Matchbox tool

Quality control for digital collections

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Overview

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Introduction

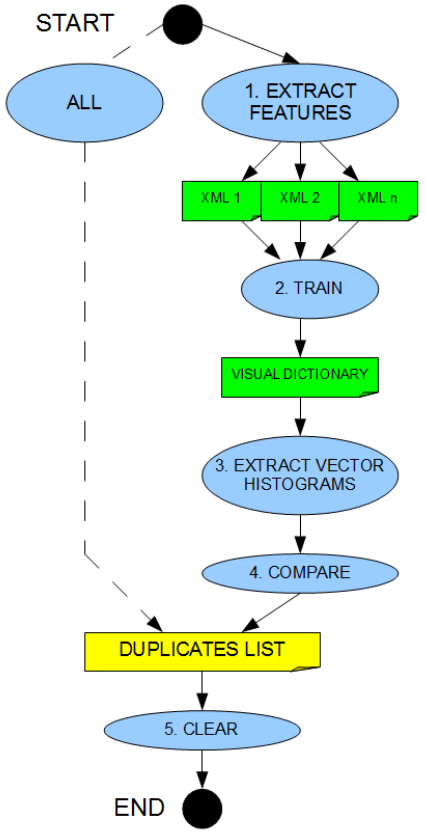
- High storage costs
- Update of digitized collection through an automatic scanning process
- Use case: Find Duplicates
- No automatic method to detect duplicates in not structured collections
- Lack expertise and efficient methods for finding images in a huge collection
- Need for automated solutions
- QA is required to select between the old and new
- Decision support - overwrite or human inspection
- Image: d = 40.000 SIFT descriptors, book: n = 700 images
- SIFT: $d^2 = 1.6 \times 10^9$ vector comparisons for a single pair of images
- BoW typical book: clustering, $n \times (n - 1) = 350.000$ vector comparisons

Matchbox Tool Description

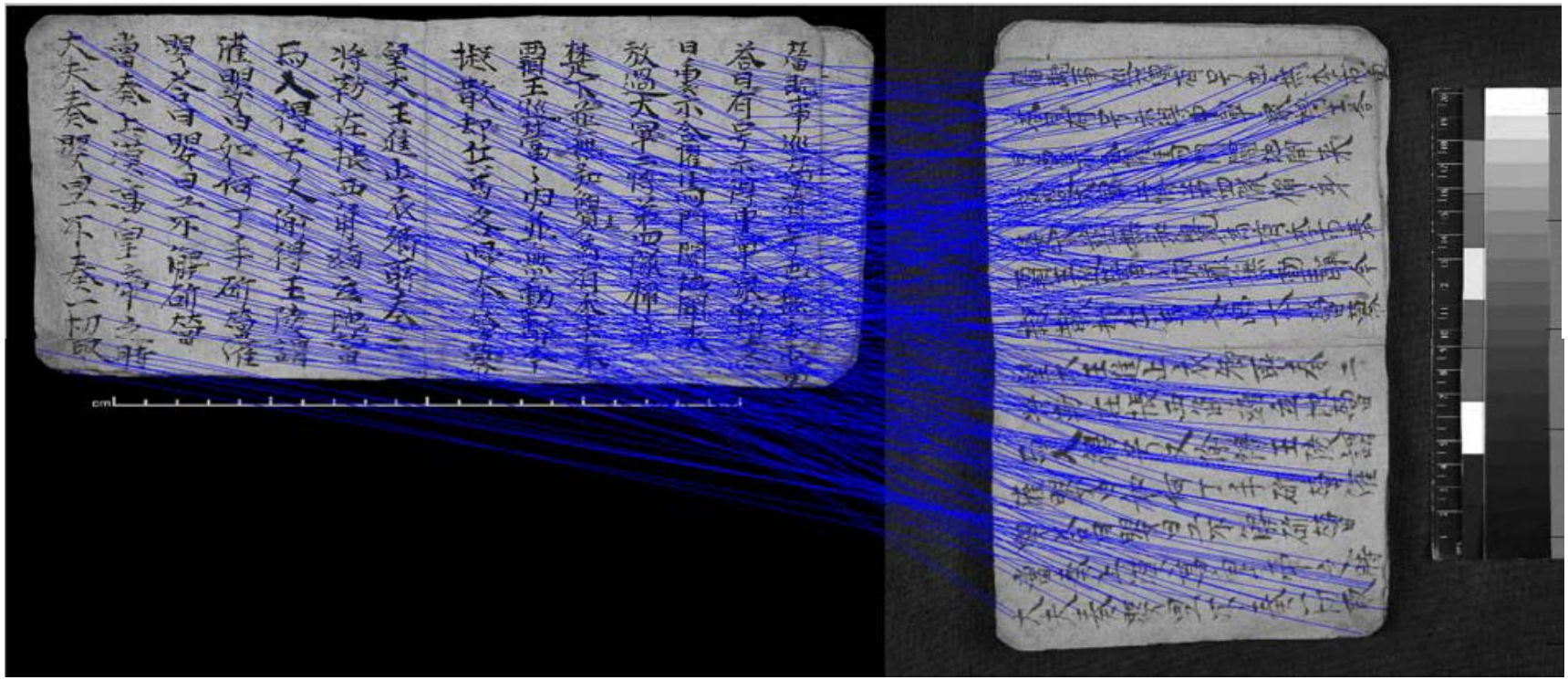
- Tool
  - C++ (DLLs on Windows or shared objects on Linux)
- Dataset
  - Austrian National Library - Digital Book Collection (about 600.000 books that will be digitized over the coming years)
- Main tasks
  - Overwriting existing collection items with new items
  - Image pairs can be compared within a book
- Output
  - Visual dictionary for further analysis
  - Duplicates

