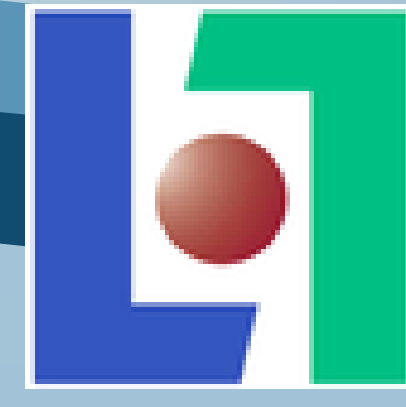


SIFT descriptor to set landmark on biological images

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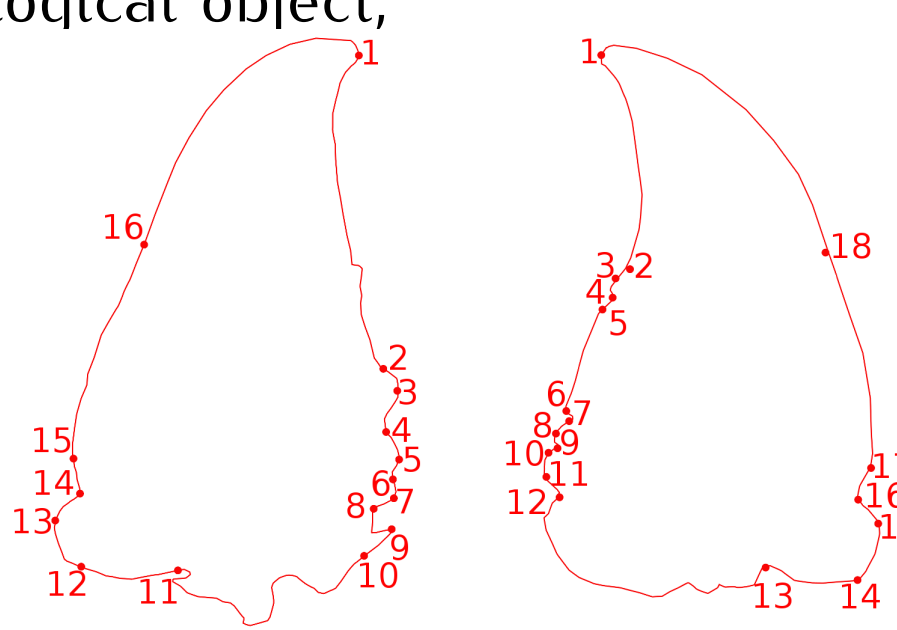


Context

- Morphometry analysis is a way to characterize the shape variations of the organisms,
- Morphometric characteristics have been used to evaluate the evolution of an organism, by finding new or sharpening definition of old one,
- Morphometrics are also used to classify the objects in different groups.

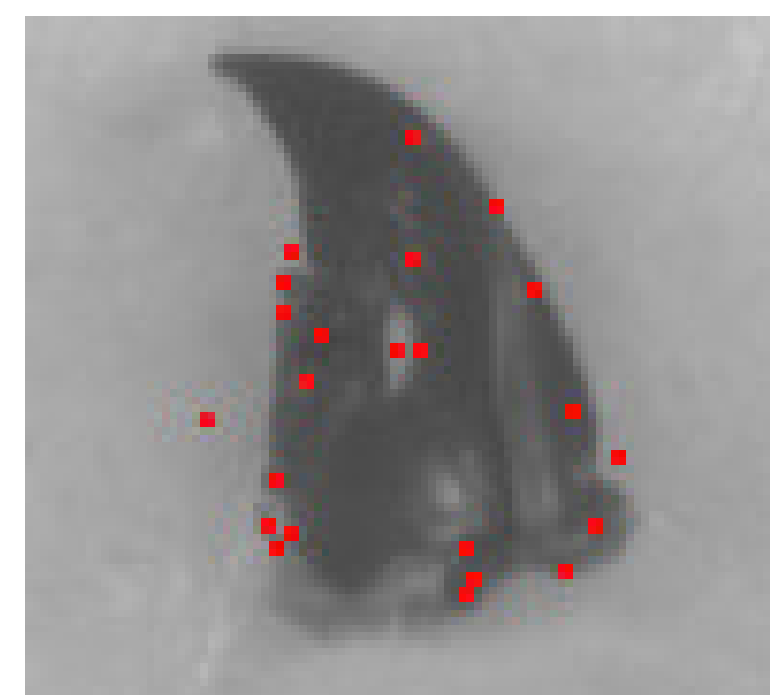
Manual landmarks

- Morphometric landmarks are points of interest in the biological object,
- Landmarks characterize specificities through the shape most often linked to biological information,
- They are usually defined by biologists manually.
- Images show manual landmarks in beetle mandibles belonging to our sample. How to **locate** the landmarks **automatically**?



