



COMPARATIVE ANALYSIS OF IMAGE ANNOTATION TOOLS: LABEL IMG, VGG ANNOTATOR, LABEL STUDIO, AND ROBOFLOW

¹Prof. P. D. Kale,

¹T&P Head, Department of Computer Engineering, BVCOEW, Pune

²Mahajan Tanvi, ³Kanawade Ankita, ⁴Shete Samrudhi, ⁵Jadhav Shweta

BE students at BVCOEW, Pune

Department of Computer Engineering,

Bharati Vidyapeeth's College of Engineering for Women, Pune, India.

Abstract : Image annotation is a critical process in the preparation of datasets for machine learning and computer vision applications. This paper provides a comparative analysis of four popular image annotation tools: LabelImg, VGG Annotator, Label Studio, and Roboflow. Each tool is evaluated based on its features, ease of use, platform support, collaboration capabilities, supported data types, integration, customization, and scalability. The goal is to offer insights into the strengths and weaknesses of each tool to guide researchers and practitioners in selecting the most suitable tool for their specific needs.

IndexTerms - Image Annotation Tools, LabelImg, VGG Annotator, Label Studio, Roboflow, Comparative Analysis, Computer Vision, Data Labeling, Collaboration, Customization, Integration, Boundary Box, Object Detection.

I. INTRODUCTION

In recent years, the field of computer vision has witnessed remarkable advancements, driven primarily by the proliferation of deep learning techniques. Deep learning, a subset of artificial intelligence (AI), has revolutionized various domains, including image recognition, natural language processing, and autonomous systems. Within computer vision, one of the most prominent and impactful applications is object detection, which involves identifying and localizing objects within images or videos. Object detection has wide-ranging applications across industries, including autonomous vehicles, surveillance systems, medical imaging, and industrial automation. Despite the effectiveness of deep learning in object detection, the performance of models heavily relies on the quality and quantity of annotated data used for training. Creating annotated datasets manually can be laborious, time-consuming, and error-prone, particularly for large-scale projects with diverse object categories. Image annotation tools streamline the annotation process by providing intuitive interfaces, annotation primitives (e.g., bounding boxes, polygons), collaboration features, and automation capabilities.

At the heart of object detection systems lie annotated datasets, which serve as the foundation for training and evaluating algorithms. Image annotation, the process of labeling objects of interest within images, is a crucial precursor to building these datasets. It involves delineating objects using various annotation types such as bounding boxes, polygons, key points, and semantic segmentation masks. The accuracy and comprehensiveness of annotations directly influence the performance and generalization capabilities of object detection models. Given the pivotal role of image annotation in the development of object detection systems, the choice of annotation tool is of paramount importance. Annotation tools vary widely in terms of features, usability, collaboration capabilities, scalability, and integration options. Understanding the strengths and limitations of different annotation tools is essential for researchers, data scientists, and engineers involved in computer vision projects.

This paper presents a comprehensive comparative analysis of four prominent image annotation tools: LabelImg, VGG Annotator, Label Studio, and Roboflow. Through this analysis, we aim to provide insights into the suitability of each tool for various use cases and project requirements. The evaluation criteria include features offered by each tool, ease of use, platform compatibility, collaboration capabilities, support for different data types, integration with other tools and frameworks, customization options, and scalability.

II. OVERVIEW OF EACH ANNOTATION TOOL

In this section, we provide a detailed overview of each annotation tool considered in our comparative analysis: LabelImg, VGG Annotator, Label Studio, and Roboflow. Each tool is evaluated based on its features, usability, platform support, collaboration capabilities, supported data types, integration options, customization features, and scalability. The insights provided aim to offer a comprehensive understanding of the strengths and limitations of each tool, aiding researchers and practitioners in selecting the most suitable annotation tool for their specific requirements.

LabelImg Tool-

LabelImg stands out as an open-source desktop tool tailored primarily for fundamental image annotation tasks, prominently including bounding box and polygon annotations. Its compatibility with a wide range of operating systems, namely Windows, Linux, and macOS, renders it highly versatile, accommodating users across various platforms. Although LabelImg boasts a user-friendly interface conducive to beginners, it might be perceived as lacking in advanced features and collaborative functionalities compared to its counterparts. Nonetheless, its simplicity renders it particularly well-suited for small-scale projects characterized by uncomplicated annotation requirements. The significance of efficient annotation tools, such as LabelImg, in augmenting the productivity and precision of annotation tasks is underscored in a related study [2]. This study emphasizes the pivotal role of streamlined annotation processes in achieving enhanced productivity and accuracy within annotation workflows. LabelImg offers a pragmatic solution for users embarking on image annotation endeavors, particularly those undertaking smaller-scale projects with straightforward annotation needs. Its compatibility across multiple operating systems and user-friendly interface makes it an accessible choice for beginners in the field of image annotation.

