Chapter 1. Introduction

1.1. Purpose and structure of this book

We live in the age of data! Traditionally every purchase we make is dutifully recorded; every money transaction is carefully registered; every web click ends up in a web click archive. Nowadays everything around us carries an RFID chip and can record data. We have data available like never before. What can we do with all this data? Can we make some sense out of it? Can we use it to learn something useful and profitable? We need a tool, a surgical knife that can empower us to cut deeper and deeper into our data, to look at it from many different perspectives, to represent its underlying structure.

Let's suppose then that we have this huge amount of data already available, waiting to be dissected. What are the options for a professional to enter the world of Business Intelligence (BI) and data analysis? The options available are of course multiple and growing rapidly. If our professional does not control an excessive budget he could turn to the world of open source software. Open source software, however, is more than a money driven choice. In many cases it represents a software philosophy for resource sharing that many professionals would like to support.

Inside the open source software world we can find a few data analysis and BI tools. KNIME software represents an easy choice for the non-initiated professional. It does not require learning a specific script and it offers a graphical way to implement and document analysis procedures. In addition - and this is not a secondary advantage - KNIME can work as an integration platform into which many other BI and data analysis tools can be plugged. It is then possible to analyze data with KNIME and to build dashboards on the same processed data with a different BI tool.

Even though KNIME is very simple and intuitive to use, any beginner would profit from an accelerated orientation through all of KNIME's nodes, categories, and settings. This book represents the beginner's luck, because it is aimed to help any beginner to gear up his/her learning process. This book is not meant to be an exhaustive guide to the whole KNIME software. It does not cover implementations under the KNIME Server, which is not open source, or topics which are considered advanced. Flow Variables, for example, and implementations of database SQL queries are not discussed here.

The book is divided into six chapters. The first chapter covers the basic concepts of KNIME, while chapter two takes the reader by the hand into the implementation of a very first analysis procedure. In the third chapter we investigate data analysis in a more in depth manner. The third chapter indeed explains how to perform some data visualization, in terms of the nodes and processing flow. Chapter four is dedicated to data modeling. It covers a few demonstrative approaches to data modeling, from naïve Bayesian networks to decision trees and artificial neural networks. Finally, chapters five and six are dedicated to reporting. Usually the results of an investigation based on data visualization or, in a later phase, on data modeling have to be shown at some point to colleagues, management, directors, customers, or external workers. Reporting represents a very important phase at the end of the data analysis process. Chapter five shows how to prepare the data for export into a report while chapter six shows how to build the report itself.

Each chapter guides the reader through a data manipulation or a data analysis process step by step. Each step is explained in details and offers some explanations about alternative employments of the current nodes. At the end of each chapter a number of exercises are proposed to the reader to test and perfect what he/she has learned so far.

Examples and exercises in this book have been implemented using KNIME 2.2.0. They should also work under subsequent KNIME versions, although there might be slight differences in their appearance. Updates and further discussions about the contents of this book can be found at the "KNIME Beginner's Luck" web site http://dataminingreporting.weebly.com/knimebeginnersluck.

1.2. The KNIME community

Web Links

http://www.knime.org	This is the first place to look for information about KNIME products. The open source Desktop version can be downloaded from here.
http://tech.knime.org/forum	In the www.knime.org site you can find a number of resources. What I find particularly useful is the KNIME Forum. Here you can ask questions about how to use KNIME or about how to extend KNIME with new nodes. Someone from the KNIME staff will always answer.
http://tech.knime.org/knime-labs	This site contains nodes still under development; i.e. the beta version of new nodes. You can already download them and use them, but they are not of product/release quality yet.
http://nodes4knime.wiki.sourceforge.net/ http://differentize.com/Jymol.aspx	Like for a lot of other open source software, extensions can be found under sourceforge.net as well as a few more web sites.
http://knime.org/supporters-0	This is the site where all contributing supporters (partners, providers, and sponsors) are listed.

Courses	
KNIME User Training	KNIME periodically offers User Training Courses. To check for the next available date and to register, just go to the KNIME Events web site http://knime.org/about/events
KNIME Reporting Training	KNIME also offers a course on its reporting suite on a monthly basis. You can find more information about this course on the KNIME Events web site (http://knime.org/about/events) or on the author's web site (http://dataminingreporting.weebly.com/dmr-courses.html)
KNIME Meetings and Workshops	Meetings and workshops are held from time to time all over the world. It is a good chance to present your work with KNIME and to get to know other people from the KNIME Community (http://knime.org/about/events)

Books	
KNIME Platform	At the moment I do not know of any book about the KNIME platform besides the one that you are currently reading.
Reporting Suite	The KNIME Reporting Suite is based on BIRT, another open source tool for reporting. Here is a basic guide on how to use BIRT: *D. Peh, N. Hague, J. Tatchell, "BIRT. A field Guide to Reporting.", Addison-Wesley, 2008*
Data Analysis and KNIME	This book shows how to apply KNIME to the most common problems in data analysis and data mining: *Berthold M.R., Borgelt C., Höppner F., Klawonn F.,"Guide to intelligent data analysis", Springer 2010.*

1.3. Download and install the KNIME Desktop version

To start playing with KNIME, first, you need to download it to your computer.

There are two available versions of KNIME:

- the open source Desktop KNIME tool, which can be downloaded free of charge at www.knime.org under the GPL version 3 license
- the Enterprise KNIME server, which can be purchased at http://knime.org/enterprise-server

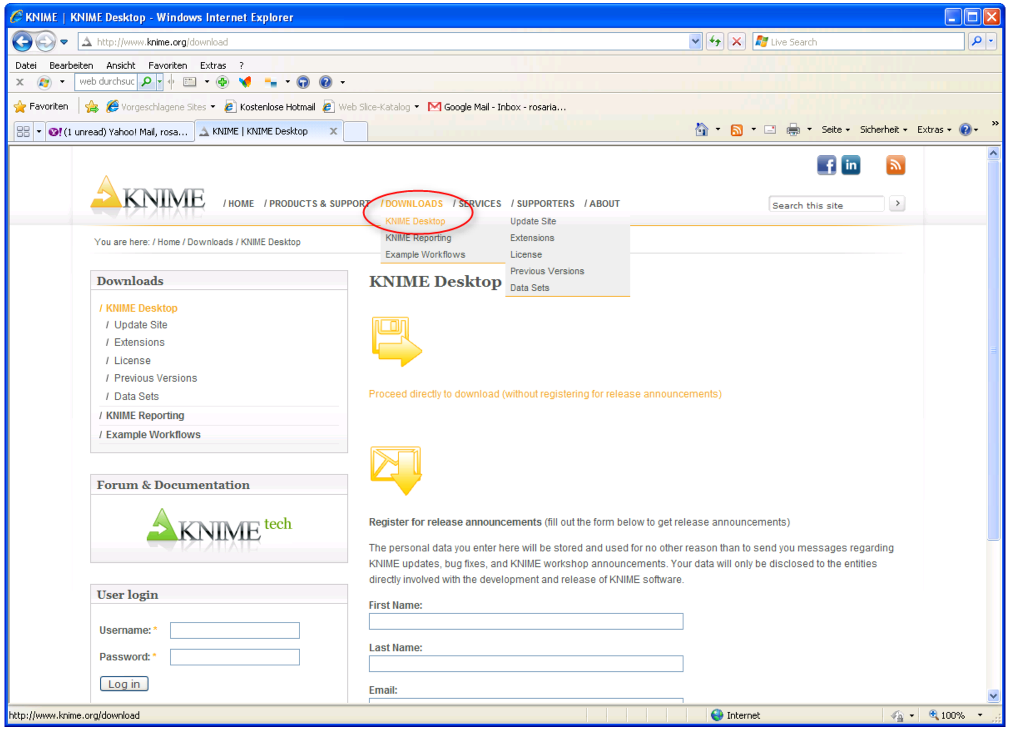
The functionalities of the two versions are very similar. The Enterprise version includes a few more centralized operations that better fit a large enterprise environment. In this book we work with KNIME Desktop (open source) version 2.2.

Download KNIME Desktop

- Go to www.knime.org
- Select the "Download" tab
- Select "KNIME Desktop" in the submenu
- Select one of the two options (with registration or without registration, as you prefer)
- Choose the version that suits your environment (Windows/Linux, 32 bit/64 bit)
- Accept the terms and conditions
- Start downloading
- You will end up with a zipped or a self-extracting archive file (*.zip or *.exe)
- Unpack your file in the destination folder
- This creates a new subfolder in the selected destination folder named "knime_2.2.x", where x represents the minor release

If you want to move the installation to a different location, just move the knime. _2.2.x folder to your preferred location.

1.1. The KNIME Download web page



You are here: / Home / Downloads / KNIME Desktop

KNIME Desktop

Proceed directly to download (without registering for release announcements)

Register for release announcements (fill out the form below to get release announcements)

The personal data you enter here will be stored and used for no other reason than to send you messages regarding KNIME updates, bug fixes, and KNIME workshop announcements. Your data will only be disclosed to the entities directly involved with the development and release of KNIME software.

Username: *

Password: *

First Name:

Last Name:

Email:

Note. To take advantage of the advanced KNIME features we need to activate the expert mode by adding the following line to the "knime.ini" file located in knime_2.2.x: `-Dknime.expert.mode=true`

We will not use the expert mode and its advanced features in this book. However, since the expert mode might slightly change the appearance of some KNIME settings, it is turned on for this book as well.

1.4. The workspace

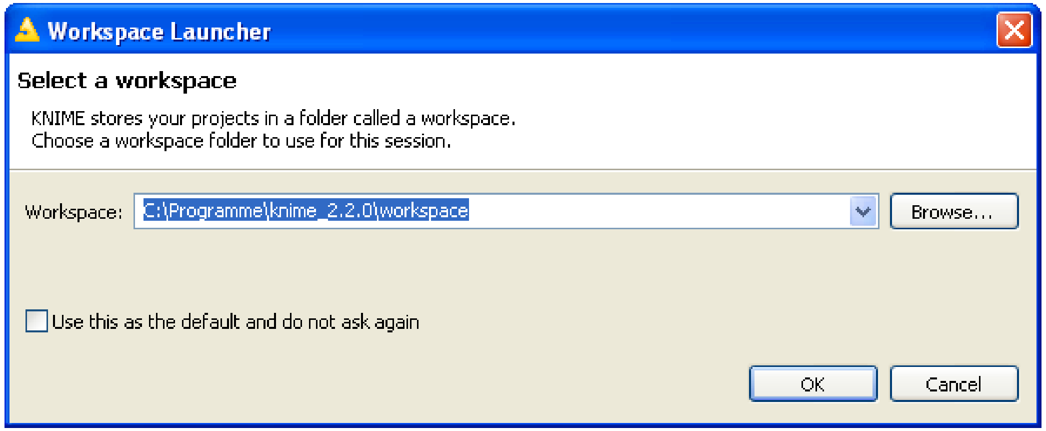
To start KNIME, open the folder “knime_2.2.x” where KNIME has been installed and run knime.exe (or knime on a Linux machine). After the splash screen, you are required to enter the path of the workspace.

The **workspace** is the directory where all your workflows and preferences are saved in the next KNIME session.

The workspace directory can be located anywhere on your hard-disk.

By default, the workspace directory is “[KNIME]\workspace”. However, you can easily change it, by changing the path requested at the beginning, before starting the KNIME working session.

1.2. The Workspace Launcher



Select a workspace

KNIME stores your projects in a folder called a workspace.
Choose a workspace folder to use for this session.

Workspace: C:\Programme\knime_2.2.0\workspace

□ Use this as the default and do not ask again

I use a different workspace for each customer. In this way I keep the work for each customer separated and I do not risk mixing up private information from different customers. If I have a large number of projects with the same customer, I use a new workspace for each new project. This keeps my work space clean and tidy and protects me from mixing up information by mistake. For this project I used the workspace “[KNIME]\knime_2.2.0\book_workspace”.

If KNIME is being started for the first time, a screen appears asking you to select between either launching the KNIME workbench or installing additional nodes. To proceed to the KNIME software, select “Open KNIME Workbench”. From now on whenever KNIME is launched, the welcome screen is no longer shown.

1.5. Download KNIME extensions

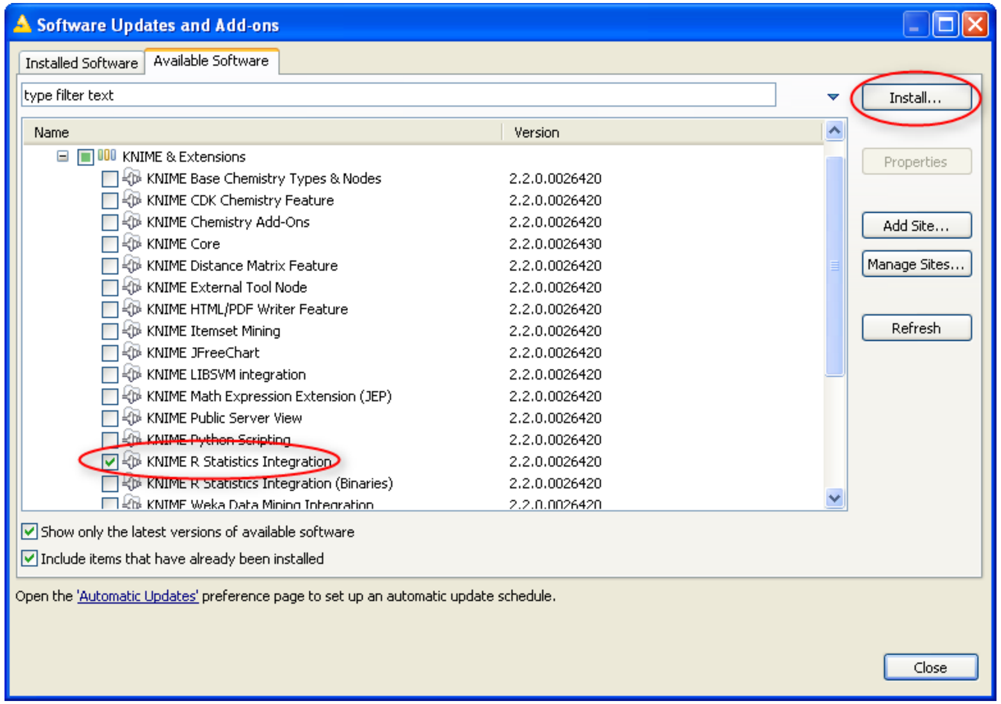
KNIME Desktop is an open source product. As every open source product, it benefits from the feedback and the side utilities that the open source community develops. A number of extensions are available for KNIME Desktop, which can also be used for the Enterprise version. However the KNIME Extensions do not come together with the basic version: they need to be installed separately on a running KNIME.

To install a new KNIME extension:

- From the **Top Menu**, select
  Help -> Software Updates
- In the “Software Updates” window, select Tab “**Available Software**”
- Open the sites and select all the extensions that you need (in this example we chose to install the “KNIME R Statistics Integration”)
- Click the “**Install**” button on the top right

Once the KNIME extension has been installed and KNIME has been restarted, you should see a new node/category in the “Node Repository” in the KNIME workbench (see a few sections ahead).

1.3. Install KNIME Extensions



Name	Version
⊟ ■ KNIME & Extensions	
□ KNIME Base Chemistry Types & Nodes	2.2.0.0026420
□ KNIME CDK Chemistry Feature	2.2.0.0026420
□ KNIME Chemistry Add-Ons	2.2.0.0026420
□ KNIME Core	2.2.0.0026430
□ KNIME Distance Matrix Feature	2.2.0.0026420
□ KNIME External Tool Node	2.2.0.0026420
□ KNIME HTML/PDF Writer Feature	2.2.0.0026420
□ KNIME Itemset Mining	2.2.0.0026420
□ KNIME JFreeChart	2.2.0.0026420
□ KNIME LIBSVM integration	2.2.0.0026420
□ KNIME Math Expression Extension (JEP)	2.2.0.0026420
□ KNIME Public Server View	2.2.0.0026420
□ KNIME Python Scripting	2.2.0.0026420
☑ KNIME R Statistics Integration	2.2.0.0026420
□ KNIME R Statistics Integration (Binaries)	2.2.0.0026420
□ KNIME Weka Data Mining Integration	2.2.0.0026420

☑ Show only the latest versions of available software

☑ Include items that have already been installed

Open the 'Automatic Updates' preference page to set up an automatic update schedule.

1.6. The KNIME workflow

KNIME does not work with scripts, it works with workflows.

What is a workflow

A workflow is an **analysis flow**, which is the **sequence of the analysis steps** necessary to reach a given result. It is the pipeline of the analysis process, something like:

Step 1. Read data
Step 2. Clean data
Step 3. Filter data
Step 4. Train a model

KNIME implements its workflows **graphically**. Each step of the data analysis is executed by a little box, called a **node**. A sequence of nodes makes a workflow.

In the KNIME whitepaper [1] a workflow is defined as follows:

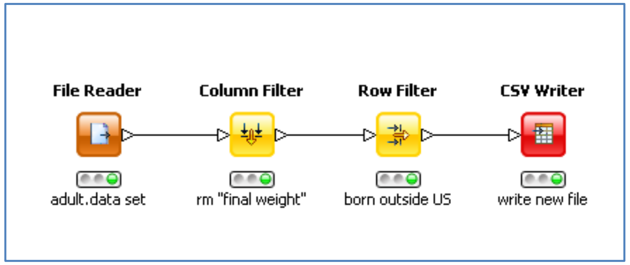
"Workflows in KNIME are essentially graphs connecting nodes, or more formally, a direct acyclic graph (DAG). "

(http://www.kdd2006.com/docs/KDD06_Demo_13_Knime.pdf)

Below is an example of a KNIME workflow, with:

- a node to read data from a file,
- a node to exclude some columns,
- a node to filter out some rows,
- a node to write the processed data into a file.

