ADAMS

Advanced **D**ata mining **A**nd **M**achine learning **S**ystem

Module: adams-imaging

Peter Reutemann

December 24, 2014

Contents

List of Figures

Chapter 1

ADAMS

ADAMS has custom image processing support that does not rely on other libraries.

The following actors are available:

- `sink.ImageWriter` – writes an image container to a file using the specified writer.
- `transformer.BufferedImageTransformer` – performs a transformation using an existing transformer class on the incoming image and outputs another image again.
- `transformer.BufferedImageFeatureGenerator` – turns a `BufferedImageContainer` into an `weka.core.Instance` object to be used in WEKA. The attaced meta-data in form of a report can be added to the output object as well.
- `transformer.ImageReader` – reads an image file using the specified image reader.

Figure 1.1 shows a flow[1] for reading images, blurring them using a gaussian blur transformer and displaying them side-by-side. Figures 1.2 and 1.3 show original and blurred image.

[1] adams-imaging-gaussian_blur.flow

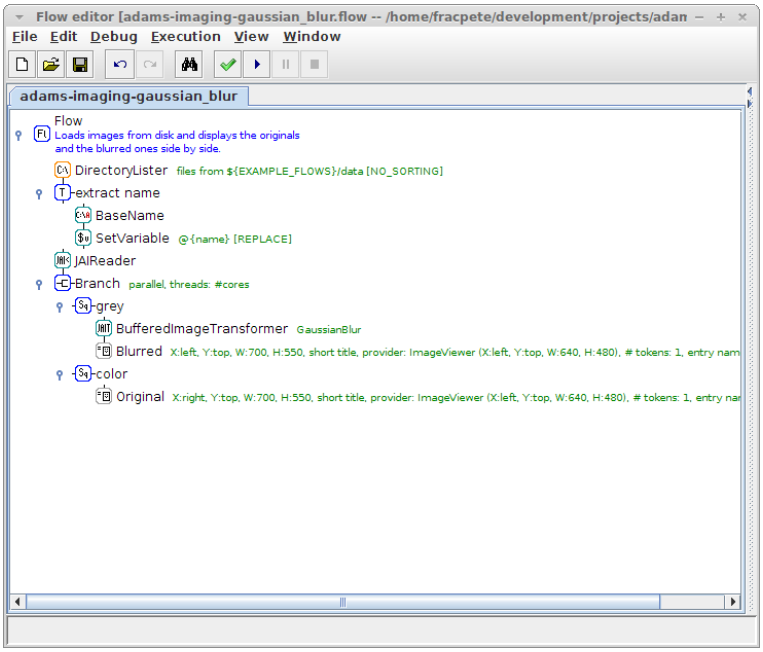


Figure 1.1: Flow for blurring images stored in a directory.

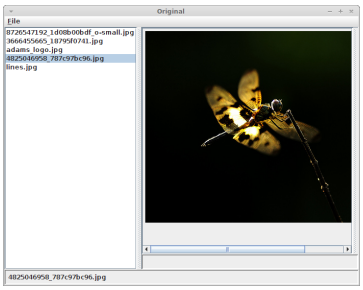


Figure 1.2: The original image.

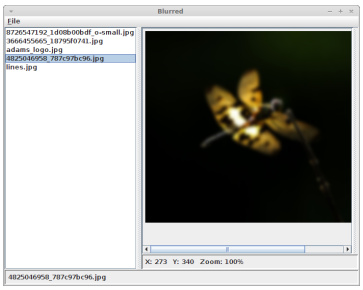


Figure 1.3: The blurred image.

Chapter 2

Java Advanced Imaging

Java Advanced Imaging (JAI) is an API to provide a simple, high-level programming model which allows developers to create their own image manipulation routines[1].

Reading and writing images are done using the *ImageReader* transformer and *ImageWriter* sink:

- `ImageReader` – use the *JAIImageReader*
- `ImageWriter` – use the *JAIImageWriter*

Since the JAI actors, readers and writers use `BufferedImageContainer`, the `BufferedImageTransformer` and `BufferedImageFeatureGenerator` transformers can be used.

[1] `http://en.wikipedia.org/wiki/Java_Advanced_Imaging`

Chapter 3

ImageJ

ImageJ is a public domain software suite written in Java (using AWT, opposed to Swing which ADAMS uses) for image processing, developed at National Institutes of Health ([3]).

