Supplementary material to Mixed Labeling: Integrating Internal and External Labels

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1 Introduction

THIS document is a supplementary material to the paper Mixed Labeling: Integrating Internal and External Labels. The document contains the graphical overview of the first two steps of the proposed algorithm with all used buffers and additional results of the proposed mixed labeling method.

2 Graphical overview of the algorithm

In Figure 1, we show the graphical overview of the first two steps of the proposed algorithm with all used buffers. The graphical overview shows the dependency of the buffers and how the buffers are used to evaluate the criteria C_1, C_2, C_3, C_4, and C_5. A red name of a buffer indicates that the buffer is used only for efficient evaluation of the criteria.

3 Additional results

In this section, we show additional results of the proposed method to demonstrate the benefits of using labels that are allowed to overlap the areas of the corresponding objects only partially. We have modified the proposed algorithm to allow labeling of the objects only with selected types of labels (labels fully enclosed in the object, labels partially overlapping the object, and external labels).

3.1 Map of the US States

In Figure 3.2, we show the results of the proposed algorithm for various combinations of label types used to label the map of the US states. We highlight the unlabeled states in grey color when all states cannot be labeled with the used combination of label types.

If we use only labels that are fully enclosed in the areas of their corresponding states (Figure 2(a)), then we can label 29 from the 50 states. If we add external labels to the labels that are fully enclosed in the areas of their corresponding states (Figure 2(b)), then we can label most of the states, but three of the states still remain unlabeled.

When we allow the internal labels to overlap their corresponding objects only partially, then we are able to label all states. Please see Figure 2(c) for the result. However, the positioning of certain labels (e.g., Rhode Island, Connecticut, New Jersey, Delaware, Maryland, and West Virginia) is ambiguous. We can improve the label layout by increasing the ambiguity threshold to position these labels externally. Please see Figure 2(d) for the result.

3.2 Human Head

In Figure 3, we show the results of the proposed algorithm for the 3D model of the human head. Several parts (e.g., skin, skull, and spine) of the human head are semitransparent to reveal the inner structures (e.g., brain and spinal cord). Thus, the projected areas of the parts are not mutually exclusive. In other words, the areas are overlapping. In this example, we compare labels that are fully enclosed in their area with labels that are allowed to overlap other areas.

If we use only labels that are fully enclosed in the area of their corresponding parts (Figure 3(a)), then we can label only the skin as the areas of the other parts overlap with the area of the skin, and therefore their labels cannot be enclosed only by their corresponding areas. In the lower-left part of Figure 3(a), we provide a visualization of the number of overlapping areas. Brighter color corresponds to more overlaps. Please note that labeling each part independently of the other parts also leads to an ambiguous label layout. Please see Figure 3(b) for the result where the positioning of skin, skull, spine, spinal cord, occipital lobe, and temporal lobe labels is ambiguous.

If we consider the overlaps of the areas by using the outlines detected as discontinuities in the *id buffer* to create *internal salience buffer*, *Voronoi buffer*, and *count buffer*, but do not evaluate the overlaps of labels with other areas (criteria C_2 and C_5), then the resulting label layout is again ambiguous. Please see Figure 3(c) for the result where the positioning of the skin, temporal lobe, and spinal cord labels is ambiguous. Only if we evaluate the overlaps of the labels