1.4. Example of a KNIME workflow



Note. A workflow is the data analysis algorithm, which in a traditional programming language would be implemented by a series of instructions and calls to functions. KNIME implements it graphically. This graphical representation makes it easy to keep an overview of the analysis process and to document it.

What is a node

A node is the **single processing unit** of a workflow.

A node takes a data set as input, processes it, and makes it available on its output port. The “processing” action of a node ranges from modeling, like an Artificial Neural Network Learner node, to data manipulation, like transposing the input data matrix, from graphical tools, like a scatter plot, to reading/writing operations.

Every node in KNIME has 3 states:

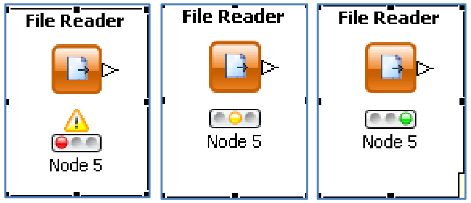
- Inactive and not yet configured → red traffic light
- Configured but not yet executed → yellow traffic light
- Executed successfully → green traffic light

If the node is executed with errors (unsuccessfully), its status stays at the yellow traffic light.

Nodes containing other nodes are called **meta nodes**.

Below are three examples of the same node (a File Reader node) in each one of the three states.

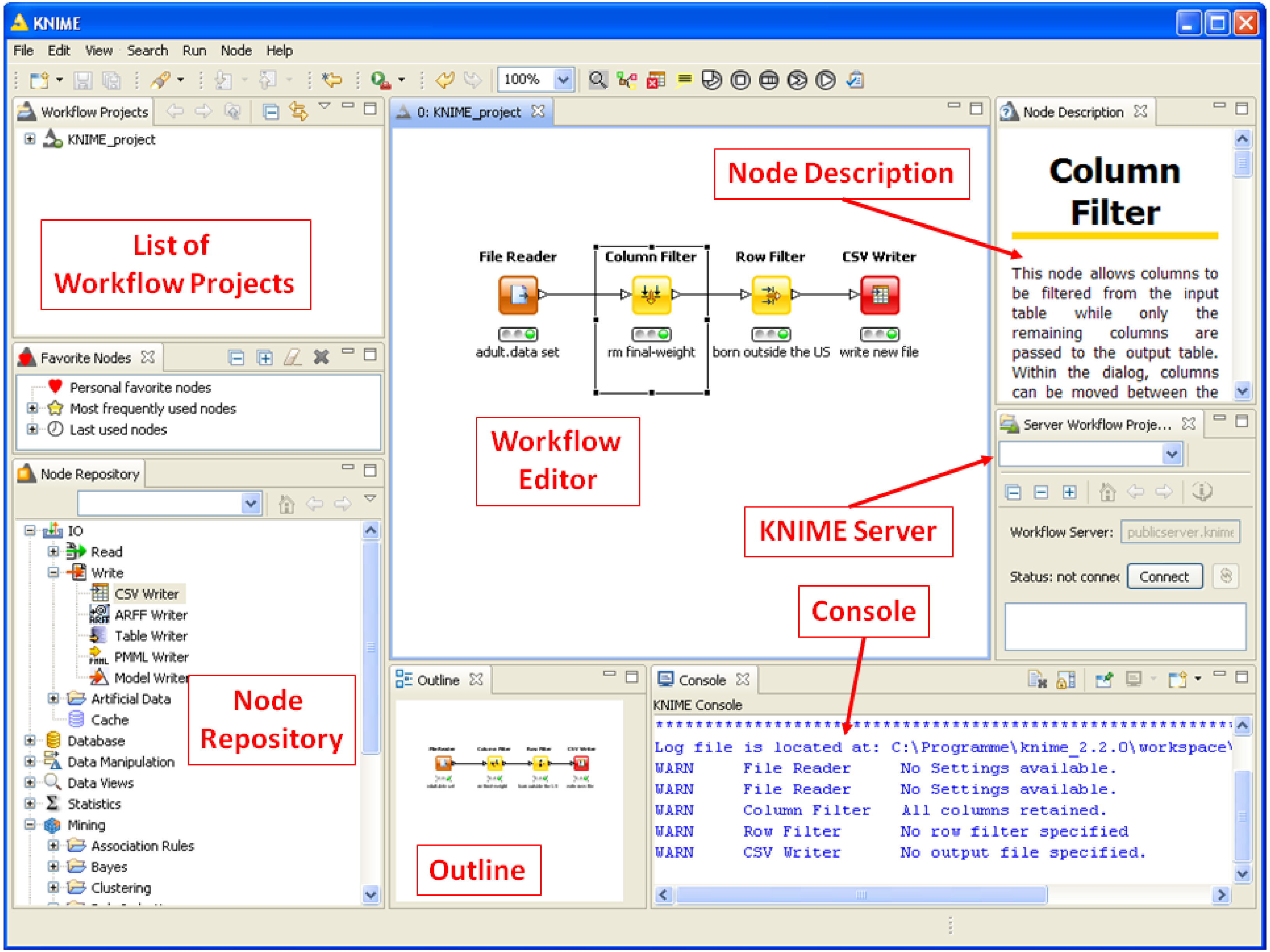
1.5. File Reader node with different status



1.7. The KNIME workbench

After accepting the path of the workspace, KNIME opens the KNIME workbench. The KNIME workbench includes a workflow editor where the user can create the workflows. The KNIME workbench was developed as an Eclipse Plug-in and many of its features are inherited from the Eclipse environment. This means that many items on the workbench are actually referring to a Java programming environment and are not necessarily of interest for KNIME beginners. I will warn the reader, when the item on the KNIME workbench is not directly related to the creation of KNIME workflows.

The “KNIME Workbench” consists of a top menu, a tool bar, and a few panels. Panels can be closed and moved around.



```
*******************************************************************
Log file is located at: C:\Programme\knime_2.2.0\workspace\
WARN     File Reader      No Settings available.
WARN     File Reader      No Settings available.
WARN     Column Filter    All columns retained.
WARN     Row Filter       No row filter specified
WARN     CSV Writer       No output file specified.
```

Let’s have a closer look at the KNIME workbench.

The KNIME workbench

Top Menu: File, Edit, View, Search, Run, Node, Help

Tool Bar: Create, Save, Run, Open Report (if reporting was installed), Open the “Add Meta node” Dialog, Buttons to reset and/or run selected or all nodes

Workflow Projects

This panel shows the list of workflow projects in the selected workspace.

Favorite Nodes

This panel helps you find the nodes that are used most often or most recently or that for some other reason you want to keep at hand.

Workflow Editor

The central area consists of the “Workflow Editor” itself.

A node can be selected from the “Node Repository” panel and dragged and dropped here, in the “Workflow Editor” panel.

Nodes can then be connected by clicking the exit of one node and releasing the mouse at the entrance of the next node.

Node Description

If a node is selected in the “Workflow Editor” or in the “Node Repository”, this panel displays a summary description of the selected node’s functionalities.

Server Workflow Projects

This panel is dedicated to work on the KNIME Server, which is not part of the KNIME Desktop open source product.

Node Repository

This panel contains all the nodes that you can use. It is something similar to a palette of tools when working in a report or with web designer software. There we use graphical tools, while in KNIME we use data analysis tools.

Outline

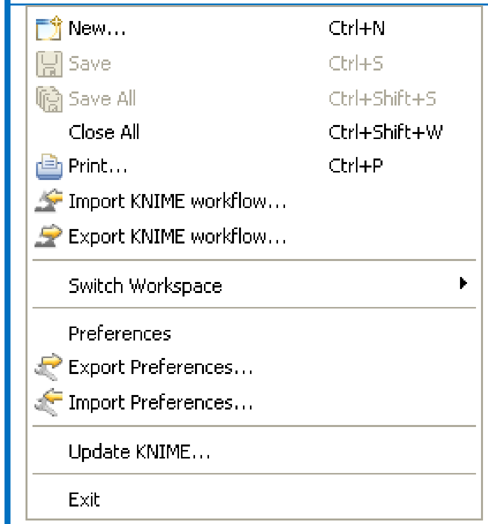
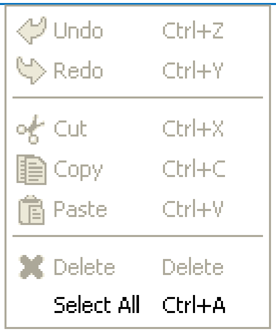
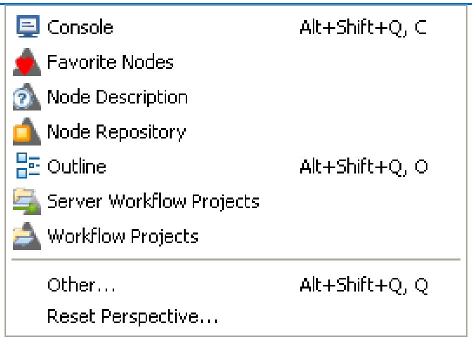
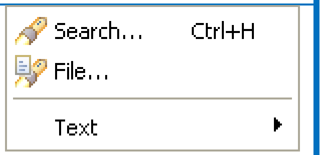
The “Outline” panel contains a small overview of the contents of the “Workflow Editor”. The “Outline” panel might not be of so much interest for small workflows. However, as soon as the workflows reach a considerable size, all the workflow’s nodes may no longer be visible in the “Workflow Editor” without scrolling. The “Outline” panel can help you locate newly created nodes faster.

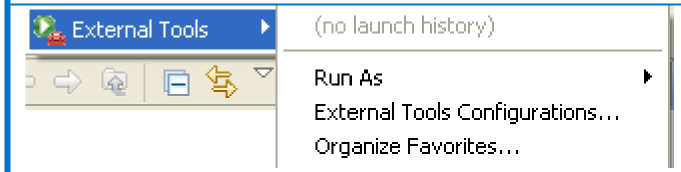
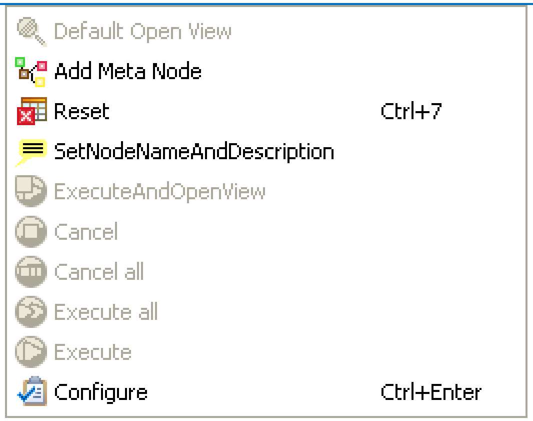
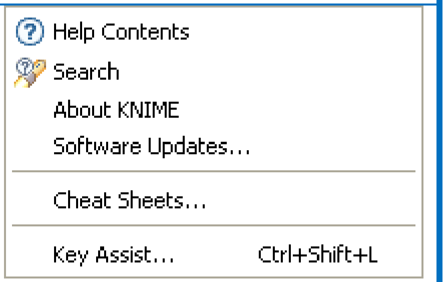
Console

The “Console” panel displays error and warning messages to the user.

This panel also shows the location of the log file, which might be of interest when the console does not show all messages.

Top menu

File	Edit	View	Search
 New… Ctrl+N Save Ctrl+S Save All Ctrl+Shift+S Close All Ctrl+Shift+W Print… Ctrl+P Import KNIME workflow… Export KNIME workflow… Switch Workspace Preferences Export Preferences… Import Preferences… Update KNIME… Exit	 Undo Ctrl+Z Redo Ctrl+Y Cut Ctrl+X Copy Ctrl+C Paste Ctrl+V Delete Delete Select All Ctrl+A	 Console Alt+Shift+Q, C Favorite Nodes Node Description Node Repository Outline Alt+Shift+Q, O Server Workflow Projects Workflow Projects Other… Alt+Shift+Q, Q Reset Perspective…	
File includes the traditional File commands, like “New” and “Save”, in addition to some specific KNIME commands, like: - Import/Export KNIME workflow - Switch Workspace - Preferences - Update KNIME	**Edit** contains the usual commands. **Cut, Copy, Paste,** and **Delete** refer to selected nodes in the workflow. **Select All** selects all the nodes of the workflow in the workflow editor.	**View** contains the list of panels that can be opened on the KNIME workbench. A closed panel can only be re-opened here. Also, when the panel disposition is messed up, the option “Reset Perspective” re-creates the original panel layout of KNIME when it was started for the first time.	**Search** refers to an internal file search or Java search. For example, if you type “column” in the Search Dialog, you are given the xml configuration files of all nodes where a column name is required. I found it only moderately useful especially for beginners.

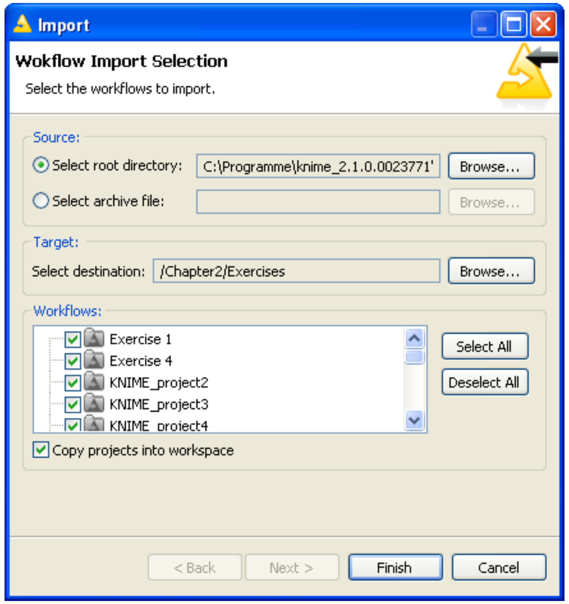
Run	Node	Help
 External Tools (no launch history) Run As External Tools Configurations… Organize Favorites…	 Default Open View Add Meta Node Reset Ctrl+7 SetNodeNameAndDescription ExecuteAndOpenView Cancel Cancel all Execute all Execute Configure Ctrl+Enter	 Help Contents Search About KNIME Software Updates… Cheat Sheets… Key Assist… Ctrl+Shift+L
Run is used to run external tools. It is useful if you need your data to be generated and/or manipulated by an external tool.	**Node** refers to all the possible operations that can be performed on a node. A node can be: - Configured - Executed - Reset (resets the results of the last “Execute” operation) - Cancelled (stopped during execution) - Given a name and description - Set to show its View (if any) Options are only active if they are possible. For example, an already successfully executed node is not re-executed unless it is reset or its configuration has been changed. The “Cancel” and “Execute” options are then inactive.Option “Add Meta Node” creates a new meta node in the workflow editor.	**Help Contents** provides general Help about the Eclipse Workbench, BIRT, and KNIME. **Search** opens a panel on the right of the “Node Description” panel to search for specific Help topics or nodes. **Software Updates** is the door to install KNIME Extensions from the KNIME Update sites. **Cheat Sheets** offer tutorials on specific Eclipse topics: the reporting tool, cvs, Eclipse Plug-ins. **Key Assist** summarizes all keyboard commands for the workflow editor.

Let’s now go through the most useful items in the Top Menu.

“File” -> “Import KNIME workflow” is a link function for workflows. It links a workflow from another workspace to the local workspace. It also works from zipped files. If flag “Copy projects into workspace” is enabled, the workflow files are copied as well and not only linked into the local workspace. Notice that changing the linked workflows changes the original workflows.

“File” -> “Export KNIME workflow” writes the selected local workflow to a zip file. The option “Exclude data from export” enables the export of only the nodes without the intermdiate data. This generates considerably smaller export files.

1.7. Import workflows



Import

Wokflow Import Selection

Select the workflows to import.

Source:

● Select root directory: C:\Programme\knime_2.1.0.0023771'

○ Select archive file:

Target:

Select destination: /Chapter2/Exercises

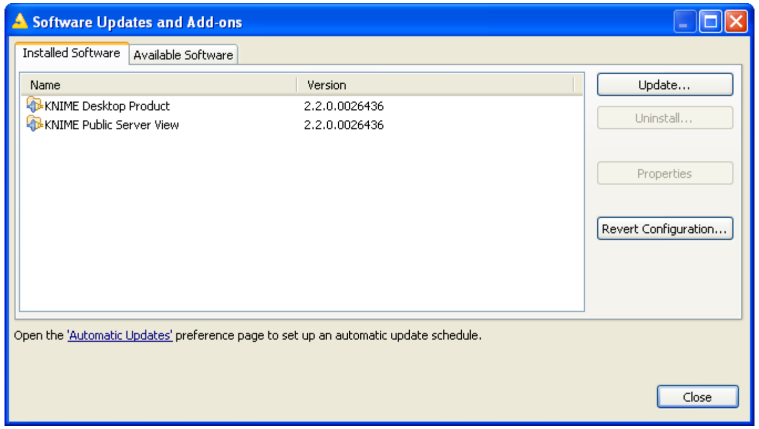
Workflows:

- ☑ Exercise 1
- ☑ Exercise 4
- ☑ KNIME_project2
- ☑ KNIME_project3
- ☑ KNIME_project4

☑ Copy projects into workspace

Simply copying a workflow from one folder to another with Windows can create a number of problems related to internal KNIME updates. Copying workflows from one location to another by means of “Import KNIME workflow” is definitely safer.