VGG Annotator Tool-

VGG Annotator emerges as a noteworthy web-based annotation tool recognized for its intuitive interface and comprehensive support for image segmentation and bounding box annotations. Its accessibility through a standard web browser simplifies the annotation process, especially for tasks involving segmentation. However, it's worth noting that VGG Annotator's collaborative functionalities may be comparatively limited when juxtaposed with more extensive frameworks. Despite this limitation, its versatility in accommodating various data types and seamless usability positions VGG Annotator as an apt choice for mid-sized projects characterized by moderate annotation complexity. A related study [6] pertaining to this work accentuates the pivotal role of user-friendly annotation tools in streamlining the annotation process. It underscores the importance of intuitive interfaces in expediting annotation workflows, thereby enhancing overall productivity and efficiency. In essence, VGG Annotator offers a user-friendly solution for annotation tasks, particularly suited for mid-sized projects with moderate annotation complexities. Its support for multiple data types and ease of use makes it a viable option for annotators seeking efficiency and simplicity in their annotation workflows.

Label Studio Tool-

Label Studio distinguishes itself as a robust open-source data labeling framework, encompassing a wide array of annotation capabilities spanning text, audio, and image annotations. Its accessibility via a web-based interface from any device underscores its versatility and convenience, fostering collaboration among annotators across diverse environments. Notably, Label Studio is adept at supporting intricate annotation workflows, thanks to its modular and extensible architecture, which permits customization through extensions and plugins. This adaptability renders Label Studio suitable for a myriad of annotation tasks, catering to the diverse needs of annotators. A related study [4] pertaining to this work underscores the significance of collaborative annotation frameworks in the development of high-quality annotated datasets. It emphasizes the pivotal role of tools like Label Studio in facilitating collaboration among annotators, thereby ensuring the accuracy and comprehensiveness of annotated datasets. Label Studio emerges as a comprehensive solution for data labeling, offering versatile annotation capabilities and fostering collaboration among annotators. Its modular architecture and customization options make it well-suited for diverse annotation tasks, contributing to the development of high-quality annotated datasets.

Roboflow Tool-

Roboflow emerges as a comprehensive cloud-based data preparation platform tailored to streamline the machine learning pipeline from data annotation to model deployment. Integrating annotation tools, dataset versioning, and model deployment functionalities, Roboflow offers a cohesive solution for annotating, managing, and deploying machine learning models. Noteworthy are its robust collaboration features and support for various data types, facilitating seamless collaboration among team members and accommodating diverse annotation requirements. One of Roboflow's key strengths lies in its integration with popular machine learning frameworks, enhancing workflow efficiency and scalability. By providing compatibility with widely-used ML frameworks, Roboflow simplifies the process of incorporating annotated data into machine learning workflows, thereby expediting model development and deployment. A related study [9] associated with this work underscores the pivotal role of scalable data preparation platforms, such as Roboflow, in accelerating the development and deployment of machine learning models. It emphasizes the importance of streamlining the data preparation process to enhance overall workflow efficiency and scalability. Roboflow offers a comprehensive solution for data preparation, annotation, and model deployment, catering to the needs of both small-scale and large-scale projects. Its robust collaboration features, support for various data types, and integration with popular ML frameworks position it as a valuable tool in accelerating the development and deployment of machine learning models.

III. IMAGE LABELING PROCESS

Image labeling, an essential component of data preparation for machine learning tasks, involves the annotation of objects or regions of interest within images. This section provides an in-depth exploration of the image labeling process, encompassing various annotation techniques, tools, and best practices.