3.1 Flow

There are four ImageJ actors available:

- `transformer.ImageJReader` – for reading any image file that JAI supports[1] and forwarding an `ImagePlusContainer` object.
- `transformer.ImageJTransformer` – performs a transformation using an existing ImageJ transformer class on the incoming image and outputs another image again. ImageJ plugin filters, commands and pre-recorded macros can be used to perform transformations.
- `transformer.ImageJFeatureGenerator` – turns an `ImagePlusContainer` into an `weka.core.Instance` object to be used in WEKA. The attaced meta-data in form of a report can be added to the output object as well.
- `transformer.ImageJReleaseAllImages` – removes all images currently listed in ImageJ's batch mode list, freeing up memory.
- `sink.ImageJReleaseImage` – removes the incoming image from ImageJ's batch mode list of images, freeing up memory.
- `sink.ImageJWriter` – for writing an `ImagePlusContainer` to a file format that ImageJ supports. If the image type cannot be determined based on the extension, you can also specify which type to generate.

Figure 3.1 shows a flow[2] for reading images, turning them into greyscale using a transformer and displaying them side-by-side. Figures 3.2 and 3.3 show original and greyscale image.

[1] `http://imagejdocu.tudor.lu/doku.php?id=faq:general:which_file_formats_are_supported_by_imagej`

[2] adams-imaging-transform_to_greyscale.flow

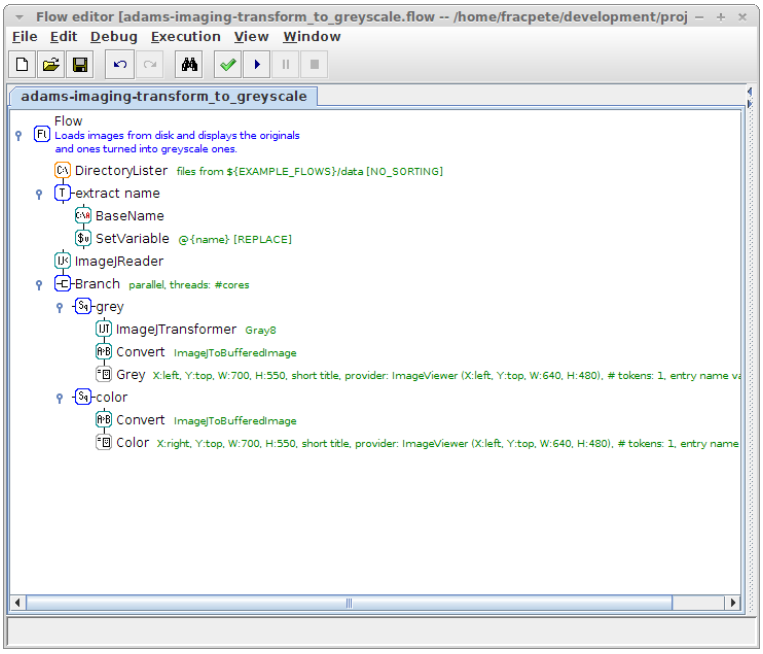


Figure 3.1: ImageJ flow for turning images stored in a directory into greyscale ones.

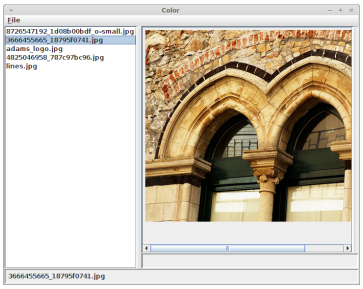


Figure 3.2: The original image.

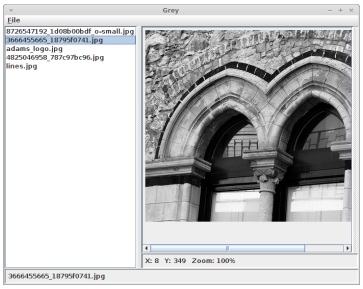


Figure 3.3: The greyscale image.

