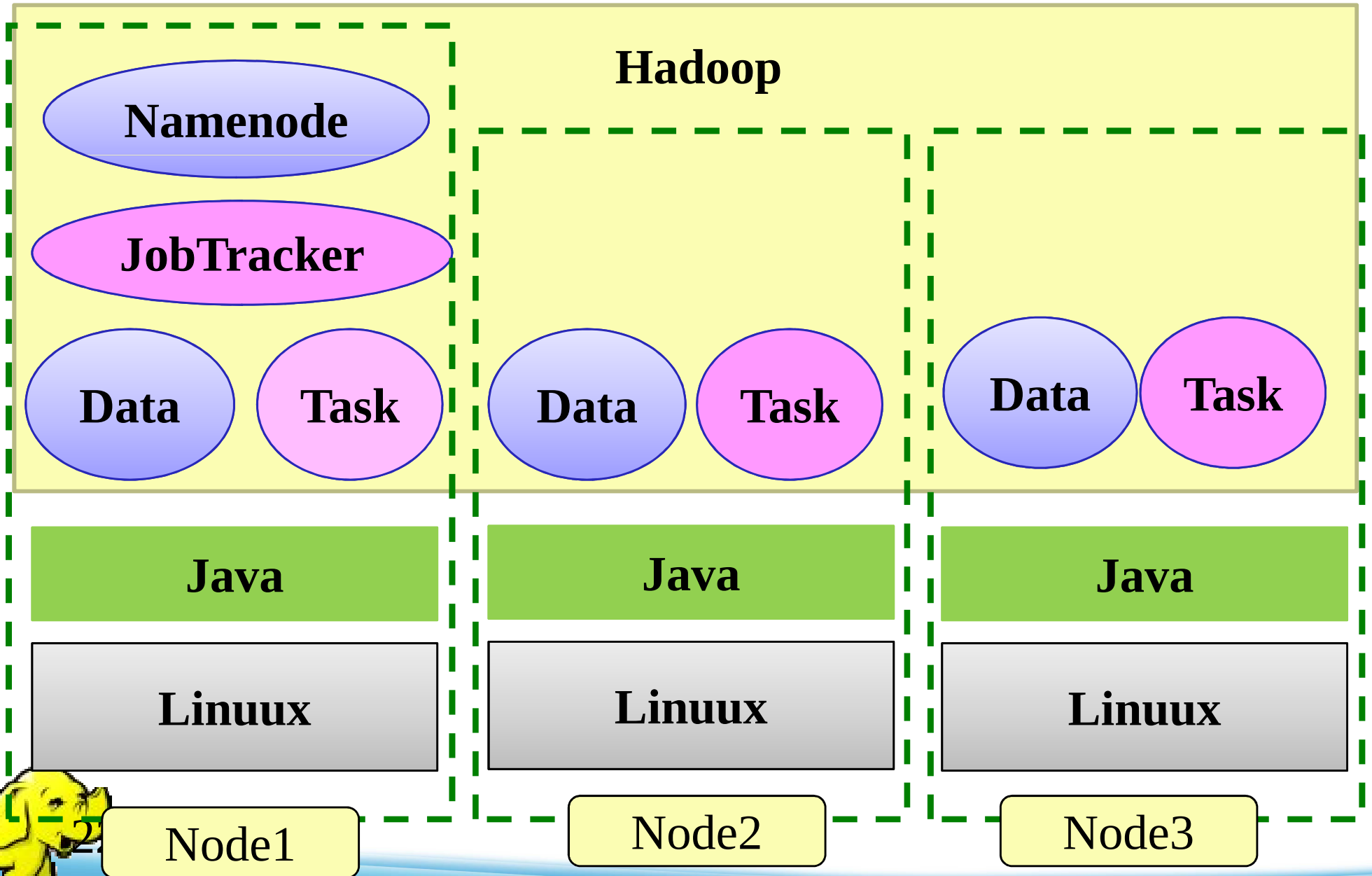


# Hadoop 的主要架構



# Building Hadoop



# 名詞

- Job
  - 任務
- Task
  - 小工作
- JobTracker
  - 任務分派者
- TaskTracker
  - 小工作的執行者
- Client
  - 發起任務的客戶端
- Map
  - 應對
- Reduce
  - 總和


- Namenode
  - 名稱節點
- Datanode
  - 資料節點
- Namespace
  - 名稱空間
- Replication
  - 副本
- Blocks
  - 檔案區塊 (64M)
- Metadata
  - 屬性資料

# 管理資料

## Namenode

- Master
- 管理HDFS的名稱空間
- 控制對檔案的讀/寫
- 配置副本策略
- 對名稱空間作檢查及紀錄
- 只能有一個

## Datanode

- Workers
- 執行讀/寫動作
- 執行Namenode的副本策略
- 可多個

# 分派程序

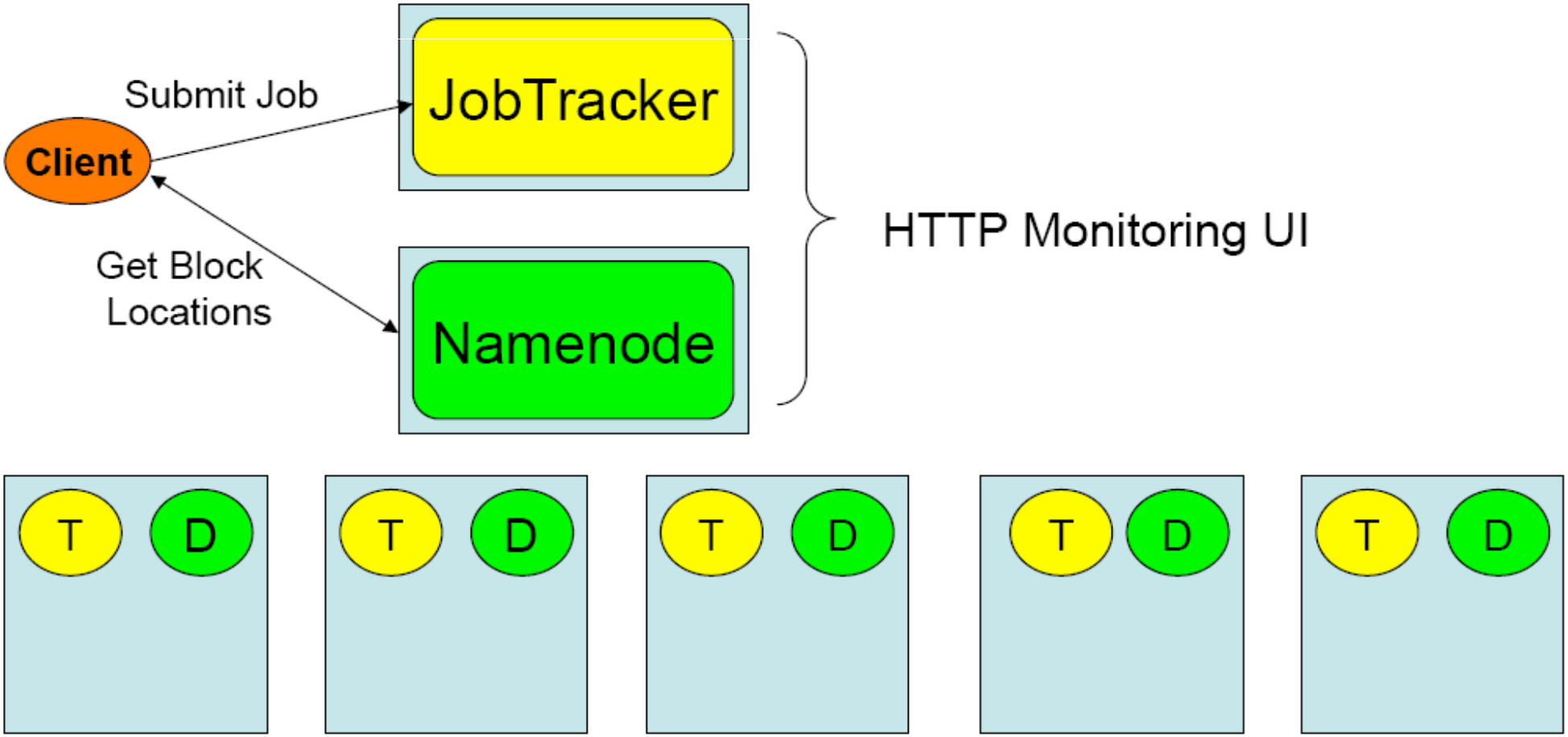
## Jobtracker

- Master
- 使用者發起工作
- 指派工作給 Tasktrackers
- 排程決策、工作分配、錯誤處理
- 只能有一個

## Tasktrackers

- Workers
- 運作Map 與 Reduce 的工作
- 管理儲存、回覆運算結果
- 可多個

# 不在雲裡的 Client



其他的 Open Source 專案:

| | | |
|---|---|---|
| **Sector** | The National Center for Data Mining (NCDM) | http://sector.sourceforge.net/ |

其他不同語言實作的 MapReduce 函式庫

http://trac.nchc.org.tw/grid/wiki/jazz/09-04-14#MapReduce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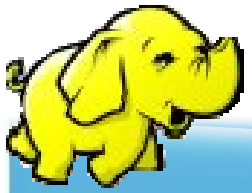
# 關於 Sector / Sphere

- http://sector.sourceforge.net/
- 由美國資料探勘中心(National Center for Data Mining)研發的自由軟體專案。
- 採用C/C++語言撰寫，因此效能較 Hadoop 更好。
- 提供「類似」Google File System與MapReduce的機制
- 基於UDT高效率網路協定來加速資料傳輸效率
- Open Cloud Consortium的Open Cloud Testbed，有提供測試環境，並開發了MalStone效能評比軟體。

Sector-Sphere

National Center for Data Mining
University of Illinois at Chicago
UIC

open data
Open Data Group
http://www.opendatagroup.com/



# Conclusions

- 所有工作都由JobTracker統一分派，由眾多TaskTracker 執行，每個TaskTracker又可以執行多個Task threads
- 所有名稱空間與檔案的metadata都由一個Namenode統籌，檔案空間為所有Datanode的集合，hdfs的基本單位為block
- Client 只需要丟工作或存取在“雲”的資料

# 四、寫Code 環境準備

## 4.A : Console 端
## 編譯與執行

4.B : 透過 Eclipse 開發與測試運算

# Java 之編譯與執行

1. 編譯
   - javac △ -classpath △ hadoop-*-core.jar △ -d △ MyJava △ MyCode.java
2. 封裝
   - jar △ -cvf △ MyJar.jar △ -C △ MyJava △ .
3. 執行
   - bin/hadoop △ jar △ MyJar.jar △ MyCode △ HDFS_Input/ △ HDFS_Output/

---

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

# WordCount1 練習 (I)

1. cd $HADOOP_HOME; mkdir input_local
2. echo "I like NCHC Cloud Course." > input_local/input1
3. echo "I like nchc Cloud Course, and we enjoy this crouse." > input_local/input2
4. bin/hadoop dfs -put input_local  input
5. bin/hadoop dfs -ls input

```
waue@vPro:/opt/hadoop$ bin/hadoop dfs -ls input
Found 2 items
-rw-r--r--   1 waue supergroup         26 2009-03-22 12:15 /user/waue/input/input1
-rw-r--r--   1 waue supergroup         52 2009-03-22 12:15 /user/waue/input/input2
waue@vPro:/opt/hadoop$
```

# WordCount1 練習 (II)

1. 編輯WordCount.java
   http://trac.nchc.org.tw/cloud/attachment/wiki/jazz/Hadoop_Lab6/WordCount.java?format=raw
2. mkdir MyJava
3. javac -classpath hadoop-*-core.jar -d MyJava WordCount.java
4. jar -cvf wordcount.jar -C MyJava .
5. bin/hadoop jar wordcount.jar WordCount input/ output/

---

- 所在的執行目錄為Hadoop_Home（因為hadoop-*-core.jar）
- javac編譯時需要classpath, 但hadoop jar時不用
- wordcount. jar = 封裝後的編譯檔，但執行時需告知class name
- Hadoop進行運算時，只有 input 檔要放到hdfs上，以便hadoop分析運算，執行檔（wordcount. jar）不需上傳，也不需每個node都放，程式的載入交由java處理

# WordCount1 練習(III)

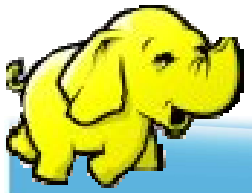
```
waue@vPro:/opt/hadoop$ bin/hadoop dfs -put input input
waue@vPro:/opt/hadoop$ mkdir MyJava
waue@vPro:/opt/hadoop$ javac -classpath hadoop-*-core.jar -d MyJava WordCount.java
waue@vPro:/opt/hadoop$ jar -cvf wordcount.jar -C MyJava .
新增 manifest
新增：WordCount.class (讀=1516)(寫=740)(壓縮 51%)
新增：WordCount$Reduce.class (讀=1591)(寫=642)(壓縮 59%)
新增：WordCount$Map.class (讀=1918)(寫=795)(壓縮 58%)
waue@vPro:/opt/hadoop$ bin/hadoop jar wordcount.jar WordCount input/ output/
09/03/22 11:39:01 WARN mapred.JobClient: Use GenericOptionsParser for parsing the argu
ments. Applications should implement Tool for the same.
09/03/22 11:39:01 INFO mapred.FileInputFormat: Total input paths to process : 1
09/03/22 11:39:01 INFO mapred.FileInputFormat: Total input paths to process : 1
09/03/22 11:39:02 INFO mapred.JobClient: Running job: job_200903201526_0007
09/03/22 11:39:03 INFO mapred.JobClient:  map 0% reduce 0%
09/03/22 11:39:08 INFO mapred.JobClient:  map 100% reduce 0%
09/03/22 11:39:15 INFO mapred.JobClient: Job complete: job_200903201526_0007
09/03/22 11:39:15 INFO mapred.JobClient: Counters: 16
09/03/22 11:39:15 INFO mapred.JobClient:   File Systems
09/03/22 11:39:15 INFO mapred.JobClient:     HDFS bytes read=320950
09/03/22 11:39:15 INFO mapred.JobClient:     HDFS bytes written=130568
09/03/22 11:39:15 INFO mapred.JobClient:     Local bytes read=168448
09/03/22 11:39:15 INFO mapred.JobClient:     Local bytes written=336932
09/03/22 11:39:15 INFO mapred.JobClient:   Job Counters
09/03/22 11:39:15 INFO mapred.JobClient:     Launched reduce tasks=1
09/03/22 11:39:15 INFO mapred.JobClient:     Launched map tasks=1
09/03/22 11:39:15 INFO mapred.JobClient:     Data-local map tasks=1
09/03/22 11:39:15 INFO mapred.JobClient:   Map-Reduce Framework
09/03/22 11:39:15 INFO mapred.JobClient:     Reduce input groups=9284
09/03/22 11:39:15 INFO mapred.JobClient:     Combine output records=18568
09/03/22 11:39:15 INFO mapred.JobClient:     Map input records=7868
09/03/22 11:39:15 INFO mapred.JobClient:     Reduce output records=9284
09/03/22 11:39:15 INFO mapred.JobClient:     Map output bytes=445846
09/03/22 11:39:15 INFO mapred.JobClient:     Map input bytes=320950
09/03/22 11:39:15 INFO mapred.JobClient:     Combine input records=47227
09/03/22 11:39:15 INFO mapred.JobClient:     Map output records=37943
09/03/22 11:39:15 INFO mapred.JobClient:     Reduce input records=9284
waue@vPro:/opt/hadoop$
```

# WordCount1 練習(IV)

```
waue@vPro:/opt/hadoop$ bin/hadoop dfs -cat output/part-00000
Cloud   2
Course, 1
Course. 1
I       2
NCHC    1
and     1
course. 1
enjoy   1
like    2
nchc    1
this    1
we      1
```

# BTW …

- 雖然Hadoop框架是用Java實作，但Map/Reduce應用程序則不一定要用 Java來寫
- Hadoop Streaming ：
  - 執行作業的工具，使用者可以用其他語言（如：PHP）套用到Hadoop的mapper和reducer
- Hadoop Pipes：C++ API