Image Processing

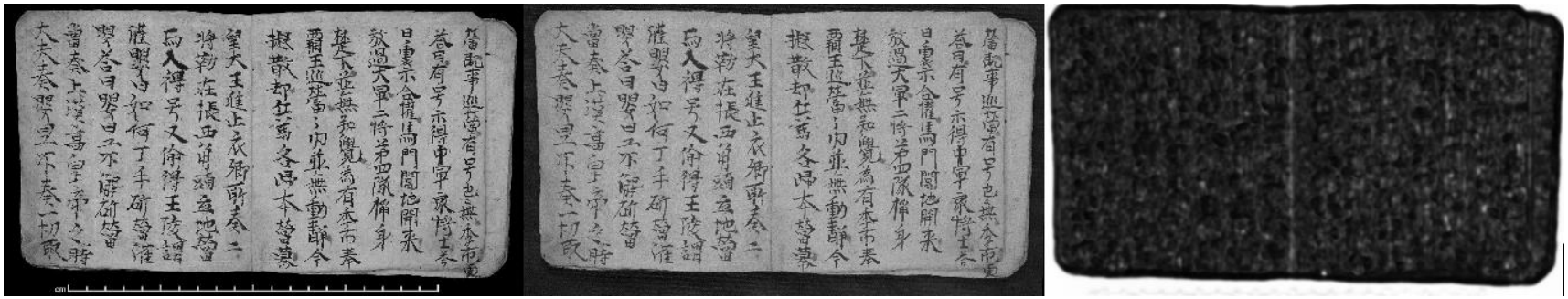
1. Document feature extraction
   - Interest keypoints - Scale Invariant Feature Transform (SIFT)
   - Local feature descriptors (invariant to geometrical distortions)
2. Learning visual dictionary
   - Clustering method applied to all SIFT descriptors of all images using k-means algorithm
   - Collect local descriptors in a visual dictionary using Bag-Of-Words (BoW) algorithm
3. Create visual histogram for each image document
4. Detect similar images based on visual histogram and local descriptors. Structural SIMilarity (SSIM) approach
   - Rotate
   - Scale
   - Mask
   - Overlaying