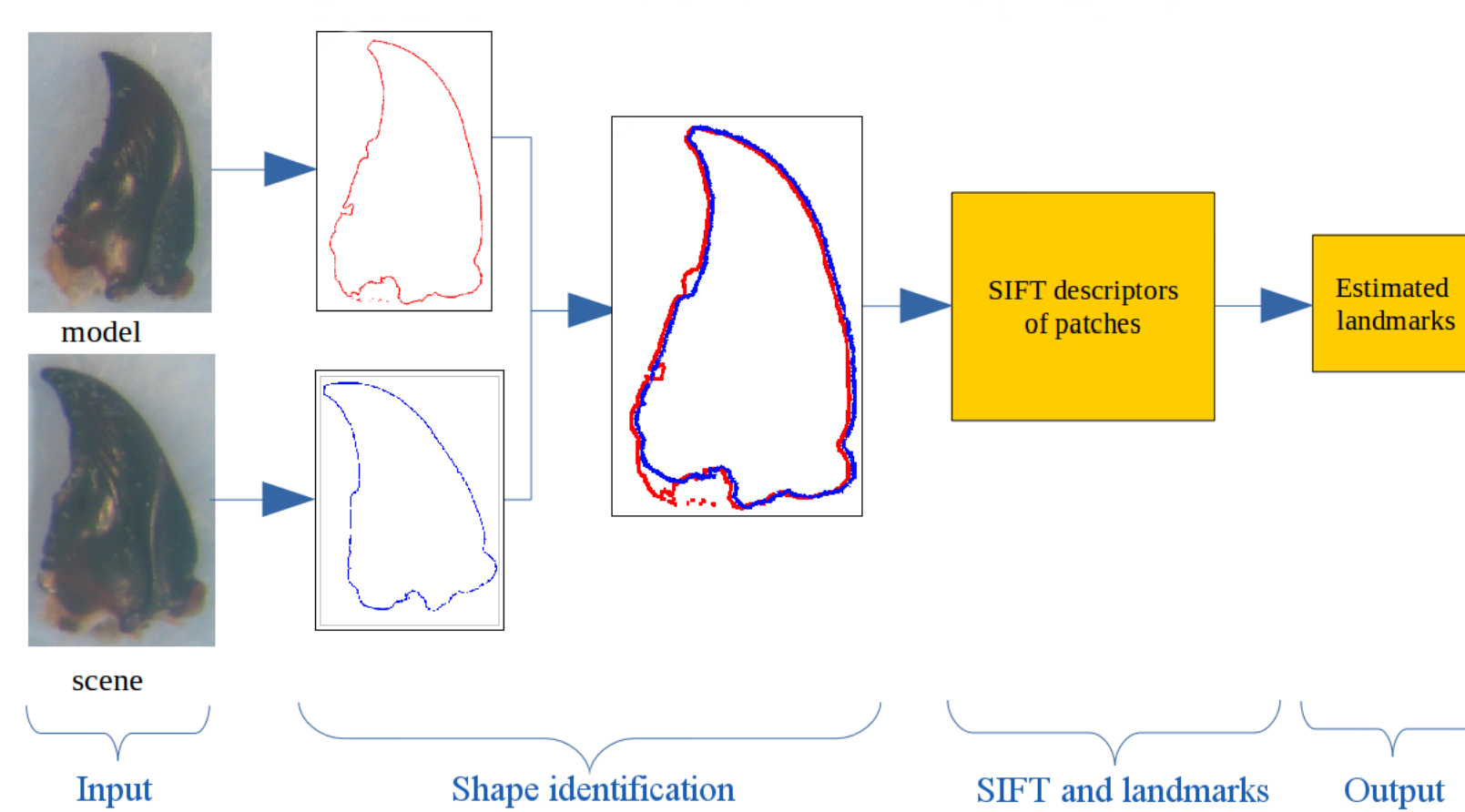
SIFT

- SIFT[4] is used to extract distinctive features from the images. It includes four steps:
 - Scale-space extrema detection
 - Keypoints localization
 - Orientation assignment
 - Keypoint descriptor
- **Limitation:** The obtained results from original SIFT method set many landmark candidates.
- **Solution:** Reducing the searching space before computing the SIFT descriptors.



Proposed method

- **Input:**
 - Model image
 - Model manual landmarks
 - Scene image
- **Output:** landmarks of scene image
- **Steps:**