# 四、寫Code 環境準備

4.A : Console 端編譯與執行

**4.B：透過 Eclipse 開發與測試運算**

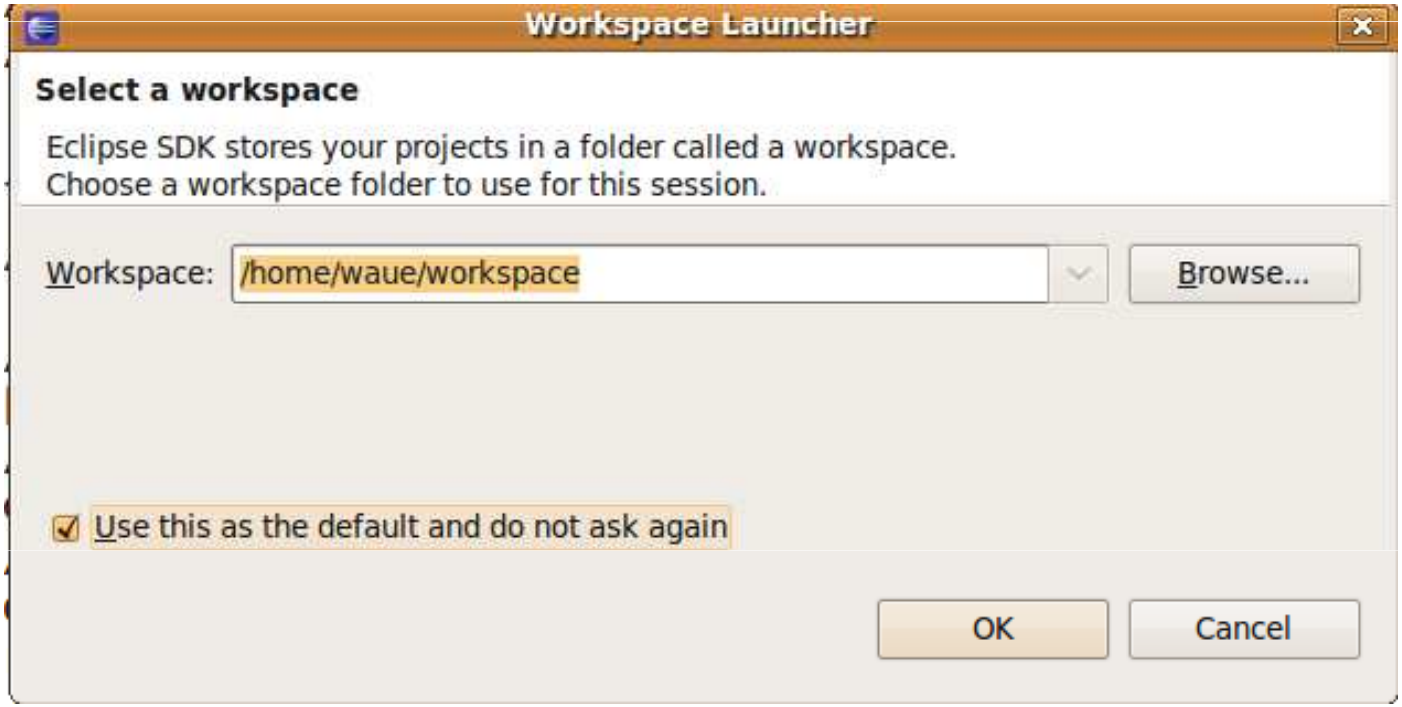
# Requirements

- Hadoop 0.20.0 up
- Java 1.6
- Eclipse 3.3 up
- Hadoop Eclipse Plugin 0.20.0 up

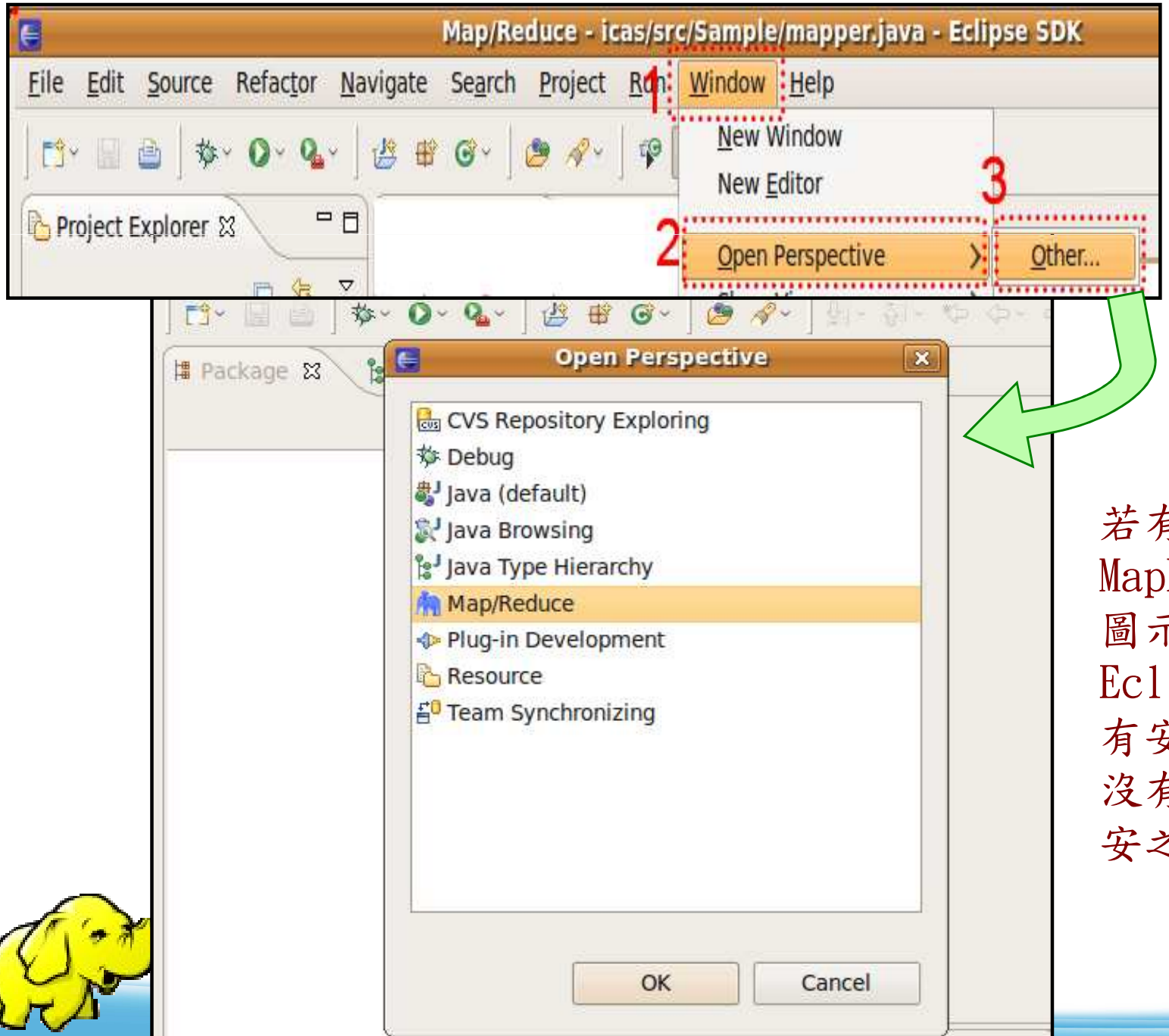
# 安裝Hadoop Eclipse Plugin

- Hadoop Eclipse Plugin 0.20.0
  - From $Hadoop_0.20.0_home/contrib/eclipse-plugin/hadoop-0.20.0-eclipse-plugin.jar
- Hadoop Eclipse Plugin 0.20.1
  - Compiler needed
  - Or download from http://hadoop-eclipse-plugin.googlecode.com/files/hadoop-0.20.1-eclipse-plugin.jar
- copy to $Eclipse_home/plugins/