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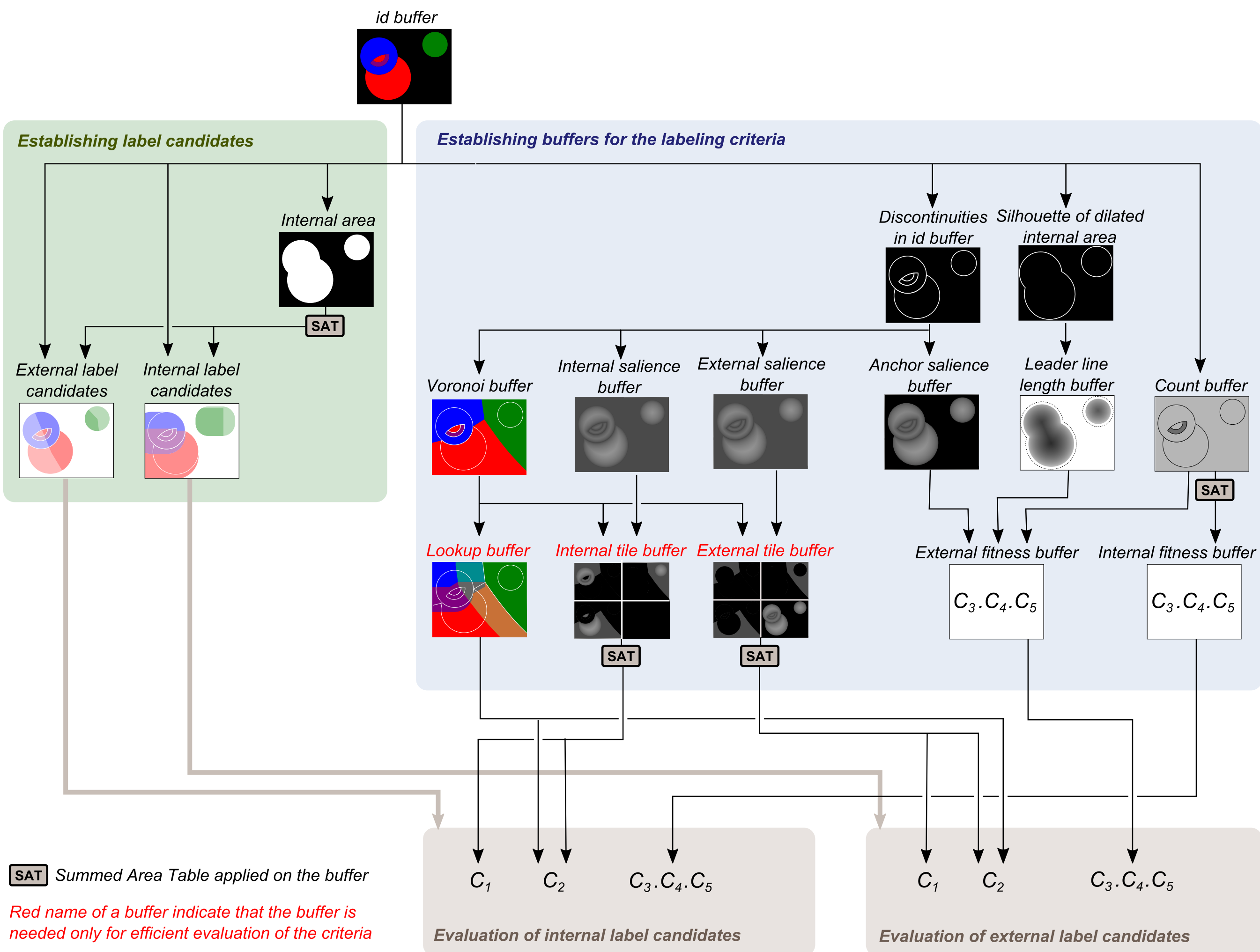


Fig. 1. Graphical overview of the first two steps of the proposed algorithm with all used buffers.

with other areas with criteria C_2 and C_5, then the resulting label layout is unambiguous. Please see Figure 3(d) for the result.

4 Examples of Limitations

This section gives examples for a selected subset of limitations, as described in section 5 - Limitations of the paper. We do not include examples for all the limitations, as we can generate them for only those cases when our method can not position every label. Consequently, we give examples for the first two cases given in section 5.

The first example, given in Figure 4(a), is an excerpt from the Gapminder dataset. If the external labels' leader lines can be only horizontal, then multiple candidates' leader lines will point to the same position. Consequently, the label for Italy can not be positioned externally without overlapping another already placed label. Our only option is to place it internally. The label's red color denotes that we intended to position it externally, but there was no sufficient space to accommodate it.