1.8. The “Software Updates” window with the list of KNIME Update Sites



Software Updates and Add-ons

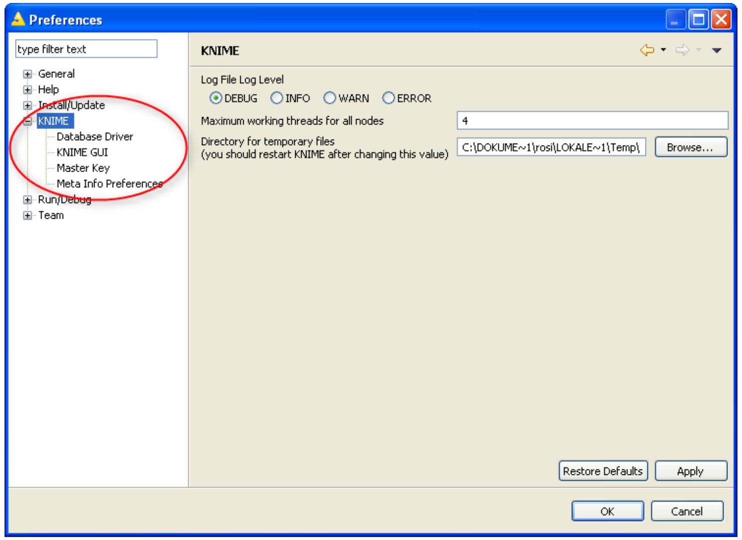
Installed Software | Available Software

Name	Version
KNIME Desktop Product	2.2.0.0026436
KNIME Public Server View	2.2.0.0026436

Open the 'Automatic Updates' preference page to set up an automatic update schedule.

“File” -> “Update KNIME” and “**Help” -> “Software Updates”** both link to the dialog window for the installation of KNIME Extensions from the KNIME Update sites.

1.9. The "Preferences" window



Log File Log Level
● DEBUG ○ INFO ○ WARN ○ ERROR

Maximum working threads for all nodes: 4

Directory for temporary files
(you should restart KNIME after changing this value): C:\DOKUME~1\rosi\LOKALE~1\Temp\

File -> Preferences brings you to the window where all settings can be adjusted. Let's now check the "KNIME" Settings.

Database Driver specifies the location of database drivers. By default no database drivers are available in KNIME. Thus, if you work with databases, the first thing to do is to set here the path of your database drivers.

KNIME GUI contains a few settings about confirmation message policies and maximum list size.

Master Key contains the master key to be used in nodes with an encryption option, like database connection nodes. The workflow is then saved with the encrypted password. If no master key is set, the password is stored in plain text!

In **Meta Info Preferences** you can upload a template for the description of meta info nodes.

Node Repository Search tool

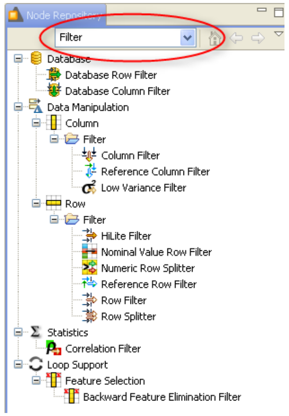
In the "Node Repository" panel there is a **search box**.

If you type a keyword in the search box and then hit "Enter", you obtain the list of nodes with that keyword in the name.

Press the "Esc" key to see all nodes again

For example, here we searched for all the nodes with the keyword "Filter" in their name.

1.10. The Search box in the "Node Repository" panel



1.8. Data and workflows for this book

In the course of this book we will implement a few workflows to show how KNIME works. In each chapter we build one or more workflows and we expect the reader to build a few more in the exercises. The data and workflows used and implemented in this book are available in the “Download Zone” of this book. There you will find a folder for each chapter containing the chapter’s demonstrative workflows and a subfolder “Exercises”. The subfolder “Exercises” contains the solutions to the exercises in the chapter.

Structure of the “Download Zone”

Data

- Data1.txt
- Projects.txt
- SoccerWorldCup2006.txt
- SoccerWorldCup2010.txt
- Adult.data
- Iris.data
- Yellow-small.data (Balloons)
- Wine.data
- Web site 1.txt

Chapter 2

- my_first_workflow.zip
- Exercises
  - Exercise1.zip
  - Exercise2.zip

Chapter 3

- writeToDB.zip
- my_first_data_exploration.zip
- Exercises
  - Exercise1.zip
  - Exercise2.zip
  - Exercise3.zip

Chapter 4

- data_preparation.zip
- my_first_data_model.zip
- my_first_ANN-zip
- Clustering and Regression.zip
- Exercises
  - Exercise1.zip
  - Exercise2.zip
  - Exercise3.zip

Chapter 5

- Projects.zip
- Exercises
  - Exercise1.zip
  - Exercise2.zip
  - Exercise3.zip

The data used for the exercises and for the demonstrative workflows were either generated by the author or downloaded from the UCI Machine Learning Repository, a public data repository (http://archive.ics.uci.edu/ml/datasets). Data generated by the author, that is not public data, are located in the “Download zone” in the “Data” folder. If the data set belongs to the UCI Repository, then a full link is provided here to download it.

Data from the UCI Machine Learning Repository:

• Adult.data:	http://archive.ics.uci.edu/ml/datasets/Adult
• Iris data:	http://archive.ics.uci.edu/ml/datasets/Iris
• Yellow-small.data (Balloons)	http://archive.ics.uci.edu/ml/datasets/Balloons
• Wine data:	http://archive.ics.uci.edu/ml/datasets/Wine

1.9. Exercises

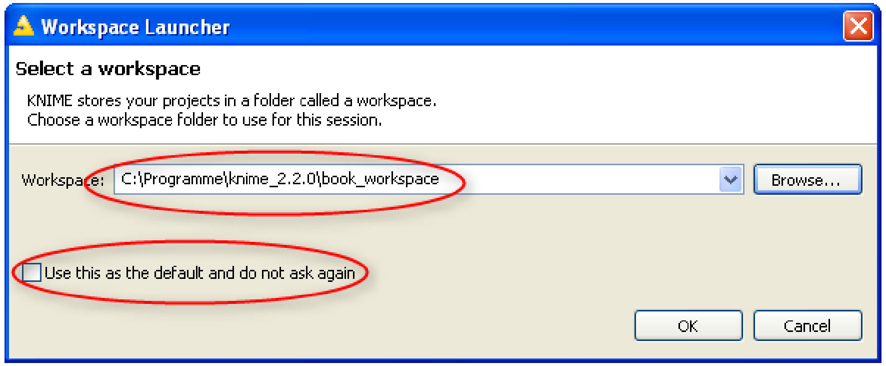
Exercise 1

Create your own workspace and name it “book_workspace”. You will use this workspace for the workflows and the exercises of this book.

Solution to Exercise 1

- Launch KNIME
- Click “Browse”
- Select the path for your new workspace
- Click “OK”

1.11. Exercise 1: Create workspace "book_workspace"



Workspace Launcher

Select a workspace

KNIME stores your projects in a folder called a workspace.
Choose a workspace folder to use for this session.

Workspace: C:\Programme\knime_2.2.0\book_workspace

□ Use this as the default and do not ask again

To keep this as your default workspace, enable the option on the bottom left.

Exercise 2

Install the following extensions:

- KNIME Math Expression Extension (JEP)
- KNIME External Tool Node
- KNIME Report Designer Feature
- KNIME Reporting Runtime Feature

Solution to Exercise 2

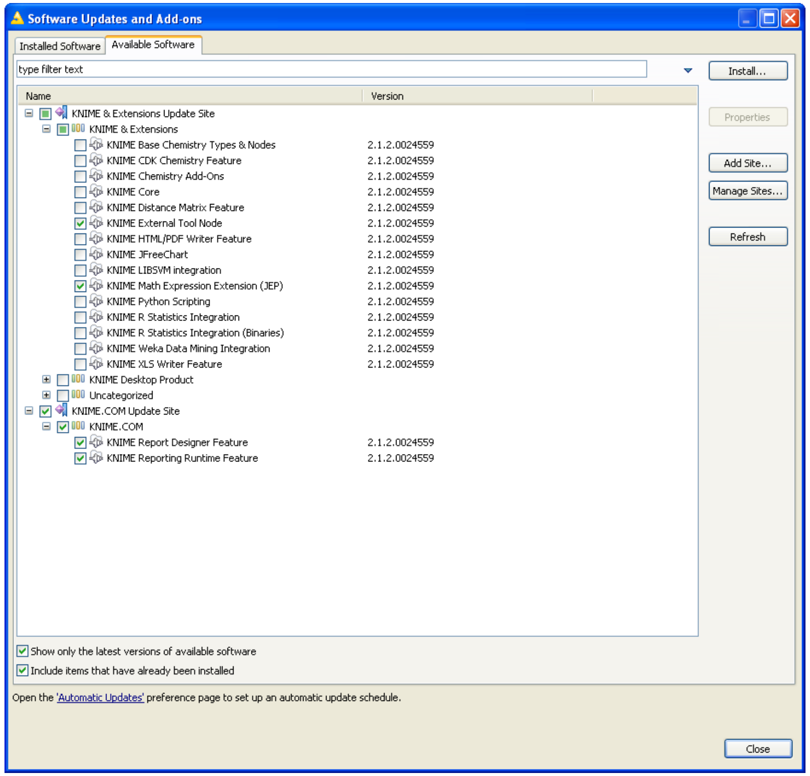
From Top Menu, select **"Help" -> "Software Updates"**

Select Tab **"Available Software"**

Select Extensions

Click **"Install"**

1.12. Exercise 2: List of KNIME extensions



Software Updates and Add-ons

Installed Software | Available Software

type filter text

Name	Version
⊟ ▣ KNIME & Extensions Update Site	
⊟ ▣ KNIME & Extensions	
□ KNIME Base Chemistry Types & Nodes	2.1.2.0024559
□ KNIME CDK Chemistry Feature	2.1.2.0024559
□ KNIME Chemistry Add-Ons	2.1.2.0024559
□ KNIME Core	2.1.2.0024559
□ KNIME Distance Matrix Feature	2.1.2.0024559
☑ KNIME External Tool Node	2.1.2.0024559
□ KNIME HTML/PDF Writer Feature	2.1.2.0024559
□ KNIME JFreeChart	2.1.2.0024559
□ KNIME LIBSVM integration	2.1.2.0024559
☑ KNIME Math Expression Extension (JEP)	2.1.2.0024559
□ KNIME Python Scripting	2.1.2.0024559
□ KNIME R Statistics Integration	2.1.2.0024559
□ KNIME R Statistics Integration (Binaries)	2.1.2.0024559
□ KNIME Weka Data Mining Integration	2.1.2.0024559
□ KNIME XLS Writer Feature	2.1.2.0024559
⊞ □ KNIME Desktop Product	
⊞ □ Uncategorized	
⊟ ☑ KNIME.COM Update Site	
⊟ ☑ KNIME.COM	
☑ KNIME Report Designer Feature	2.1.2.0024559
☑ KNIME Reporting Runtime Feature	2.1.2.0024559

☑ Show only the latest versions of available software

☑ Include items that have already been installed

Open the 'Automatic Updates' preference page to set up an automatic update schedule.

Exercise 3

Search all “Row Filter” nodes in the Node Repository.

From the “Node Description” panel, can you explain what the difference is between a “Row Filter”, a “Reference Row Filter”, and a “Nominal Value Row Filter”?

Show the node effects by using the following data tables:

Original Table

Position	name	team
1	The Black Rose	4
2	Cynthia	4
3	Tinkerbell	4
4	Mother	4
5	Augusta	3
6	The Seven Seas	3

Reference Table

Ranking	scores
1	22
3	14
4	10

Solution to Exercise 3

Row Filter

The node allows for row filtering according to certain criteria. It can include or exclude: certain ranges (by row number), rows with a certain row ID, and rows with a certain value in a selectable column (attribute). In the example below we used the following filter criterion: **`team > 3`**

Original table

Position	name	team
1	The Black Rose	4
2	Cynthia	4
3	Tinkerbell	4
4	Mother	4
5	Augusta	3
6	The Seven Seas	3

Filtered table

Position	name	team
1	The Black Rose	4
2	Cynthia	4
3	Tinkerbell	4
4	Mother	4

Reference Row Filter

This node has two input tables. The first input table, connected to the top port, is taken as the reference table; the second input table, connected to the bottom port, is the table to be filtered. You have to choose the reference column in the reference table and the filtering column in the second table. All rows with a value in the filtering column that also exists in the reference column are kept, if the option “include” is selected; they are removed if the option ”exclude” is selected.

Reference Table

Ranking	scores
1	22
3	14
4	10

Filtering Table

Position	name	team
1	The Black Rose	4
2	Cynthia	4
3	Tinkerbell	4
4	Mother	4
5	Augusta	3
6	The Seven Seas	3

Resulting Table

Position	name	team
1	The Black Rose	4
3	Tinkerbell	4
4	Mother	4

In the example above, we use "Ranking" as the reference column in the reference table and "Position" as the filtering column in the filtering table. We have chosen to include the common rows.

Nominal Value Row Filter

Filters the rows based on the selected value of a nominal attribute. A nominal column and one or more nominal values of this attribute can be selected as the filter criterion. Rows that have these nominal values in the selected column are included in the output data. Basically it is a Row Filter applied to a column with nominal values. Nominal columns are string columns and nominal values are the values in it.

In the example below, we use "name" as the nominal column and "`name = Cynthia`" as the filtering criterion.

Original table

Position	name	team
1	The Black Rose	4
2	Cynthia	4
3	Tinkerbell	4
4	Mother	4
5	Augusta	3
6	The Seven Seas	3

Filtered table

Position	name	team
2	Cynthia	4

Chapter 2. My first workflow

2.1. Workflow operations

If you have started KNIME for the first time, your “Workflow Projects” panel on the top left corner of the KNIME window only contains an empty workflow named “KNIME_Project”. You can start from this empty workflow or you can create a new one.

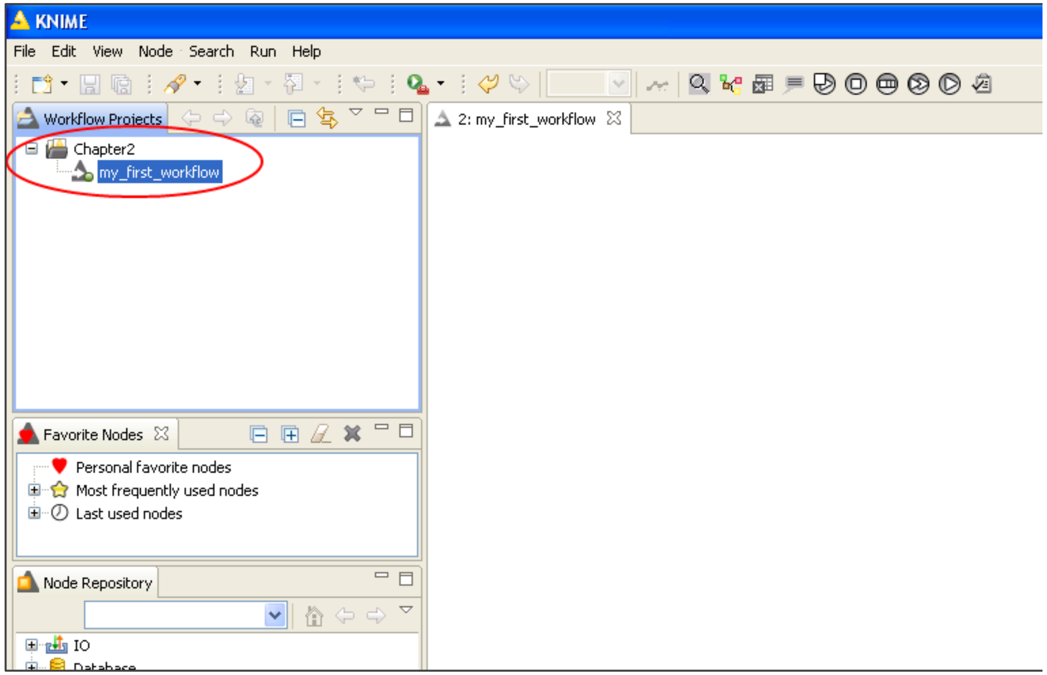
First of all, if you are planning on a career working with KNIME, you need to learn how to keep your space clean. Workflow Groups can help you group workflows by topic or project. I usually define a workflow group for each project or subproject I work on, into which I put all the workflows related to the same topic. Now let’s create then a new workflow group and call it “Chapter 2”.

Once this has been done, you need to populate the newly created workflow group with a new workflow, let’s call it “my_first_workflow”.

Eventually in the “Workflow Projects” panel, you will see workflow group “Chapter2” with a workflow “my_first_workflow” in it.

For now, “my_first_workflow” is an empty workflow. If you double click it in the “Workflow Projects” panel, the workflow editor opens to an empty page.

2.1. Final workflow structure

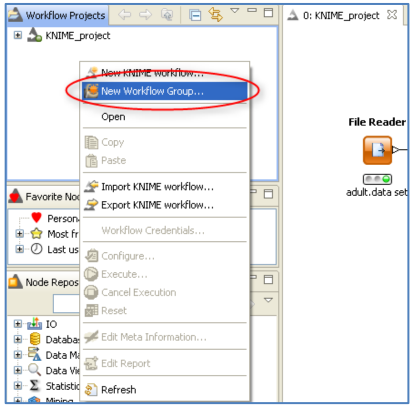


Create a new workflow group

- Right click the “Workflow Projects” panel

- Select “New Workflow Group”

2.2. Create a new workflow group

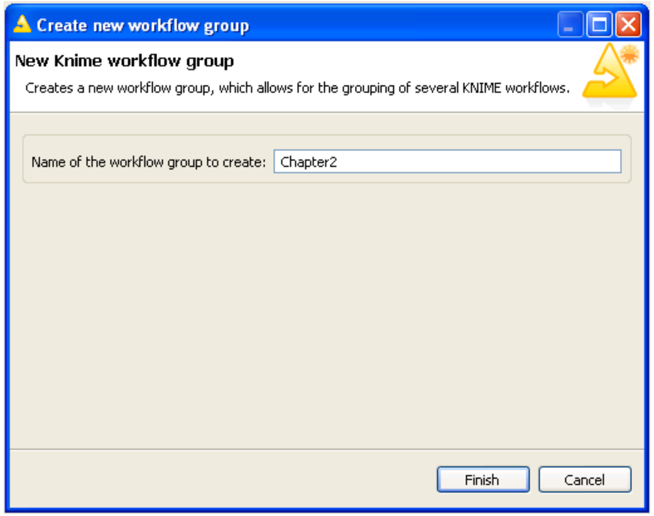


In the “New Knime workflow group” dialog:

- Enter the name of the group

- Click “Finish”

2.3. Create a new workflow group named "Chapter2"



New Knime workflow group

Creates a new workflow group, which allows for the grouping of several KNIME workflows.