# 1 打開Eclipse, 設定專案目錄



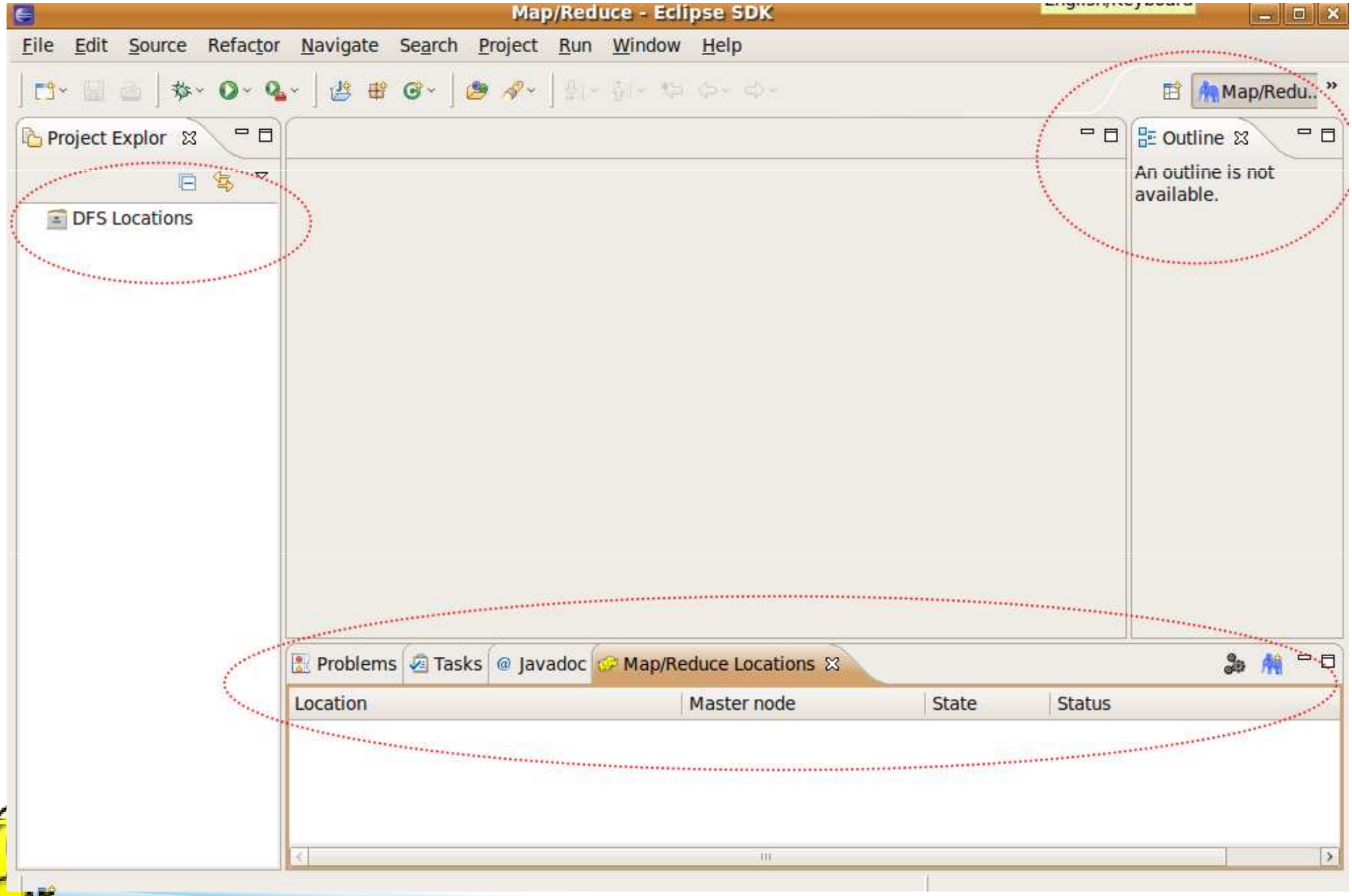
# 2. 使用Hadoop mode視野



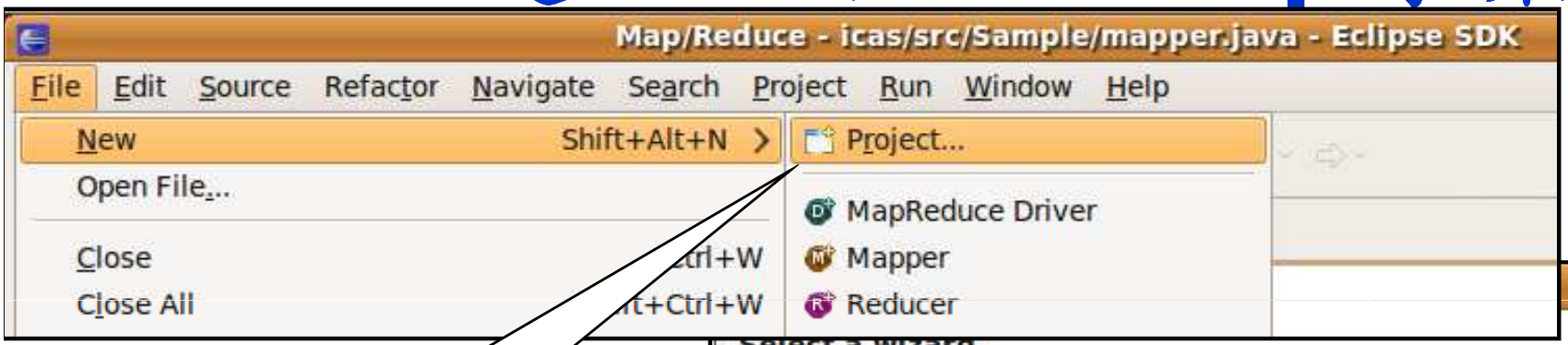

1. Window
2. Open Perspective
3. Other

若有看到MapReduce的大象圖示代表Hadoop Eclipse plugin有安裝成功， 若沒有請檢查是否有安之裝正確

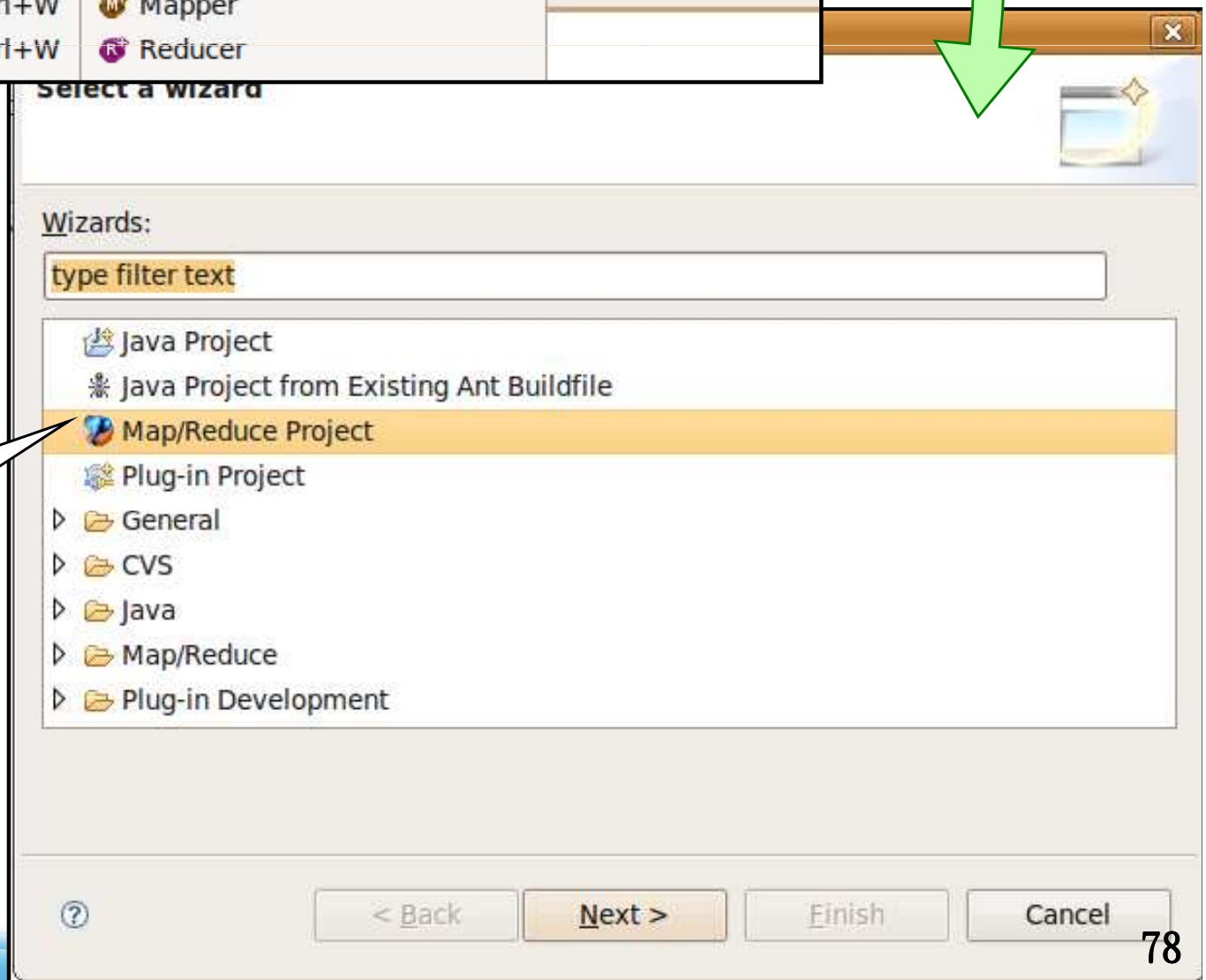
# 3. 使用Hadoop視野，主畫面將出現三個功能



# 4.建立一個Hadoop專案

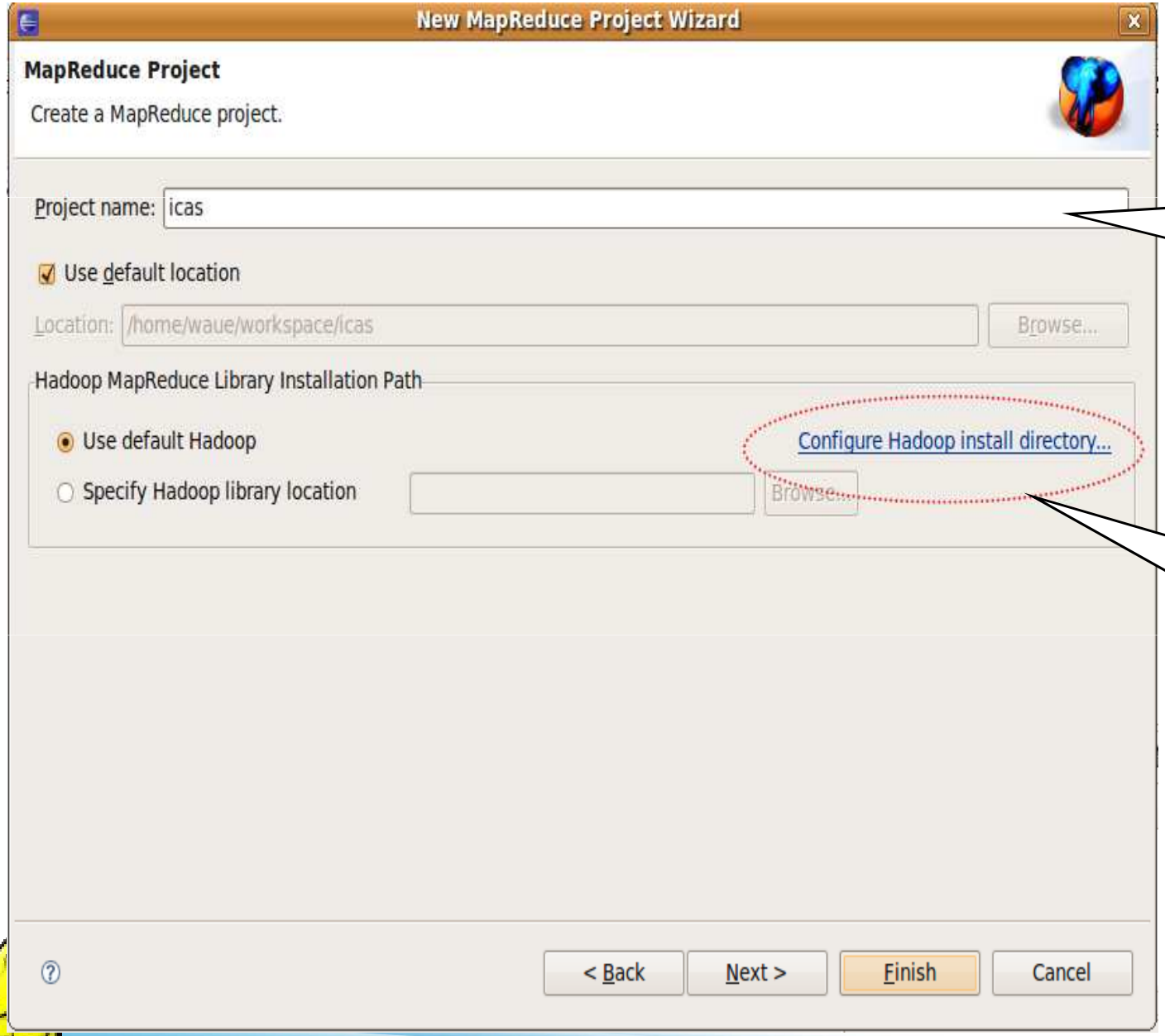



開出新專案




選擇Map/Reduce專案

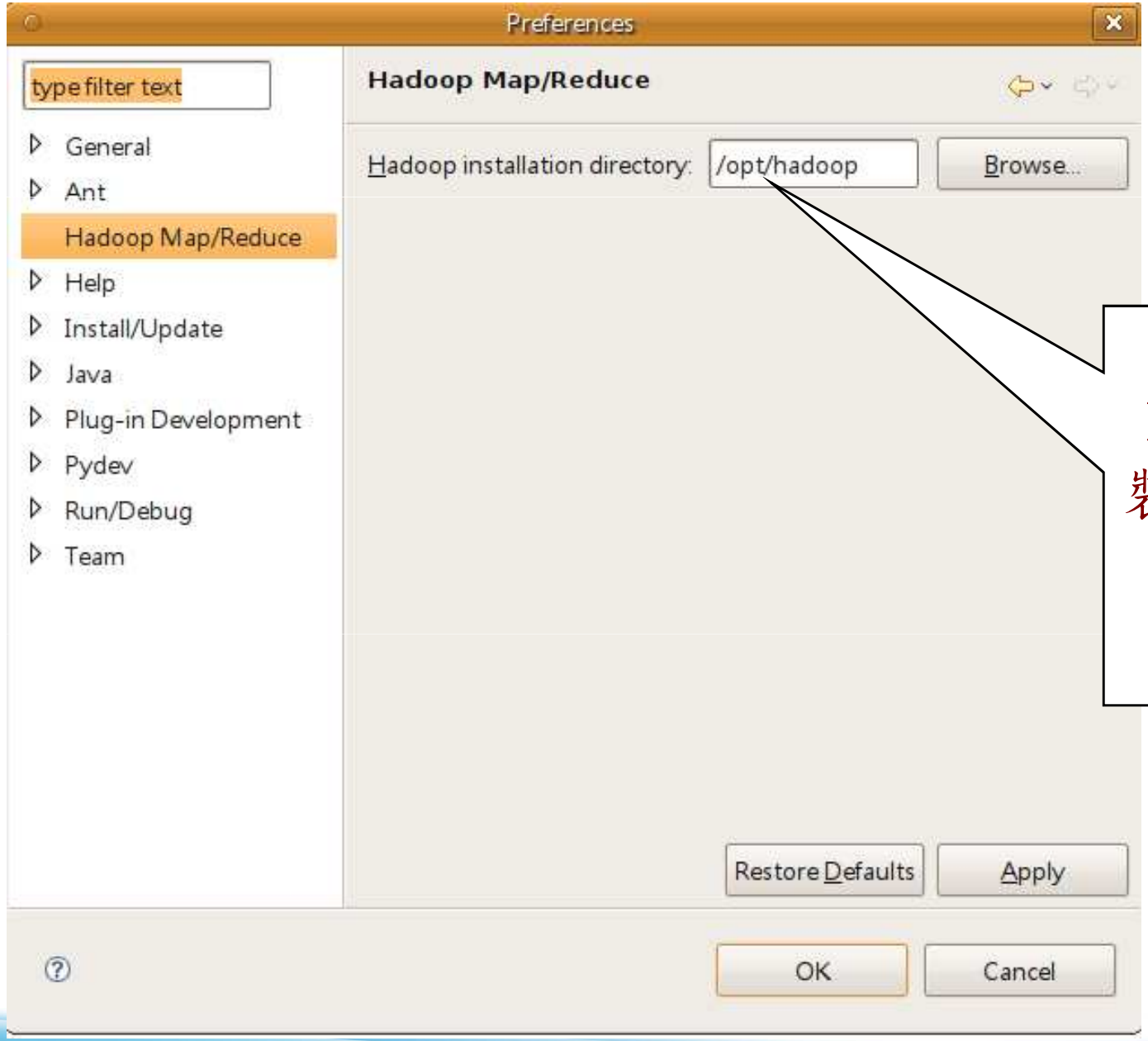
# 4-1. 輸入專案名稱並點選設定Hadoop安裝路徑




由此設定專案名稱

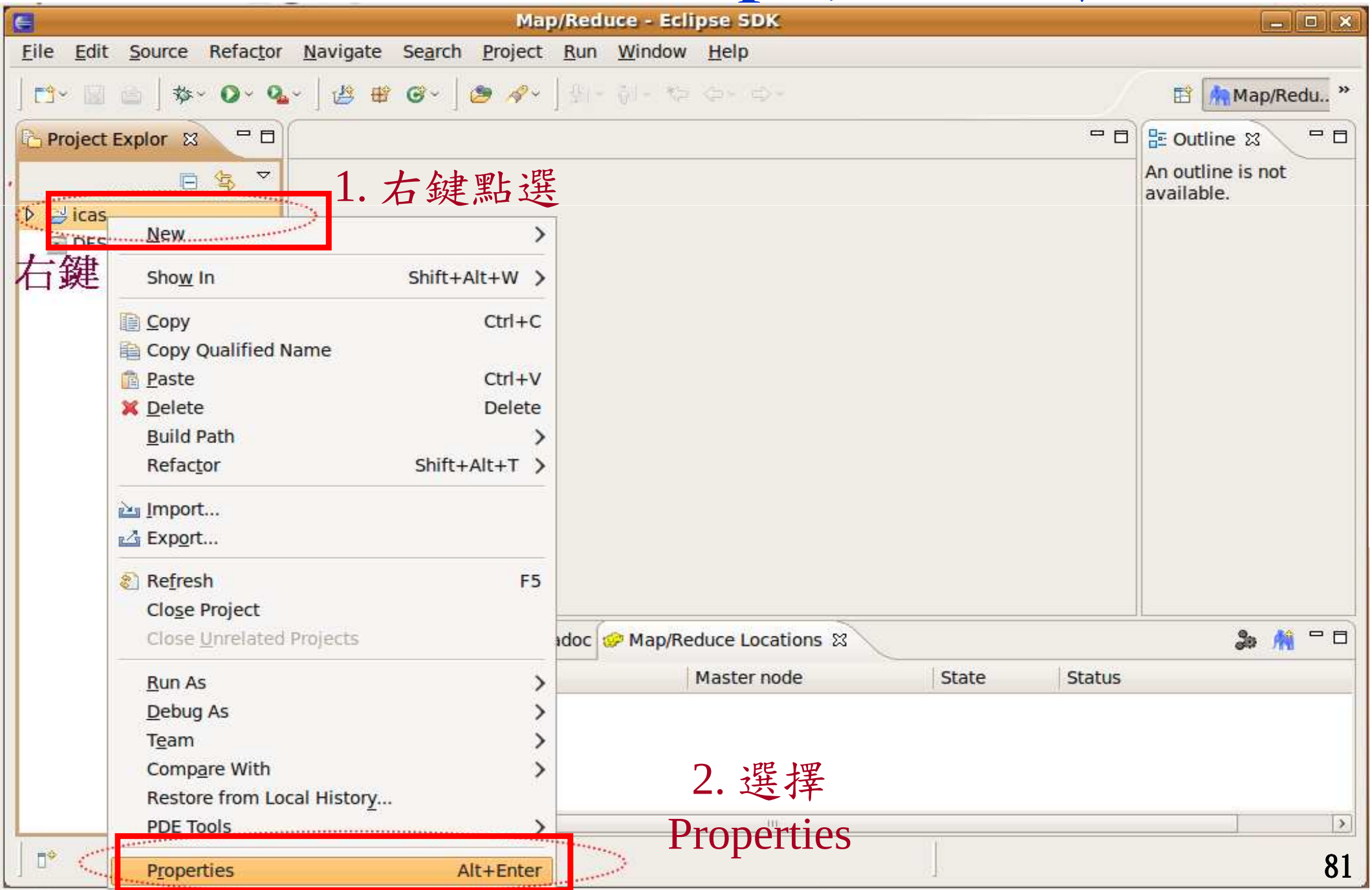
由此設定Hadoop的安裝路徑

# 4-1-1. 填入Hadoop安裝路徑




於此輸入您Hadoop的安裝路徑，之後選擇 ok

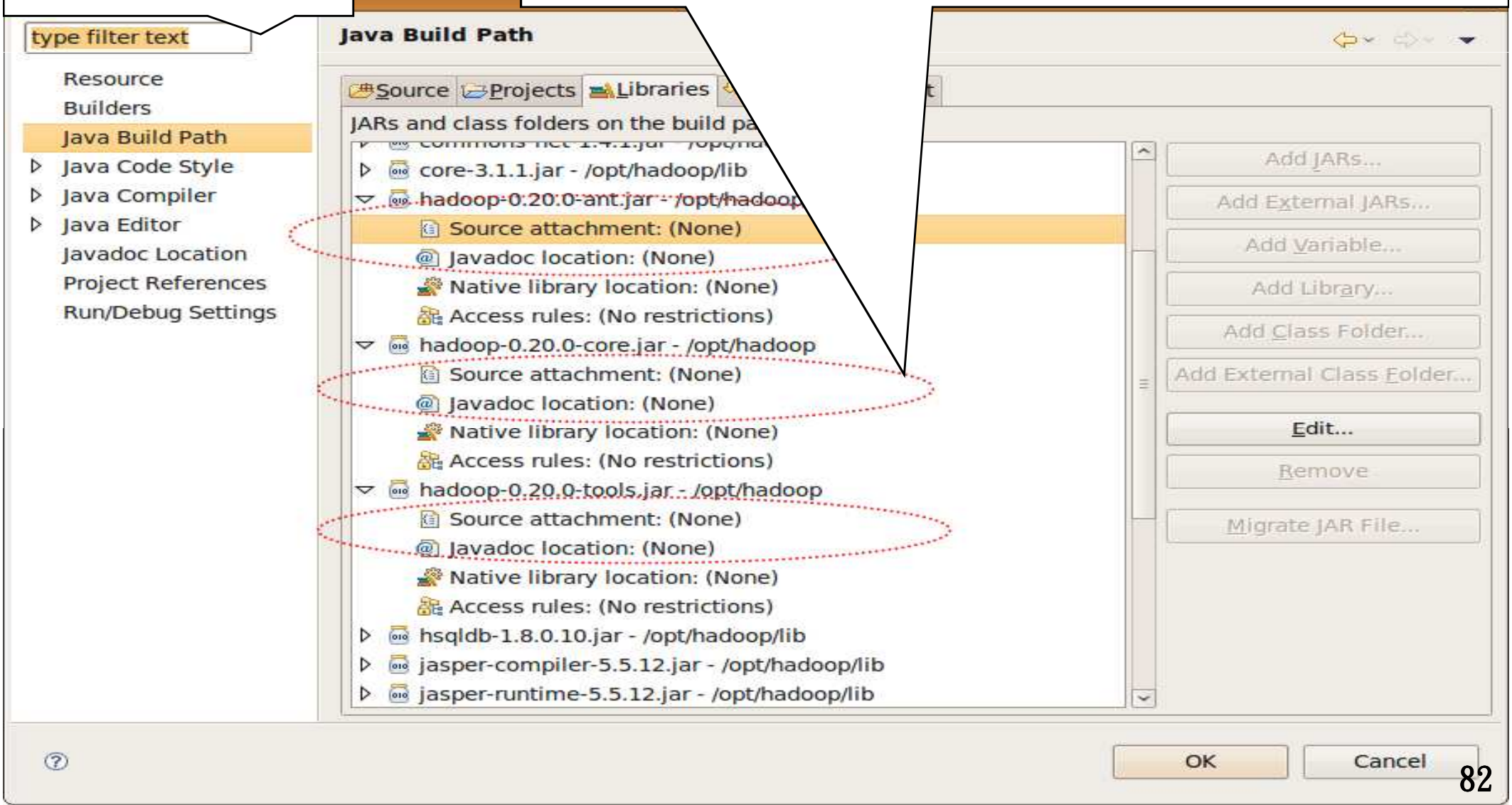
# 5. 設定Hadoop專案細節



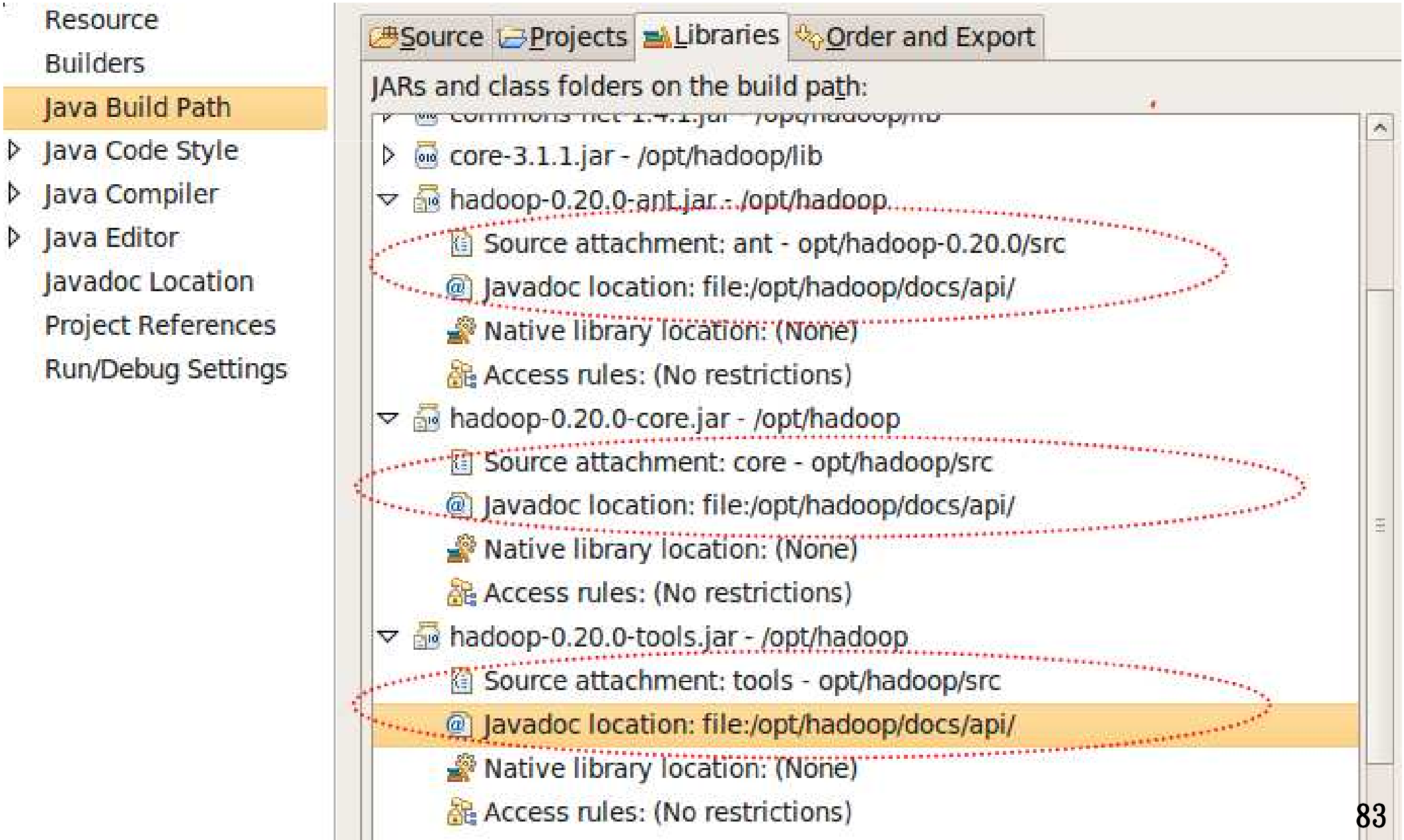
# 5-1. 設定原始碼與文件路徑

選擇 Java Build Path

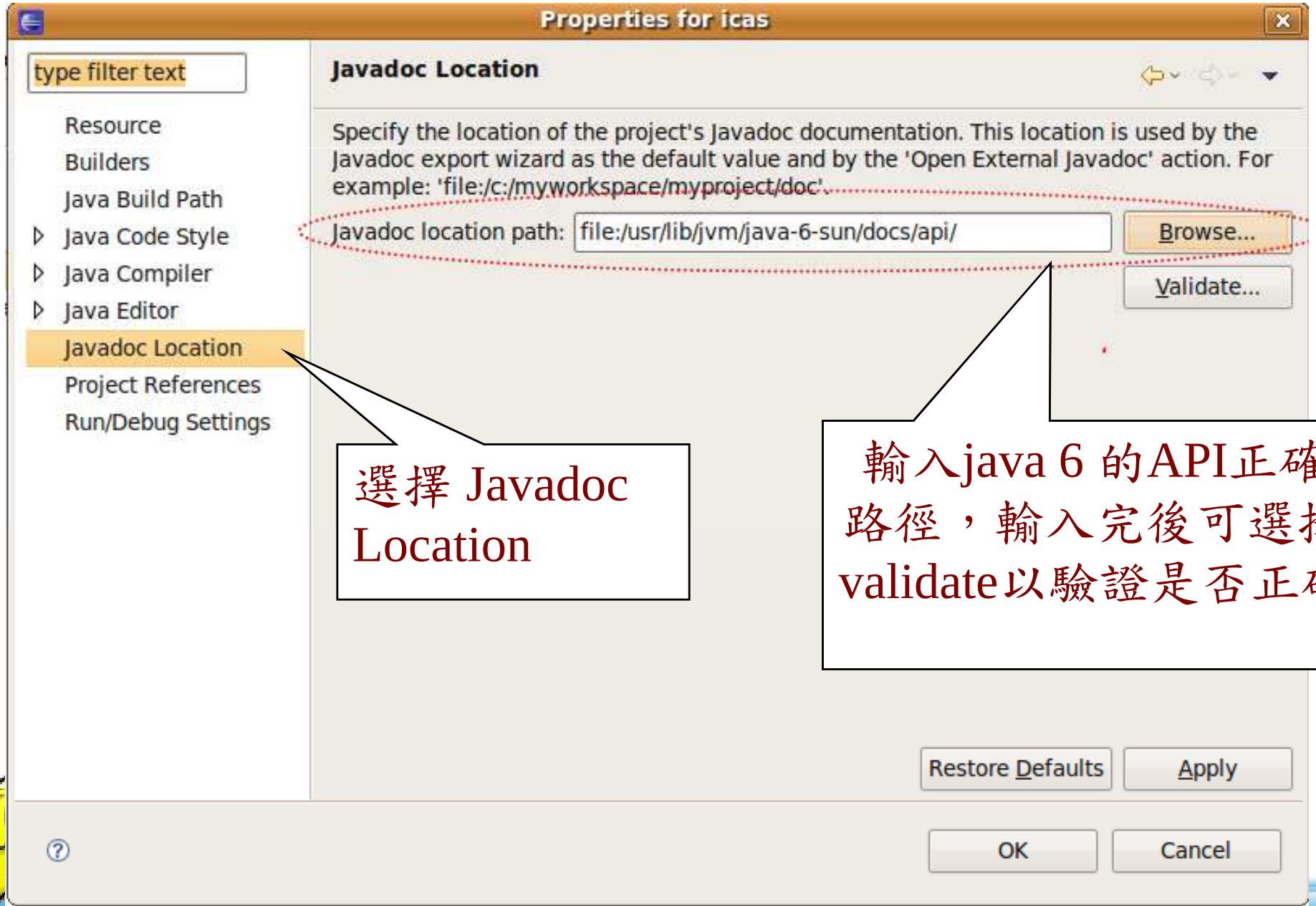
以下請輸入正確的Hadoop原始碼與API文件檔路徑，如
source ：/opt/hadoop/src/
javadoc：file:/opt/hadoop/docs/api/



# 5-1-1. 完成圖


Resource
Builders
Java Build Path
Java Code Style
Java Compiler
Java Editor
Javadoc Location
Project References
Run/Debug Settings
Source
Projects
Libraries
Order and Export
JARs and class folders on the build path:
core-3.1.1.jar - /opt/hadoop/lib
hadoop-0.20.0-ant.jar - /opt/hadoop
Source attachment: ant - opt/hadoop-0.20.0/src
