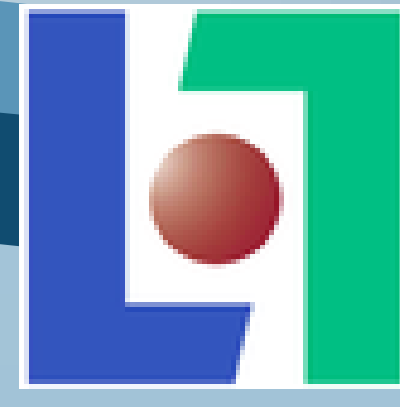


# SIFT descriptor to set landmark on biological images

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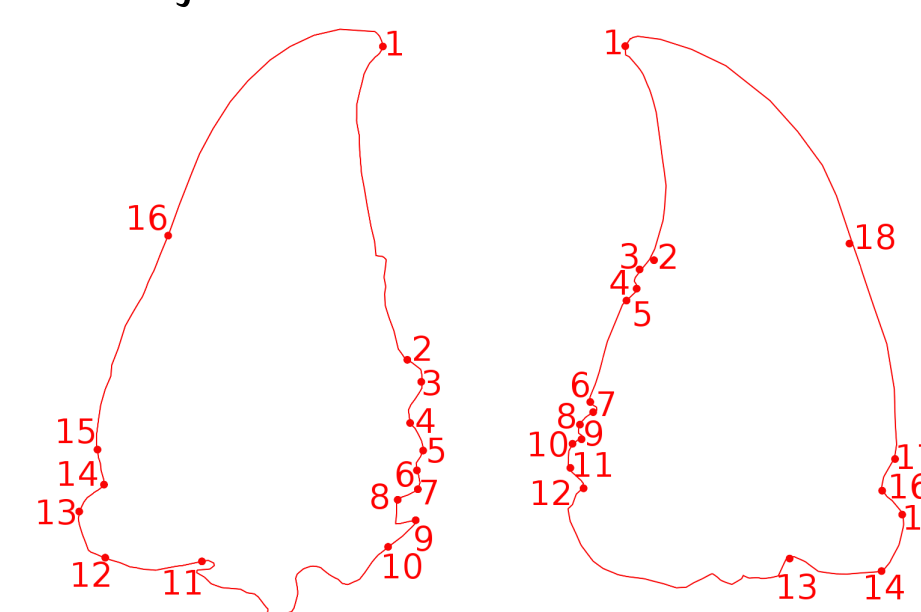


## Context

- **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.

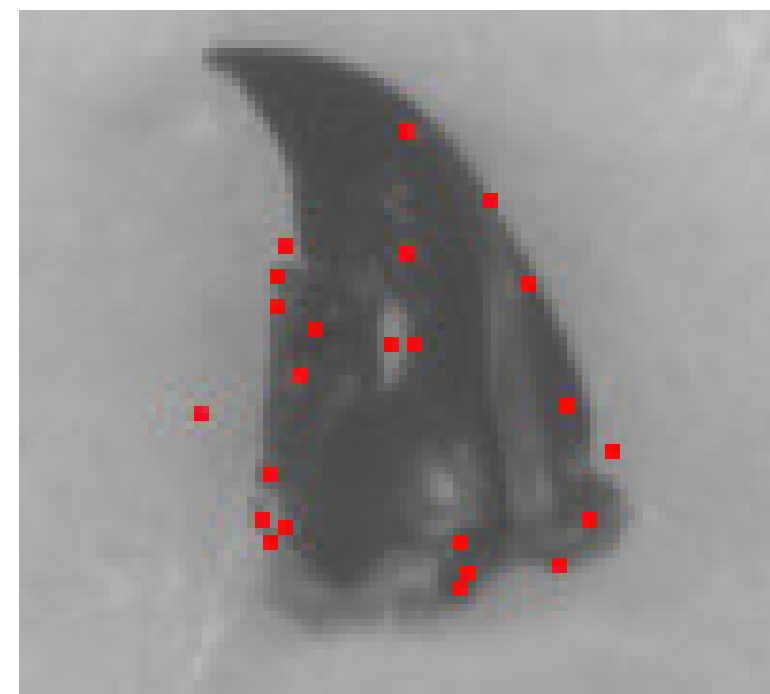
## Manual landmarks

- Morphometric landmarks are points of interest in 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**?