3.2 Plugins

By default, ADAMS includes plugins located in the following directory on Linux/Unix/Mac:

```
$HOME/.adams/imagej/plugins
```

and on Windows here:

```
%USERPROFILE%/_adams/imagej/plugins
```

You can override this directory by using the `ADAMS_IMAGEJ_DIR` environment variable, which defines the directory one level above the *plugins* directory. For instance, if your plugins directory is located at:

```
/home/user/imagej/plugins
```

You have to define the `ADAMS_IMAGEJ_DIR` environment variable as follows:

```
ADAMS_IMAGEJ_DIR=/home/user/imagej
```

Chapter 4

ImageMagick

ImageMagick® is a software suite to create, edit, compose, or convert bitmap images ([4]). On Windows, in order to process images with ImageMagick, you need to set the `IM_TOOLPATH` environment variable, pointing to the installation. Similar, for dcraw, you need to defined the `DCRAW_TOOLPATH` variable and, for ufraw, the `UFRAW_TOOLPATH` one.

There are three ImageMagick actors available:

- `transformer.ImageMagickOperation` – performs the ImageMagick (convert, dcraw, ufraw) operations that the user selected from the class hierarchy.
- `transformer.ImageMagickTransformer` – performs any ImageMagick command on the incoming image that the `convert` tool[1] supports and outputs another image again.

Reading and writing images are done using the *ImageReader* transformer and *ImageWriter* sink:

- `ImageReader` – use the *ImageMagickImageReader* or *UIfrawImageReader*
- `ImageWriter` – use the *ImageMagickImageWriter*

There is no separate transformer for generating a WEKA instance, since the ImageMagick actors process and output `BufferedImageContainer` objects as well, just like the JAI actors. You can use the `BufferedImageFeatureGenerator` for generating WEKA output.

The example flow[2] in Figure 4.1 loads a single photo from disk and then uses ImageMagick to resize it to 90 by 90 pixels and scaling it by 200% (see 4.2). Finally, the modified image is displayed in the image viewer.

[1] `http://www.imagemagick.org/script/convert.php`

[2] adams-imaging-imagemagick_script.flow

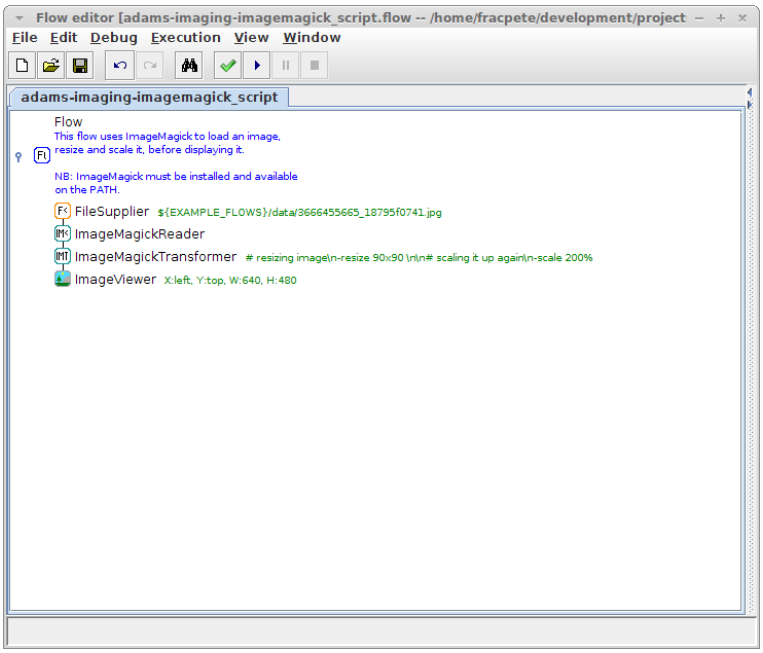


Figure 4.1: ImageMagick flow for processing (resizing) a single image.

```
# resizing image
-resize 90x90
# scaling it up again
-scale 200%
```

Figure 4.2: ImageMagick commands to resizing.

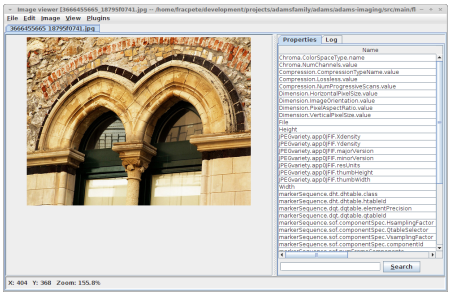


Figure 4.3: The original image.

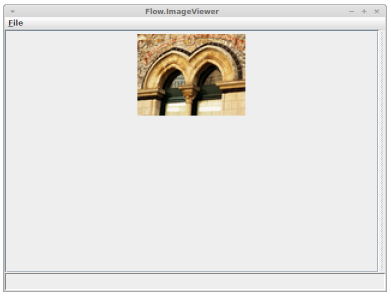


Figure 4.4: The resized image.