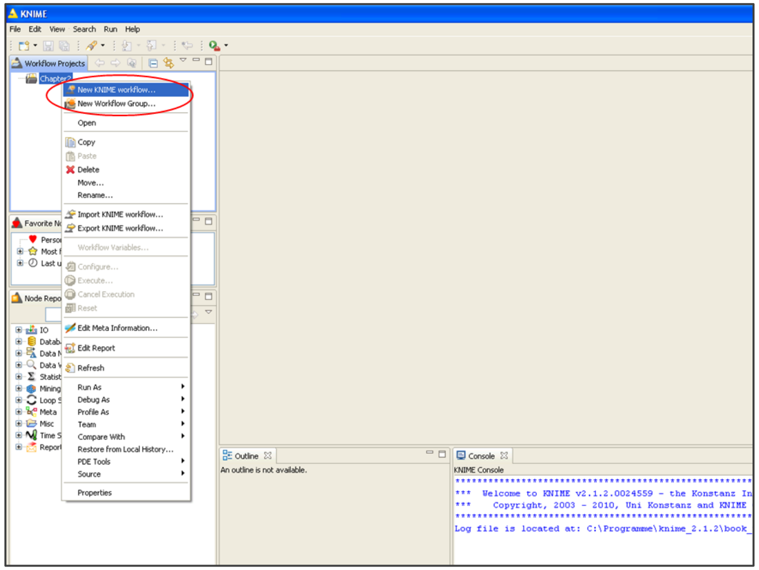
Name of the workflow group to create: Chapter2

Create a new workflow

- Right click the workflow group in the “Workflow Projects” panel

- Select “New KNIME Workflow”

2.4. Create a new workflow



An outline is not available.

KNIME Console

```
******************************************************
***  Welcome to KNIME v2.1.2.0024559 - the Konstanz In
***    Copyright, 2003 - 2010, Uni Konstanz and KNIME
******************************************************
Log file is located at: C:\Programme\knime_2.1.2\book_
```

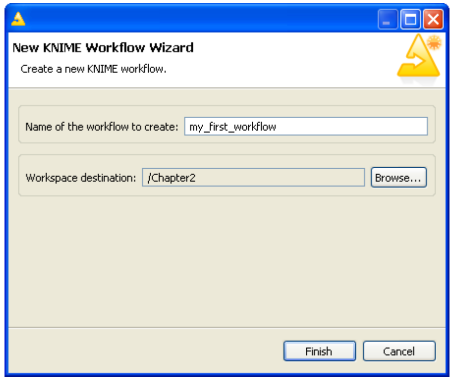
In the “New KNIME Workflow Wizard” dialog

- Enter the name of the new workflow

- Specify where it should be located, for example under a workflow group

- Click “Finish”

2.5. Create a new workflow named "my_first_workflow" and placed under "Chapter2"



New KNIME Workflow Wizard

Create a new KNIME workflow.

Name of the workflow to create: my_first_workflow

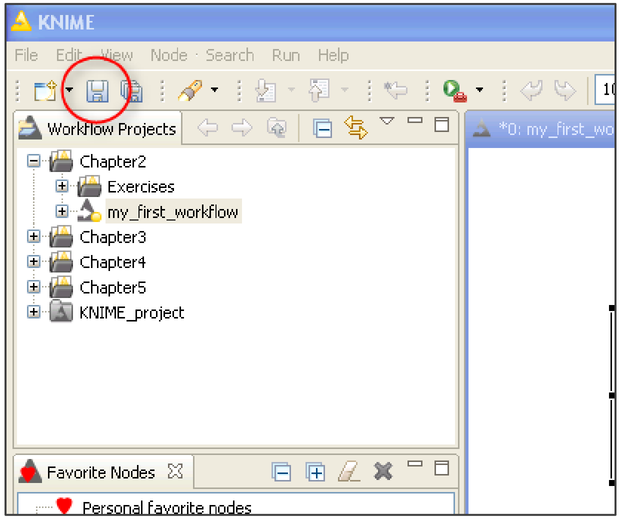
Workspace destination: /Chapter2

Save a workflow

To save the workflow, click the floppy disk icon under the Top Menu at any time.

Saving the workflow saves the workflow architecture, the nodes' configuration, and the data at the output of each node.

2.6. Save a workflow



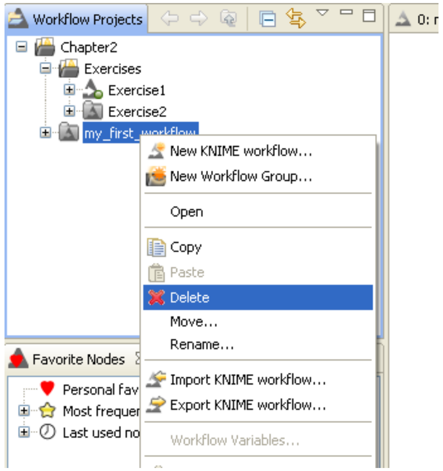
Delete a workflow

To delete a workflow

- Right click the workflow in the “Workflow Projects” panel
- Select “Delete”

In the “Delete Workflow” dialog, the flag “Delete project contents on disk” removes the workflow project physically from the hard disk. There is no way to get it back.

2.7. Delete a workflow



2.2. Node operations

In Chapter 1, we have seen that a node is the basic computational unit of a KNIME workflow. We have also seen that nodes are available in the "Node Repository" panel on the bottom left, organized in categories. And we have seen that every node has three states: not yet configured (red), configured (yellow), and successfully executed (green).

In this section we are going to explore:

- How to add a new node to a workflow (status = inactive, not configured; red light)
- How to configure the node (status = configured, not executed; yellow light)
- How to execute the node (status = successfully executed; green light)

Create a new node

- Drag and drop the node from the "Node Repository" panel into the workflow editor

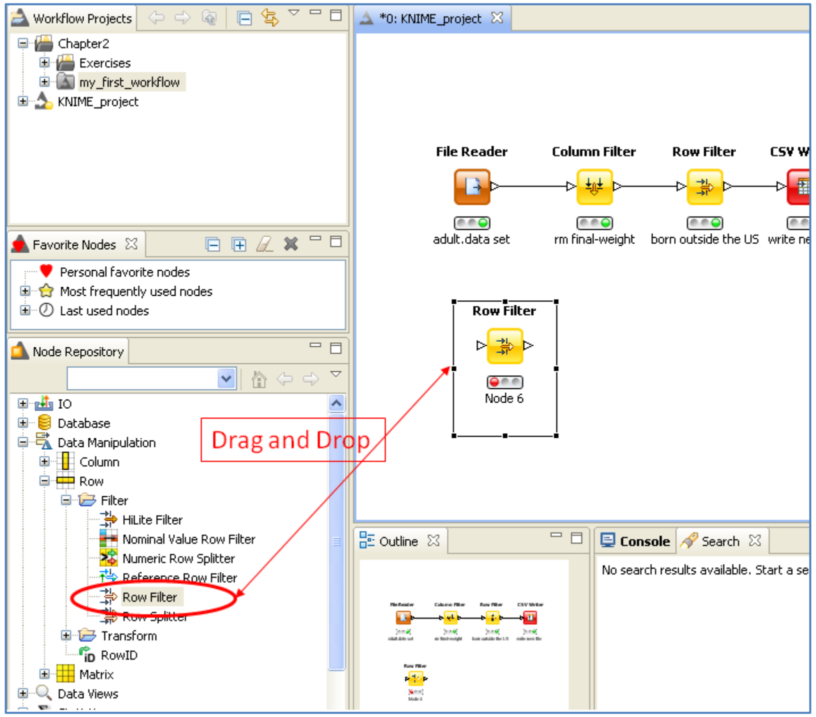
- The node is imported with red traffic light status

- To connect the node with existing nodes, click the output triangle of the first node and release the mouse at the input triangle of the second node

- If you already have the "Node Description" panel open on the right, it shows a short description of the node functionality

- If the "Node Description" panel is not yet open,
  - ○ Open the "View" item in the Top Menu,
  - ○ Select "Node Description"

2.8. Drag and drop the node into the workflow editor to create a new node



Configure a node

- Double click the node

OR

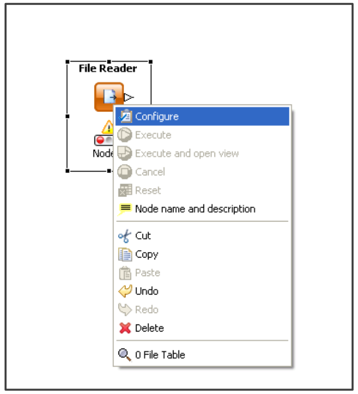
- Right click the node and select “Configure”

If all input ports are connected, the “Configuration Dialog” appears for you to fill in the configuration settings.

Every node has a different “Configuration Dialog”, since every node performs a different task.

After a successful configuration, the node switches its traffic light to yellow.

2.9. Right click the node and select "Configure" to configure the node



Execute a node

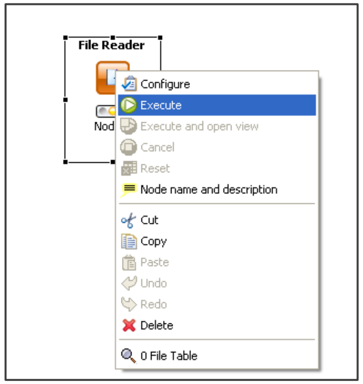
The node is now configured, which means it knows what to do.

In order to actually make it perform its task, we need to execute it.

- Right click the node
- Select “Execute”.

If execution is successful, the node switches its traffic light to green.

2.10. Right click the node and select "Execute" to run the node



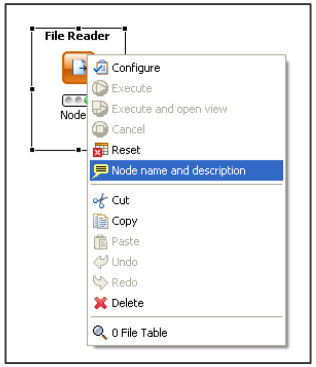
Finally we need to give a meaningful name to this node so that we can easily recognize which task it is performing in the workflow. The default name assigned to a node by KNIME is “Node n”, where “n” is a progressive number. You can customize the node’s name. Together with the name you can supply a short description of the node task. This keeps the overview of the workflow clearer and fulfills the purpose of the workflow documentation.

Name and description

In order to change the node’s name:

- Right click the node
- Select “Node name and description”

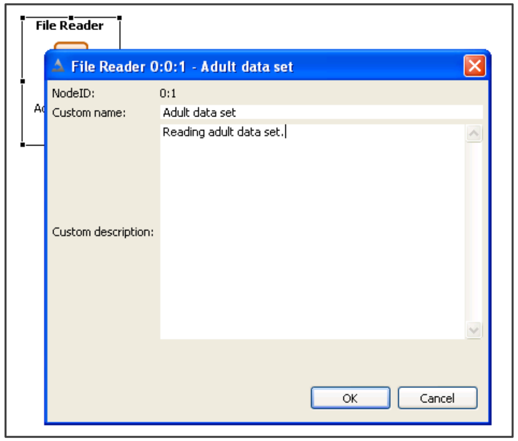
2.11. Right click the node and select "Node name and description" to enter a name and a description



In the Name and Description dialog:

- Enter the node’s new name
- Enter a description of its task
- Click “OK”

2.12. The "Node Name and Description" dialog



File Reader 0:0:1 - Adult data set

NodeID: 0:1

Custom name: Adult data set

Custom description: Reading adult data set.

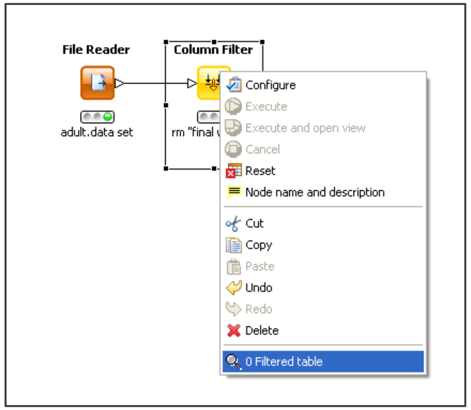
View the processed data

If execution was successful (green light), you can see the processed data by right clicking the node and selecting the last option.

The option to view the processed data is the last item of the shortcut menu (right-click menu) for all nodes with output data, but it takes on different names for different nodes.

The table with the processed data is then shown.

2.13. Right click the node and select the last option to see the processed data



2.3. Read data from file

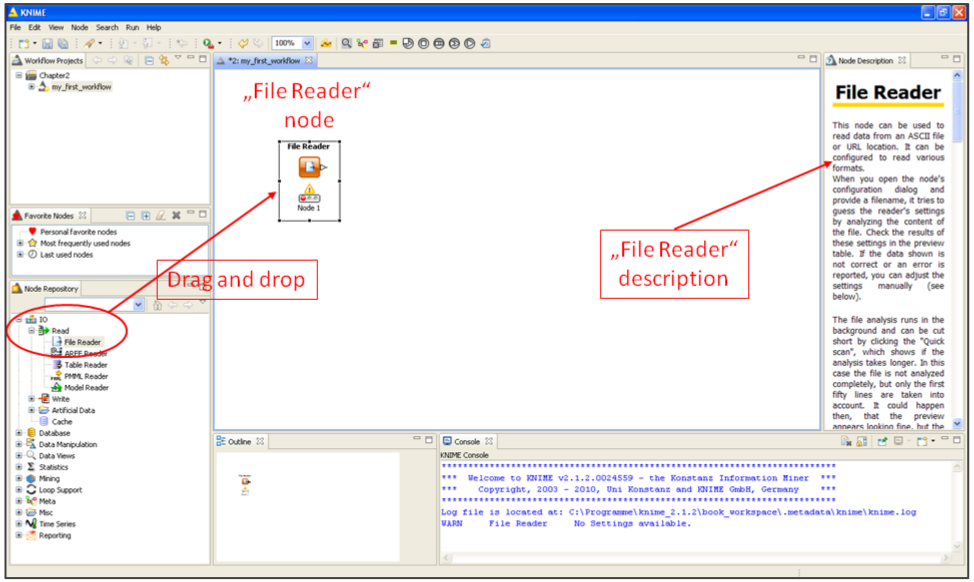
The first step in all data analysis works consists of reading data. Data is usually read from a file or from a database (DB). In this chapter we describe how to read and write data from and to a file. Reading and writing data from and to a database is described in section 3.5 “Database operations”.

Create a “File Reader” node

2.14. Create a "File Reader" node

In the “Node Repository” on the bottom left panel

- Expand the “IO” category
- Expand the “Read” sub-category
- Drag and drop the “File Reader” node into the workflow editor
- If the “Node Description” panel on the right is enabled, it shows the description of the “File Reader” node. To activate the “Node Description” panel, go to the Top Menu, open “View” and select “Node Description”.



File Reader

This node can be used to read data from an ASCII file or URL location. It can be configured to read various formats.
When you open the node's configuration dialog and provide a filename, it tries to guess the reader's settings by analyzing the content of the file. Check the results of these settings in the preview table. If the data shown is not correct or an error is reported, you can adjust the settings manually (see below).

The file analysis runs in the background and can be cut short by clicking the "Quick scan", which shows if the analysis takes longer. In this case the file is not analyzed completely, but only the first fifty lines are taken into account. It could happen then, that the preview appears looking fine, but the

KNIME Console

```
**************************************************************************
***  Welcome to KNIME v2.1.2.0024559 - the Konstanz Information Miner  ***
***    Copyright, 2003 - 2010, Uni Konstanz and KNIME GmbH, Germany    ***
**************************************************************************
Log file is located at: C:\Programme\knime_2.1.2\book_workspace\.metadata\knime\knime.log
WARN     File Reader     No Settings available.
```

Note. Below the “File Reader” node you might notice a little yellow warning triangle. If you hover over it with the mouse, the following tooltip appears: “No Settings available”. This is because the File Reader node is not yet configured to read anything (it needs at least the filename!). At the moment, the node is in the red traffic light state: not even configured.