 - Shape identification (segmentation and registration)
 - SIFT and landmarks



Segmentation

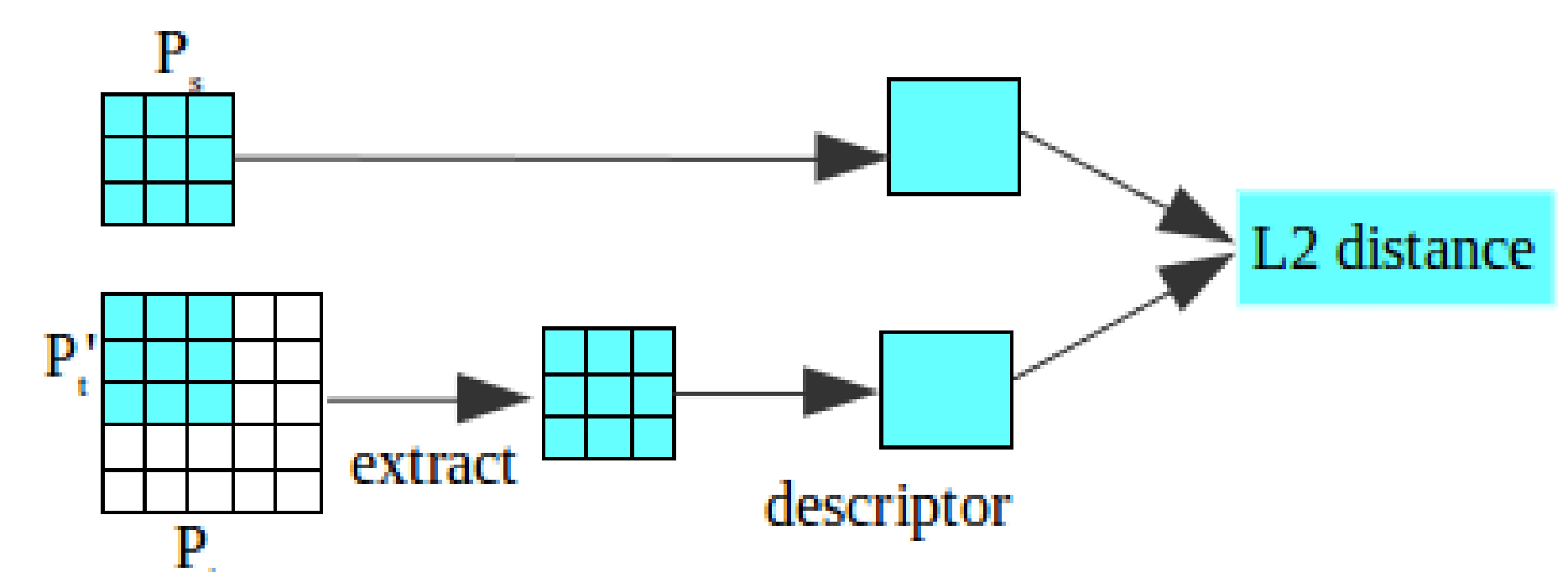
1. Converting the image to binary one by applying a threshold determined by histogram analysis[3].
2. Contours points are extracted by Canny algorithm[1]. The thresholds ratio in Canny: $T_{lower} = (1/3) \times T_{upper}$, in which T_{lower} equals to the threshold value in step 1.

Registration

Model and scene image are segmented to extract the contours points. The contours points are registered by applying Principal Component Analysis[2, 5] Iteration (PCAI).