Chapter 5

BoofCV

BoofCV is an API for real-time computer vision and robotics applications[1].

There are two BoofCV actors available:

- `transformer.BoofCVTransformer` – performs a transformation using an existing BoofCV transformer class on the incoming image and outputs another image again.
- `transformer.BoofCVDetectLines` – detects lines in images using a Hough line detector based on polar parametrization.
- `transformer.BoofCVFeatureGenerator` – turns a `BoofCVImageContainer` into an `weka.core.Instance` object to be used in WEKA. The attaced meta-data in form of a report can be added to the output object as well.

[1] `http://boofcv.org/`

Chapter 6

LIRE

The Lucene Image Retrieval library [6] provides a wide range of feature generators that work on *BufferedImageContainer* objects.

Chapter 7

Object conversion

JAI and ImageMagick actors generate and accept a different type of token, *BufferedImageContainer* namely, which cannot be processed by ImageJ actors. Vice versa, the tokens generated by ImageJ actors, of type *ImagePlusContainer*, are not accepted by JAI/ImagMagick actors. In order to exchange data between the two domains, the *Convert* transformer can once again be used.

The following conversions are available to convert from one format into another:

- *BoofCVImageToBufferedImage* – for BoofCV to JAI/ImageMagick conversion.
- *BufferedImageToBoofCV* – for JAI/ImageMagick to BoofCV conversion.
- *BufferedImageToImageJ* – for JAI/ImageMagick to ImageJ conversion.
- *ColorToHex* – turns a Color object into its hexa-decimal notation.
- *ImageJToBufferedImage* – converting from ImageJ to JAI/ImageMagick.
- *HexToColor* – turns a color in hexa-decimal notation back into a Color object.

Chapter 8

OCR

A common task in image processing is *optical character recognition* (OCR). ADAMS offers a simple wrapper around the open-source *tesseract* engine [9]. The engine is available for Windows, Linux and Mac OSX. It supports multiple languages, however, these need to be installed in order to be actually available.

The follwoing actors are available:

- *TesseractConfiguration* – standalone for configuring OCR, mainly to define where the tesseract executable is located.
- *TesseractOCR* – this transformer turns an image file into one or more text files, which need to be further processed in the flow then.[1]

By default, the *TesseractConfiguration* standalone uses the globally defined preferences as default values. In the preferences dialog (*Main menu* → *Program* → *Preferences* → *Tesseract*) you can specify the location of the tesseract executable and the default language (see Figure 8.1).

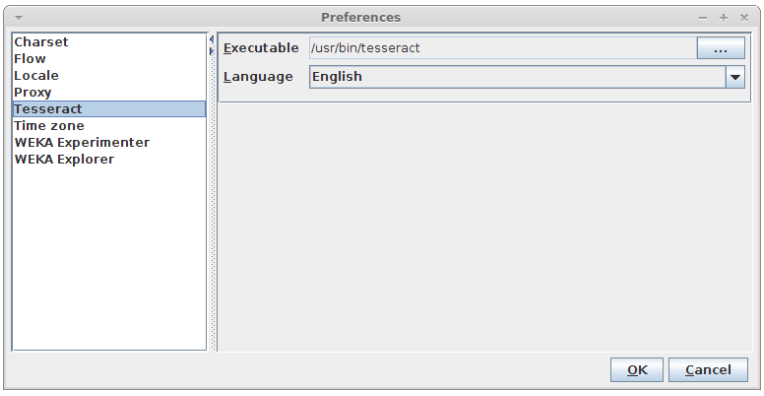


Figure 8.1: Preferences for tesseract.

[1] adams-imaging-ocr.flow

Chapter 9

Interaction

The *PixelSelector* transformer allows the user to interact with the flow. The interaction with the user works as follows: an image viewer instance is displayed when the *PixelSelector* transformer receives an image token as input. The use then right-clicks on a pixel that he wants to process, e.g., labelling for WEKA data generation. After all the pixels have been selected and processed, the user then hits the *OK* button to close the dialog. The *PixelSelector* then forwards the image container with the attached, enriched report for further processing.