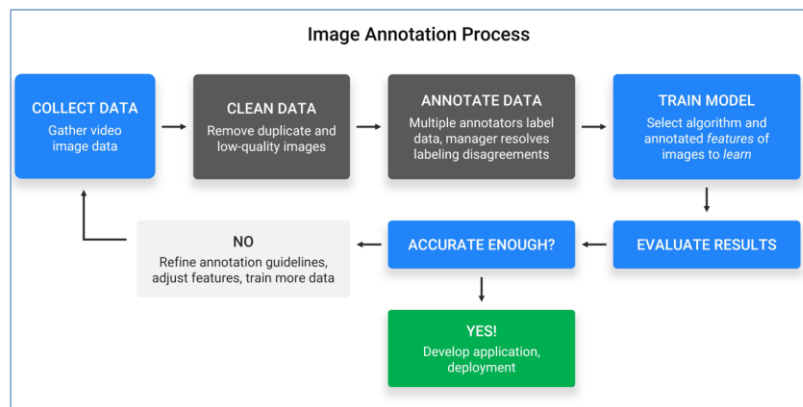


Figure 1: Image Annotation Process [8]

LabelImg Tool- To install LabelImg, you can use pip, assuming Python 3 is already installed on your device. Simply open your command line interface and run the command `pip3 install labelImg`. Once installed, you can launch LabelImg by typing `labelImg` in your command prompt. LabelImg supports labeling in YOLO text or VOC XML file formats, with the default recommendation being the VOC XML format due to its association with object detection standards like ImageNet. After installation, you can define custom classes for your annotation task.

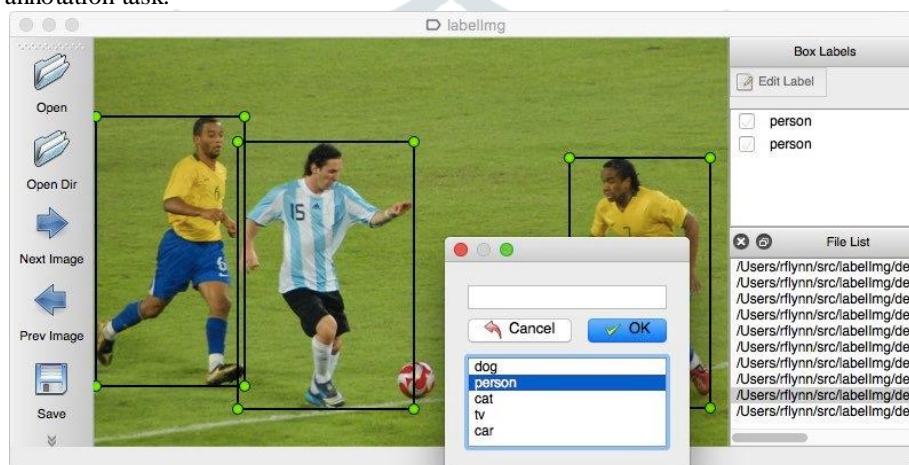


Figure 2: LabelImg Tool Dashboard

To start using LabelImg, you need to open the directory containing the images you want to label. Then, select the directory where you want to save the labeled files, ensuring it is different from the image directory to avoid overwriting the original images. LabelImg provides an interactive window where you can draw bounding boxes or polygons over objects within the images. You can use the "Create Rectbox" option to draw rectangular boxes around objects or the "Create Polygons" option for objects with irregular shapes. As you annotate the images, LabelImg automatically generates XML files containing the coordinates of the bounding boxes or polygons, along with the corresponding class labels. These XML files are saved in the specified directory and can be used for training machine learning models.[8] You can assign a class label to each annotated object by choosing from the predefined custom classes you defined earlier. LabelImg allows you to annotate multiple objects within a single image, facilitating the labeling of complex scenes with multiple objects of interest. LabelImg provides a simple and efficient solution for image labeling tasks. By following these steps, you can annotate images with precision and accuracy, creating high-quality datasets for training machine learning models in object detection and related tasks.

VGG Annotation Tool- To install the VGG Image Annotator (VIA), you don't need to perform any installation steps as it's a web-based tool accessible directly through your browser. Simply navigate to the VIA website to start using it. Once you're on the VIA portal, you'll find a left-hand sidebar where you can define the project you're working on. This helps you organize your labeling efforts efficiently. To begin labeling images, you can load your image files into VIA by clicking on "Add Files" on the left-hand sidebar and selecting the files from your local drive for upload. Your images will then appear in the sidebar for labeling. Labeling images in VIA is intuitive. You can choose the shape of annotation you'd like to make (e.g., bounding boxes, polygons) from the options provided in the left-hand sidebar. Simply click and draw your annotation around the object you want to label directly on the image.