Javadoc location: file:/opt/hadoop/docs/api/
Native library location: (None)
Access rules: (No restrictions)
hadoop-0.20.0-core.jar - /opt/hadoop
Source attachment: core - opt/hadoop/src
Javadoc location: file:/opt/hadoop/docs/api/
Native library location: (None)
Access rules: (No restrictions)
hadoop-0.20.0-tools.jar - /opt/hadoop
Source attachment: tools - opt/hadoop/src
Javadoc location: file:/opt/hadoop/docs/api/
Native library location: (None)
Access rules: (No restrictions)

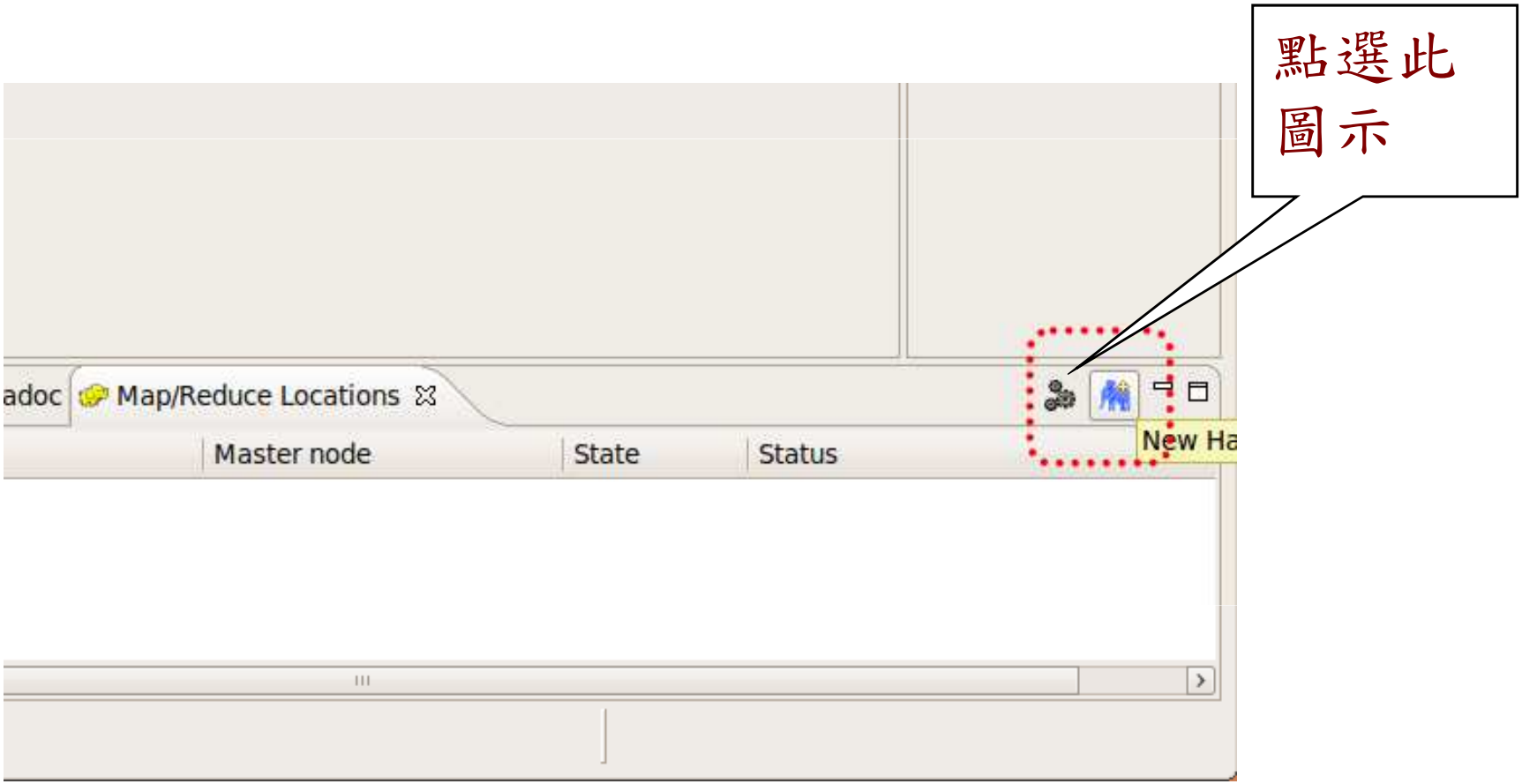
# 5-2. 設定java doc的完整路徑




選擇 Javadoc Location

輸入java 6 的API正確路徑，輸入完後可選擇validate以驗證是否正確

# 6. 連結Hadoop Server與Eclipse



# 6-1. 設定你要連接的Hadoop主機

任意填一個名稱

輸入主機位址或domain name

MapReduce 監聽的Port (設定於mapred-site.xml)

New Hadoop location...

**Define Hadoop location**

Define the location of a Hadoop infrastructure for running MapReduce applications.

General | Advanced parameters

Location name: hadoop

Map/Reduce Master
Host: localhost
Port: 9001

DFS Master
☑ Use M/R Master host
Host: localhost
Port: 9000

User name: waue

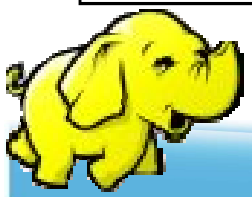
SOCKS proxy
☐ Enable SOCKS proxy
Host: host
Port: 1080

Load from file | Validate location

Finish | Cancel

HDFS監聽的Port (設定於core-site.xml)