If we restrict the leader line to be vertical only, we observe another limitation of the proposed methods, as depicted in Figure 4(b). After the method positions several labels externally topside of the head, there is no space remaining for the rest. Again, the method places the rest of the labels internally.

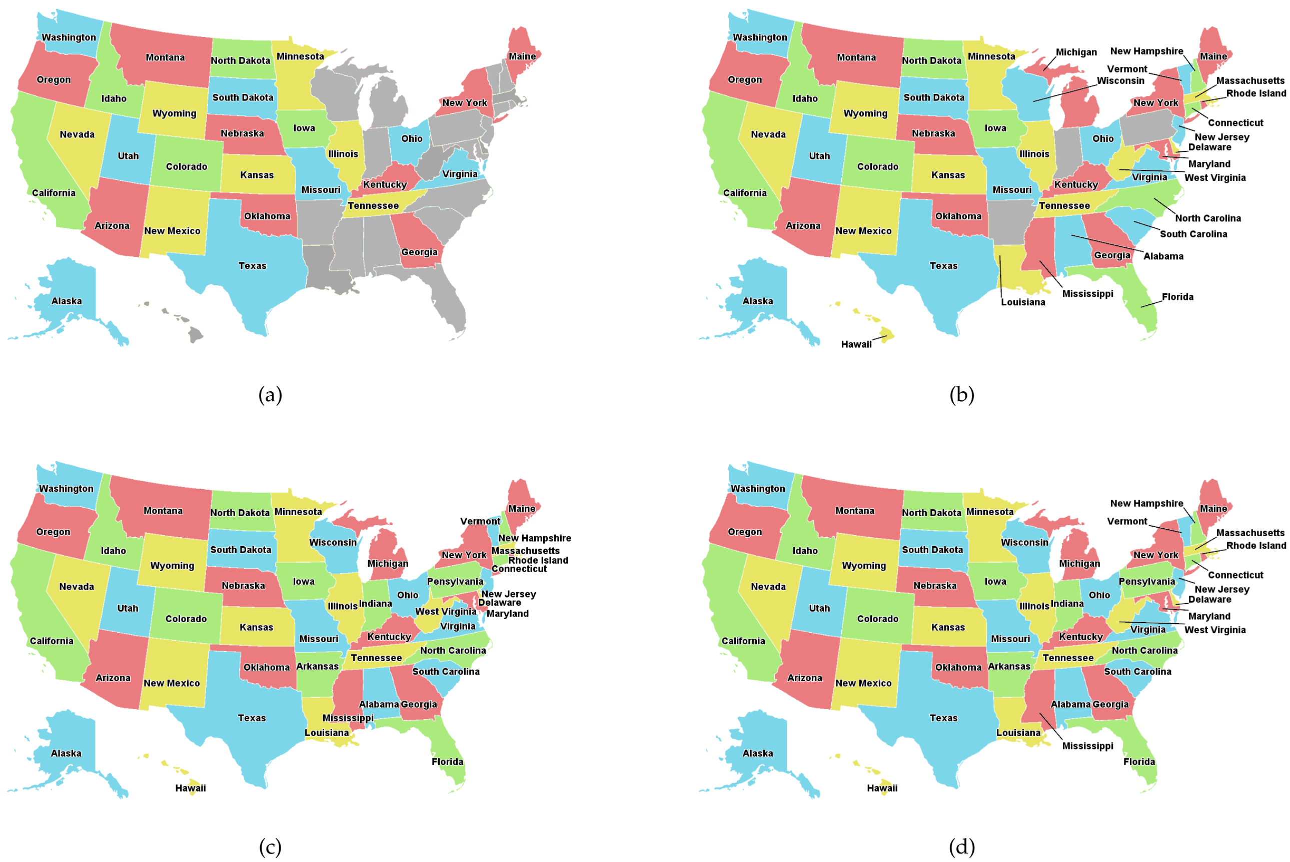
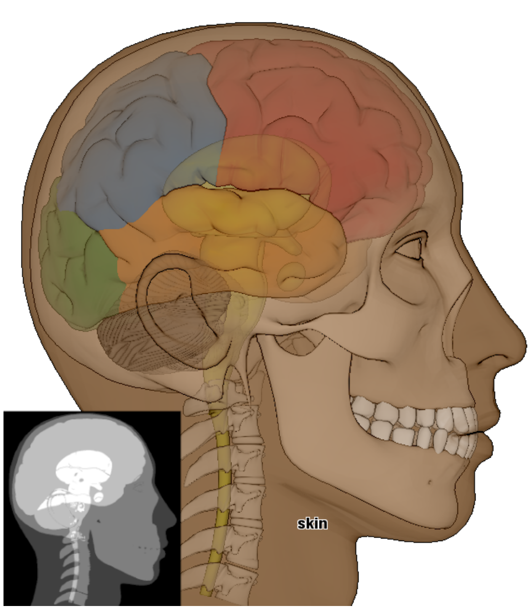
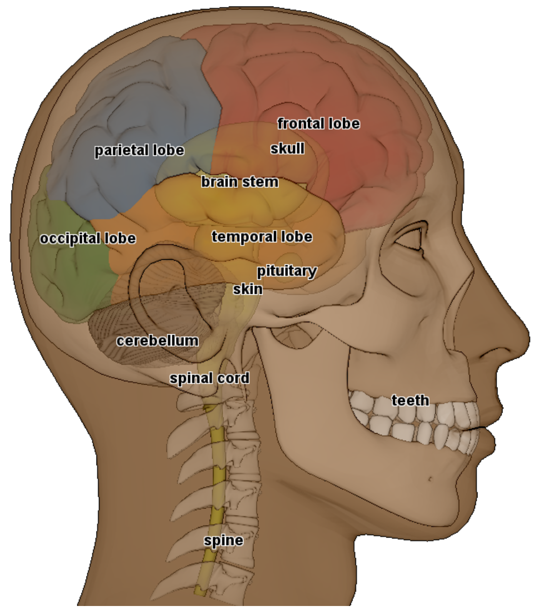