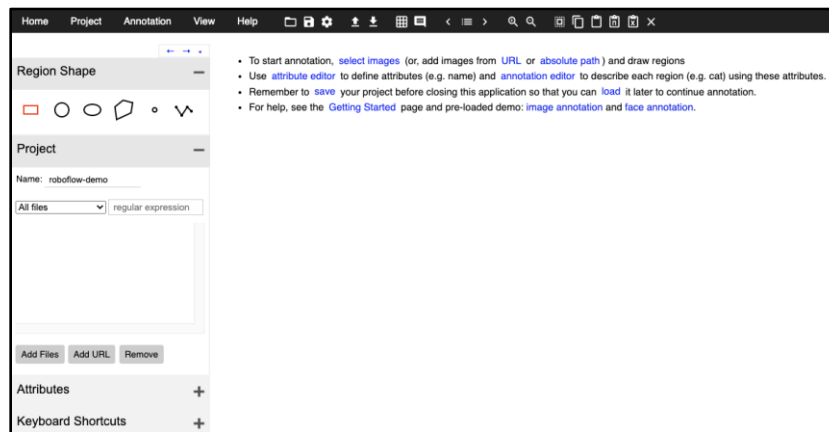


Figure 3: VGG Annotation Tool Dashboard

Assigning class labels to your annotations is also straightforward. You first need to define a Region Attribute, such as "class-label", which represents the class of the annotated object. Then, fill in the assigned class labels for each annotated object accordingly. Once you've finished labeling your dataset in VIA, you can export it for further use. Simply click on "Annotation" in the upper left corner and select "Export Annotations as CSV". This action will download a file containing your annotations to your local file store. If you need to convert your VIA annotations to a different format, you can use tools like Roboflow. By signing up and uploading your dataset, you can easily convert your annotations to any desired format compatible with various machine learning frameworks. In conclusion, VIA offers a convenient and user-friendly platform for image labeling tasks. By following these steps, you can efficiently label your images and create high-quality annotated datasets for training machine learning models.

Label Studio Tool- To initiate the labeling workflow with Label Studio, start by installing the application. You can easily install Label Studio by following the installation instructions provided on their official website or through their documentation. Once the installation process is complete, proceed to launch Label Studio either by accessing the application directly or through your preferred web browser. Following installation, create accounts as necessary for Label Studio.[10] This step typically involves setting up an account to manage and establish labeling projects. You may need to sign up or log in to access the full suite of features and functionalities offered by Label Studio. With the accounts set up, move on to configuring the labeling project. Define key parameters such as the project name, description, and labeling instructions. This step is pivotal in structuring your labeling efforts and providing clear guidance to annotators regarding the task at hand. Customize the labeling interface to suit the specific requirements of your project. This involves selecting and configuring the types of annotations to be made, such as bounding boxes, polygons, or text labels. Additionally, tailor the layout preferences and incorporate any necessary tools or features to facilitate efficient annotation.