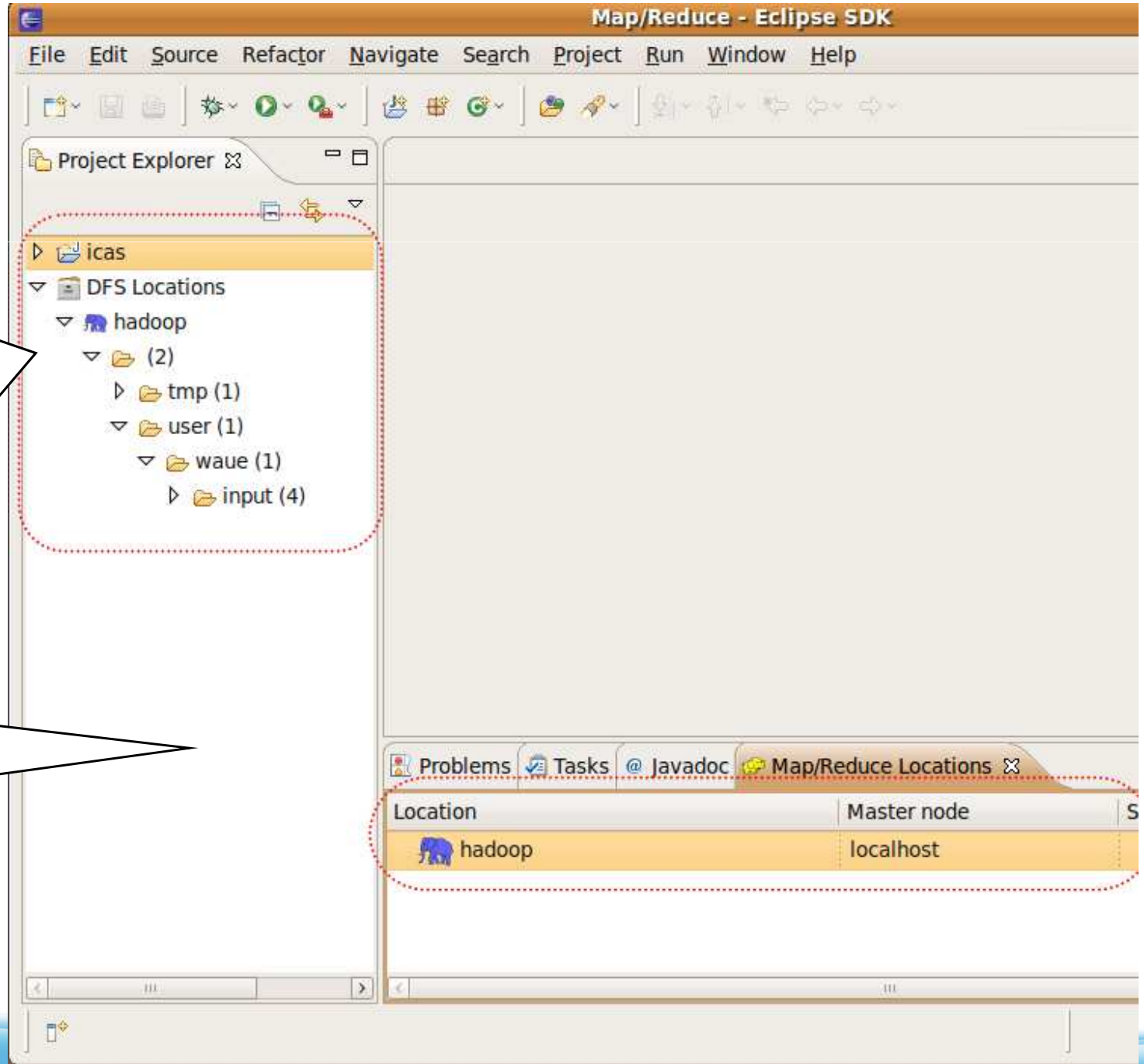
你在此Hadoop Server上的Username



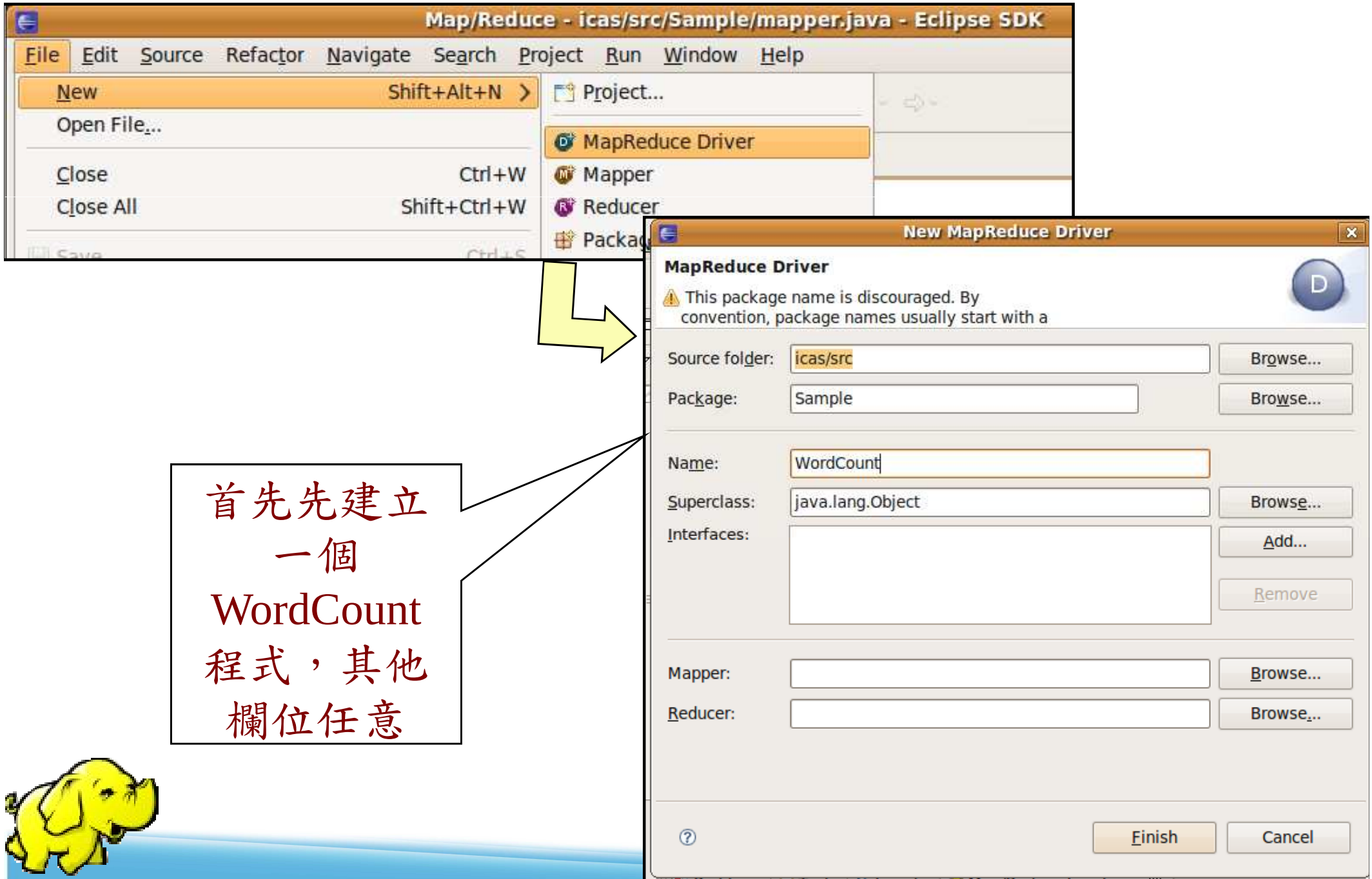
# 6-2 若正確設定則可得到以下畫面

HDFS的資訊，可直接於此操作檢視、新增、上傳、刪除等命令

若有Job運作，可於此視窗檢視



# 7. 新增一個Hadoop程式




首先先建立一個WordCount程式，其他欄位任意

# 7.1 於程式窗格內輸入程式碼

File Edit Source Refactor Navigate Search Project Run Window Help

Project Explorer

DFS Locations
- secuse
  - (2)
    - user (1)
      - waue (3)
    - var (1)
- hadoop020
  - src
    - (default package)
      - CheckAndDelete
      - GetFromHdfs.jav
      - HelloHadoop.jav
      - HelloHadoopV2.
      - HelloHadoopV3.
      - HelloMapperV2.
      - HelloReducerV2.
      - PutToHdfs.java
      - TsmMenu.java
      - WordCount.java
      - WordCountV02(
      - WordCountV2.ja

WordCount.java

```
//1.    在hdfs 上來源檔案的路徑為 你所指定的 <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hdfs 的輸出路徑為 你所指定的 <output>
//
public class WordCount {

    public static class TokenizerMapper extends
            Mapper<Object, Text, Text, IntWritable> {

        private final static IntWritable one = new IntWritable(1);
        private Text word = new Text();

        public void map(Object key, Text value, Context context)
                throws IOException, InterruptedException {
            StringTokenizer itr = new StringTokenizer(value.toString());
            while (itr.hasMoreTokens()) {
                word.set(itr.nextToken());
                context.write(word, one);
            }
        }
    }

    public static class IntSumReducer extends
            Reducer<Text, IntWritable, Text, IntWritable> {
        private IntWritable result = new IntWritable();

        public void reduce(Text key, Iterable<IntWritable> values,
                Context context) throws IOException, InterruptedException {
            int sum = 0;
            for (IntWritable val : values) {
                sum += val.get();
            }
            result.set(sum);
            context.write(key, result);
```

此區為程式窗格

Outline
- import declarations
- WordCount
  - TokenizerMapper
  - IntSumReducer
  - main(String[])

Problems | Tasks | Javadoc | Console | Map/Reduce Locations

| Location | Master node | State | Status |
|---|---|---|---|
| secuse | secuse.nchc.org.tw | | |

# 7.2 補充

若之前doc部份設定正確，則滑鼠移至程式碼可取得API完整說明

mapper.java | reducer.java | WordCount.java

```
package Sample;

import org.apache.hadoop.conf.Configuration;
import org.apache.hadoop.fs.Path;
import org.apache.hadoop.io.IntWritable;
import org.apache.hadoop.io.Text;
import org.apache.hadoop.mapreduce.Job;
import org.apache.hadoop.mapreduce.lib.input.FileInputFormat;
import org.apache.hadoop.mapreduce.lib.output.FileOutputFormat;
import org.apache.hadoop.util.GenericOptionsParser;
```

**org.apache.hadoop.util.GenericOptionsParser**

GenericOptionsParser is a utility to parse command line arguments generic to the Hadoop framework. GenericOptionsParser recognizes several standarad command line arguments, enabling applications to easily specify a namenode, a jobtracker, additional configuration resources etc.

***Generic Options***

The supported generic options are:

```
-conf <configuration file>     specify a configuration file
-D <property=value>            use value for given property
-fs <local|namenode:port>      specify a namenode
```

Press 'F2' for focus

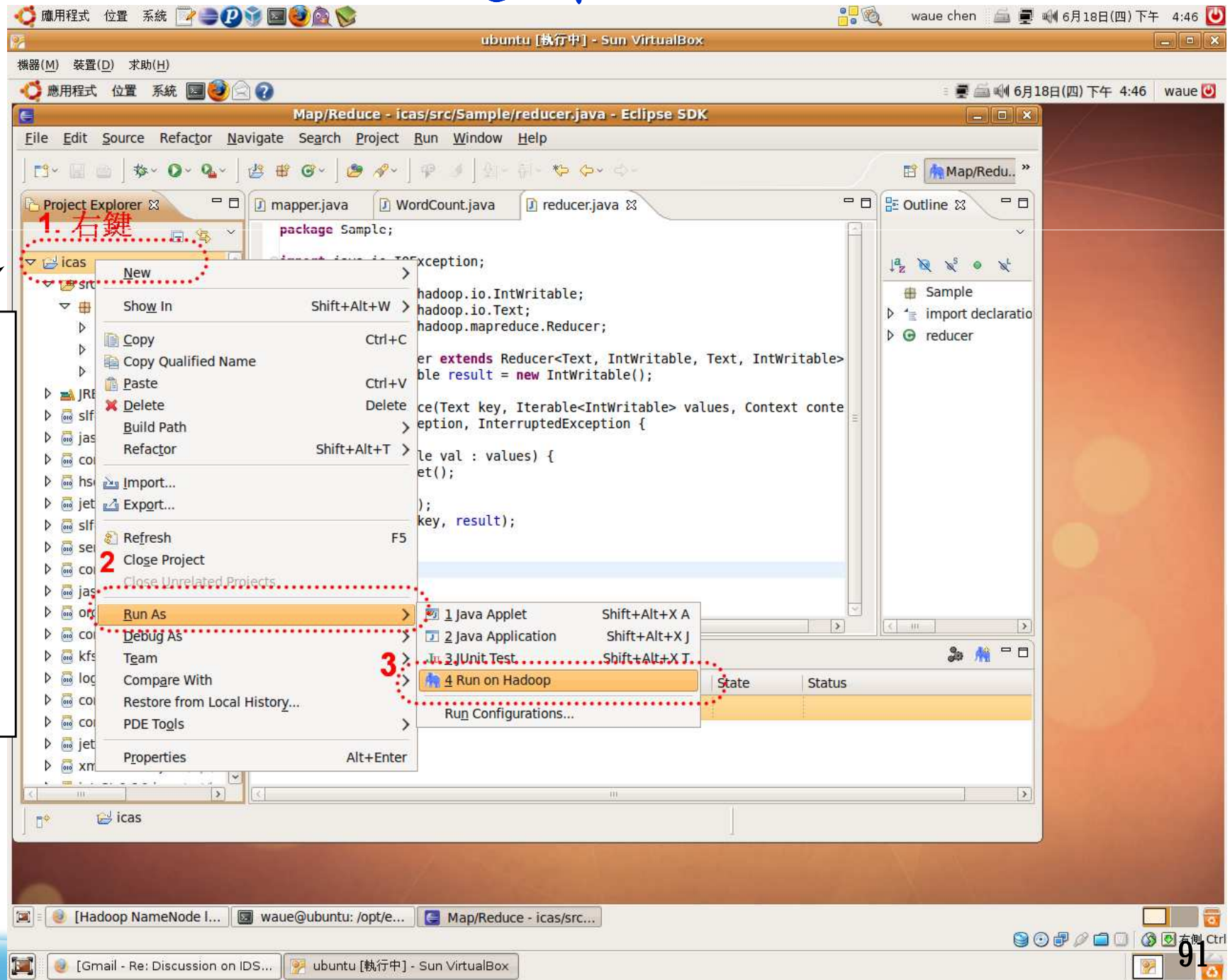
Outline: Sample, import declaratio, org.apache.ha, org.apache.ha, org.apache.ha

Problems | Tasks | Javadoc | Map/Reduce Locations | Console

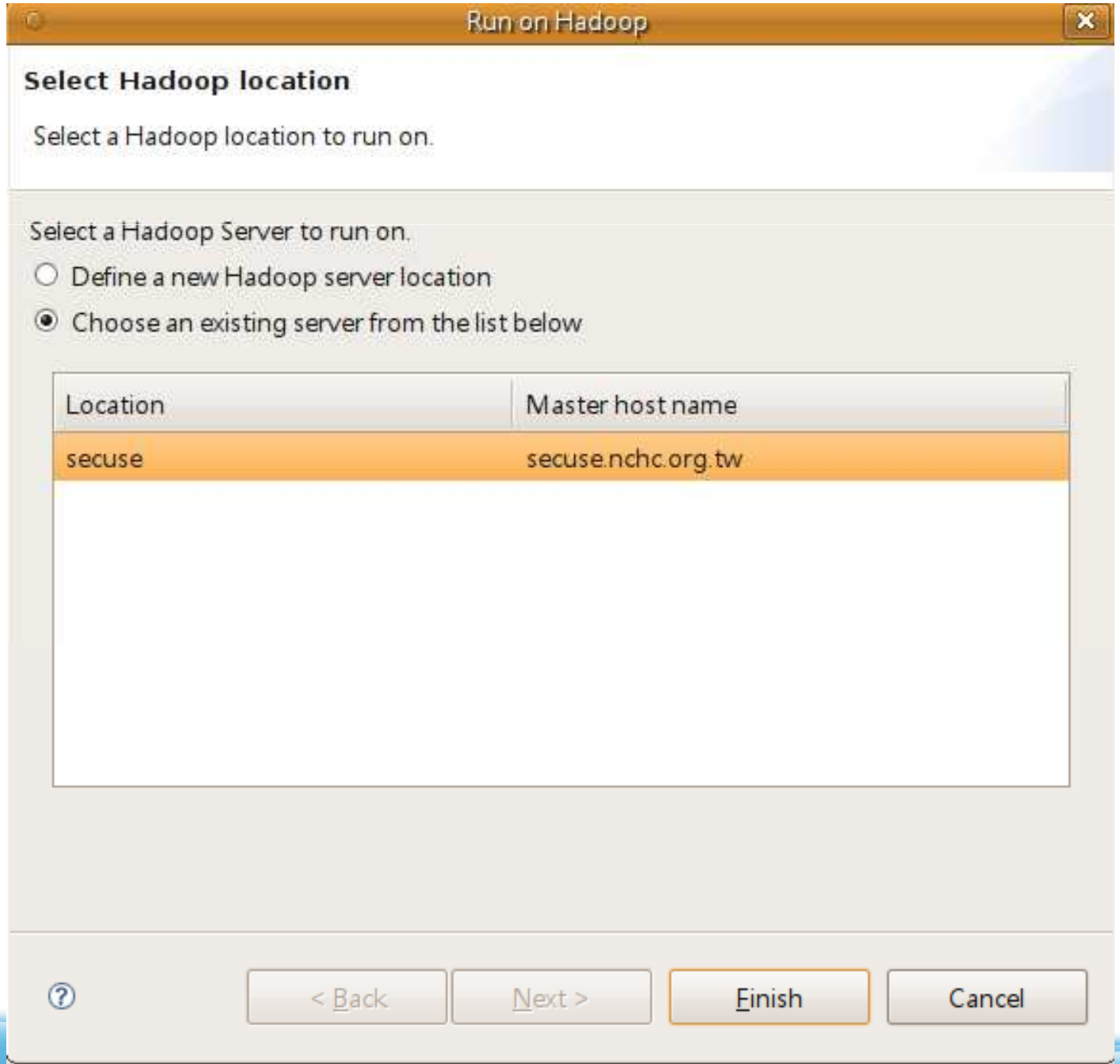
| Location | Master node | State | Status |
|---|---|---|---|
| job_200906161902_0005 | | FAILED | Maps : 2/2 (1.0) Reduces : 1/1 (1.0) |

# 8. 運作

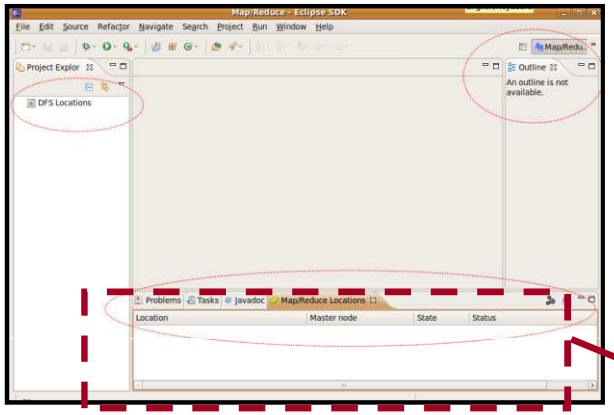
於欲運算的程式碼處點選右鍵 → Run As → **Run on Hadoop**