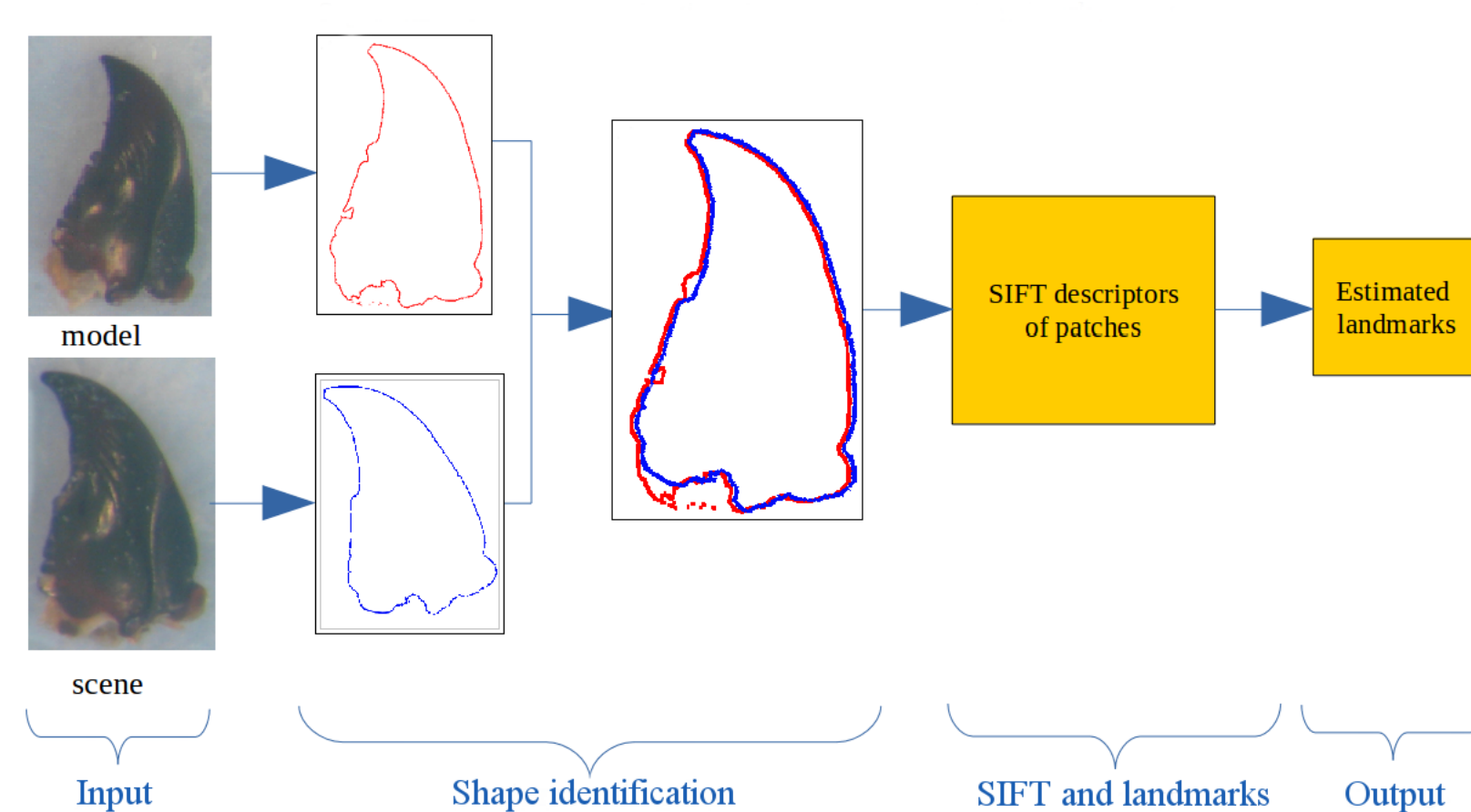
## SIFT

- 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

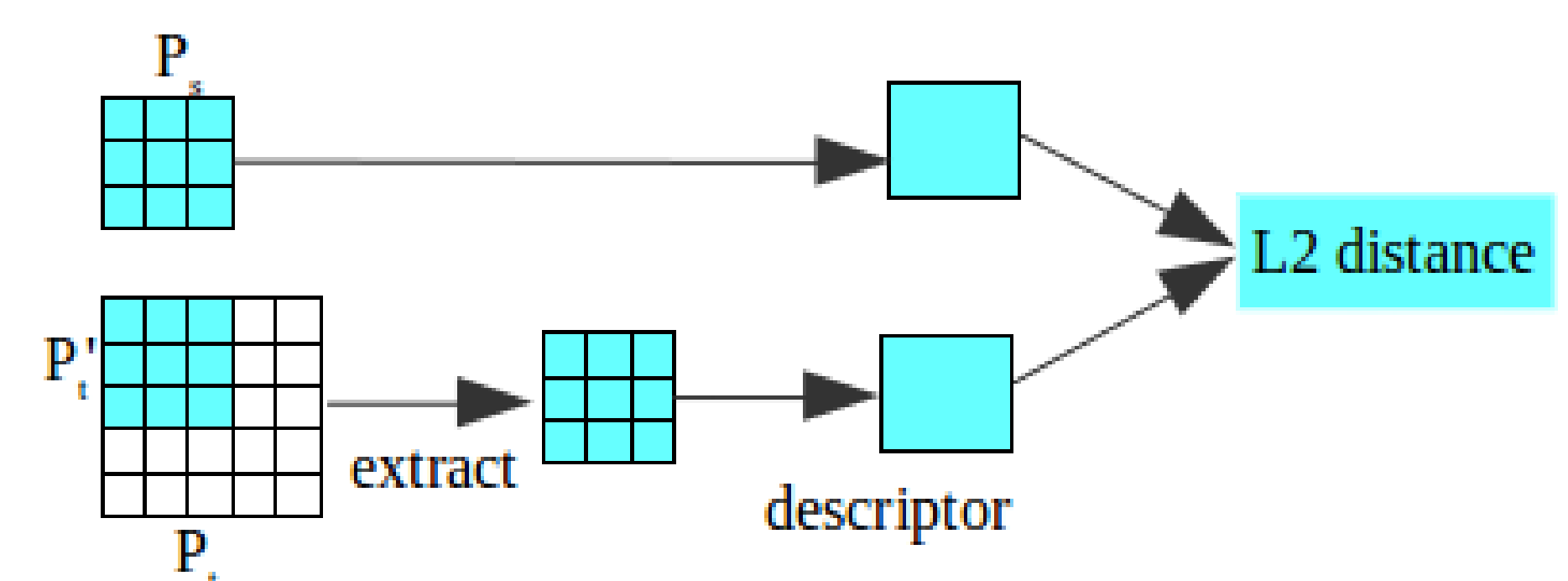
- 1 Converting the image to binary one by applying a **threshold** determined by histogram analysis[3].
- 2 Contours points are extracted by Canny algorithm[1]. The thresholds ratio in Canny:  $T_{lower} = (1/3) \times T_{upper}$ , in which  $T_{lower}$  equals to the threshold value in step 1.

## Registration

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

- 1 Compute the centroid point and principal axis of each list of contour points,
- 2 Compute the translation and rotation values between two lists of contour points,
- 3 Register the 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.