1. Compute the centroid point and principal axis of each list of contour point,
2. Compute the transformation values between two lists of contour points,
3. Register two lists of contour points,
4. Sort the contour points of scene image followed y-direction,
5. Select a subset of contour points of scene image and repeat step 1,
6. PCAI stop automatically when the angle difference between two lists of contour points is less than 1.5 degree.

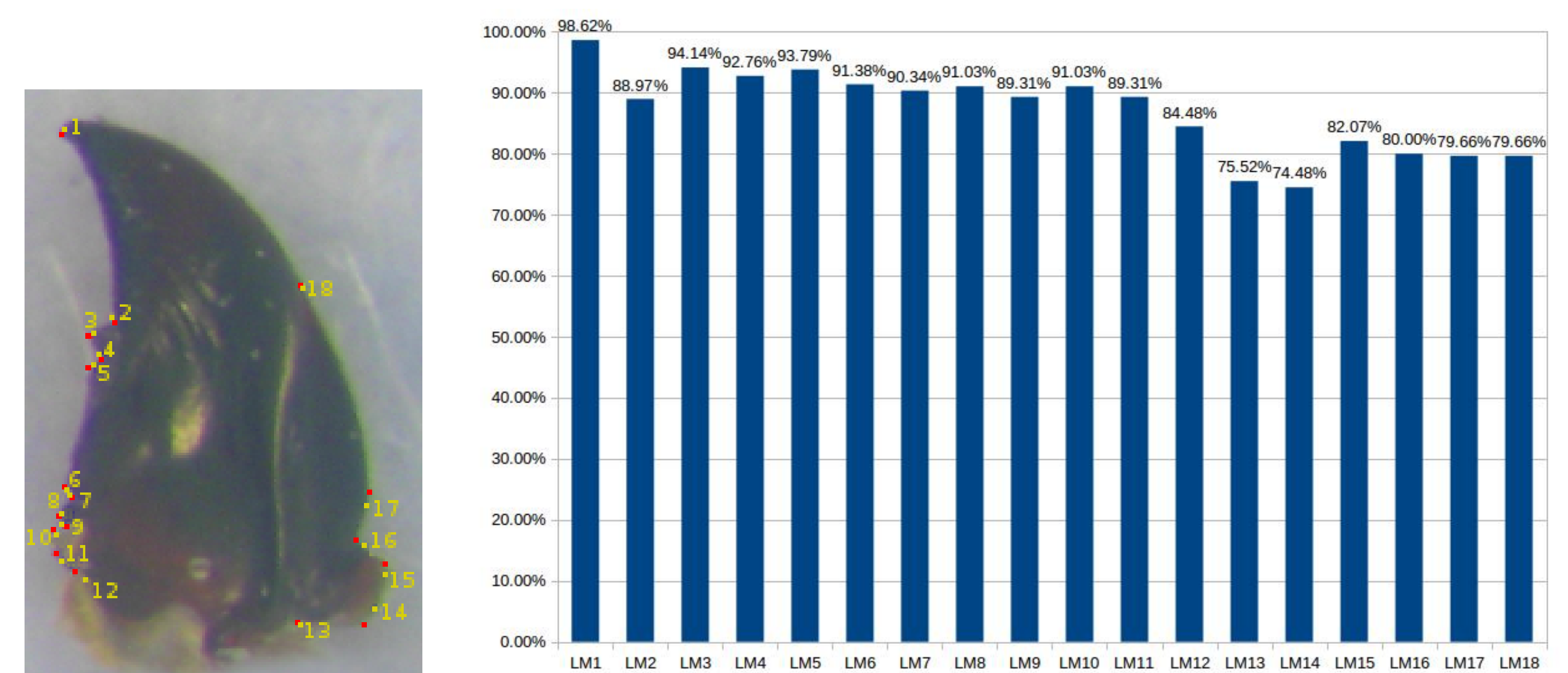
SIFT and landmarks



1. A patch P_m is initialized at each manual landmark of model image (size of 9×9),
2. Calculate the SIFT descriptor for P_m ,
3. At the same position in the scene image, a patch P_s is created (size of 36×36),
4. For each pixel in P_s , a patch P'_s is extracted with the same size of P_m ,
5. Calculate the SIFT descriptor for all P'_s ,
6. Compute the distance between the descriptor of P_m and each P'_m ,
7. At the end, the pixel that has the minimum distance with P_m is kept.