# 8-1 選擇之前設定好所要運算的主機



# 8.2 運算資訊出現於Eclipse 右下方的Console 視窗

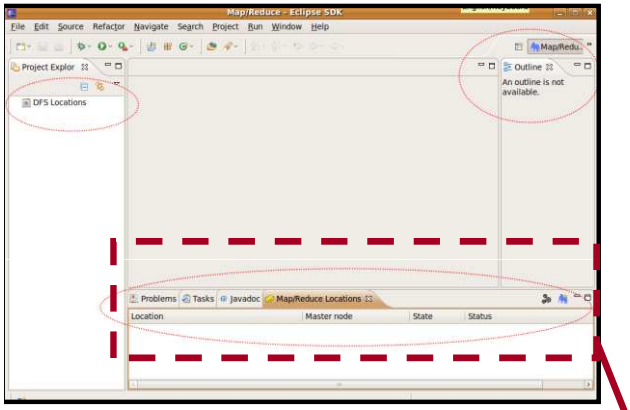



放大

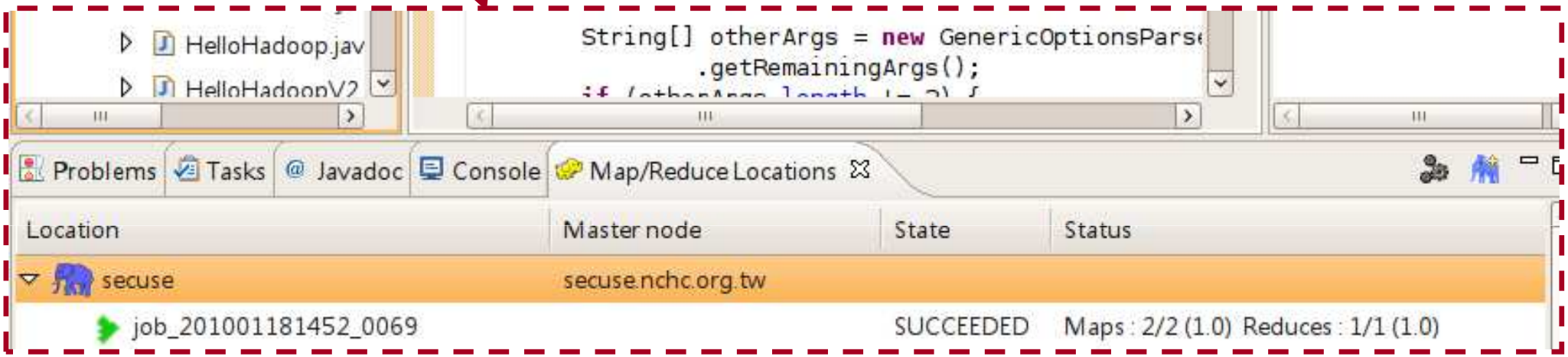
Problems | Tasks | Javadoc | Console | Map/Reduce Locations

```
<terminated> WordCount (1) [Java Application] /usr/lib/jvm/java-6-sun-1.6.0.16/bin/java (2010/1/20 下午 6:15:07)
10/01/20 18:15:08 WARN conf.Configuration: DEPRECATED: hadoop-site.xml found in the classpath. Usage of hadc
10/01/20 18:15:08 WARN mapred.JobConf: The variable mapred.task.maxvmem is no longer used. Instead use mapre
10/01/20 18:15:08 WARN mapred.JobConf: The variable mapred.task.maxvmem is no longer used. Instead use mapre
10/01/20 18:15:08 INFO input.FileInputFormat: Total input paths to process : 2
10/01/20 18:15:08 INFO mapred.JobClient: Running job: job_201001181452_0078
10/01/20 18:15:09 INFO mapred.JobClient:  map 0% reduce 0%
10/01/20 18:15:16 INFO mapred.JobClient:  map 100% reduce 0%
10/01/20 18:15:28 INFO mapred.JobClient:  map 100% reduce 100%
10/01/20 18:15:30 INFO mapred.JobClient: Job complete: job_201001181452_0078
10/01/20 18:15:30 INFO mapred.JobClient: Counters: 17
10/01/20 18:15:30 INFO mapred.JobClient:   Job Counters
10/01/20 18:15:30 INFO mapred.JobClient:     Launched reduce tasks=1
10/01/20 18:15:30 INFO mapred.JobClient:     Launched map tasks=2
10/01/20 18:15:30 INFO mapred.JobClient:     Data-local map tasks=2
10/01/20 18:15:30 INFO mapred.JobClient:   FileSystemCounters
10/01/20 18:15:30 INFO mapred.JobClient:     FILE_BYTES_READ=153
```

# 8.3 剛剛運算的結果出現如下圖



放大



# Conclusions

- 優點
  - 快速開發程式
  - 易於除錯
  - 智慧尋找函式庫
  - 自動鍊結API
  - 直接操控 HDFS 與 JobTracker
  - …
- 缺點
  - Plugin 並會因Eclipse 版本而有不同的狀況

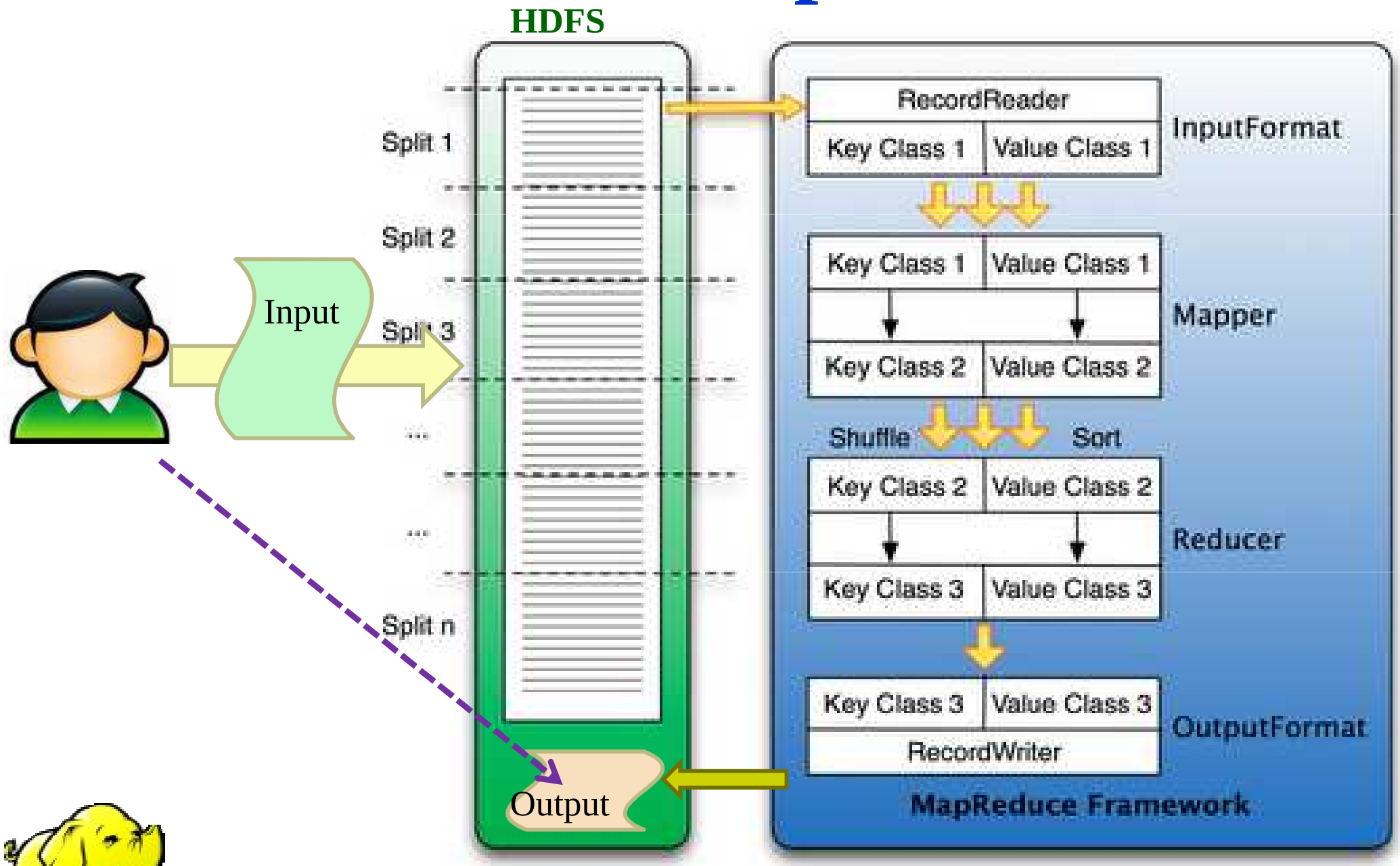
# 五、開發Hadoop Map/Reduce

程式設計者只需要解決”真實的”問題，
架構面留給MapReduce

# Hadoop 的MapReduce API提供

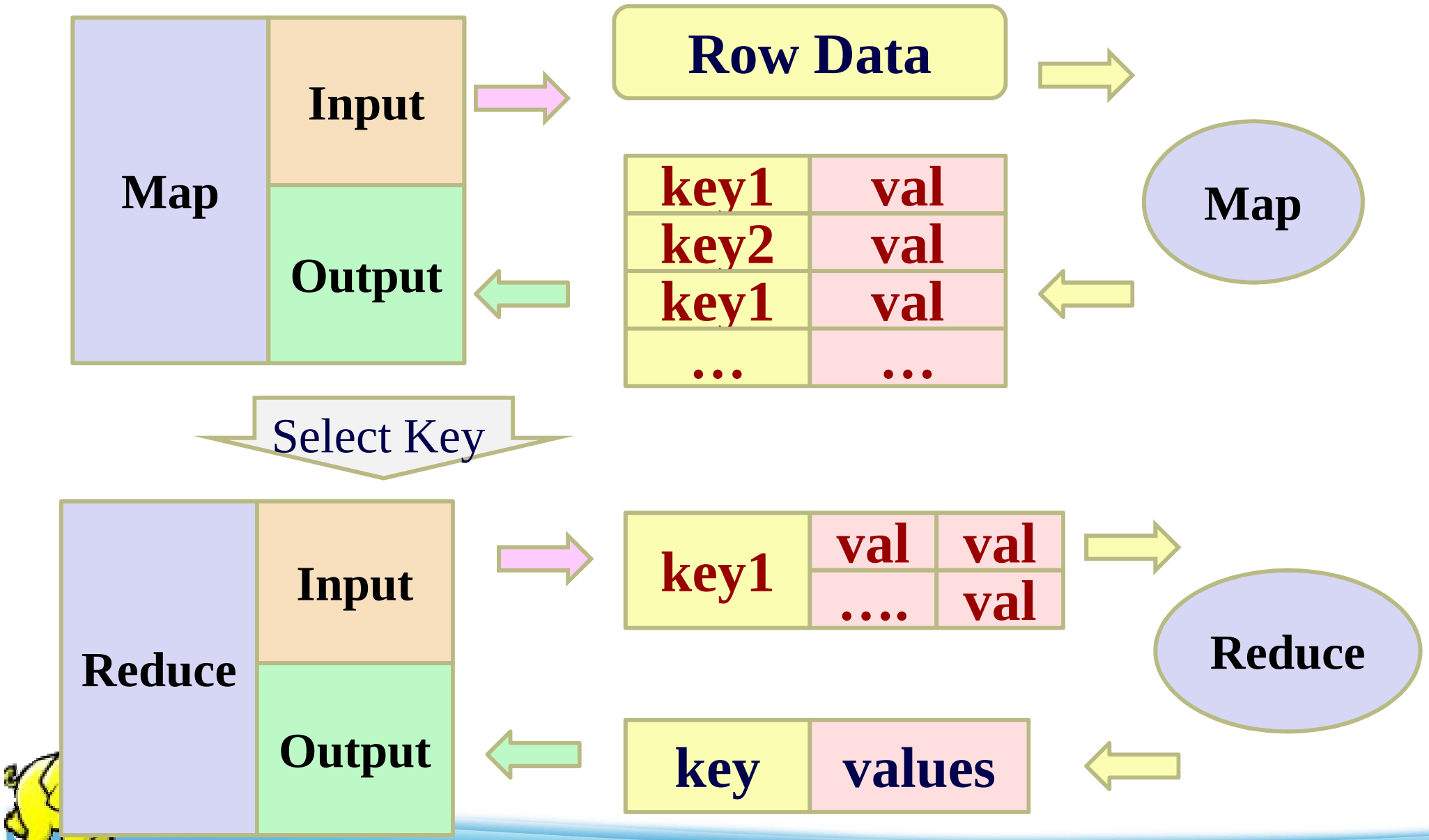
- 自動的平行化與工作分配
- 容錯特性
- 狀態監控工具
- 一個乾淨的抽象化(abstration)供程式設計師使用

# HDFS & MapReduce




部份圖片來源：http://www.larsgeorge.com/2009/05/hbase-mapreduce-101-part-i.html

# <Key, Value> Pair



# Program Prototype (v 0.20)

Map 區

Reduce 區

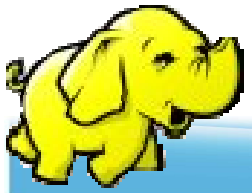
設定區

```
Class MR{
    static public Class Mapper …{
    }
    static public Class Reducer …{
    }
    main(){
        Configuration conf = new Configuration();
        Job job = new Job(conf, “job name");
        job.setJarByClass(thisMainClass.class);
        job.setMapperClass(Mapper.class);
        job.setReduceClass(Reducer.class);
        FileInputFormat.addInputPaths(job, new Path(args[0]));
        FileOutputFormat.setOutputPath(job, new Path(args[1]));
        job.waitForCompletion(true);
}}
```

Map 程式碼

Reduce 程式碼

其他的設定參數程式碼



# Class Mapper (v 0.20)

```
import org.apache.hadoop.mapreduce.Mapper;
class MyMap extends
        Mapper < INPUT KEY Class , INPUT VALUE Class , OUTPUT KEY Class , OUTPUT VALUE Class >
{
// 全域變數區
public void map ( INPUT KEY Class key, INPUT VALUE Class value,
        Context context )throws IOException,InterruptedException
        {
        // 區域變數與程式邏輯區
        context.write( NewKey, NewValue);
        }
}
```

# Class Reducer (v 0.20)

```
import org.apache.hadoop.mapreduce.Reducer;
class MyRed extends
        Reducer < INPUT KEY Class , INPUT VALUE Class , OUTPUT KEY Class , OUTPUT VALUE Class >
{
// 全域變數區
public void reduce ( INPUT KEY Class key, Iterable< INPUT VALUE Class > values,
        Context context) throws IOException,InterruptedException
        {
        // 區域變數與程式邏輯區
        context.write( NewKey, NewValue);
        }
}
```

# 其他常用的設定參數

- 設定 Combiner
  - Job.setCombinerClass ( … );
- 設定 output class
  - Job.setMapOutputKeyClass( … );
  - Job.setMapOutputValueClass( … );
  - Job.setOutputKeyClass( … );
  - Job.setOutputValueClass( … );

# Class Combiner

- 指定一個combiner，它負責對中間過程的輸出進行聚集，這會有助於降低從Mapper 到 Reducer數據傳輸量。
- 可不用設定交由Hadoop預設
- 也可不實做此程式，引用Reducer
- 設定
  - JobConf.setCombinerClass(Class)

# 範例一 (1) - mapper

```
public class HelloHadoop {

    static public class HelloMapper extends
                    Mapper<LongWritable, Text, LongWritable, Text> {
        public void map(LongWritable key, Text value, Context context)
        throws IOException, InterruptedException {
                    context.write((LongWritable) key, (Text) value);
        }
    }  // HelloReducer end
```

..(待續) …

# 範例一 (2) - reducer

```
static public class HelloReducer extends
        Reducer<LongWritable, Text, LongWritable, Text> {
    public void reduce(LongWritable key, Iterable<Text> values,
    Context context) throws IOException, InterruptedException {
        Text val = new Text();
        for (Text str : values) {
            val.set(str.toString());
        }
        context.write(key, val);
    }
} // HelloReducer end
```