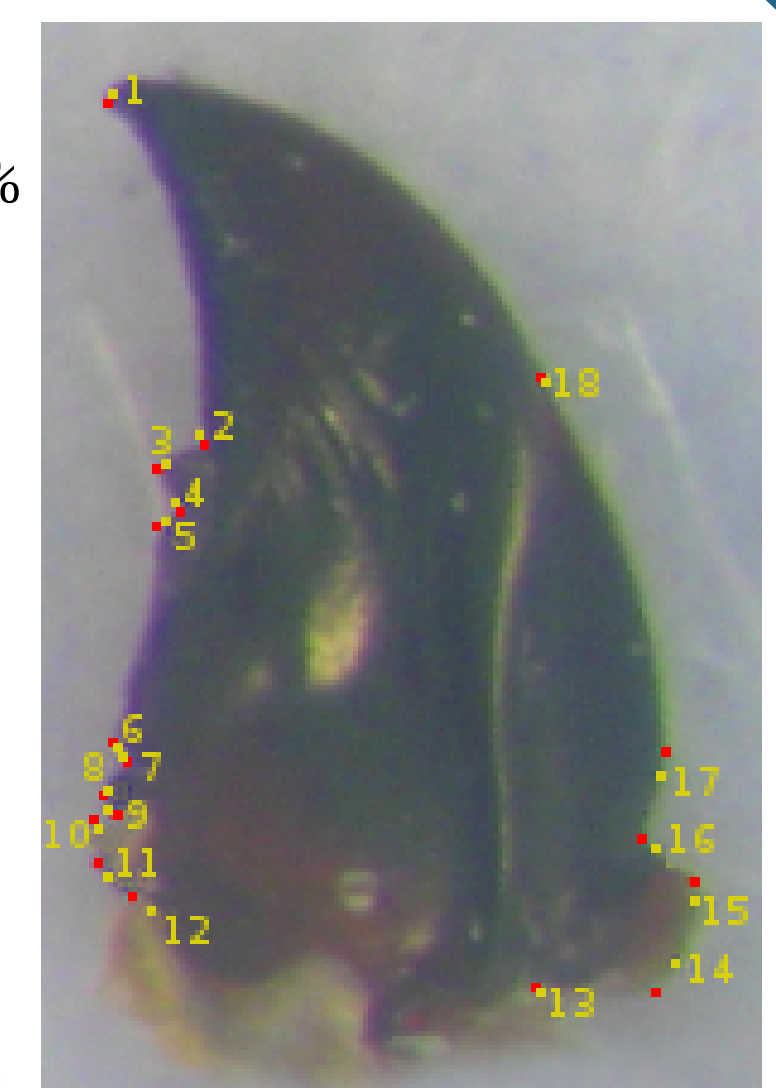
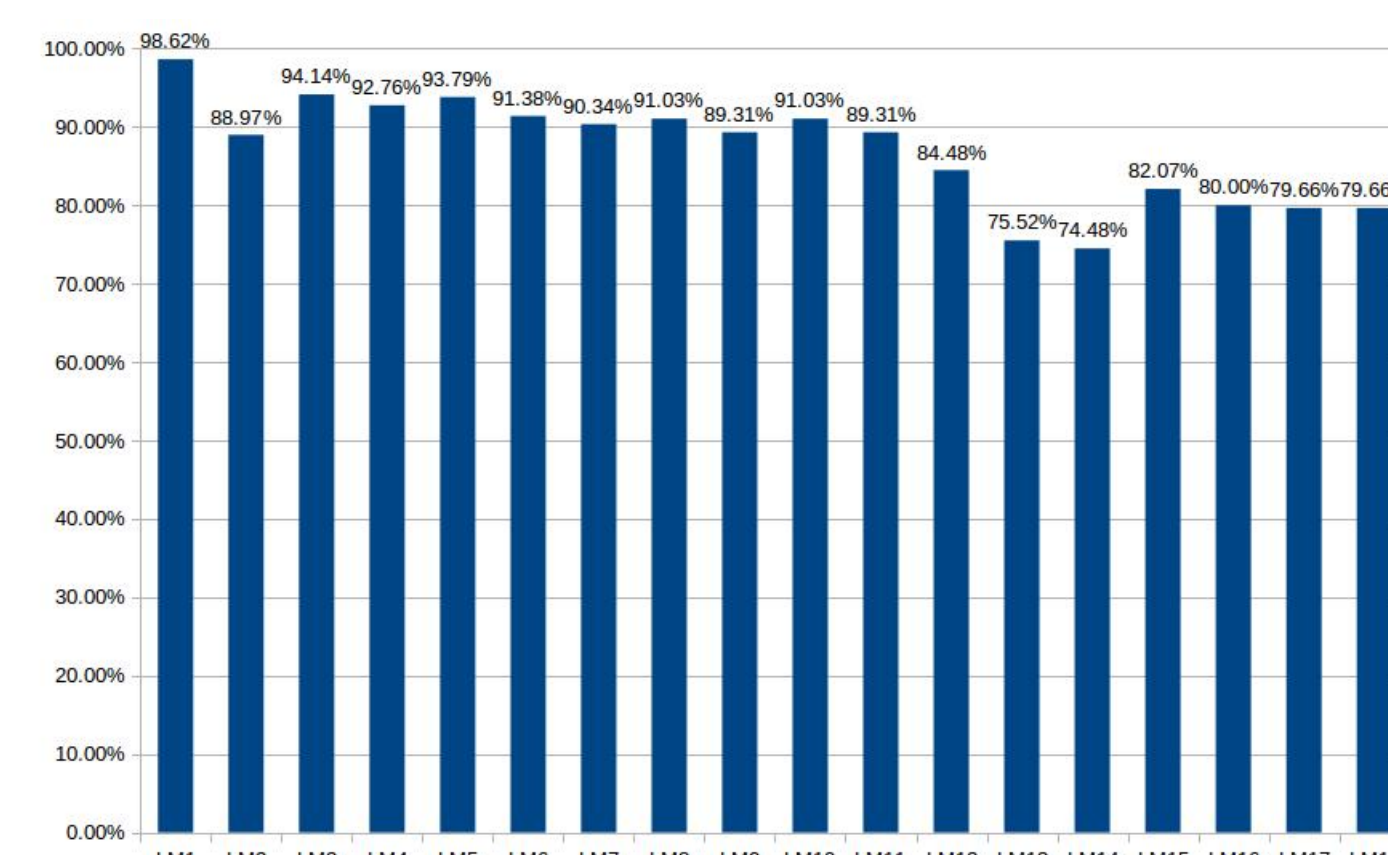
## SIFT and landmarks



