

IMAGE ANNOTATING TOOLS FOR AGRICULTURAL PURPOSE – A REQUIREMENTS STUDY

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Abstract. Images of natural scenes, like those relevant for agriculture, are characterised with a variety of forms of objects of interest and similarities between objects that one might want to discriminate. This introduces uncertainty to the analysis of such images. Requirements for an image annotation tool to be used in pattern recognition design for agriculture were discussed. A selection of open source annotating tools were presented. Advices how to use the software to handle uncertainty and missing functionalities were described.

Key words: image annotation, agriculture, uncertainty.

1. Introduction

With the growing advancements in the field of supervised learning, the need for a labelling tool that optimizes the process of image annotating (both automatic and manual) increases. There are both one-fits-all tools available as well as products tailored to the specific needs of certain applications, e.g. medical diagnosis [1] or robotics competition [2]. Several attempts to comparing features of the available tools have been proposed by the research community, e.g. in respect of its ability to utilize ontologies [3, 4, 5], its appropriateness for e-health and generally for the medical domain [6, 7] or suitability for the biomedical appliances [8]. However, research community in the field of life sciences, especially in agricultural sciences, faces several problems occurring specifically in this area and this article addresses these specific issues.

Increasingly more publications presenting various subjects for pattern recognition in the field of agriculture appears (e.g. cows health monitoring [9], Spider Mites detection [10], weeds detection [11], precision herbicide application [12]). Pattern recognition in this field is quite often difficult due to the diversity of forms of the same objects and similarity of a sought object to other objects. This difficulty may introduce uncertainty about the border of an object or uncertainty about object classification.

As long as there is no agriculture dedicated annotating software available, in the next section of this paper a best selection of software that could be used is presented. In the following sections the several uncertainties of a different kind which could be met in tasks of pattern recognition in agriculture, and suggestions how to handle them are described.

2. Selected software

In the search executed for this paper, no software dedicated to the agricultural image annotations were found. This shifted the interest to search explicitly for the software that is open source. Open source software has many advantages in the analysed case. One of the main advantages of the open source systems is the ability of free adaptation of the software to the needs. It may be easily carried out by the community if the feature request is submitted. The community may develop and share the software for free. So, this adaptation does not necessarily impose having programming skills. But if one has programming skills, one can modify the software according to needs. The licence and access to source code allow for it.

Fortunately, there is a wide range of the free or open source software available. This analysis does not suffer from the exclusion of the proprietary software from the analysis, as the open source tools described in the following section are meeting the state-of-the-art requirements of the image labelling.

The last reason for focusing explicitly on the free software in this analysis is related to the financial aspect. Although many proprietary tools provide free or trial access to the software (Labelbox [13], oclavi.com, rectlabel.com, supervise.ly), other products usually require purchase (e.g. taqadam.io, prodi.gy, scale.com, appen.com, thehive.ai).

The criteria used to include a software in this analysis were the following: 1) software has been accessible through the online search engines with the phrase “image annotation tool”; 2) the software has been available on the lists of the top image annotation tools found through the online search engines with the phrase “top image annotation tools”. Finally, ten projects of annotating tools were selected.

The properties helping in comparison of the searched software are summarized in the table 1 (offline tool), and table 2 (online tools), sorted by the number of contributors.

The following criteria were chosen to summarise the software so that it should be helpful in consideration what would be the best solution in a specific case.

Online/Offline It is important if the process requires data sharing, e.g. if the images are annotated by several experts and their inputs need to be viewed, e.g., for the purpose of comparison or evaluation. Offline tools provide an option of exporting annotations usually in multiple data formats, therefore the information may be exchanged. However, this leads to creating multiple parallel data repositories and data synchronization may become a problem. Online tools support collaborative work on data sets and access of multiple users to one repository is possible. However, the size of the images in repository may be a problem, impacting the speed of annotation process, if the internet connection is slow. Always an online software may be used with advantages of an offline tool, if installed as a service on a local machine.

License type The code of the open source software developed by the community is made available at the popular software version control services (e.g. Github, Gitlab) with

Tab. 1. Examined offline software.