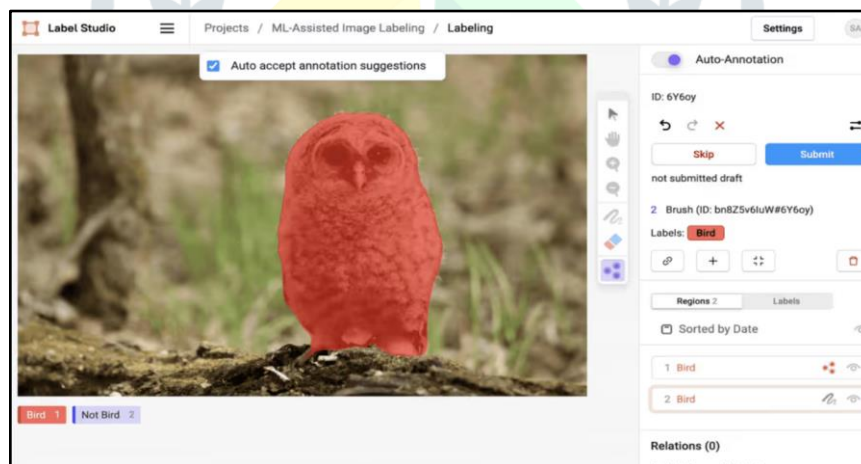


Figure 4: Label Studio Tool Dashboard

Import the data intended for labeling into Label Studio as labeling tasks. This could encompass various data formats, including images, videos, text documents, or other data types supported by Label Studio. Ensure that the data is appropriately formatted and organized to streamline the labeling process. Once the data is imported, annotators can commence labeling and annotating the data according to the instructions provided during project setup.[9] Utilize the labeling interface to generate annotations accurately and consistently across all tasks, ensuring the integrity and quality of the labeled dataset. Finally, upon completion of the labeling process, export the labeled data or annotations for further utilization. Label Studio offers various export options, including CSV, JSON, or XML formats, enabling seamless integration with downstream workflows or machine learning pipelines. By adhering to these steps, you can effectively manage and execute the labeling workflow using Label Studio, ensuring the precise and efficient annotation of data essential for machine learning and AI applications.

Roboflow Tool- Start by creating a dataset. Upload your data to your project page on the Roboflow dashboard to begin a new dataset. This involves organizing and uploading your images or other data files. Next, annotate your images. Use Roboflow's labeling interface to annotate images by selecting them from the Assign or Dataset pages. Utilize tools like Bounding Box and

Polygon Annotation to annotate accurately. If needed, train a model locally using the annotated images. Use your preferred machine learning framework to train the model.

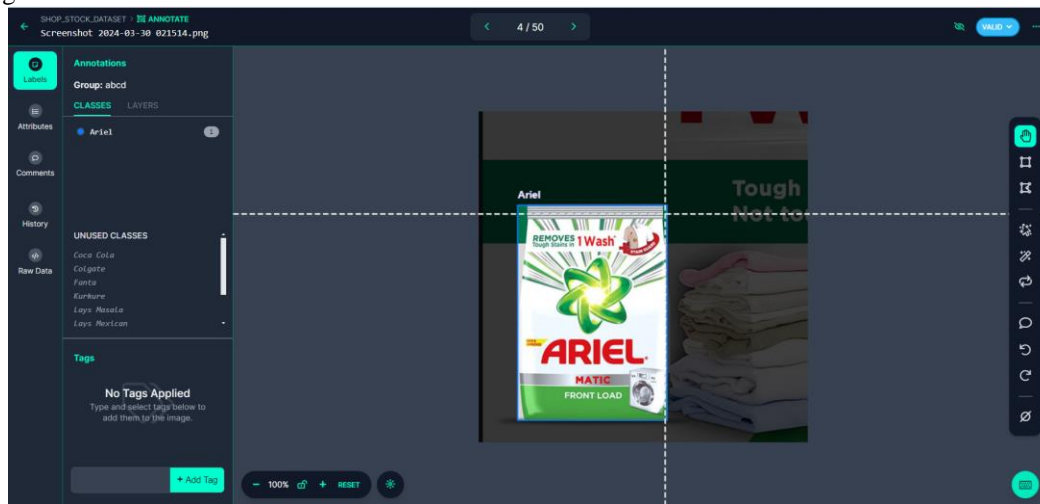


Figure 5: Roboflow Tool Dashboard

Upload the model weights to Roboflow for further analysis and management. Utilize Roboflow's native model to label your images automatically, simplifying the labeling process. By following these steps, you can efficiently utilize Roboflow for dataset creation, annotation, model training, and image labeling.

IV. COMPARATIVE ANALYSIS

Comparative analysis of four popular image annotation tools: LabelImg, VGG Annotator, Label Studio, and Roboflow. Each tool offers unique features and capabilities, catering to different needs and preferences in the image annotation process.

Feature	LabelImg	VGG Annotator	Label Studio	Roboflow
Annotations	Basic (bounding box, polygon)	Image segmentation, bounding boxes	Text, audio, image (various formats)	Image segmentation, bounding boxes
Platform	Windows, Linux, macOS	Web-based	Web-based	Cloud-based
Flexibility	Limited	Good for segmentation tasks	Versatile for complex tasks	Streamlined ML pipeline
Ease of Use	Simple	User-friendly	User-friendly	User-friendly
Collaboration	Not supported	Limited	Supported with versioning	Supported with versioning
Data Types	Primarily images	Images	Text, audio, images	Various data types
Integration	Limited	Limited	Popular ML frameworks	Popular ML frameworks
Customization	Limited options	Limited	Workflow and dataset organization	Workflow, dataset organization, model deployment
Scalability	Best for small projects	Suitable for mid-sized projects	Scalable with cloud infrastructure	Scalable with cloud infrastructure