Matching of keypoints

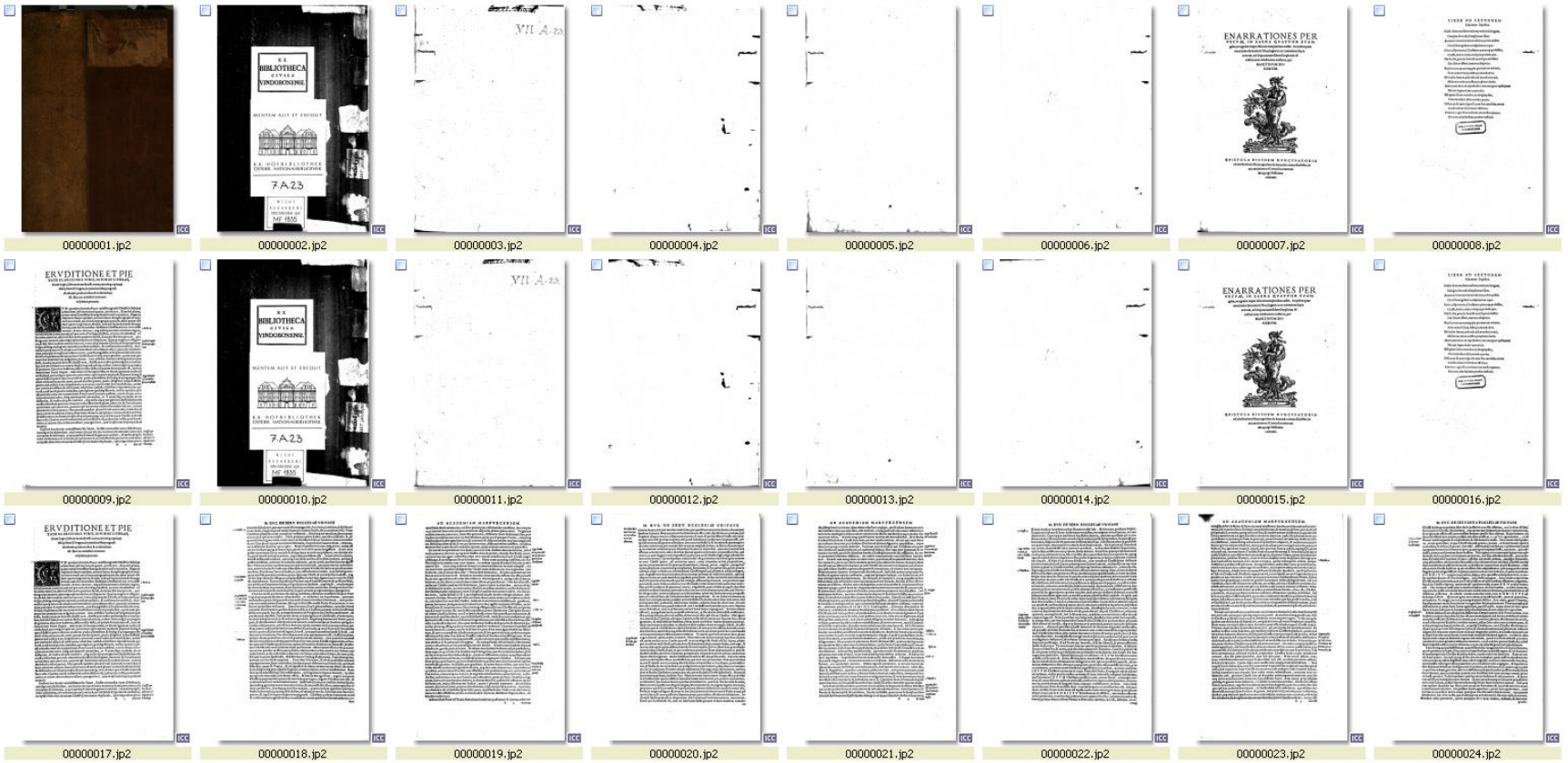


Pixel wise comparison - SSIM



SCAPE

Images 10 to 17 are duplicates of images 2 to 9



High similarity but no duplicates


00000108.jp2


00000109.jp2


00000110.jp2


00000111.jp2


00000118.jp2


00000119.jp2


00000120.jp2


00000121.jp2

Matchbox Tool Features

- Reduce costs
- Improves quality
- Saves time
- Automatically
- Increase efficiency of human work with particular focus
- Invariant to format, rotation, scale, translation, illumination, resolution, cropping, warping, distortions
- Application: assembling collections, missing files, duplicates, compare two images independent from format (profile, pixel)