	License	Language	Annotation types	Labels	# of contr.	update 2019
LabelImg [14]	MIT	Python	b-box	User definable	57	yes
Sloth [15]	GNU GPL	Python	b-box point, polygon	User definable	8	no
Mask Editor [16]	MIT	Matlab	b-box, polygon, ellipse, freehand	User definable	1	no
Ratsnake [1]	Free software	Java	b-box, polygon, freehand	User definable	n/a	n/a

an appropriate license. New features may be added depending on the community demand. If required, individual and specific features may be freely added by every user with programming background.

Language Language denotes the primary programming language used for the development of the tool. Online projects mostly utilize more than one programming language or technology. For the online tools the main backend technology is provided.

Annotation type Several types of annotation types are usually available in the form of the following shapes: rectangle (bounding box, b-box), circle, ellipse, point, or line. Using a predefined shape speeds up the process. More complex shapes may be marked using the polygon feature or freehand shape. There exists also an option of creating annotations based on several examples of the class to annotate.

Labels Every annotation may be assigned to one or more categories which are usually defined by the user. Online tools may provide an option of sharing labels created by different users, however in some projects label categories may be imposed and defined by an administrator.

Number of contributors and updates This information makes it possible to take into consideration the probability of experiencing the development of the software and the emergence of new features. Repositories of the open source projects are publicly available and the history of changes in the project may be tracked. Several of the selected projects are constantly developed by large groups of contributors.

Tab. 2. Examined online software.

	License	Language	Annotation types	Labels	# of contr.	update 2019
CVAT [17]	MIT	Python	b-box, polygon, polyline, points	User definable	50	yes
LabelMe [18]	GNU GPL	Python	Polygon, b-box, circle, line point	Free text	31	yes
imglab [19]	MIT	Java Script	b-box, polygon, circle, ellipse, point	User definable	26	yes
Image Tagger [2]	MIT	Python	b-box, polygon, line, point	User definable	13	yes
Via [20]	BSD-2	Java Script	b-box, polygon, circle, ellipsis, polyline, point	User definable	9	yes
Rhoban Tagger [21]	MIT	PHP	Examples	Admin defined	1	no

3. Agriculture requirements

Pattern recognition of agriculture objects cause a need to add some special requirements to the image annotating tools. All of them are driven by the uncertainty imposed by nature. Some of living forms try to look like others to hide. Some of living forms change their look to adapt to the environment. Different look is also related to different life stage or growth phase.

Annotation tools presented already could meet some of the extra requirements just

by the untypical use of the software functionality, but some of them need an extension of the software. Of course at first the requirements for such tools should be defined.

As an introduction to the requirements for the image annotation tools, reasons for pattern recognition being a hot topic in agriculture will be presented. The first reason is the ecological approach to agriculture. It can have a different scale from just reduction of use of chemicals to even something called 'organic farming'. Secondly, economics are considered, due to the observable trend of equipment becoming cheaper and labour costs growing larger.

A current philosophy applied to agriculture is not to eliminate pests or weeds but to allow them to exist, as long as it is kept on a safe level. The consequence of such approach is resignation from preventive use of pesticides. To reduce usage of chemicals the knowledge about the condition of the crop is needed. This means that the crop should be monitored. In organic farming chemistry can not be used at all and weeds should be removed mechanically. The consequence of the above, is that possibilities of usage of pattern recognition in that field are widely investigated. In such circumstances a lot of AI is required to analyse increasing number of samples and to navigate robots. On the other hand the AI needs annotated learning material. The consequent requirement is development of the good tool for annotating, that is taking into account difficulties of such kind of images.

The diversity of possibilities for pattern recognition is significant. It reflects the diversity of agriculture aspects. The diversity can be categorised in several ways. At first it can be grouped by animals and plants. The second aspect is the location of image collection: field, buildings, laboratories. This strongly influences possible assumptions about what can be invariant and what can vary (e.g. lighting, relative position of objects and the camera, etc.). The third aspect is related to the requirements for the result provided by a system: classification of images, detection of objects, measurement of objects (quantitative description).