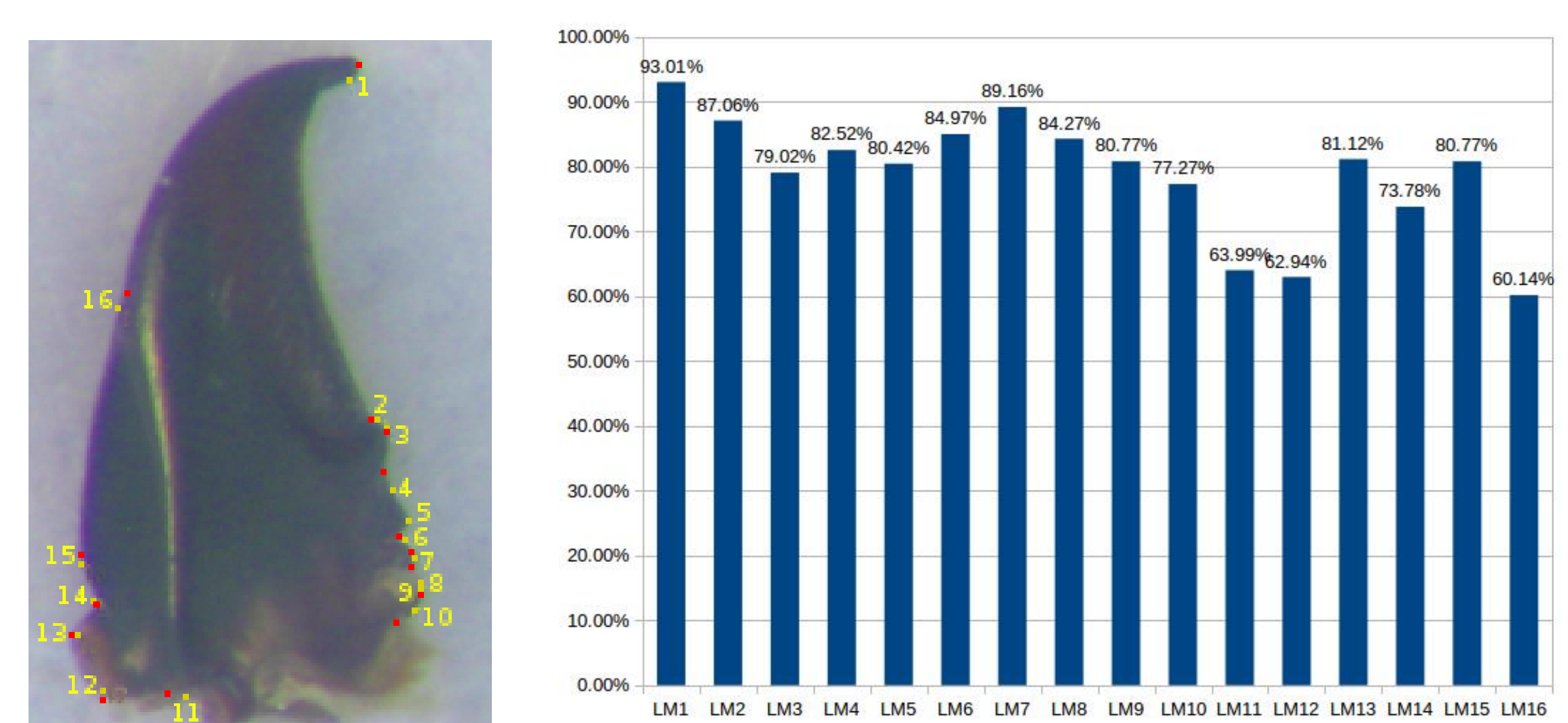
Results on right mandibles

- Highest accuracy: 1st landmark with 98.62%
- Lowest accuracy: 13th, 14th landmark with app. 75%



Results on left mandibles

- Highest accuracy: 1st landmark with 93.01%
- Lowest accuracy: 11th, 12th and 16th landmark from 60% to app. 63%



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