Training Description

- **Goal:** to be able to detect duplicates in digital image collections
- **Outcomes of training:** learn how to install the matchbox and how to set up associated workflows.
- **Teacher activity:**
  - Tool presentation
  - Carry out a number of duplicate detection experiments
- **Attendee activity:** complete some workflows for
  - Image duplicate search
  - Content-based image comparison
  - Customize duplicate search workflow
  - Understand and describe outputs of different commands

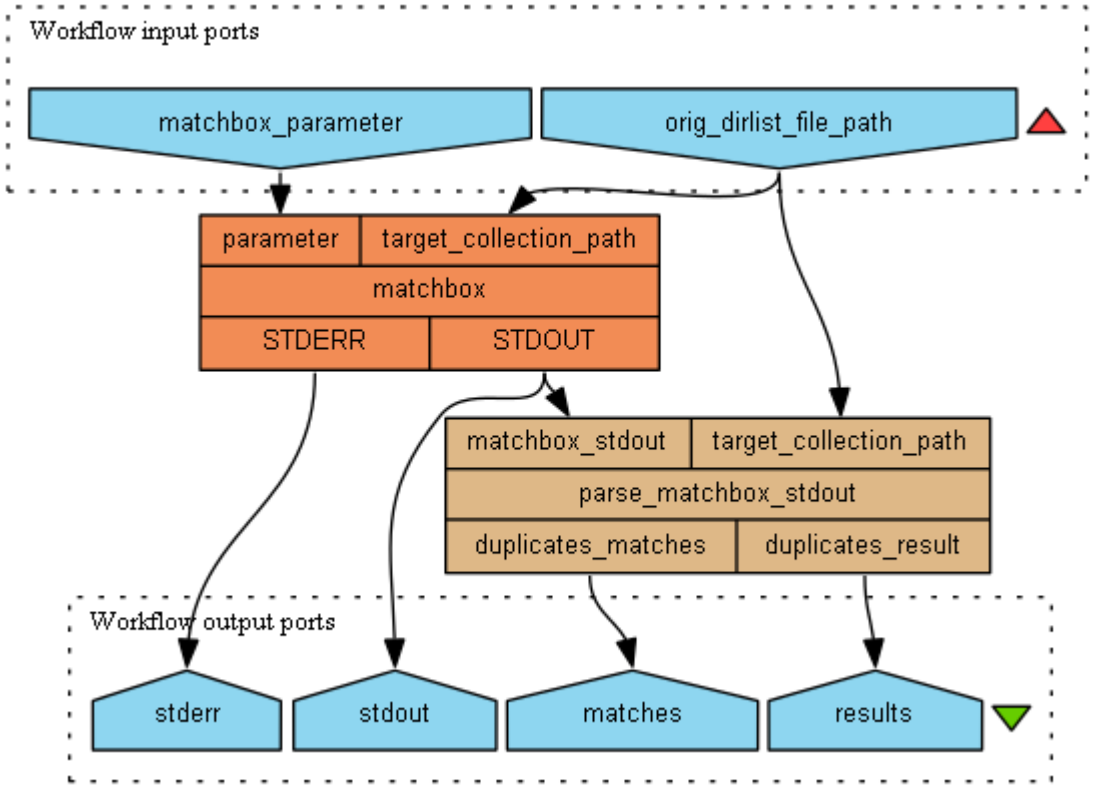
Installation Guidelines

- Linux OS with more than 10GB disk and 8GB RAM
- Git
- Python2.7
- Cmake
- C++ compiler
- The newest OpenCV version
- Matchbox HTTP URL: https://github.com/openplanets/scape.git or download ZIP from the same page (“pc-qa-matchbox”)
- Digital collection should have at least 15 files in order to build BoW