As long as the source of difficulties is the same in all of agricultural pattern recognition cases – the Nature, an actual problem usually is specific for a project. In the following analysis some of examples are presented.

3.1. Labelling uncertainty

As was mentioned before, it is a part of survive strategy to look similar. But it is not the only reason indicating of a problem of difficulty in discrimination. Lets consider an example. There is a task of monitoring of influence of different treatment for activity of some insects. An idea is to measure the activity indirectly through the count of their excrements. Unfortunately, at least for a non biologist, such excrements (annotated) look like other objects existing on the same picture that are not annotated. Someone responsible for the pattern recognition aspects, would like to know what have to be determined as the object and what out of the similar objects is not, and in which cases



Fig. 1. An example image presenting many aspects. a poppy in wheat is a weed. Poppies are in different life stage (flower, green capsule, dried that make its stem similar to wheat). Overlapping between poppies, and between poppies and wheat. (source: https://commons.wikimedia.org/wiki/File:Klatschmohn_in_Weizenfeld.JPG)

the expert was not sure of the correct determination. Even for a biologist, without additional knowledge, it may be difficult to discriminate correctly the specified objects. If at the current stage of a project there is only the picture available to the expert, the available label should be yes/no/not sure.

The mentioned requirement may be solved with the software. The uncertainty can be annotated by adding to one object few labels. All of the presented software allow to do that. The problem is a shift to the following stage of system development, that means to the stage of metrics defining and proper interpretation of labels of annotation.

3.2. Uncertainty of borders

The problem of borders is something more than a fuzzy border and problem of decision which pixels to choose. Of course, this is a problem to annotate the object when the border is not sharp. But a solution can be quite easy. The software should allow to put an annotation in annotation. In such a case more label categories should be added. Then the maximum range of an object should be annotated at first, and in the next step the minimum range marked into the maximum one.

More difficult problem is when objects overlap each other (eg. like the wheat and poppy on fig. 1). The requirements of quantitative description became a difficult task. If e.g. the relation of numbers of objects of different kind is expected then the whole object should be counted as one. In order to be able to learn and evaluate the result, within annotations there should be such an information.

3.3. Risk of omission

Omission of an object during annotating has two main consequences. The first consequence is that the interesting object (that might be treated as an example for the learning process) would be lost. The second, and even more important, consequence is that a proper answer of a system verified on such data would be wrongly judged as returning an error of a false positive type. The consequent requirement is to ensure that all areas of a picture have been analysed. In some cases pictures have such a size that it is not possible to have on a screen the whole picture and still to see necessary details of objects or even to identify them. It would be good if a software scrolls automatically the picture in a resolution set while the expert is analysing the picture. Unfortunately the analysed software do not have such functionality and scrolling can be made only manually.

4. Conclusions

Some of the described requirements for an annotating tool may be satisfied with existing software, some of them require enhancement of the functionality of the software. Even though, the proposed non typical usage of software would allow one to handle the specified problems, it should be made carefully and some additional processing of results of annotation should be made. Functionality is one aspect of a good software, another key aspect is ergonomics. A software with good ergonomics can speed up the work and

reduce the number of mistakes. As the number of project and their scale increase, the need for dedicated tools also increases.

Good annotating software is just the first step in the preparations to build a system for pattern recognition. To handle the uncertainty of the knowledge incorporated in the process of annotation of images the next step is required. This step is to properly define or choose the metrics that could rank potential systems in the way which reflects the expectations.

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Appendix: Repositories of presented open source annotation tools

- <https://github.com/bit-bots/imagetagger>
- <https://github.com/Rhoban/tagger>
- <https://github.com/cvhciKIT/sloth>
- <https://github.com/Chuanhai/Mask-Editor>
- <https://github.com/wkentaro/labelme>
- <https://github.com/opencv/cvat>
- <https://github.com/NaturalIntelligence/imglab>
- <https://github.com/bit-bots/imagetagger>
- <https://github.com/tzutalin/labelImg/tree/master>
- <https://gitlab.com/vgg/via>