Configure the “File Reader” node

- Double-click the node

OR

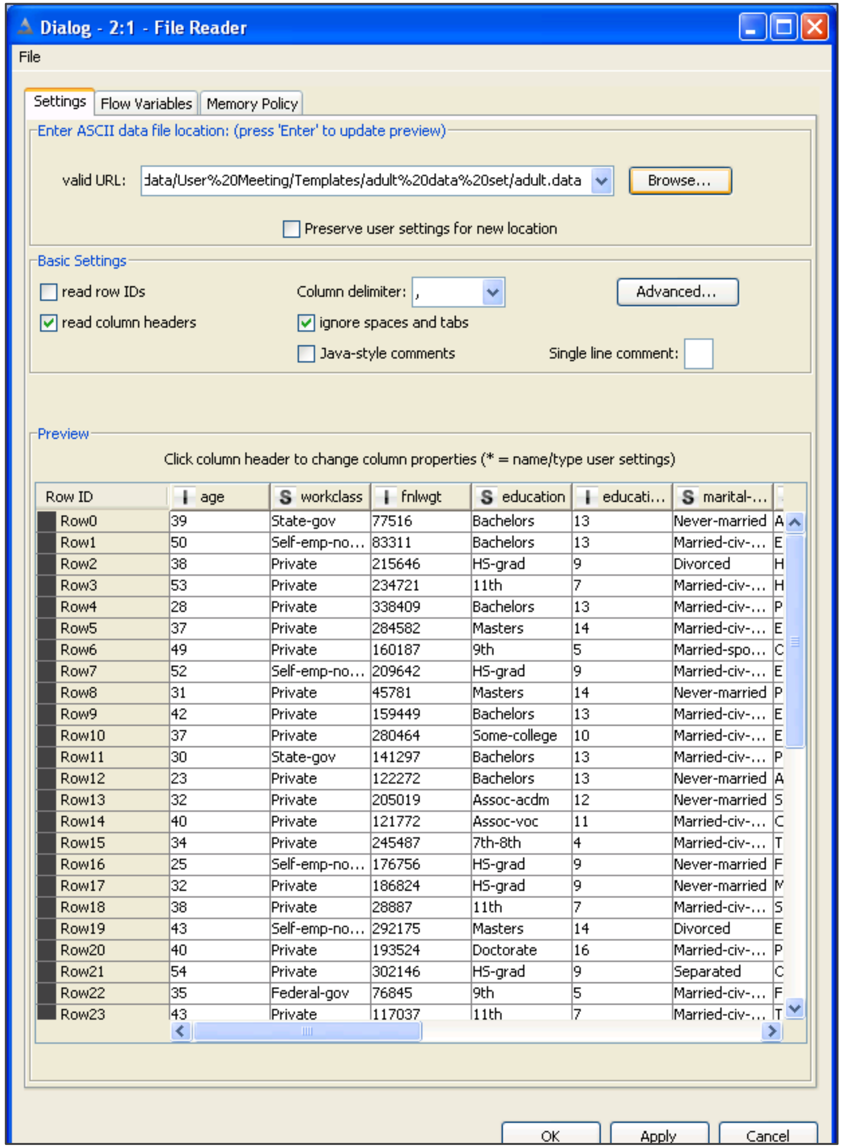
- Right-click the node and select “Configure”

- Specify the file path in the configuration dialog. We used the adult.data file, downloadable from the UCI Machine Learning Repository (http://archive.ics.uci.edu/ml/datasets/Adult).
  If it is a comma or tab separated file, the File Reader automatically detects its structure.

- Next, enable/disable the number of respective checkboxes according to the structure of the data in the file.

A preview of the data is available on the bottom and reports possible reading errors.

2.15. "File Reader" node configuration window



Enter ASCII data file location: (press 'Enter' to update preview)

valid URL: data/User%20Meeting/Templates/adult%20data%20set/adult.data

□ Preserve user settings for new location

Basic Settings

□ read row IDs

☑ read column headers

Column delimiter: ,

☑ ignore spaces and tabs

□ Java-style comments

Single line comment:

Preview

Click column header to change column properties (* = name/type user settings)

Row ID	I age	S workclass	I fnlwgt	S education	I educati...	S marital-...	
Row0	39	State-gov	77516	Bachelors	13	Never-married	A
Row1	50	Self-emp-no...	83311	Bachelors	13	Married-civ-...	E
Row2	38	Private	215646	HS-grad	9	Divorced	H
Row3	53	Private	234721	11th	7	Married-civ-...	H
Row4	28	Private	338409	Bachelors	13	Married-civ-...	P
Row5	37	Private	284582	Masters	14	Married-civ-...	E
Row6	49	Private	160187	9th	5	Married-spo...	C
Row7	52	Self-emp-no...	209642	HS-grad	9	Married-civ-...	E
Row8	31	Private	45781	Masters	14	Never-married	P
Row9	42	Private	159449	Bachelors	13	Married-civ-...	E
Row10	37	Private	280464	Some-college	10	Married-civ-...	E
Row11	30	State-gov	141297	Bachelors	13	Married-civ-...	P
Row12	23	Private	122272	Bachelors	13	Never-married	A
Row13	32	Private	205019	Assoc-acdm	12	Never-married	S
Row14	40	Private	121772	Assoc-voc	11	Married-civ-...	C
Row15	34	Private	245487	7th-8th	4	Married-civ-...	T
Row16	25	Self-emp-no...	176756	HS-grad	9	Never-married	F
Row17	32	Private	186824	HS-grad	9	Never-married	M
Row18	38	Private	28887	11th	7	Married-civ-...	S
Row19	43	Self-emp-no...	292175	Masters	14	Divorced	E
Row20	40	Private	193524	Doctorate	16	Married-civ-...	P
Row21	54	Private	302146	HS-grad	9	Separated	C
Row22	35	Federal-gov	76845	9th	5	Married-civ-...	F
Row23	43	Private	117037	11th	7	Married-civ-...	T

Customize column properties

It is possible to customize the way that column data is read.

For example, let’s read column “fnlwgt” as a String instead of as an Integer and set “final weight” as column header instead of “fnlwgt”.

- Click the column header of column “fnlwgt”
- The window to customize the column properties opens

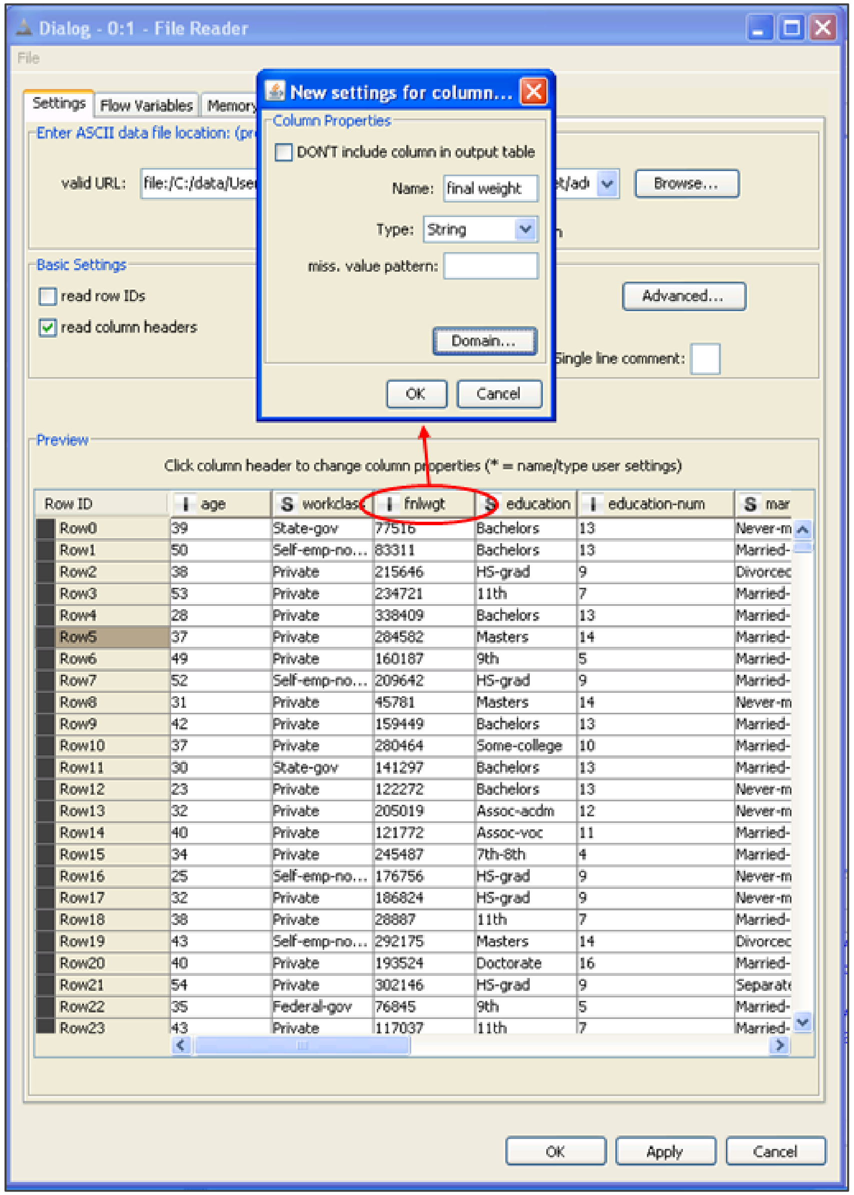
Here you can:

- Change the column name (= column header) from “fnlwgt” to “final weight”

- Change the column data type from Integer to String or Double

- Introduce a special character to represent a missing value in the data of the file

2.16. Customize how to read columns



Enter ASCII data file location: (pr

valid URL: file:/C:/data/User …t/adı

Basic Settings

□ read row IDs

☑ read column headers

Single line comment:

New settings for column...

Column Properties

□ DON'T include column in output table

Name: final weight

Type: String

miss. value pattern:

Preview

Click column header to change column properties (* = name/type user settings)

Row ID	I age	S workclas	I fnlwgt	S education	I education-num	S mar
Row0	39	State-gov	77516	Bachelors	13	Never-m
Row1	50	Self-emp-no...	83311	Bachelors	13	Married-
Row2	38	Private	215646	HS-grad	9	Divorcec
Row3	53	Private	234721	11th	7	Married-
Row4	28	Private	338409	Bachelors	13	Married-
Row5	37	Private	284582	Masters	14	Married-
Row6	49	Private	160187	9th	5	Married-
Row7	52	Self-emp-no...	209642	HS-grad	9	Married-
Row8	31	Private	45781	Masters	14	Never-m
Row9	42	Private	159449	Bachelors	13	Married-
Row10	37	Private	280464	Some-college	10	Married-
Row11	30	State-gov	141297	Bachelors	13	Married-
Row12	23	Private	122272	Bachelors	13	Never-m
Row13	32	Private	205019	Assoc-acdm	12	Never-m
Row14	40	Private	121772	Assoc-voc	11	Married-
Row15	34	Private	245487	7th-8th	4	Married-
Row16	25	Self-emp-no...	176756	HS-grad	9	Never-m
Row17	32	Private	186824	HS-grad	9	Never-m
Row18	38	Private	28887	11th	7	Married-
Row19	43	Self-emp-no...	292175	Masters	14	Divorcec
Row20	40	Private	193524	Doctorate	16	Married-
Row21	54	Private	302146	HS-grad	9	Separate
Row22	35	Federal-gov	76845	9th	5	Married-
Row23	43	Private	117037	11th	7	Married-

Advanced reading options

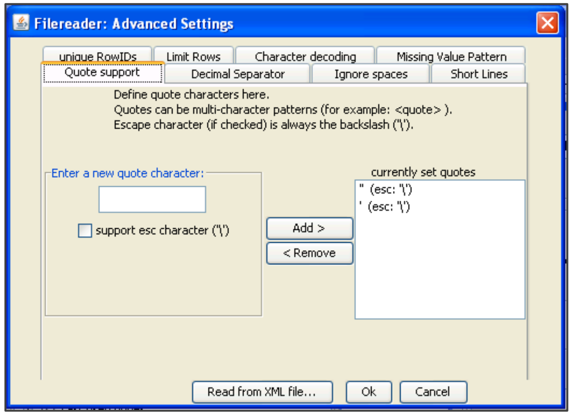
Under the “Advanced” button you will find some more reading options. Each option tab is extensively described. I provide brief comments here on only three of them.

To read the adult.data file however we do not need to enable any of those options, as the adult.data file a pure ASCII file.

“Quote Support” allows the definition of special quote characters.

Quote characters are essential because they define the start and the end of a string. The default quote characters are “ and ‘.

2.17. Advanced settings: Quote Support



Define quote characters here.
Quotes can be multi-character patterns (for example: <quote>).
Escape character (if checked) is always the backslash ('\').

Enter a new quote character:

□ support esc character ('\')

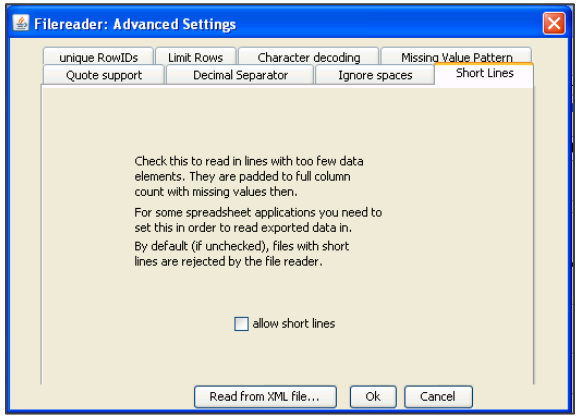
currently set quotes

" (esc: '\')
' (esc: '\')

“Short Lines” allows the reading of lines shorter than expected.

By default, lines with fewer columns than expected would otherwise cause the node to fail during execution. If this option is on, such lines are read and the missing final columns are padded with missing values.

2.18. Advanced settings: Short Lines



Check this to read in lines with too few data elements. They are padded to full column count with missing values then.

For some spreadsheet applications you need to set this in order to read exported data in.

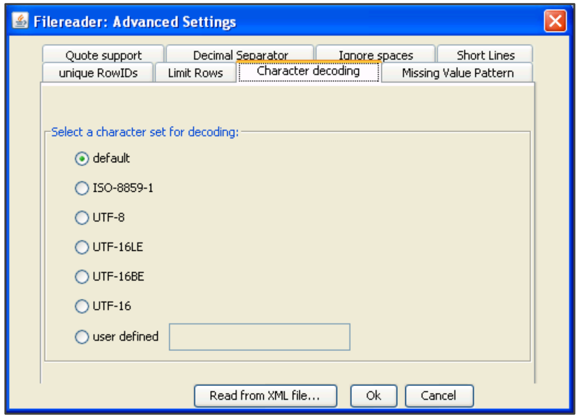
By default (if unchecked), files with short lines are rejected by the file reader.

□ allow short lines

“Character Decoding” offers you the possibility of reading files encoded with a different locale than just ASCII (default).

Files with text in a different language than English need to have an encoding enabled, in order to be read properly.

2.19. Advanced settings: Character Decoding



Select a character set for decoding:

● default
○ ISO-8859-1
○ UTF-8
○ UTF-16LE
○ UTF-16BE
○ UTF-16
○ user defined

Click on “OK” at the bottom of the “Advanced Settings” window.

If you are satisfied with the data preview and your settings, click “OK” at the bottom of the “File Reader Configuration” window.

Note. After configuring the "File Reader" node, its state moves to the yellow traffic light.

Finally we need to give this node a meaningful name so that we can easily recognize what its task is in the workflow. The default name of our File Reader is "Node 1" because it is the first node created in the workflow. In order to change the node's name:

- Right click the node and select "Node name and description"
- Enter the node's new name (for example "Adult data set") and a description of its task
- Click "OK"

We have now changed the name of the "File Reader" node from "Node 1" to "Adult data set".

In order to make the node read the file, we need to execute it. Proceed as follows:

- Right click the node
- Select "Execute"

Note. If the reading process is successful the node switches its traffic light to green.

Note. On every configuration window you will find a tab, called "Flow Variables". Flow Variables are used to pass variables from one node to another. However, we are not going to work with Flow Variables in this book, since they belong to a more advanced course on KNIME usage.

2.4. KNIME data

If execution was successful you can also see the resulting data.

- Right click the "File Reader" node
- Select "File Table"

A table with the read data appears. Let’s have a look at this table now to understand how data is structured inside KNIME.

First of all, data in KNIME is organized as a **table**.

Each row is identified by a **Row ID**. By default, Row IDs are Strings like “Row n” where “n” is a progressive number. But RowIDs can be forced to be anything, with the only condition that they must be unique. Not unique RowIDs will cause an error.

Columns are identified by **column headers**. If no column headers are available, default column headers like “Col n” - where “n” is a progressive number - are assigned by KNIME. In adult.data file column headers were included. We enabled the checkbox “Read column headers” and we now have a header for each column in the final data table. Even column headers need to be unique. If a column header is repeated, KNIME adds a suffix “(#n)” (n = progressive number) to each multiple occurrence of a column header.

Each column contains data with a set **data type**. A few common data types are defined in KNIME:

- Double (“**D**”)
- Integer (“**I**”)
- String (“**S**”)
- Date/time (calendar + clock icon)
- Unknown (“**?”)**

Date/time type is never generated by reading from a file. Dates are read from a text file just as Strings.

Unknown Type refers to columns with mixed data types, for example String and Integer, or with an indefinable data type, for example with all missing values.

Missing values are data cells with a special “missing value” status and are displayed by default with a question mark (“?”), unless the display character for the missing value was defined differently in the “File Reader” node configuration.

KNIME data structure

Data in KNIME is organized as a **table** with a fixed number of columns.

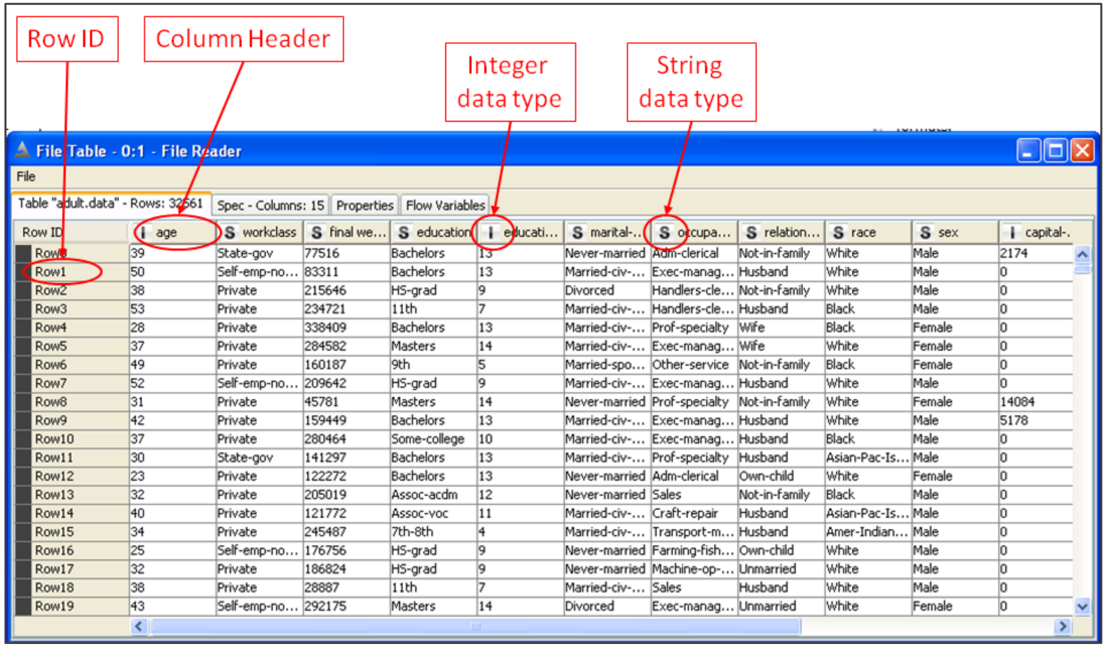
Each row is identified by a **Row ID**.