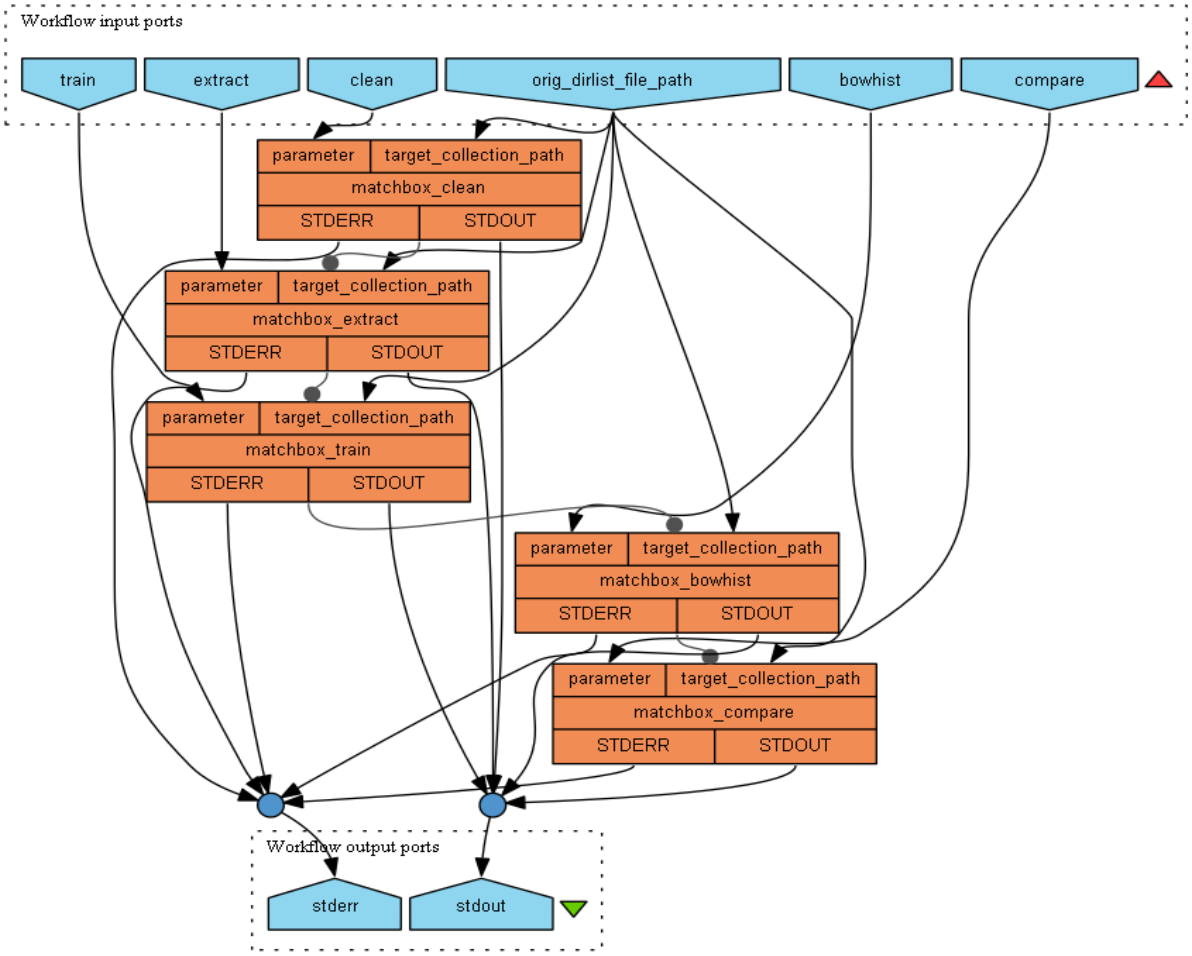
Practical Exercises

1. Identifying duplicate images in digital collections
   a. Move digital collection to the server where matchbox is installed. For Windows use pscp, WinScp or Web Interface.
   b. cd scape/pc-qa-matchbox/Python directory in matchbox source code
   c. sudo python2.7 ./FindDuplicates.py /home/matchbox/matchbox-data/ all --help
   d. Define which step of the workflow should be executed: all, extract, compare, train, bowhist, clean
   e. Optional parameters are not supported yet
   f. Correct command sequence if not "all“:
      1. clean
      2. extract
      3. train
      4. bowhist
      5. Compare