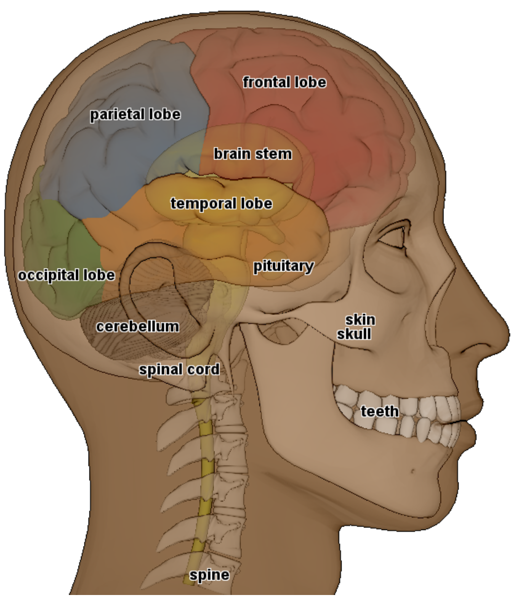
Fig. 2. Map of the US states labeled with various combinations of label types: (a) Only labels fully contained inside of their corresponding areas. The unlabeled areas are highlighted in grey color. (b) Labels fully contained inside of their corresponding areas together with external labels. The unlabeled areas are highlighted in grey color. (c) Labels fully contained inside of their corresponding areas, together with labels partially overlapping their corresponding areas. (d) Labels fully contained inside of their corresponding areas together with labels partially overlapping their corresponding areas and few external labels.