The *PixelSelector* transformer is very generic, which means the actor is responsible for the actions that the user can select from the right-click menu. This is done by selecting the appropriate actions from the list of available ones, e.g., *AddClassification* (package `adams.flow.transformer.pixelselector`), which is used for attaching classification labels to pixels. In order to make these selections visible not just in the report that is displayed on the right-hand side in the dialog, appropriate overlays can be selected as well, e.g., the *ClassificationOverlay* (package `adams.flow.transformer.pixelselector`) overlay, which displays the pixels with the associated labels on the screen.

Figure 9.1 shows a flow[1] that lets the user hand-label all JPG images in a directory and generated WEKA data from it. It uses a cropped region of 5x5 pixels around the selected pixels for the data generation. The user interface for selecting the pixels is shown in Figure 9.2 and a resulting dataset in Figure 9.3.

Of course, due to the interactive nature, labelling is performed on-the-fly and no record is kept. Once the image has been processed, the *PixelSelector* will forget about it. If you want to preserve the attached report, you can use the *ReportFileWriter* transformer to save the report to disk.

In order to re-use a previously saved report, you can use the *SetReportFromFile* or *SetReportFromSource* transformer to replace the default report in the image container after you loaded the image with the one stored on disk. This allows you to continue work with previously generated labels, saving you a lot of work.

Since the *SetReportFromFile* and *SetReportFromSource* transformers generate *ReportHandler* tokens, you need to explicitly cast the type of the tokens to the desired one, e.g., *BufferedImageContainer*, using the *Cast* control actor.

[1] adams-imaging-pixelselector.flow

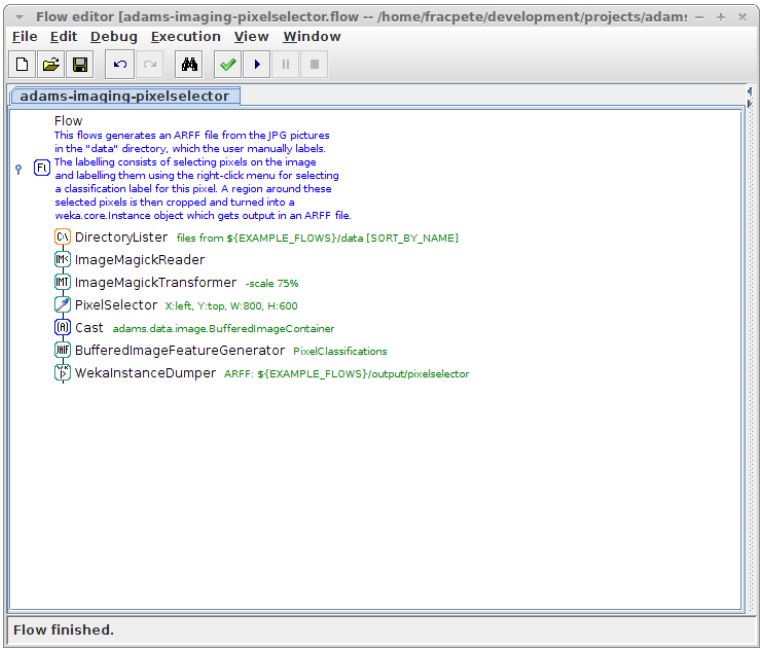


Figure 9.1: Flow for generating ARFF file from user-labelled pixels.

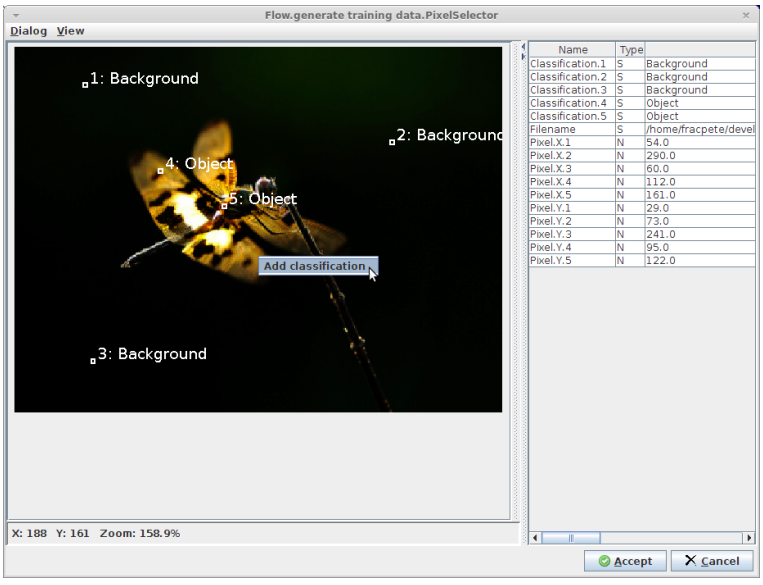


Figure 9.2: User interface for labelling pixels, displaying some pixels labelled already.