Scenario: professional duplicate search



Scenario: find duplicates using nested commands



Analysis of the Tool Results

- [1 of 20] 1
- [2 of 20] 2 => [10]
- [3 of 20] 3
- [4 of 20] 4
- [5 of 20] 5
- [6 of 20] 6
- [7 of 20] 7 => [15]
- [8 of 20] 8 => [16]
- [9 of 20] 9 => [17]
- [10 of 20] 10 => [2]

[11 of 20] 11
[12 of 20] 12
[13 of 20] 13
[14 of 20] 14
[15 of 20] 15 => [7]
[16 of 20] 16 => [8]
[17 of 20] 17 => [9]
[18 of 20] 18
[19 of 20] 19
[20 of 20] 20

3,4,5,6 with associated duplicates 11,12,13,14 are nearly empty pages

compare.exe -l 4 /root/samples/matchboxCollection/00000012.jp2.SIFTComparison.feat.xml.gz /root/samples/matchboxCollection/00000003.jp2.SIFTComparison.feat.xml.gz

OpenCV Error: Assertion failed (CV_IS_MAT(points1) && CV_IS_MAT(points2) && CV_ARE_SIZES_EQ(points1, points2)) in cvFindFundamentalMat, file /root/down/OpenCV-2.4.3/modules/calib3d/src/fundam.cpp, line 599

Practical Exercises

Output for collection with multiple duplicates:

=== compare images from directory /root/samples/col_multiple_dup/ ===

...loading features

...calculating distance matrix

[1 of 16] 92

[2 of 16] 85 => [77, 79, 81, 83]

[3 of 16] 82 => [78, 80, 84]

[4 of 16] 78 => [80, 82, 84]

[5 of 16] 87

[6 of 16] 89

[7 of 16] 86

[8 of 16] 88

[9 of 16] 79 => [77, 81, 83, 85]

[10 of 16] 91

[11 of 16] 90

[12 of 16] 83 => [77, 79, 81, 85]

[13 of 16] 84 => [78, 80, 82]

[14 of 16] 81 => [77, 79, 83, 85]

[15 of 16] 77 => [79, 81, 83, 85]

[16 of 16] 80 => [78, 82, 84]