..(待續) …

# 範例一 (3) - main

```
public static void main(String[] args) throws IOException,
                InterruptedException, ClassNotFoundException {
        Configuration conf = new Configuration();
        Job job = new Job(conf, "Hadoop Hello World");
        job.setJarByClass(HelloHadoop.class);
        FileInputFormat.setInputPaths(job, "input");
        FileOutputFormat.setOutputPath(job, new Path("output-hh1"));
        job.setMapperClass(HelloMapper.class);
        job.setReducerClass(HelloReducer.class);
        job.waitForCompletion(true);
    } // main end
} // wordcount class end
// 完
```

# 七、Hadoop 程式範例

## 7.1：HDFS 操作篇

7.2：MapReduce運算篇

# 傳送檔案至HDFS

// 將檔案從local上傳到 hdfs， src 為 local 的來源，dst 為 hdfs 的目的端

```
public class PutToHdfs {
  static boolean putToHdfs(String src, String dst, Configuration conf) {
    Path dstPath = new Path(dst);
    try {
      // 產生操作hdfs的物件
      FileSystem hdfs = dstPath.getFileSystem(conf);
      // 上傳
      hdfs.copyFromLocalFile(false, new Path(src),new Path(dst));
    } catch (IOException e) {
      e.printStackTrace();
      return false;
    }
    return true;
  }
```

# 從HDFS取回檔案

// 將檔案從hdfs下載回local, src 為 hdfs的來源, dst 為 local 的目的端

```
public class GetFromHdfs {
static boolean getFromHdfs(String src,String dst, Configuration conf) {
  Path dstPath = new Path(src);
  try {
    // 產生操作hdfs的物件
    FileSystem hdfs = dstPath.getFileSystem(conf);
    // 下載
    hdfs.copyToLocalFile(false, new Path(src),new Path(dst));
  } catch (IOException e) {
    e.printStackTrace();
    return false;
  }
  return true;
}
```

# 檢查與刪除檔案

// checkAndDelete函式，檢查是否存在該資料夾，若有則刪除之

```
public class CheckAndDelete {
  static boolean checkAndDelete(final String path, Configuration conf) {
    Path dst_path = new Path(path);
    try {
      // 產生操作hdfs的物件
      FileSystem hdfs = dst_path.getFileSystem(conf);
      // 檢查是否存在
      if (hdfs.exists(dst_path)) {
        // 有則刪除
        hdfs.delete(dst_path, true);
      }  } catch (IOException e) {
      e.printStackTrace();
      return false;
    }     return true;    }
```

# 七、Hadoop 程式範例

7.1：HDFS 操作篇

**7.2：MapReduce運算篇**

# 範例二 (1) HelloHadoopV2

**說明：**

此程式碼比HelloHadoop 增加了

* 檢查輸出資料夾是否存在並刪除
* input 資料夾內的資料若大於兩個，則資料不會被覆蓋
* map 與 reduce 拆開以利程式再利用

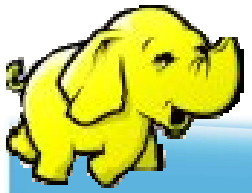
**測試方法：**

將此程式運作在hadoop 0.20 平台上，執行：

```
---------------------------
hadoop jar V2.jar HelloHadoopV2
---------------------------
```

**注意：**

1. 在hdfs 上來源檔案的路徑為 "/user/$YOUR_NAME/input" , 請注意必須先放資料到此hdfs上的資料夾內，且此資料夾內只能放檔案，不可再放資料夾
2. 運算完後，程式將執行結果放在hdfs 的輸出路徑為 "/user/$YOUR_NAME/output-hh2"



# 範例二 (2)

```
public class HelloHadoopV2 {
public static void main(String[] args) throws
      IOException,
     InterruptedException, ClassNotFoundException
      {
   Configuration conf = new Configuration();
   Job job = new Job(conf, "Hadoop Hello World
     2");
   job.setJarByClass(HelloHadoopV2.class);
   // 設定 map and reduce 以及 Combiner class
   job.setMapperClass(HelloMapperV2.class);
   job.setCombinerClass(HelloReducerV2.class);
   job.setReducerClass(HelloReducerV2.class);
   // 設定map的輸出型態
   job.setMapOutputKeyClass(Text.class);
   job.setMapOutputValueClass(Text.class);
   // 設定reduce的輸出型態
   job.setOutputKeyClass(Text.class);
   job.setOutputValueClass(Text.class);
```

```
   FileInputFormat.addInputPath
            (job, new Path("input"));
   FileOutputFormat.setOutputPath
            (job, new Path("output-hh2"));
   // 呼叫checkAndDelete函式，
   // 檢查是否存在該資料夾，若有則刪除之
   CheckAndDelete.checkAndDelete("output-hh2",
     conf);
   boolean status = job.waitForCompletion(true);
   if (status) {
     System.err.println("Integrate Alert Job Finished
      !");
   } else {
     System.err.println("Integrate Alert Job Failed
      !");
     System.exit(1);
} } }
```

# 範例二 (3)

```
public class HelloMapperV2 extends
    Mapper <LongWritable, Text, Text,
    Text> {
  public void map(LongWritable key, Text
    value, Context context)
    throws IOException,
    InterruptedException {
   context.write(new Text(key.toString()),
    value);
} }
```

```
public class HelloReducerV2 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();
   Text final_value = new Text();
   // 將key值相同的values，透過 && 符號分隔
    之
   for (Text tmp : values) {
    str += tmp.toString() + " &&";
   }
   final_key.set(key);
   final_value.set(str);
   context.write(final_key, final_value);
} }
```

# 範例三 (1) HelloHadoopV3

說明：

此程式碼再利用了 HelloHadoopV2 的 map , reduce 檔，並且自動將檔案上傳到hdfs上運算並自動取回結果，還有提示訊息 、參數輸入 與 印出運算時間 的功能

測試方法：

將此程式運作在hadoop 0.20 平台上，執行：

```
---------------------------
hadoop jar V3.jar HelloHadoopV3 <local_input> <local_output>
---------------------------
```

注意：

1. 第一個輸入的參數是在local 的 輸入資料夾，請確認此資料夾內有資料並無子目錄

2. 第二個輸入的參數是在local 的 運算結果資料夾，由程式產生不用事先建立，若有請刪除之

# 範例三 (2)

```
public class HelloHadoopV3 {
  public static void main(String[] args) throws
      IOException,
     InterruptedException, ClassNotFoundException
      {
String hdfs_input = "HH3_input";
   String hdfs_output = "HH3_output";
   Configuration conf = new Configuration();
   // 宣告取得參數
   String[] otherArgs = new
     GenericOptionsParser(conf, args)
      .getRemainingArgs();
   // 如果參數數量不為2 則印出提示訊息
   if (otherArgs.length != 2) {
     System.err
        .println("Usage: hadoop jar
     HelloHadoopV3.jar <local_input>
     <local_output>");
     System.exit(2);
   }
```

```
Job job = new Job(conf, "Hadoop Hello World");
job.setJarByClass(HelloHadoopV3.class);
// 再利用上個範例的map 與 reduce
job.setMapperClass(HelloMapperV2.class);
job.setCombinerClass(HelloReducerV2.class);
job.setReducerClass(HelloReducerV2.class);
// 設定map reduce  的key value輸出型態
job.setMapOutputKeyClass(Text.class);
job.setMapOutputValueClass(Text.class);
job.setOutputKeyClass(Text.class);
job.setOutputValueClass(Text.class);
```

# 範例三 (2)

```
// 用 checkAndDelete 函式防止overhead的錯誤
  CheckAndDelete.checkAndDelete(hdfs_input,
    conf);
  CheckAndDelete.checkAndDelete(hdfs_output,
    conf);
// 放檔案到hdfs
  PutToHdfs.putToHdfs(args[0], hdfs_input, conf);
// 設定hdfs 的輸入輸出來源路定
  FileInputFormat.addInputPath(job, new
    Path(hdfs_input));
  FileOutputFormat.setOutputPath(job, new
    Path(hdfs_output));
  long start = System.nanoTime();
  job.waitForCompletion(true);
```

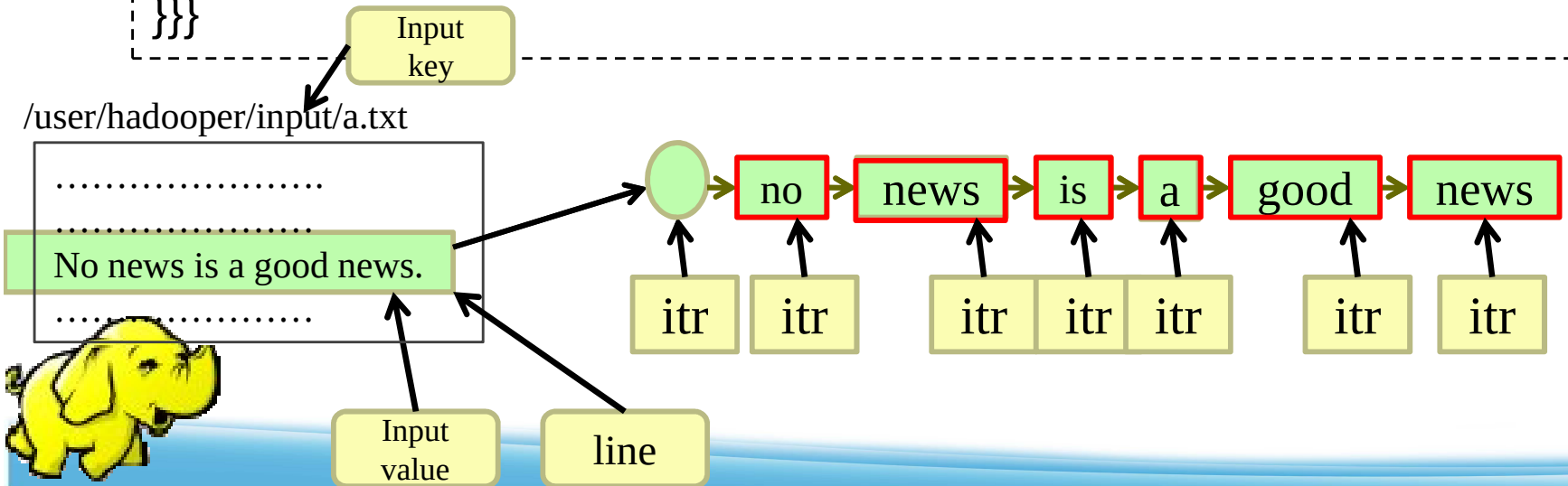
```
// 把hdfs的結果取下
  GetFromHdfs.getFromHdfs(hdfs_output, args[1],
    conf);
  boolean status = job.waitForCompletion(true);
  // 計算時間
  if (status) {
    System.err.println("Integrate Alert Job Finished
    !");
    long time = System.nanoTime() - start;
    System.err.println(time * (1E-9) + " secs.");
  } else {
    System.err.println("Integrate Alert Job Failed !");
    System.exit(1);
} } }
```

# 範例四 (1)

```
public static void main(String[] args) throws Exception {
    Configuration conf = new Configuration();
    String[] otherArgs = new GenericOptionsParser(conf, args).getRemainingArgs();
    if (otherArgs.length != 2) {
      System.err.println("Usage: hadoop jar WordCount.jar <input> <output>");
      System.exit(2);
    }
    Job job = new Job(conf, "Word Count");
    job.setJarByClass(WordCount.class);
    job.setMapperClass(TokenizerMapper.class);
    job.setCombinerClass(IntSumReducer.class);
    job.setReducerClass(IntSumReducer.class);
    job.setOutputKeyClass(Text.class);
    job.setOutputValueClass(IntWritable.class);
    FileInputFormat.addInputPath(job, new Path(args[0]));
    FileOutputFormat.setOutputPath(job, new Path(args[1]));
    CheckAndDelete.checkAndDelete(args[1], conf);
    System.exit(job.waitForCompletion(true) ? 0 : 1);
  }
```

# 範例四 (2)

```
class TokenizerMapper extends Mapper<LongWritable, Text, Text, IntWritable> {
        private final static IntWritable one = new IntWritable(1);
        private Text word = new Text();
        public void map( LongWritable key, Text value, Context context)
        throws IOException , InterruptedException {
                String line = ((Text) value).toString();
                StringTokenizer itr = new StringTokenizer(line);
                while (itr.hasMoreTokens()) {
                        word.set(itr.nextToken());
                        context.write(word, one);
}}}
```

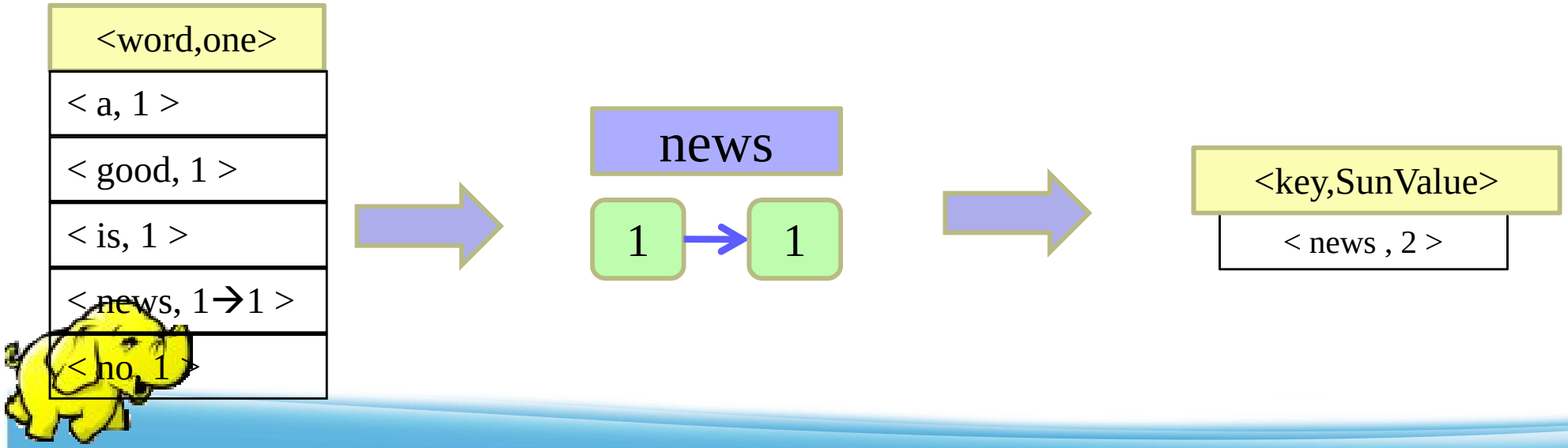



| <word,one> |
|---|
| < no , 1 > |
| < news , 1 > |
| < is , 1 > |
| < a, 1 > |
| < good , 1 > |
| < news, 1 > |

# 範例四 (3)

```
class IntSumReducer extends Reducer< Text, IntWritable, Text, IntWritable> {
        IntWritable result = new IntWritable();
        public void reduce( Text key, Iterable <IntWritable> values, Context context)
        throws IOException, InterruptedException {
                int sum = 0;
                for ( IntWritable val : values )
                        sum += val.get();
                result.set(sum);
                context.write ( key, result);
}}
```

```
for ( int i ; i < values.length ; i ++ ){
  sum += values[i].get()
}
```



# 範例五 (1) WordCountV2

**說明：**

用於字數統計，並且增加略過大小寫辨識、符號篩除等功能

**測試方法：**

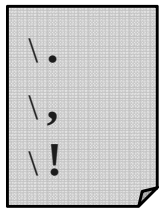
將此程式運作在hadoop 0.20 平台上，執行：

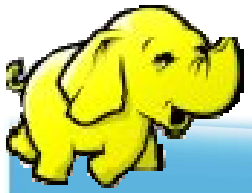
```
---------------------------
hadoop jar WCV2.jar WordCountV2 -Dwordcount.case.sensitive=false \
  <input> <output> -skip patterns/patterns.txt
---------------------------
```

**注意：**

1. 在hdfs 上來源檔案的路徑為 你所指定的 <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hdfs 的輸出路徑為 你所指定的 <output>
3. 請建立一個資料夾 pattern 並在裡面放置pattern.txt，內容如