- 1 A patch  $P_m$  is initialized at each manual landmark of model image (size of  $9 \times 9$ ),
- 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  $36 \times 36$ ),
- 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  $P'_s$ ,
- 7 At the end, the pixel that has the minimum distance with  $P_m$  is kept.

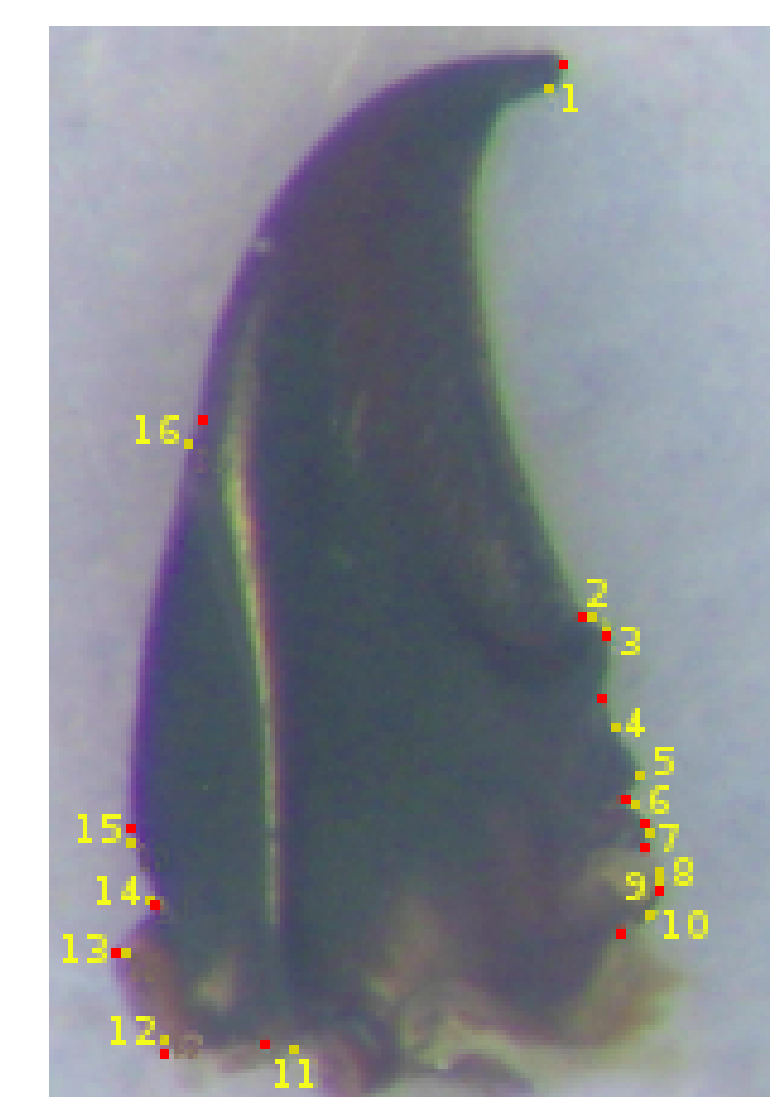
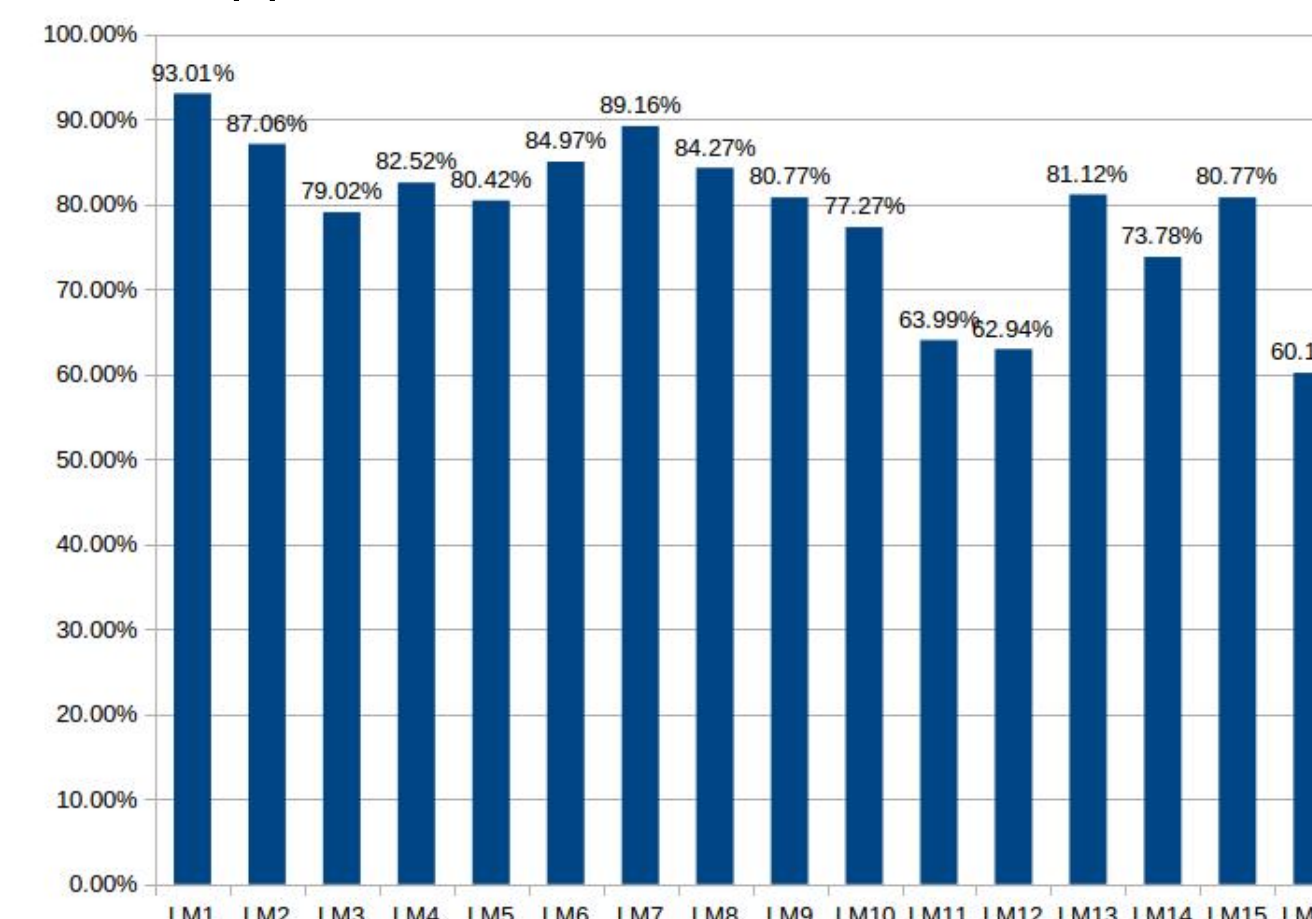
## Results on right mandibles

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



## Results on left mandibles

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



## Conclusions

- A solution based on SIFT descriptor for landmark estimation is presented,
- The results show that method **succeed in locating** all landmarks in request images,
- The accuracy of method is sufficient to be **proposed to biologists** as a **replacement of manual positioning**.

## Bibliography

- [1] J. Canny. A computational approach to edge detection. *Pattern Analysis and Machine Intelligence, IEEE Transactions on*, (6):679–698, 1986.
- [2] I. Jolliffe. *Principal component analysis*. Wiley Online Library, 2002.
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- [4] D. G. Lowe. Distinctive image features from scale-invariant keypoints. *International journal of computer vision*, 60(2):91–110, 2004.