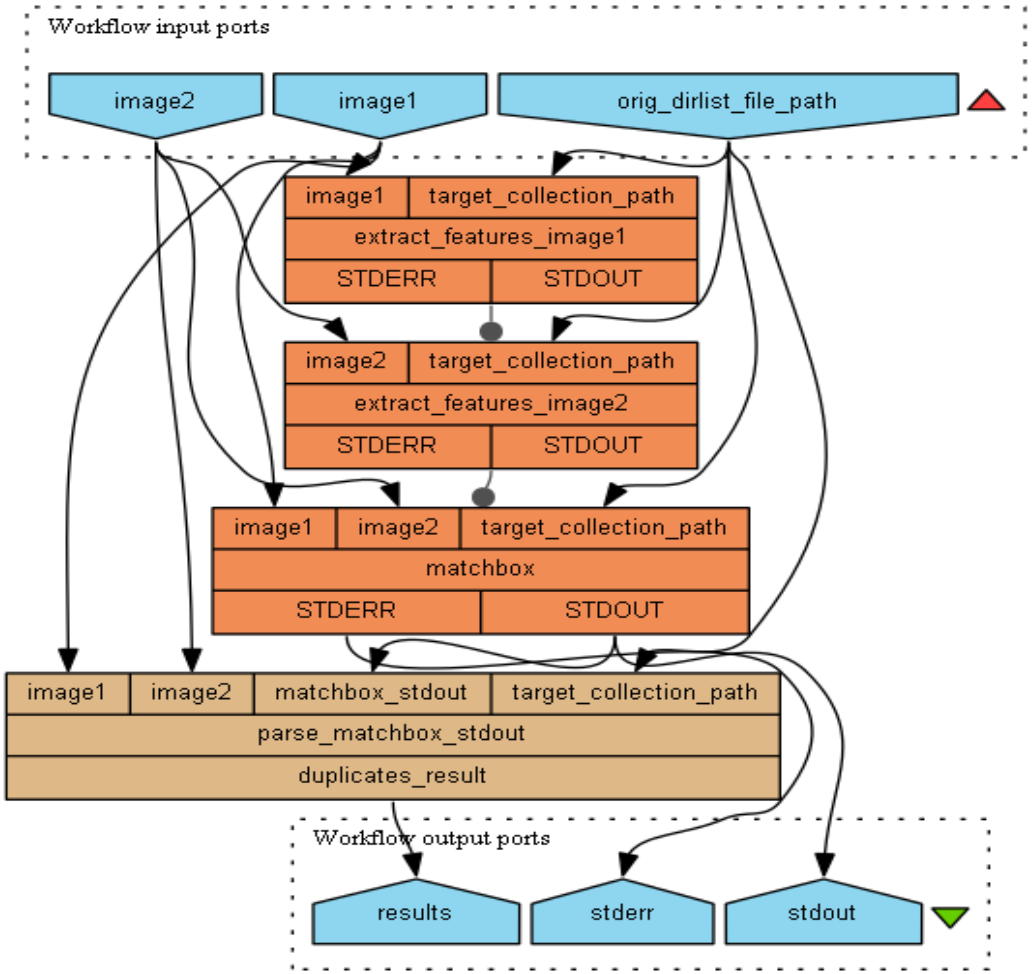
Practical Exercises

2. Compare two images by profile information
   - **extractfeatures** /home/matchbox/matchbox-data/00000001.jp2
   - **extractfeatures** /home/matchbox/matchbox-data/00000002.jp2
   - **compare** /home/matchbox/matchbox-data/00000001.jp2.ImageProfile.feat.xml.gz /home/matchbox/matchbox-data/00000002.jp2.ImageProfile.feat.xml.gz
   - Output:

```
<?xml version="1.0"?>
<comparison>
  <task level="2" name="ImageProfile">
     <result>0.000353421</result>   => high similarity
  </task>
</comparison>

<?xml version="1.0"?>
<comparison>
  <task level="2" name="ImageProfile">
     <result>14.1486</result>          => low similarity
  </task>
</comparison>
```