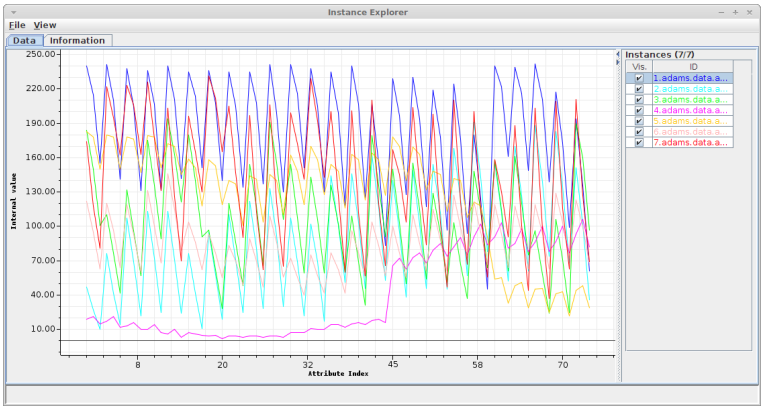


Figure 9.3: Example dataset generated using the PixelSelector.

Chapter 10

Feature output

Of course, the data can be turned into a format that is suitable for machine learning applications like WEKA ([10]). For JAI and ImageMagick transformers, both generating *BufferedImageContainer* tokens, the *BufferedImageFeatureGenerator* can be used to generate such output. For ImageJ generated tokens, outputting *ImagePlusContainer* tokens, you have to use the *ImageJFeatureGenerator* instead. What kind of output is generated, depends on the *feature converter* defined in those feature generator transformers. By default, spreadsheet data is generated, which can be stored in CSV files. Figure 10.1 shows a flow[1] that generates a CSV file from images using ImageJ. The resulting dataset, as displayed in the spreadsheet viewer, is shown in Figure 10.2.

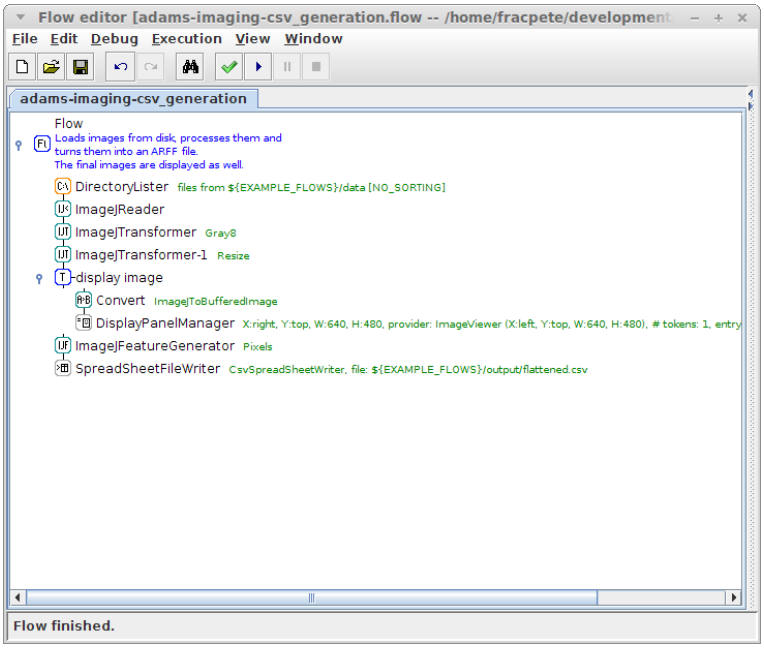
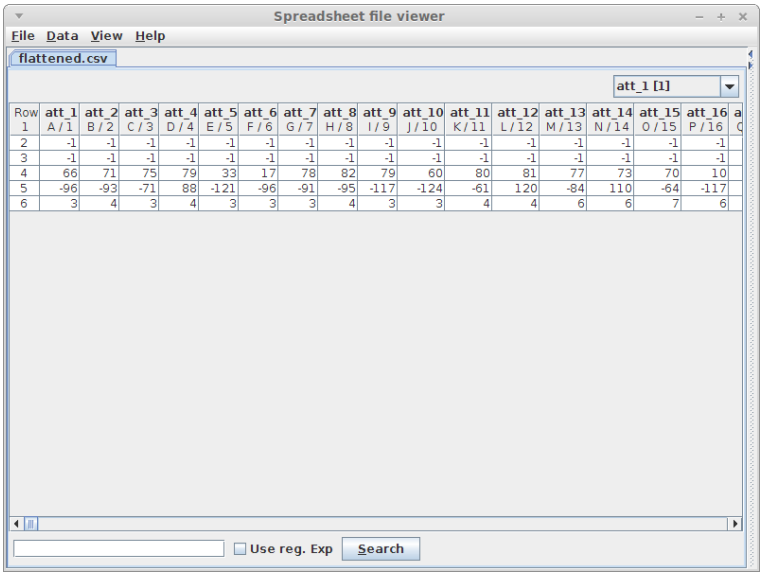