Table 1: Comparison of Annotation tool

V. Conclusion and Future Work

In conclusion, after conducting a comparative analysis of popular image annotation tools, it's evident that each tool offers unique features and capabilities suited for different needs in the annotation process. Among the tools evaluated, Roboflow emerges as a standout choice due to its comprehensive integration of annotation tools, dataset versioning, and model deployment functionalities. Roboflow streamlines the entire machine learning pipeline, minimizing manual work and enhancing efficiency. Its robust collaboration features and support for various data types make it a preferred option for both small-scale and large-scale projects. Additionally, Roboflow's integration with popular ML frameworks and its scalability with cloud-based infrastructure position it as a versatile tool for image annotation tasks.

Looking ahead, future work in the field of image annotation tools could focus on further enhancing automation features, such as leveraging AI for more advanced annotation tasks. Additionally, there is scope for improving collaboration functionalities and customization options to cater to diverse project requirements. As the field of computer vision continues to evolve, advancements in image annotation tools will play a crucial role in accelerating the development and deployment of machine learning models. By staying abreast of emerging technologies and continuously refining annotation processes, researchers and practitioners can unlock new possibilities in the realm of computer vision.

REFERENCES

- [1] M. M. Adnan, M. S. M. Rahim, A. Rehman, Z. Mehmood, T. Saba and R. A. Naqvi, "Automatic Image Annotation Based on Deep Learning Models: A Systematic Review and Future Challenges," in IEEE Access, vol. 9, pp. 50253-50264, 2021, doi: 10.1109/ACCESS.2021.3068897.
- [2] N. Fiedler, M. Bestmann, and N. Hendrich, "ImageTagger: An Open Source Online Platform for Collaborative Image Labeling," 2018.
- [3] S.S. Killikatt, A. Patil, S. Pharakate, S. Koli, S. Wankhade, and M. Patil, "Object Detection and Image Annotation Using Deep Learning," International Research Journal of Modernization in Engineering Technology and Science, vol. 5, no. 6, pp. 1598-1605, June 2023, doi: 10.56726/IRJMETS41723.
- [4] A. Hanbury, "A survey of methods for image annotation," Journal of Visual Languages and Computing, vol. 19, pp. 617-627, 2008, doi: 10.1016/j.jvlc.2007.01.012.
- [5] T. Sumathi, C. L. Devasena, and M. Hemalatha, "An Overview of Automated Image Annotation Approaches," Science Academy Publisher International Journal of Research and Reviews in Information Sciences, vol. 1, Apr. 2011.
- [6] X. Ning, Y. Li, Y. Xu, and X. Lu, "Research on the Image Annotation Technology for Product Quality and Safety Inspection Data," 2020 J. Phys.: Conf. Ser. 1487 012020, CCEAI 2020, IOP Conf. Series: Journal of Physics: Conf. Series 1487 (2020), doi: 10.1088/1742-6596/1487/1/012020.
- [7] <https://blog.roboflow.com/vgg-image-annotator/>
- [8] <https://viso.ai/computer-vision/labeling-for-image-annotation/>
- [9] N. Mamat, M. F. Othman, R. Abdulghafor, A. A. Alwan, and Y. Gulzar, "Enhancing Image Annotation Technique of Fruit Classification Using a Deep Learning Approach," Sustainability, vol. 15, no. 2, p. 901, Jan. 2023, doi: 10.3390/su15020901.
- [10] S. Kunisetti and S. Ravichandran, "Multi Label Automatic Image Annotation Neural Network to Handle Multi Media Image Retrieval," in Revue d'Intelligence Artificielle, vol. 36, no. 6, pp. 931-937, Dec. 2022, doi: 10.18280/ria.360615.
- [11] U. Ojha, U. Adhikari and D. K. Singh, "Image annotation using deep learning: A review," 2017 International Conference on Intelligent Computing and Control (I2C2), Coimbatore, India, 2017, pp. 1-5, doi: 10.1109/I2C2.2017.8321819.
- [12] M. Aljabri, M. AlAmir, M. AlGhamdi, M. Abdel-Mottaleb, and F. Collado-Mesa, "Towards a Better Understanding of Annotation Tools for Medical Imaging: A Survey," Multimedia Tools and Applications, vol. 81, no. 18, pp. 25877-25911, Mar. 25, 2022. <https://doi.org/10.1007/s11042-022-12100-1>