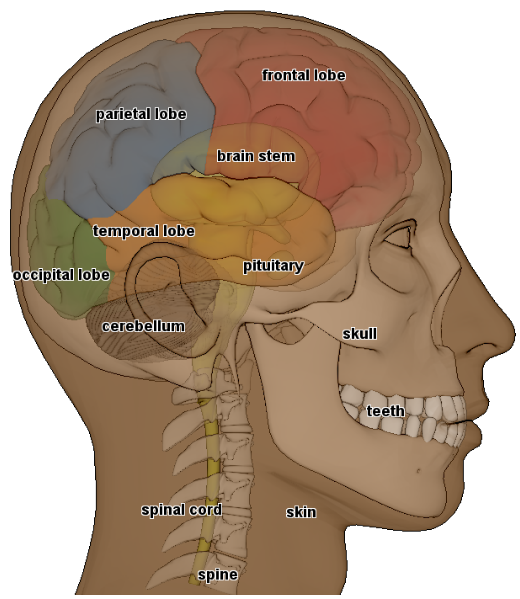
(a)



(b)

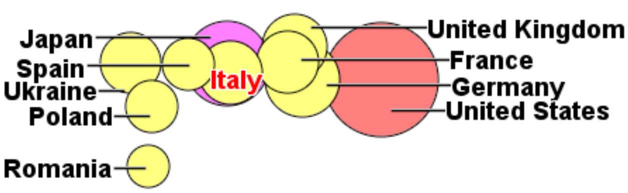


(c)

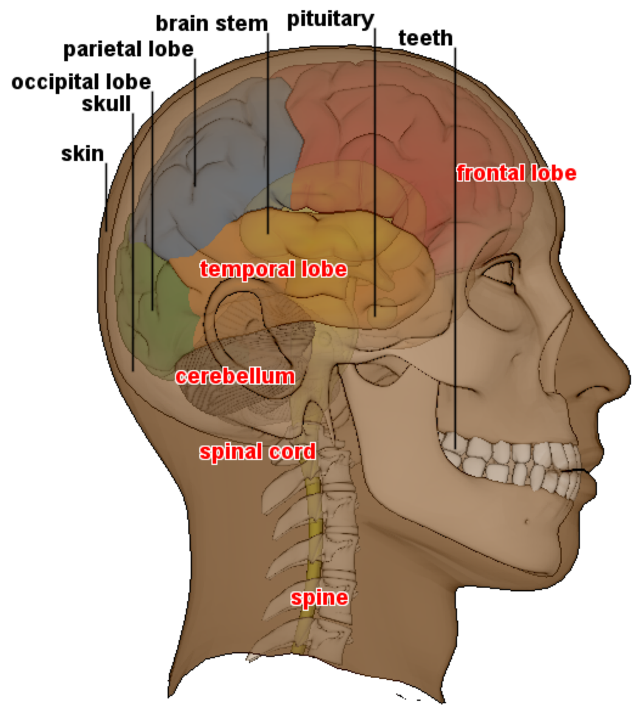


(d)

Fig. 3. (a) Only labels fully contained in their corresponding object's area while overlapping no other object. In the lower-left corner, we depict the count buffer. The brighter color corresponds to more overlapping areas. (b) Internal labels without considering the effects of transparency on the division of overlapping areas. We position every label in the most central part of its corresponding object. (c) Internal labels positioned without considering criteria C_2 and C_5. We position every label disregarding overlap of its neighboring objects. (d) Internal labels positioned with utilizing criteria C_2 and C_5.



(a)



(b)

Fig. 4. (a) Excerpt from the Gapminder dataset with horizontal leader lines only. The method positions most of the labels externally; however, the label for Italy has no feasible positions remaining and consequently is positioned internally. (b) Model of the human head with vertical leader lines only. After several labels are positioned externally, the space above of the model quickly fills up, and no feasible external label positions are available for the unlabeled objects. Consequently, the remainder of the objects is labeled internally.