Scenario: compare image pair based on profiles



Practical Exercises

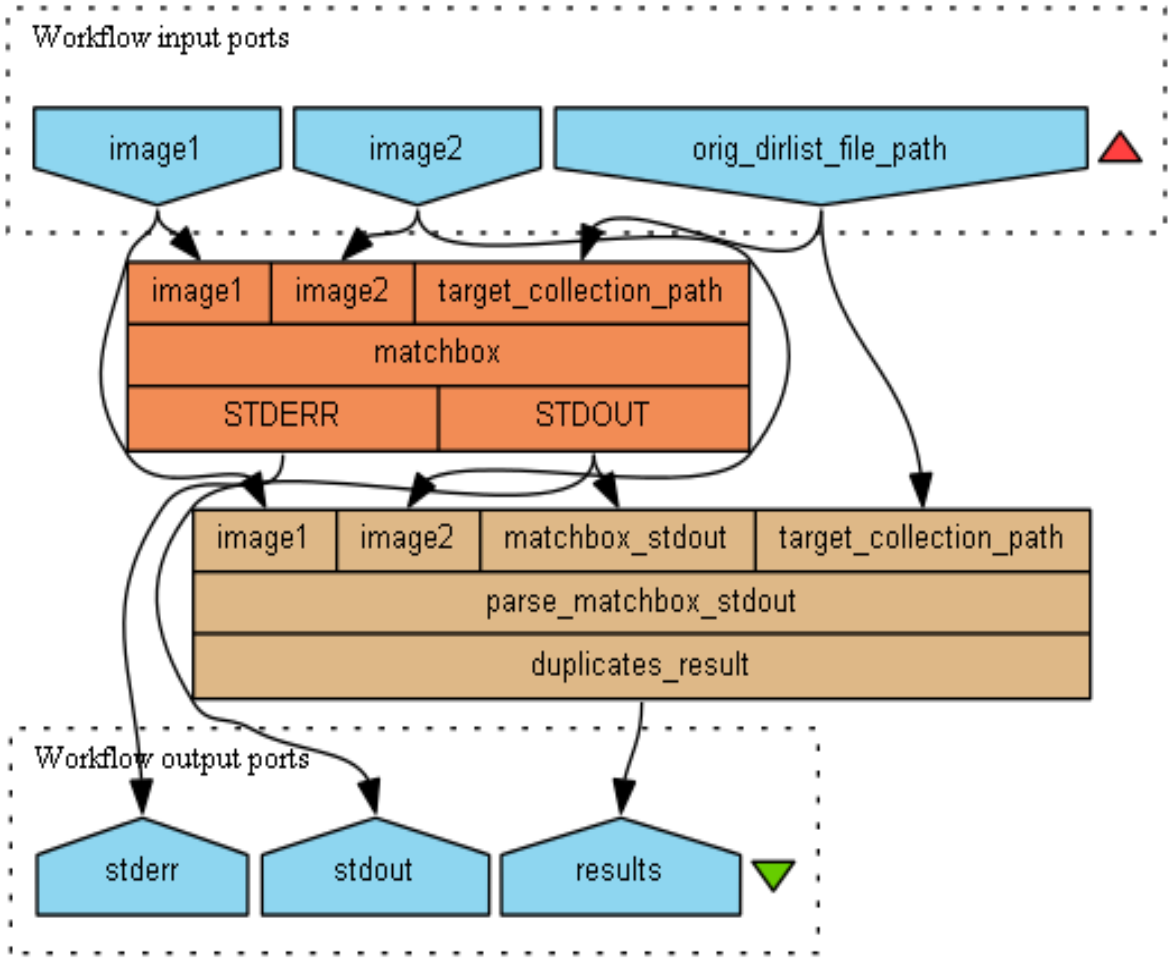
3. Compare two images based on SSIM method
   - python2.7 FindDuplicates.py /root/samples/matchboxCollection/ --img1=00000001.jp2 --img2=00000002.jp2 compareimagepair
   - Output:

=== compare image pair 00000001.jp2 00000002.jp2 from directory /samples/matchboxCollection/ ===

dir: /root/samples/matchboxCollection/
img1: /root/samples/matchboxCollection/00000001.jp2.BOWHistogram.feat.xml.gz
img2: /root/samples/matchboxCollection/00000002.jp2.BOWHistogram.feat.xml.gz

...calculating distance matrix
[1 of 2] 71 => if images are not duplicates
[1 of 2] 1 => [2] => if images are duplicates

Scenario: check duplicate pair using SSIM



Practical Exercises

1. Exercise: Identifying duplicate images in digital collections
   a. You have a collection of 20 digital documents. Write a command to search duplicates in one turn
   b. Write commands to search duplicates using customized workflow
   c. Describe outputs
2. Exercise: Identifying multiple duplicates in digital collection
   a. You have a collection that contains multiple duplicates of one document. Write a command to detect all these duplicates
   b. Describe outputs
3. Exercise: Compare two images
   a. You have analyzed a collection of 20 digital documents. Write a command to perform a content-based comparison of two particular documents
   b. Describe outputs

Conclusion

- Decision making support for duplicate detection in document image collections
- An automatic approach delivers a significant improvement when compared to manual analysis
- The tool is available as Taverna components for easy invocation and testing
- System ensures quality of the digitized content and supports managers of libraries and archives with regard to long term digital preservation

Thank you for your attention!