**（一行一個，前置提示符號\）→**



# 範例五 (2)

```
public class WordCountV2 extends Configured implements Tool {
  public static class Map extends MapReduceBase implements
     Mapper<LongWritable, Text, Text, IntWritable> {
    static enum Counters {      INPUT_WORDS     }
    private final static IntWritable one = new IntWritable(1);
    private Text word = new Text();
    private boolean caseSensitive = true;
    private Set<String> patternsToSkip = new HashSet<String>();
    private long numRecords = 0;
    private String inputFile;
    public void configure(JobConf job) {
    caseSensitive = job.getBoolean("wordcount.case.sensitive", true);
    inputFile = job.get("map.input.file");
    if (job.getBoolean("wordcount.skip.patterns", false)) {
       Path[] patternsFiles = new Path[0];
       try {
         patternsFiles = DistributedCache.getLocalCacheFiles(job);
       } catch (IOException ioe) {
         System.err
            .println("Caught exception while getting cached files: "
               + StringUtils.stringifyException(ioe));
       }
       for (Path patternsFile : patternsFiles) {
         parseSkipFile(patternsFile);
    }}}
```

```
private void parseSkipFile(Path patternsFile) {
    try {
      BufferedReader fis = new BufferedReader(new FileReader(
         patternsFile.toString()));
      String pattern = null;
      while ((pattern = fis.readLine()) != null) {
       patternsToSkip.add(pattern);        }
    } catch (IOException ioe) {
      System.err.println("Caught exception while parsing the cached
       file '"+ patternsFile + "' : " + tringUtils.stringifyException(ioe));
       }}
  public void map(LongWritable key, Text value,
      OutputCollector<Text, IntWritable> output, Reporter reporter)
      throws IOException {
    String line = (caseSensitive) ? value.toString() : value.toString()
       .toLowerCase();
    for (String pattern : patternsToSkip)
      line = line.replaceAll(pattern, "");
    StringTokenizer tokenizer = new StringTokenizer(line);
    while (tokenizer.hasMoreTokens()) {
      word.set(tokenizer.nextToken());
      output.collect(word, one);
      reporter.incrCounter(Counters.INPUT_WORDS, 1); }
```

# 範例五 (3)

```
if ((++numRecords % 100) == 0) {
      reporter.setStatus("Finished processing " + numRecords
         + " records " + "from the input file: " + inputFile);
}  }  }
 public static class Reduce extends MapReduceBase implements
    Reducer<Text, IntWritable, Text, IntWritable> {
  public void reduce(Text key, Iterator<IntWritable> values,
      OutputCollector<Text, IntWritable> output, Reporter reporter)
      throws IOException {
    int sum = 0;
    while (values.hasNext()) {
      sum += values.next().get(); }
    output.collect(key, new IntWritable(sum));     }  }
  public int run(String[] args) throws Exception {
   JobConf conf = new JobConf(getConf(), WordCount.class);
   conf.setJobName("wordcount");
   String[] otherArgs = new GenericOptionsParser(conf, args)
      .getRemainingArgs();
   if (otherArgs.length < 2) {
    System.out.println("WordCountV2 [-
      Dwordcount.case.sensitive=<false|true>] \\ ");
    System.out.println("           <inDir> <outDir> [-skip
      Pattern_file]");
    return 0;     }
   conf.setOutputKeyClass(Text.class);
   conf.setOutputValueClass(IntWritable.class);
```

```
   conf.setMapperClass(Map.class);
   conf.setCombinerClass(Reduce.class);
   conf.setReducerClass(Reduce.class);
   conf.setInputFormat(TextInputFormat.class);
   conf.setOutputFormat(TextOutputFormat.class);
   List<String> other_args = new ArrayList<String>();
   for (int i = 0; i < args.length; ++i) {
    if ("-skip".equals(args[i])) {
     DistributedCache
        .addCacheFile(new Path(args[++i]).toUri(), conf);
     conf.setBoolean("wordcount.skip.patterns", true);
    } else {other_args.add(args[i]); }    }
   FileInputFormat.setInputPaths(conf, new Path(other_args.get(0)));
   FileOutputFormat.setOutputPath(conf, new
      Path(other_args.get(1)));
   CheckAndDelete.checkAndDelete(other_args.get(1), conf);
   JobClient.runJob(conf);
   return 0;  }
  public static void main(String[] args) throws Exception {
  int res = ToolRunner.run(new Configuration(), new WordCountV2(),
      args);
   System.exit(res);
  }}
```

# 範例六 (1) WordIndex

**說明：**

將每個字出於哪個檔案，那一行印出來

**測試方法：**

將此程式運作在hadoop 0.20 平台上，執行：

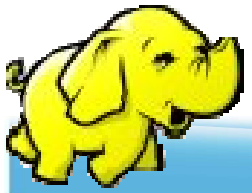
```
---------------------------
hadoop jar WI.jar WordIndex <input> <output>
---------------------------
```

**注意：**

1. 在hdfs 上來源檔案的路徑為 你所指定的 <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hdfs 的輸出路徑為 你所指定的 <output>



# 範例六 (2)

```
public class WordIndex {
  public static class wordindexM extends
    Mapper<LongWritable, Text, Text, Text> {
   public void map(LongWritable key, Text value,
     Context context)
      throws IOException, InterruptedException {

    FileSplit fileSplit = (FileSplit)
     context.getInputSplit();

    Text map_key = new Text();
    Text map_value = new Text();
    String line = value.toString();
    StringTokenizer st = new
     StringTokenizer(line.toLowerCase());
    while (st.hasMoreTokens()) {
      String word = st.nextToken();
      map_key.set(word);
      map_value.set(fileSplit.getPath().getName() +
     ":" + line);
      context.write(map_key, map_value);
    }   }   }
```

```
static public class wordindexR extends
   Reducer<Text, Text, Text, Text> {
 public void reduce(Text key, Iterable<Text>
   values,
    OutputCollector<Text, Text> output, Reporter
   reporter)
    throws IOException {
  String v = "";
  StringBuilder ret = new StringBuilder("\n");
  for (Text val : values) {
    v += val.toString().trim();
    if (v.length() > 0)
      ret.append(v + "\n");
  }
  output.collect((Text) key, new
   Text(ret.toString()));
 }  }
```

# 範例六 (2)

```
public static void main(String[] args) throws
    IOException,
    InterruptedException,
    ClassNotFoundException {
  Configuration conf = new Configuration();
  String[] otherArgs = new
    GenericOptionsParser(conf, args)
      .getRemainingArgs();
  if (otherArgs.length < 2) {
    System.out.println("hadoop jar
    WordIndex.jar <inDir> <outDir>");
    return;
  }
  Job job = new Job(conf, "word index");
  job.setJobName("word inverted index");
  job.setJarByClass(WordIndex.class);
  job.setMapOutputKeyClass(Text.class);
  job.setMapOutputValueClass(Text.class);
  job.setOutputKeyClass(Text.class);
  job.setOutputValueClass(Text.class);
  job.setMapperClass(wordindexM.class);
  job.setReducerClass(wordindexR.class);
  job.setCombinerClass(wordindexR.class);
  FileInputFormat.setInputPaths(job, args[0]);
  CheckAndDelete.checkAndDelete(args[1],
    conf);
  FileOutputFormat.setOutputPath(job, new
    Path(args[1]));
  long start = System.nanoTime();
  job.waitForCompletion(true);
  long time = System.nanoTime() - start;
  System.err.println(time * (1E-9) + " secs.");
}}
```

# 範例七 (1) YourMenu

說明：

將之前的功能整合起來

測試方法：

將此程式運作在hadoop 0.20 平台上，執行：

---

hadoop jar YourMenu.jar <功能>

---

注意：

1. 此程式需與之前的所有範例一起打包成一個jar檔

# 範例七 (2)

```
public class YourMenu {
  public static void main(String argv[]) {
    int exitCode = -1;
    ProgramDriver pgd = new ProgramDriver();
    if (argv.length < 1) {

      System.out.print("**********************************
      ********\n"
        + "歡迎使用 NCHC 的運算功能 \n" + "指令： \n"
        + "  Hadoop jar NCHC-example-*.jar <功能> \n" + "功能：
      \n"
        + "  HelloHadoop: 秀出Hadoop的<Key,Value>為何 \n"
        + "  HelloHadoopV2: 秀出Hadoop的<Key,Value> 進階版
      \n"
        + "  HelloHadoopV3: 秀出Hadoop的<Key,Value> 進化版
      \n"
        + "  WordCount: 計算輸入資料夾內分別在每個檔案的
      字數統計 \n"
        + "  WordCountV2: WordCount 進階版 \n"
        + "  WordIndex: 索引每個字與其所有出現的所在列 \n"
        + "*****************************************\n");
    } else {
```

```
try {
      pgd.addClass("HelloHadoop", HelloHadoop.class, "
      Hadoop hello world");
      pgd.addClass("HelloHadoopV2",
      HelloHadoopV2.class, " Hadoop hello world V2");
      pgd.addClass("HelloHadoopV3",
      HelloHadoopV3.class, " Hadoop hello world V3");
      pgd.addClass("WordCount", WordCount.class, "
      word count.");
      pgd.addClass("WordCountV2",
      WordCountV2.class, " word count V2.");
      pgd.addClass("WordIndex", WordIndex.class,
      "invert each word in line");
      pgd.driver(argv);
      // Success
      exitCode = 0;
      System.exit(exitCode);
    } catch (Throwable e) {
      e.printStackTrace();
}}}}
```

補充

# ogram Prototype (v 0.18)

Map 區

Reduce 區

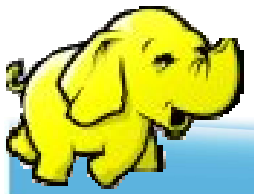
設定區

```
Class MR{
    Class Mapper …{
    }
    Class Reducer …{
    }
    main(){
        JobConf conf = new JobConf( "MR.class" );
        conf.setMapperClass(Mapper.class);
        conf.setReduceClass(Reducer.class);
        FileInputFormat.setInputPaths(conf, new Path(args[0]));
        FileOutputFormat.setOutputPath(conf, new Path(args[1]));
        JobClient.runJob(conf);
}}
```

Map 程式碼

Reduce 程式碼

其他的設定參數程式碼



補充

# Class Mapper (v0.18)

```
import org.apache.hadoop.mapred.*;
class MyMap extends MapReduceBase
implements Mapper < INPUT KEY , INPUT VALUE , OUTPUT KEY , OUTPUT VALUE >
{
// 全域變數區
public void map ( INPUT KEY key, INPUT VALUE value,
        OutputCollector< OUTPUT KEY , OUTPUT VALUE > output,
        Reporter  reporter) throws IOException
        {
        // 區域變數與程式邏輯區
        output.collect( NewKey, NewValue);
        }
}
```

補充

# Class Reducer (v0.18)

```
import org.apache.hadoop.mapred.*;
class MyRed extends MapReduceBase
implements Reducer < INPUT KEY , INPUT VALUE , OUTPUT KEY , OUTPUT VALUE >
{
// 全域變數區
public void reduce ( INPUT KEY key, Iterator< INPUT VALUE > values,
        OutputCollector< OUTPUT KEY , OUTPUT VALUE > output,
        Reporter  reporter) throws IOException
        {
        // 區域變數與程式邏輯區
        output.collect( NewKey, NewValue);
        }
}
```

# Conclusions

- 以上範例程式碼包含
  - Hadoop 的key,value 架構
  - 操作Hdfs 檔案系統
  - Map Reduce運算方式
- 執行hadoop 運算時，程式檔不用上傳至hadoop上，但資料需要再HDFS內
- 可運用範例七的程式達成連續運算
- Hadoop 0.20 與 Hadoop 0.18 有些API有些許差異，因此在網路上找到Hadoop的程式如果compiler有錯，可以換換對應的Function試試

# 二、HBase 安裝說明

# 安裝

需先安裝過 Hadoop…

```
$ wget
  http://ftp.twaren.net/Unix/Web/apache/hadoop/hbase/hbase-
  0.20.6/hbase-0.20.6.tar.gz
  $ sudo tar -zxvf hbase-*.tar.gz -C /opt/
  $ sudo ln -sf /opt/hbase-0.20.6 /opt/hbase
  $ sudo chown -R $USER:$USER /opt/hbase
```

# 系統環境設定

$ vim /opt/hbase/conf/hbase-env.sh

```
# 基本設定
export JAVA_HOME=/usr/lib/jvm/java-6-sun
export HADOOP_HOME=/opt/hadoop
export HBASE_HOME=/opt/hbase
export HBASE_LOG_DIR=/var/hadoop/hbase-logs
export HBASE_PID_DIR=/var/hadoop/hbase-pids
export HBASE_CLASSPATH=$HBASE_CLASSPATH:/opt/hadoop/conf
```

```
# 叢集選項
export HBASE_MANAGES_ZK=true
```

# 服務參數設定

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

| Name | value |
|---|---|
| hbase.rootdir | hdfs://localhost:9000/hbase |
| hbase.tmp.dir | /var/hadoop/hbase-${user.name} |
| hbase.cluster.distributed | true |
| hbase.zookeeper.property .clientPort | 2222 |
| hbase.zookeeper.quorum | Host1, Host2 |
| hbase.zookeeper.property .dataDir | /var/hadoop/hbase-data |

# 停止與啟動服務

需先啟動 Hadoop…

- 全部啟動/關閉

```
$ bin/start-hbase.sh
$ bin/stop-hbase.sh
```

- 個別啟動/關閉

```
$ bin/hbase-daemon.sh start/stop zookeeper
$ bin/hbase-daemon.sh start/stop master
$ bin/hbase-daemon.sh start/stop regionserver
$ bin/hbase-daemon.sh start/stop thrif
$ bin/hbase-daemon.sh start/stop rest
```

# 測試

```
$ hbase shell
> create 'test', 'data'
0 row(s) in 4.3066 seconds
> list
test
1 row(s) in 0.1485 seconds
> put 'test', 'row1', 'data:1',
        'value1'
0 row(s) in 0.0454 seconds
> put 'test', 'row2', 'data:2',
        'value2'
0 row(s) in 0.0035 seconds
> put 'test', 'row3', 'data:3',
        'value3'
0 row(s) in 0.0090 seconds
```

```
> scan 'test'
ROW COLUMN+CELL
row1 column=data:1, timestamp=1240148026198,
        value=value1
row2 column=data:2, timestamp=1240148040035,
        value=value2
row3 column=data:3, timestamp=1240148047497,
        value=value3
3 row(s) in 0.0825 seconds
> disable 'test'
09/04/19 06:40:13 INFO client.HBaseAdmin: Disabled test
0 row(s) in 6.0426 seconds
> drop 'test'
09/04/19 06:40:17 INFO client.HBaseAdmin: Deleted test
0 row(s) in 0.0210 seconds
> list
0 row(s) in 2.0645 seconds
```

# 連線到 HBase 的方法

- Java client
  - *get(byte [] row, byte [] column, long timestamp, int versions);*
- Non-Java clients
  - Thrift server hosting HBase client instance
- Sample ruby, c++, & java (via thrift) clients
  - REST server hosts HBase client
- TableInput/OutputFormat for MapReduce
  - HBase as MR source or sink
- HBase Shell
  - JRuby IRB with “DSL” to add get, scan, and admin
  - *./bin/hbase shell YOUR_SCRIPT*

進階課程

# Hadoop + RDBMS

## Hadoop 0.20 + MySQL 5.5

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# Hadoop 與 JDBC

- JDBC ：用於執行SQL的Java API，目的在於無論機器改變、或資料庫改變，程式碼都可以不用改變
  - 支援 MySQL, PostgreSQL, Oracle, SQL…
  - 非預設就有，需額外針對資料庫形式下載對應的Jar 檔
- Hadoop 0.19 開始設計能與JDBC溝通的API
  - *org.apache.hadoop.**mapred**.lib.db (0.19)*
  - *org.apache.hadoop.**mapreduce**.lib.db (*0.20~0.21*)*

# DBConfiguration

- DBConfiguration.configureDB ( 參數 )
  - 參數：

| job | driverClass | dbUrl | userName | passwd |
|---|---|---|---|---|
| Hadoop 定義的 job | JDBC driver | 資料庫url | 帳號 | 密碼 |
| job | com.mysql.jdbc.Driver | jdbc:mysql://localhost/mydb | root | rootpasswd |

# DBInputFormat

- 從DB端讀取資料
  - **DBRecordReader** ：從table中讀取bytes記錄
  - **DBInputSplit**：描述輸入bytes的範圍
- setInput() ：設定初始輸入資料

# DBWritable

- **DBWritable**： 定義key-value 格式
  - public void write(PreparedStatement statement) throws SQLException;
  - public void readFields(ResultSet resultSet) throws SQLException;

# DBOutputFormat

- 對DB端寫入資料
- DBOutputFormat.setOutput() 設置輸出資訊

# Conclusions

- Hadoop 可以支援 RDBMS 與NoSQL
- NoSQL 的HBase 結構上與 Hadoop設計相近，又是針對存取大資料量，彼此互相支援
- 透過Java的 JDBC ，Hadoop 也可以對 MySQL 等資料庫作存取動作