Figure 10.1: Generating a CSV file using ImageJ.

[1] adams-imaging-csv_generation.flow



Row 1	att_1 A / 1	att_2 B / 2	att_3 C / 3	att_4 D / 4	att_5 E / 5	att_6 F / 6	att_7 G / 7	att_8 H / 8	att_9 I / 9	att_10 J / 10	att_11 K / 11	att_12 L / 12	att_13 M / 13	att_14 N / 14	att_15 O / 15	att_16 P / 16	a
2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
4	66	71	75	79	33	17	78	82	79	60	80	81	77	73	70	10	
5	-96	-93	-71	88	-121	-96	-91	-95	-117	-124	-61	120	-84	110	-64	-117	
6	3	4	3	4	3	3	3	4	3	3	4	4	6	6	7	6	

Figure 10.2: The ImageJ generated CSV file.

Chapter 11

Miscellaneous actors

The imaging module offers some more actors that have not been introduced yet. Available sources:

- *ColorProvider* – outputs Color objects generated by a configured color provider.
- `NewImage` – creates an image with a specific color and user-defined dimensions.

Available transformers:

- *Draw* – Performs draw operations on images, like setting pixels, drawing lines, rectangles, ovals, text, images[1].
- *ImageInfo* – Allows you to obtain *width* and *height* information from an image.
- *ImageMetaData* – Extracts meta-data (EXIF or IPTC) from an image as spreadsheet using various libraries (e.g., Sanselan[8], Meta-Data Extractor[7]).[2]
- *LocateObjects* – provides a framework for algorithms that locate objects in images.

Available sinks:

- *FFmpeg* – actor for processing videos using ffmpeg[5][3].

[1] adams-imaging-draw.flow
[2] adams-imaging-meta_data.flow
[3] adams-imaging-ffmpeg.flow

Bibliography

[1] *ADAMS* – Advanced Data mining and Machine learning System
`https://adams.cms.waikato.ac.nz/`

[2] *JAI* – Java Advanced Imaging API
`http://java.sun.com/javase/technologies/desktop/media/jai/`

[3] *ImageJ* – Image Processing and Analysis in Java
`http://rsbweb.nih.gov/ij/`

[4] *ImageMagick* – Software suite to Convert, Edit, and Compose Images
`http://www.imagemagick.org/`

[5] *FFmpeg* – a complete, cross-platform solution to record, convert and stream audio and video
`http://ffmpeg.org/`

[6] *LIRE* – Lucene Image Retrieval
`http://code.google.com/p/lire/`

[7] *MetaData-Exrtactor* – Library for reading metadata from image files.
`https://code.google.com/p/metadata-extractor/`

[8] *Sanselan* – Apache Imaging (formerly known as Sanselan)
`http://commons.apache.org/proper/commons-imaging/`

[9] *tesseract* – An OCR Engine that was developed at HP Labs between 1985 and 1995... and now at Google.
`http://code.google.com/p/tesseract-ocr/`

[10] Mark Hall, Eibe Frank, Geoffrey Holmes, Bernhard Pfahringer, Peter Reutemann, Ian H. Witten (2009); *The WEKA Data Mining Software: An Update*; SIGKDD Explorations, Volume 11, Issue 1.
`http://www.cs.waikato.ac.nz/ml/weka/`