Columns are identified by **column headers**.

Each column represents a **data type**

- Double (“**D**”)
- Integer (“**I**”)
- String (“**S**”)
- Date/time (calendar + clock icon)
- Unknown (“**?”)**

2.20. The KNIME data structure



Row ID	I age	S workclass	S final we...	S education	I educati...	S marital-...	S occupa...	S relation...	S race	S sex	I capital-.
Row0	39	State-gov	77516	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	2174
Row1	50	Self-emp-no...	83311	Bachelors	13	Married-civ-...	Exec-manag...	Husband	White	Male	0
Row2	38	Private	215646	HS-grad	9	Divorced	Handlers-cle...	Not-in-family	White	Male	0
Row3	53	Private	234721	11th	7	Married-civ-...	Handlers-cle...	Husband	Black	Male	0
Row4	28	Private	338409	Bachelors	13	Married-civ-...	Prof-specialty	Wife	Black	Female	0
Row5	37	Private	284582	Masters	14	Married-civ-...	Exec-manag...	Wife	White	Female	0
Row6	49	Private	160187	9th	5	Married-spo...	Other-service	Not-in-family	Black	Female	0
Row7	52	Self-emp-no...	209642	HS-grad	9	Married-civ-...	Exec-manag...	Husband	White	Male	0
Row8	31	Private	45781	Masters	14	Never-married	Prof-specialty	Not-in-family	White	Female	14084
Row9	42	Private	159449	Bachelors	13	Married-civ-...	Exec-manag...	Husband	White	Male	5178
Row10	37	Private	280464	Some-college	10	Married-civ-...	Exec-manag...	Husband	Black	Male	0
Row11	30	State-gov	141297	Bachelors	13	Married-civ-...	Prof-specialty	Husband	Asian-Pac-Is...	Male	0
Row12	23	Private	122272	Bachelors	13	Never-married	Adm-clerical	Own-child	White	Female	0
Row13	32	Private	205019	Assoc-acdm	12	Never-married	Sales	Not-in-family	Black	Male	0
Row14	40	Private	121772	Assoc-voc	11	Married-civ-...	Craft-repair	Husband	Asian-Pac-Is...	Male	0
Row15	34	Private	245487	7th-8th	4	Married-civ-...	Transport-m...	Husband	Amer-Indian...	Male	0
Row16	25	Self-emp-no...	176756	HS-grad	9	Never-married	Farming-fish...	Own-child	White	Male	0
Row17	32	Private	186824	HS-grad	9	Never-married	Machine-op-...	Unmarried	White	Male	0
Row18	38	Private	28887	11th	7	Married-civ-...	Sales	Husband	White	Male	0
Row19	43	Self-emp-no...	292175	Masters	14	Divorced	Exec-manag...	Unmarried	White	Female	0

2.5. Filter data columns

In the next step, we want to filter out the column “final weight” from the read data set. In the “Node Repository” panel, on the bottom left, there is a whole category called “Data Manipulation” with nodes dedicated to managing the data structure. This category includes operations on columns, rows, and on the full data matrix.

Create a “Column Filter” node

- In the “Node Repository” panel on the bottom left, the node “Column Filter” is located under:

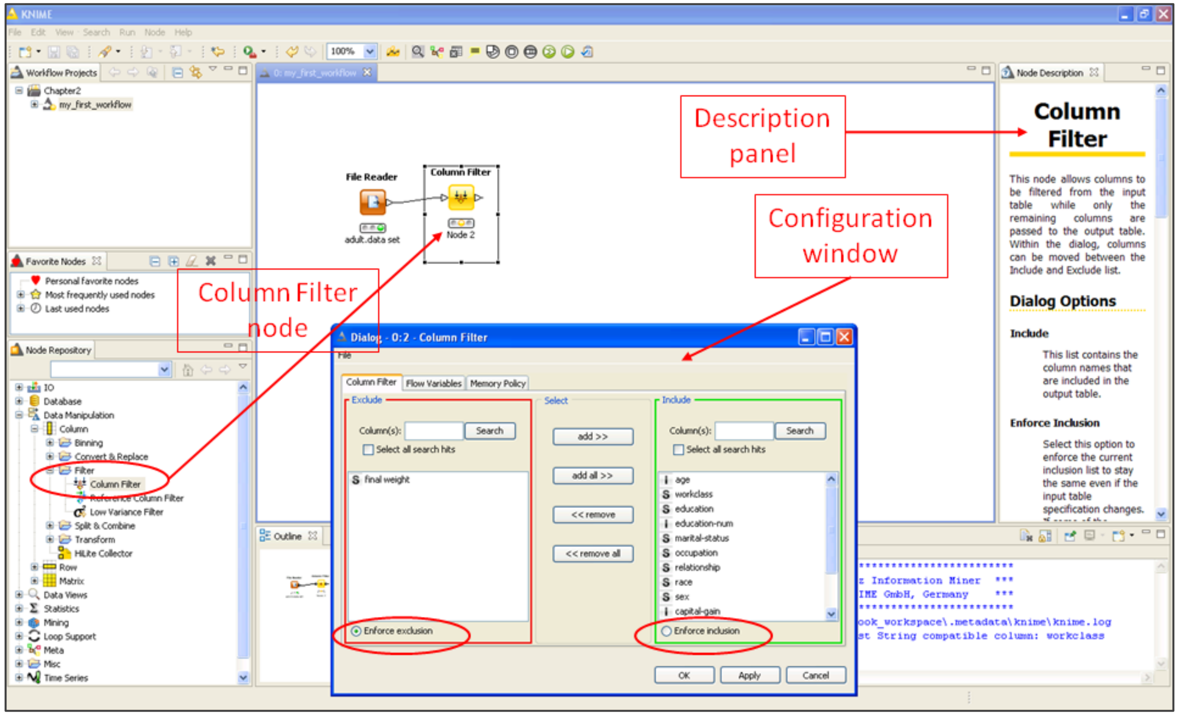
  `“Data Manipulation” -> “Column” -> “Filter”`

- Drag and drop the “Column Filter” node from the “Node Repository” panel into the workflow editor panel.

  The description for this node appears in the “Node Description” panel on the right.

- Connect the “Column Filter” node with the previous node (in our workflow, the “File Reader” node “adult.data set”)

2.21. Creating and setting up a "Column Filter" node



Column Filter

This node allows columns to be filtered from the input table while only the remaining columns are passed to the output table. Within the dialog, columns can be moved between the Include and Exclude list.

Dialog Options

Include

This list contains the column names that are included in the output table.

Enforce Inclusion

Select this option to enforce the current inclusion list to stay the same even if the input table specification changes.

Dialog - 0:2 - Column Filter

File

Column Filter | Flow Variables | Memory Policy

Exclude
Column(s): [ ] Search
□ Select all search hits
S final weight
● Enforce exclusion

Select
add >>
add all >>
<< remove
<< remove all

Include
Column(s): [ ] Search
□ Select all search hits
I age
S workclass
S education
I education-num
S marital-status
S occupation
S relationship
S race
S sex
I capital-gain
○ Enforce inclusion

OK | Apply | Cancel

```
*************************
z Information Miner   ***
IME GmbH, Germany     ***
*************************
ook_workspace\.metadata\knime\knime.log
st String compatible column: workclass
```

Configure the "Column Filter" node

- Double-click the "Column Filter" node to open its configuration window (fig. 2.21).

In the configuration window you see 2 sets of columns:

- The columns to be included from the data table (**"Include" set** on the right)
- The columns to be excluded from the data table (**"Exclude" set** on the left)

You can add and remove columns from one set to the other with the buttons **"Add"** and **"Remove"**.

There are 2 column filter modes:

- **"Enforce Inclusion"** keeps the "Include" set fixed. If one more input column is added from the previous node, this new column is automatically inserted into the "Exclude" set.
- **"Enforce Exclusion"** keeps the "Exclude" set fixed. If one more input column is added from the previous node, this new column is automatically inserted into the "Include" set.

There are also two **"Search"** buttons to search for a specific column, in case too many columns are in the "Include" or "Exclude" set.

- Set the "Column Filter" configuration properties. We only removed the column "final weight". We set the column filter mode to "Enforce Exclusion", because we want to keep all possible input columns besides "final weight".
- Click "OK".

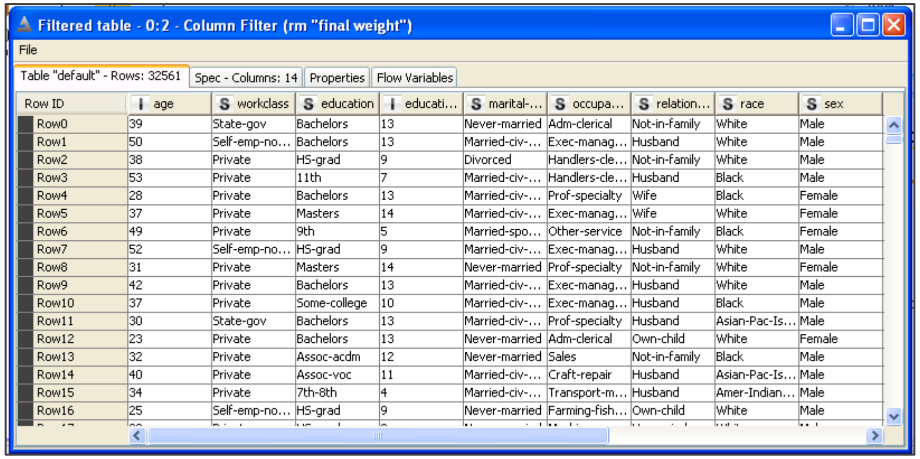
After completing the configuration, right click the "Column Filter" node and select "Node name and description".

Give the node a meaningful name. We named it "rm 'final weight'".

Right click the node and select "Execute" to run the column filter.

To see the final processed data, right-click the "rm final weight" node and select "Filtered Table".
The column "final weight" should no longer be listed.

2.22. The column filtered table does not contain column "final weight"



Filtered table - 0:2 - Column Filter (rm "final weight")

Row ID	age	workclass	education	educati…	marital-…	occupa…	relation…	race	sex
Row0	39	State-gov	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male
Row1	50	Self-emp-no…	Bachelors	13	Married-civ-…	Exec-manag…	Husband	White	Male
Row2	38	Private	HS-grad	9	Divorced	Handlers-cle…	Not-in-family	White	Male
Row3	53	Private	11th	7	Married-civ-…	Handlers-cle…	Husband	Black	Male
Row4	28	Private	Bachelors	13	Married-civ-…	Prof-specialty	Wife	Black	Female
Row5	37	Private	Masters	14	Married-civ-…	Exec-manag…	Wife	White	Female
Row6	49	Private	9th	5	Married-spo…	Other-service	Not-in-family	Black	Female
Row7	52	Self-emp-no…	HS-grad	9	Married-civ-…	Exec-manag…	Husband	White	Male
Row8	31	Private	Masters	14	Never-married	Prof-specialty	Not-in-family	White	Female
Row9	42	Private	Bachelors	13	Married-civ-…	Exec-manag…	Husband	White	Male
Row10	37	Private	Some-college	10	Married-civ-…	Exec-manag…	Husband	Black	Male
Row11	30	State-gov	Bachelors	13	Married-civ-…	Prof-specialty	Husband	Asian-Pac-Is…	Male
Row12	23	Private	Bachelors	13	Never-married	Adm-clerical	Own-child	White	Female
Row13	32	Private	Assoc-acdm	12	Never-married	Sales	Not-in-family	Black	Male
Row14	40	Private	Assoc-voc	11	Married-civ-…	Craft-repair	Husband	Asian-Pac-Is…	Male
Row15	34	Private	7th-8th	4	Married-civ-…	Transport-m…	Husband	Amer-Indian…	Male
Row16	25	Self-emp-no…	HS-grad	9	Never-married	Farming-fish…	Own-child	White	Male

2.6. Filter data rows

Now let's retain only those data rows that refer to people born outside of the United States that is only those rows with "native-country" other than "United States".

Create a "Row Filter" node

In the "Node Repository" panel on the bottom left, open the node category "Data Manipulation" and navigate to the node "Row Filter" in:

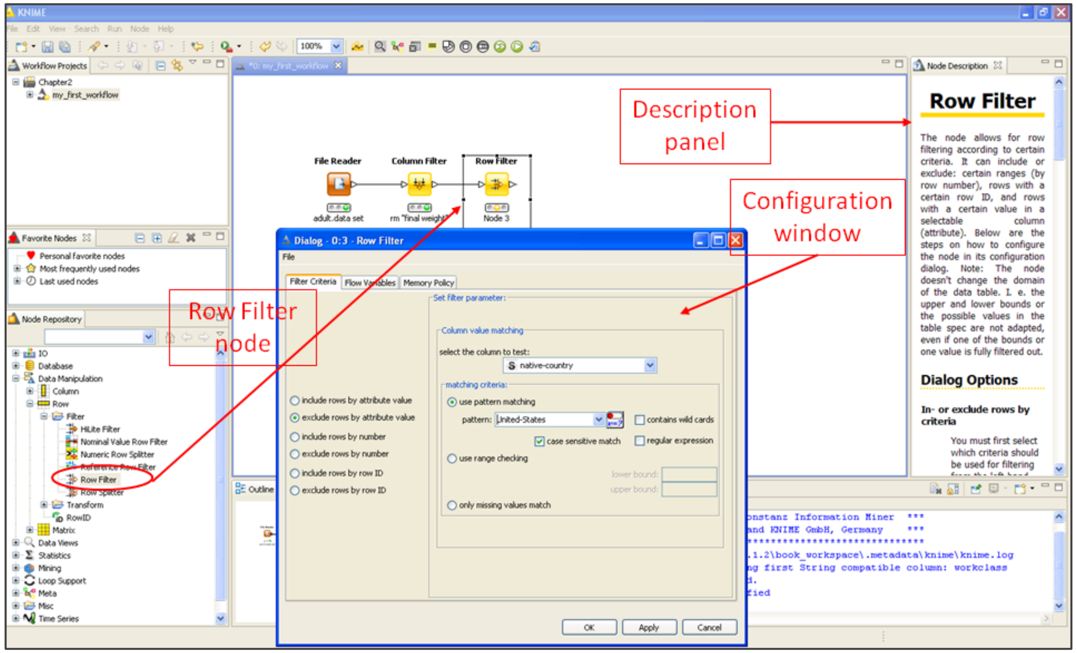
```
"Data Manipulation" -> "Row" -> "Filter"
```

Drag and drop the "Row Filter" node from the "Node Repository" panel into the workflow editor panel.

The description for this node appears in the "Node Description" panel on the right.

Connect the "Row Filter" node with the "Column Filter" node " rm final weight "

2.23. Creating and setting up a "Row Filter" node



Dialog - 0:3 - Row Filter

Filter Criteria | Flow Variables | Memory Policy

○ include rows by attribute value
● exclude rows by attribute value
○ include rows by number
○ exclude rows by number
○ include rows by row ID
○ exclude rows by row ID

Set filter parameter:

Column value matching

select the column to test: native-country

matching criteria:

● use pattern matching

pattern: United-States □ contains wild cards

☑ case sensitive match □ regular expression

○ use range checking

lower bound:

upper bound:

○ only missing values match

OK Apply Cancel

Row Filter

The node allows for row filtering according to certain criteria. It can include or exclude: certain ranges (by row number), rows with a certain row ID, and rows with a certain value in a selectable column (attribute). Below are the steps on how to configure the node in its configuration dialog. Note: The node doesn't change the domain of the data table. I. e. the upper and lower bounds or the possible values in the table spec are not adapted, even if one of the bounds or one value is fully filtered out.

Dialog Options

In- or exclude rows by criteria

You must first select which criteria should be used for filtering

Configure the "Row Filter" node

- Double click the "Row Filter" node to open its configuration window.

The node implements 3 filter criteria, which are shown on the side.

Each of these criteria can be used to **include** or to **exclude rows**.

- Implement your row filter criterion
- Click "OK"

Row Filter criteria

- Select rows **by attribute value** (pattern matching)
- Select rows **by row number**
- Select rows **by RowID** (pattern matching on RowID)

Row filter criteria

By attribute value

All rows, for which the value in a given column matches a given pattern, are filtered out or kept.

After you “select the column to test”, you need to define the matching mode.

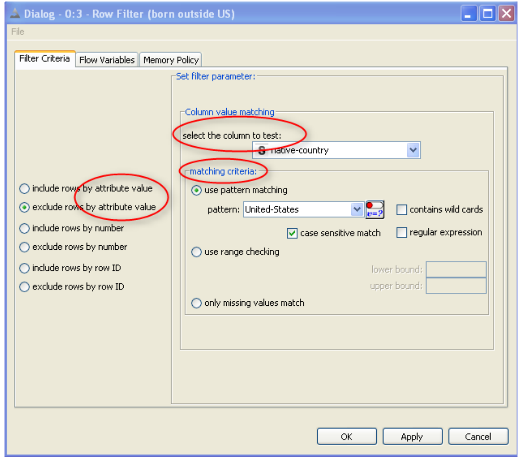
For **String values**, “use pattern matching” requires the given pattern to be either entered manually or selected from a list of pre-defined patterns.

A matching value with wildcards * (for example “United*”) or with a regular expression is also possible.

For **Integer values**, “use range checking” requires a lower boundary and/or an upper boundary, which will be the same value if the condition is equality.

For **Missing values**, choose the last matching option.

2.24. Row filter criterion by attribute value



○ include rows by attribute value
● exclude rows by attribute value
○ include rows by number
○ exclude rows by number
○ include rows by row ID
○ exclude rows by row ID

Set filter parameter:

Column value matching

select the column to test: S native-country

matching criteria:

● use pattern matching

pattern: United-States □ contains wild cards

☑ case sensitive match □ regular expression

○ use range checking

lower bound:
upper bound:

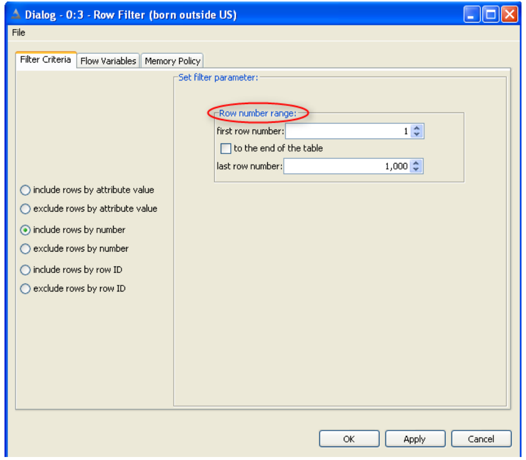
○ only missing values match

By row number

If you know where your desired or undesired rows are, you can just enter the **row number range** to be filtered out.

For example, if I know that the first 10 rows are garbage, I would select the filter criterion “exclude row by number” and set the row number range 1-10.

2.25. Row filter criterion by row number



○ include rows by attribute value
○ exclude rows by attribute value
● include rows by number
○ exclude rows by number
○ include rows by row ID
○ exclude rows by row ID

Set filter parameter:

Row number range:

first row number: 1

□ to the end of the table

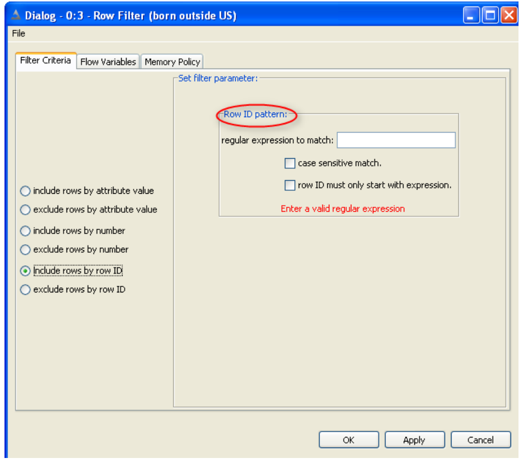
last row number: 1,000

By RowID

A special row filter by attribute value runs on the RowIDs.

Here the matching pattern is given by a regular expression. The regular expression has to match the whole RowID or just its beginning,

2.26. Row filter by RowID



○ include rows by attribute value
○ exclude rows by attribute value
○ include rows by number
○ exclude rows by number
● include rows by row ID
○ exclude rows by row ID

Set filter parameter:

Row ID pattern:

regular expression to match:

□ case sensitive match.

□ row ID must only start with expression.

Enter a valid regular expression

In order to retain all rows with data referring to people born outside of the United States, we need to:

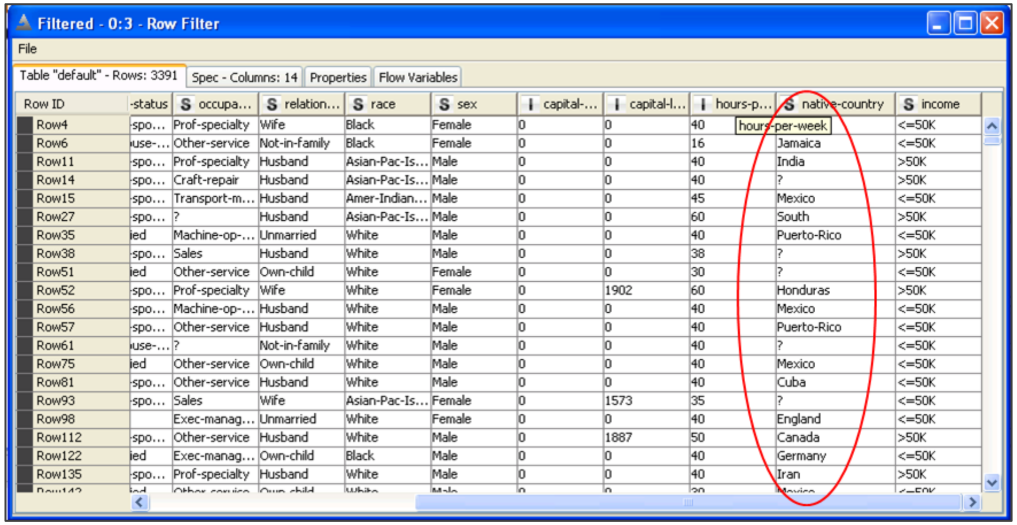
- ➢ Set filter mode “exclude row by attribute value”
- ➢ Set the column to test to “native-country”
- ➢ Enable “use pattern matching”, because it is a string comparison
- ➢ Set pattern “United States”

We have just implemented the following filter criterion: `native-country != “United States”`

- Right click the “Row Filter” node and select “Node name and description”. Give it a meaningful name. We named it “born outside US”. The name of a node is important for documentation purposes. Since KNIME is a graphical tool, it is easy to keep an overview of what a workflow does if the name of each node is a clear indication of its task.

- Right click the node and select “Execute” to run the row filter

2.27. The row filtered table has no pattern "United States" in column "native-country“



Filtered - 0:3 - Row Filter

File

Table "default" - Rows: 3391 | Spec - Columns: 14 | Properties | Flow Variables

Row ID	-status	S occupa…	S relation…	S race	S sex	I capital-…	I capital-l…	I hours-p…	S native-country	S income
Row4	-spo…	Prof-specialty	Wife	Black	Female	0	0	40	hours-per-week	<=50K
Row6	use-…	Other-service	Not-in-family	Black	Female	0	0	16	Jamaica	<=50K
Row11	-spo…	Prof-specialty	Husband	Asian-Pac-Is…	Male	0	0	40	India	>50K
Row14	-spo…	Craft-repair	Husband	Asian-Pac-Is…	Male	0	0	40	?	>50K
Row15	-spo…	Transport-m…	Husband	Amer-Indian…	Male	0	0	45	Mexico	<=50K
Row27	-spo…	?	Husband	Asian-Pac-Is…	Male	0	0	60	South	>50K
Row35	ied	Machine-op-…	Unmarried	White	Male	0	0	40	Puerto-Rico	<=50K
Row38	-spo…	Sales	Husband	White	Male	0	0	38	?	>50K
Row51	ied	Other-service	Own-child	White	Female	0	0	30	?	<=50K
Row52	-spo…	Prof-specialty	Wife	White	Female	0	1902	60	Honduras	>50K
Row56	-spo…	Machine-op-…	Husband	White	Male	0	0	40	Mexico	<=50K
Row57	-spo…	Other-service	Husband	White	Male	0	0	40	Puerto-Rico	<=50K
Row61	use-…	?	Not-in-family	White	Male	0	0	40	?	<=50K
Row75	ied	Other-service	Own-child	White	Male	0	0	40	Mexico	<=50K
Row81	-spo…	Other-service	Husband	White	Male	0	0	40	Cuba	<=50K
Row93	-spo…	Sales	Wife	Asian-Pac-Is…	Female	0	1573	35	?	<=50K
Row98		Exec-manag…	Unmarried	White	Female	0	0	40	England	<=50K
Row112	-spo…	Other-service	Husband	White	Male	0	1887	50	Canada	>50K
Row122	ied	Exec-manag…	Own-child	Black	Male	0	0	40	Germany	<=50K
Row135	-spo…	Prof-specialty	Husband	White	Male	0	0	40	Iran	>50K

To see the final processed data, right click the “born outside US” node and select “Filtered”.

There should be no “United States” in column native-country.

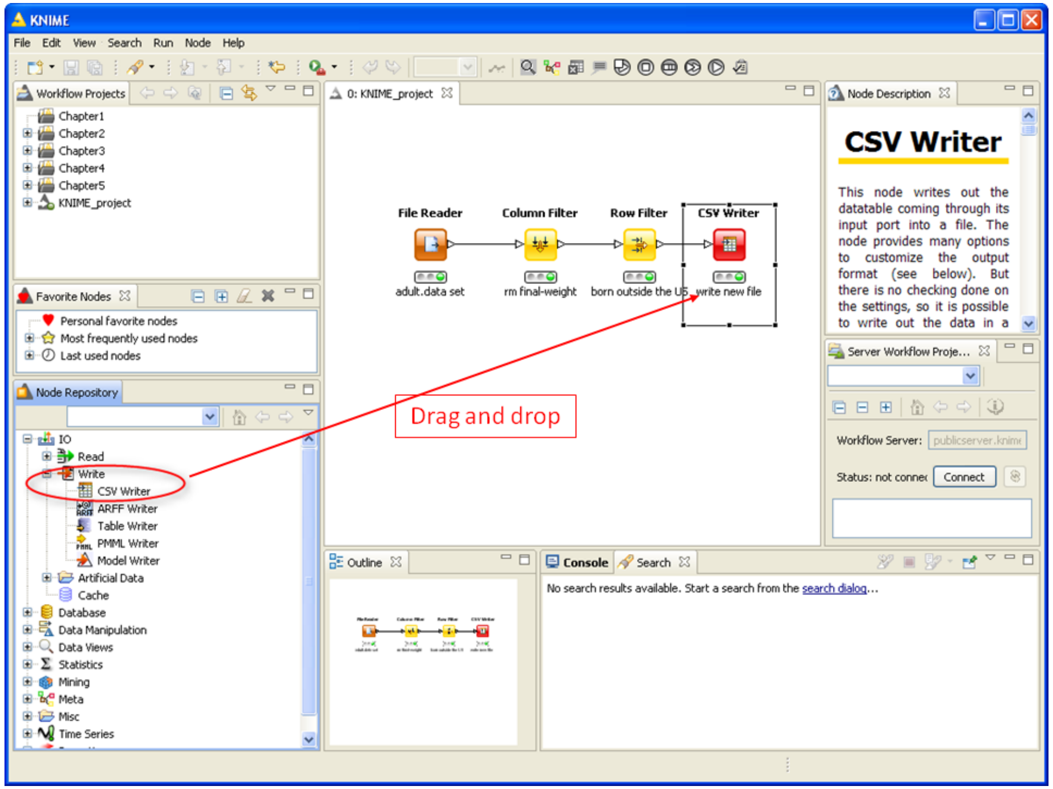
2.7. Write data to a file

Now we want to write our processed data to a file. There are many nodes that can write to a file. Let’s choose the easiest and most standard format: the CSV (Comma Separated Values) format.

Create a “CSV Writer” node

In the “Node Repository” in the bottom left panel:

- Expand “IO” category
- Expand “Write” sub-category
- Drag and drop “CSV Writer” node into the workflow editor
- If the “Node Description” panel on the right is enabled, it fills up with the description of the “CSV Writer” node. To activate the “Node Description” panel, go to the Top Menu, open “View” and select “Node Description”.
- Right click the node and select “Configure” to open its configuration window.

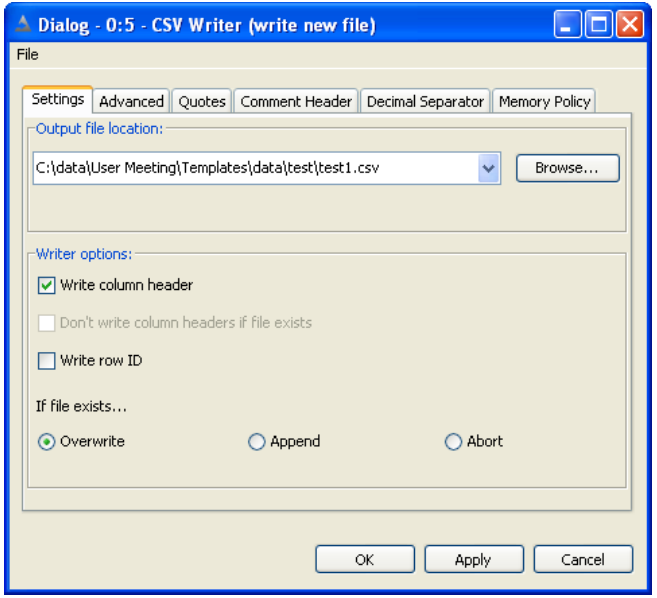

2.28. Create a "CSV Writer" node

This node writes out the datatable coming through its input port into a file. The node provides many options to customize the output format (see below). But there is no checking done on the settings, so it is possible to write out the data in a

No search results available. Start a search from the search dialog...

Configure the "CSV Writer" node

2.29. Configuring a "CSV Writer" node



Dialog - 0:5 - CSV Writer (write new file)

Output file location:

C:\data\User Meeting\Templates\data\test\test1.csv

Writer options:

☑ Write column header

□ Don't write column headers if file exists

□ Write row ID

If file exists...

● Overwrite ○ Append ○ Abort

"Settings" is the most important tab of this configuration window. It requires:

- The path of the output file
- A few options, such as:
  - Write column headers and/or RowID in output file
  - Writing mode if file exists
    - Overwrite
    - Append
    - Abort (does not write to file)

There are a few more tabs in this configuration window:

- **"Advanced"** allows specification of a different separation character other than "," and a new missing value character.
- **"Quotes"** is for setting quote characters other than the default.
- **"Comment header"** is to write a header with comments on top of the data.
- **"Decimal Separator"** is to specify a new decimal separator (default is ".")
- **"Memory Policy"** offers a few strategies to handle memory and data. It comes in useful when the workflow deals with a large amount of data.
- In this book we do not investigate the tab "Flow variables".

Note. Writing in mode "Append" can be tricky, because it just appends the new data to an existing file. It does not check whether the columns existing in the file have the same order as the columns to be written from the input data table. If you change the order of the data columns, for example because of a new or deleted column, the output csv file might not be consistent anymore.

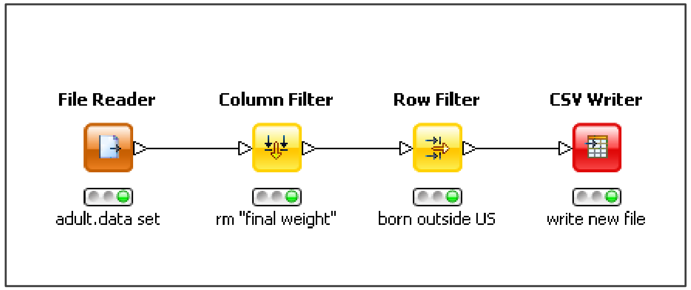
Let's now change the node's name:

- Right click the node and select "Node name and description"
- Enter the node's new name (for example "write new file") and a description of its task
- Click "OK"
- Right click the node and select "Execute"

We have created our first workflow to read data from a file, reorganize rows and columns, and finally write the data to an output file.

This is what the final workflow looks like.

2.30. Workflow "my_first_workflow"



2.8. Exercises

Exercise 1

In a workflow group "Exercises" under the existing workflow group "Chapter2" create an empty workflow "Exercise1".

Workflow "Exercise1" should perform the following operations:

- Read file data1.txt (from the "Download Zone") with column "ranking" as String and name "marks";
- Remove initial comments from data read from file;
- Remove column "class"

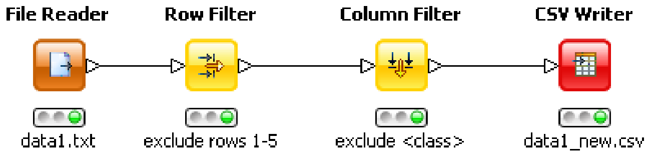
- Write final data to file in CSV format (for example with name "data1_new.csv") using character ";" as separator

Enter a name and a short description for all nodes in the workflow.

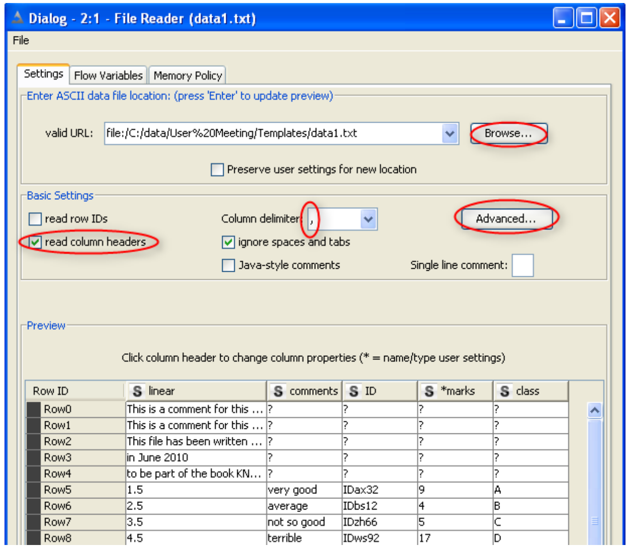
Save and execute workflow Exercise1. Execution must be without errors (green lights for all nodes).

Solution to Exercise 1

2.31. Exercise 1: The workflow



2.32. Exercise1: "File Reader" configuration settings



Enter ASCII data file location: (press 'Enter' to update preview)

valid URL: file:/C:/data/User%20Meeting/Templates/data1.txt

□ Preserve user settings for new location

Basic Settings

□ read row IDs

☑ read column headers

Column delimiter: ,

☑ ignore spaces and tabs

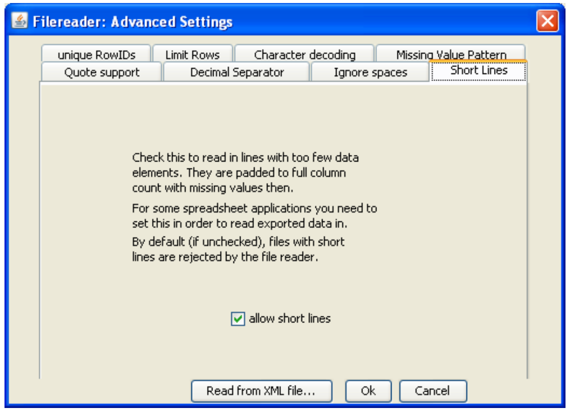
□ Java-style comments

Single line comment:

Click column header to change column properties (* = name/type user settings)

Row ID	S linear	S comments	S ID	S *marks	S class
Row0	This is a comment for this ...	?	?	?	?
Row1	This is a comment for this ...	?	?	?	?
Row2	This file has been written ...	?	?	?	?
Row3	in June 2010	?	?	?	?
Row4	to be part of the book KN...	?	?	?	?
Row5	1.5	very good	IDax32	9	A
Row6	2.5	average	IDbs12	4	B
Row7	3.5	not so good	IDzh66	5	C
Row8	4.5	terrible	IDws92	17	D

2.33. Exercise 1: "File Reader" "Short Lines" tab configuration



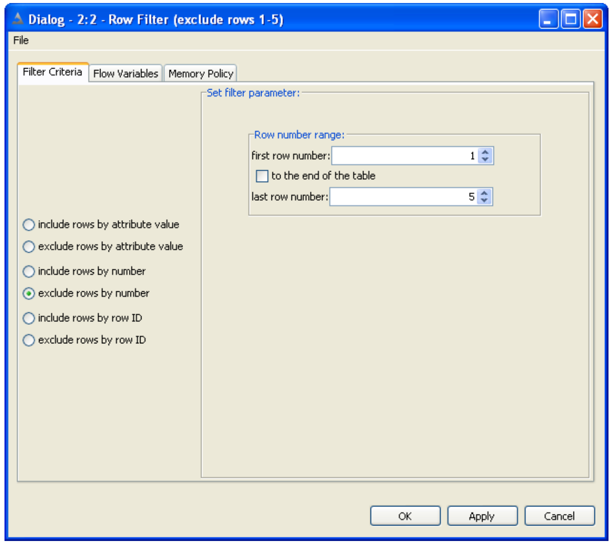
Check this to read in lines with too few data elements. They are padded to full column count with missing values then.

For some spreadsheet applications you need to set this in order to read exported data in.

By default (if unchecked), files with short lines are rejected by the file reader.

☑ allow short lines

2.34. Exercise 1: “Row Filter” configuration options



Set filter parameter:

Row number range:

first row number: 1

☐ to the end of the table

last row number: 5

○ include rows by attribute value

○ exclude rows by attribute value

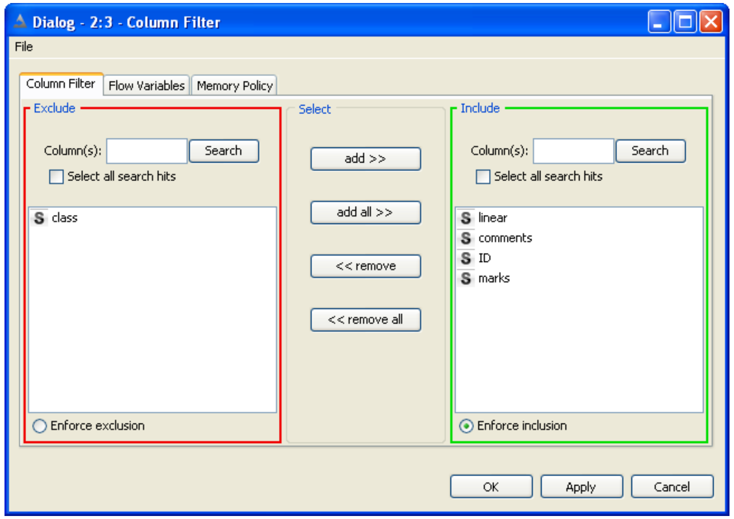
○ include rows by number

● exclude rows by number

○ include rows by row ID

○ exclude rows by row ID

2.36. Exercise 1: “Column Filter” configuration options



Exclude

Column(s):

☐ Select all search hits

S class

○ Enforce exclusion

Select

Include

Column(s):

☐ Select all search hits

S linear

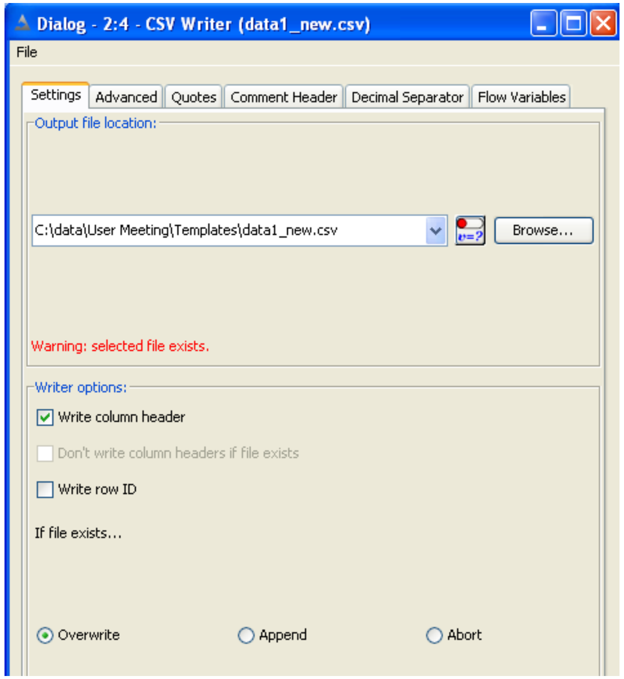
S comments

S ID

S marks

● Enforce inclusion

2.35. Exercise 1: “CSV Writer” configuration settings



Output file location:

C:\data\User Meeting\Templates\data1_new.csv

Warning: selected file exists.

Writer options:

☑ Write column header

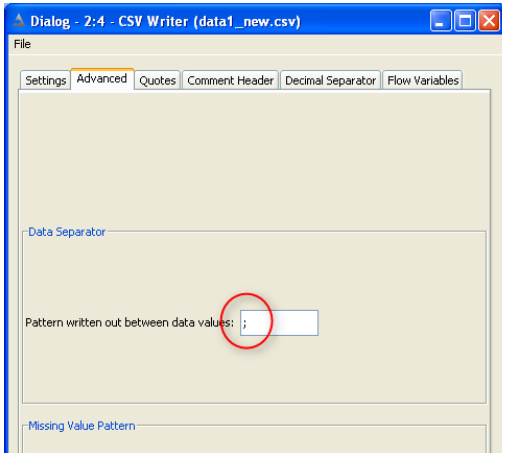
☐ Don't write column headers if file exists

☐ Write row ID

If file exists...

● Overwrite ○ Append ○ Abort

2.37. Exercise 1: “CSV Writer” “Advanced” tab configuration



Data Separator

Pattern written out between data values: ;

Missing Value Pattern

Exercise 2

In the workflow group “Chapter2\Exercises” create a workflow “Exercise2” to perform the following operations:

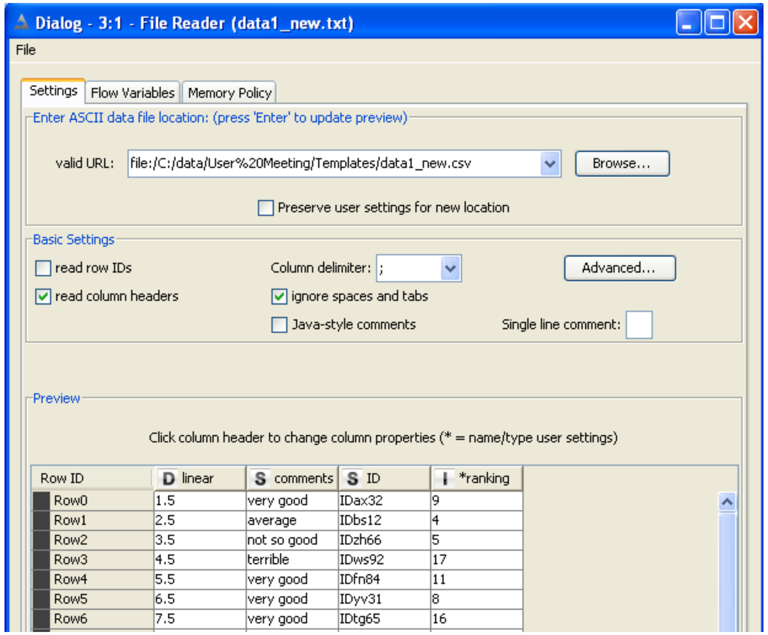
- Read the CSV file written in Exercise1 (data1_new.csv) and rename column “marks” to “ranking”
- Filter out rows with comments = “average”
- Exclude column “ranking”
- Write final data to file in “Append” mode and with a tab as a separating character

Rename all nodes where necessary. Save and execute workflow “Exercise2”.

Solution to Exercise 2

We recycled the workflow structure from the workflow created in Exercise 1. That is we do a “Copy and Paste” operation (Ctrl-C, Ctrl-V) on the whole Exercise 1 workflow from the workflow editor for Exercise 1 into the workflow editor for Exercise 2.

2.38. Exercise 2: “File Reader” configuration options



Enter ASCII data file location: (press 'Enter' to update preview)

valid URL: file:/C:/data/User%20Meeting/Templates/data1_new.csv

□ Preserve user settings for new location

Basic Settings

□ read row IDs

☑ read column headers

Column delimiter: ;

☑ ignore spaces and tabs

□ Java-style comments

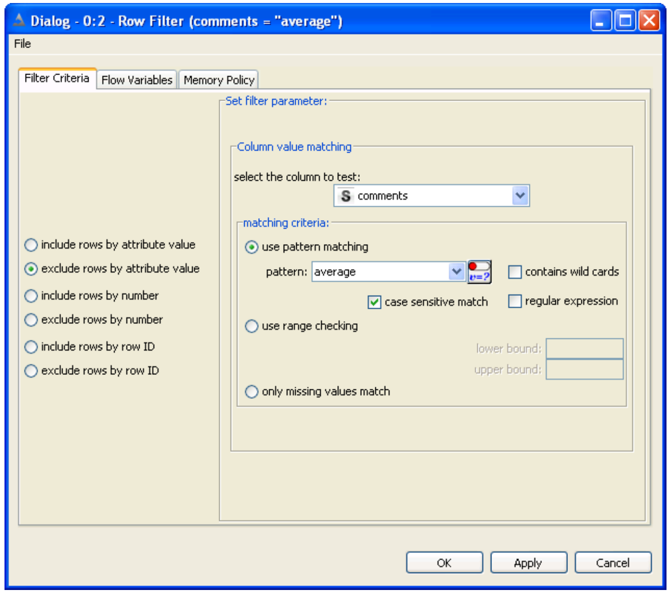
Single line comment:

Preview

Click column header to change column properties (* = name/type user settings)

Row ID	D linear	S comments	S ID	I *ranking
Row0	1.5	very good	IDax32	9
Row1	2.5	average	IDbs12	4
Row2	3.5	not so good	IDzh66	5
Row3	4.5	terrible	IDws92	17
Row4	5.5	very good	IDfn84	11
Row5	6.5	very good	IDyv31	8
Row6	7.5	very good	IDtg65	16

2.39. Exercise 2: “Row Filter” configuration options



○ include rows by attribute value

● exclude rows by attribute value

○ include rows by number

○ exclude rows by number

○ include rows by row ID

○ exclude rows by row ID

Set filter parameter:

Column value matching

select the column to test: S comments

matching criteria:

● use pattern matching

pattern: average

□ contains wild cards

☑ case sensitive match

□ regular expression

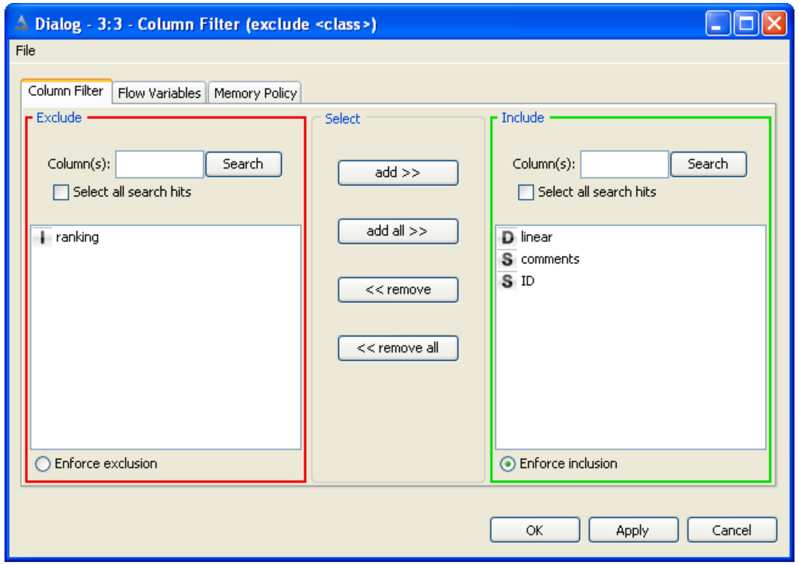
○ use range checking

lower bound:

upper bound:

○ only missing values match

2.40. Exercise 2: "Column Filter" configuration options



Dialog - 3:3 - Column Filter (exclude <class>)

File

Exclude

Column(s): Search

□ Select all search hits

ranking

○ Enforce exclusion

Select

Include

Column(s): Search

□ Select all search hits

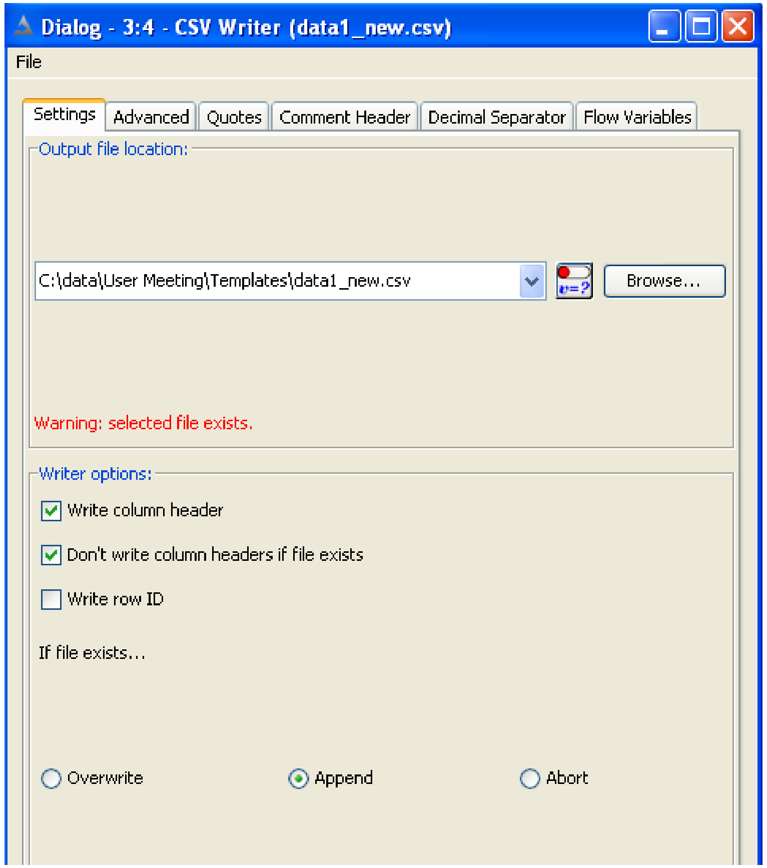
D linear

S comments

S ID

● Enforce inclusion

2.41. Exercise 2: "CSV Writer" configuration options



Dialog - 3:4 - CSV Writer (data1_new.csv)

File

Output file location:

C:\data\User Meeting\Templates\data1_new.csv

Warning: selected file exists.

Writer options:

☑ Write column header

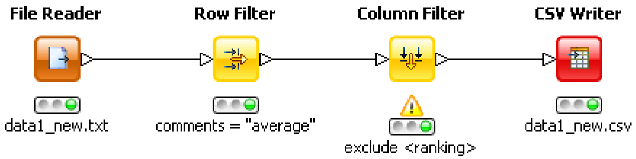
☑ Don't write column headers if file exists

□ Write row ID

If file exists...

○ Overwrite ● Append ○ Abort

2.42. Exercise 2: The workflow



Note. You can disable the option “**allow short lines**” in the “Advanced Settings” window, because now all the rows of the input file have the same length. There are no comments anymore.

Note. Notice the **yellow triangle** under the Column Filter. This is a warning message that comes from the copy of the workflow and that remains even when the node has the green light. Hovering over the yellow triangle shows the warning message *“Some columns are not available: marks”.* This is correct. We renamed column “marks” to “ranking”. However, the column filter still works; only a warning message is issued. We now have a new column called “ranking”. If we open the configuration window of the column filter, we see that the column “ranking” was automatically inserted into the “Exclude” set. This is because the option “Enforce Inclusion” is enabled. Clicking the “OK” button accepts the current configuration settings and makes the yellow triangle disappear.

Note. We saved the data in **“Append” mode** into the csv file. The data from Exercise2 has only 3 columns, while the existing data in the file has 4 columns. The “CSV Writer” node does not check the consistency of the number and the position of the columns to be written with the number and the positions of the existing columns. It is possible to write inconsistent data to a file. You need to be careful when working in “Append” mode in combination with a “CSV Writer” node.