MEDICAL UNIVERSITY OF VIENNA

Implementing Virtual Microscopy for Academic Education in Pathology at the Medical University of Vienna

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Objective

The current COVID 19 epidemic has emphasized the need for digital solutions in education. Digital Pathology is ideally suited to translate conventional state of the art teaching into the digital space[1]. Consequently, the Department of Pathology has adapted its digital education environment by reusing and integrating already established institutional infrastructure for remote teaching, while at the same time establishing a new framework capable of enhancing the learning process of individual students.

Methods and Materials

The optimal requirements of a virtual learning and teaching environment were investigated from a students', teachers' and institutional viewpoint using literature research and personal interviews. Based on the findings available solutions were evaluated. A prototype of the software solution with the greatest potential was implemented and its performance tested in use case scenarios. Subsequently, the technical requirements were adjusted to meet real life conditions in terms of storage size, user number and user interface responsiveness.

In a next step the software solution was integrated into the teaching environment and has been tested under real life conditions within two semesters (WS21/22, SS22). Additionally, the software solution is evaluated during this term's courses by means of a structured survey for students as well as open feedback rounds for educators and student tutors working with it.

Lastly, efforts are undertaken to integrate the institutional identity management solution (Shibboleth) and learning management system (Moodle) into the software solution in order to develop new learning tools.
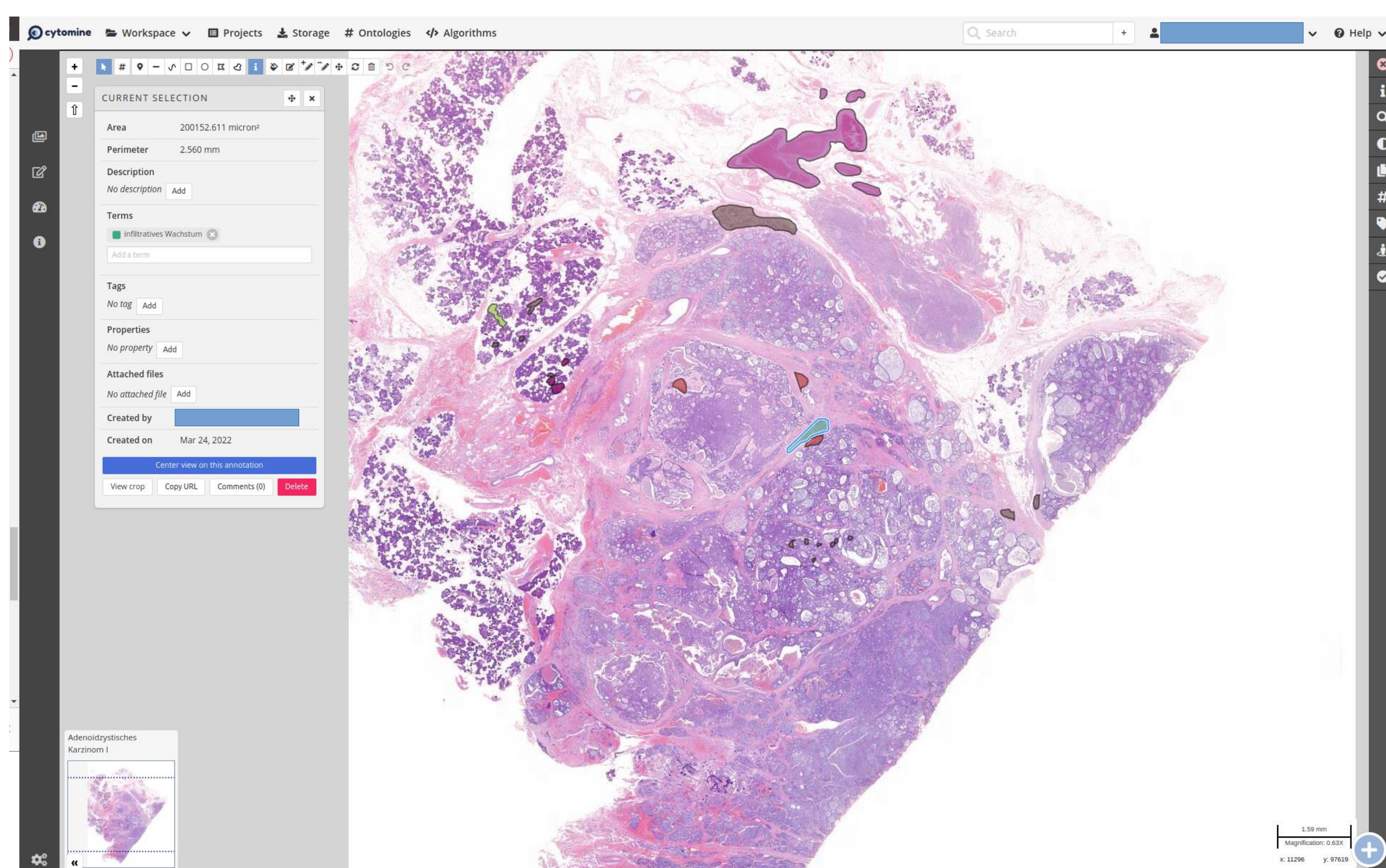
Figure 1: This figure depicts the user interface of the deployed software solution (Cytomine[2]). It showcases a digitized Whole Slide Image (WSI) of an Adenoid Cystic Carcinoma of the parotid gland. The educator has created multiple relevant annotations (colored by different terms) of which one (middle of the image, highlighted in blue) has been selected to display additional information (e.g. the defined Term: 'infiltrative growth').

Results

Mandatory requirements established by students (on demand remote access, interactivity, embedded cross referenced annotations and descriptions), teachers (ease of use, autonomous extension of case collections) and for institutional use (ease of maintenance, long term availability, open source, resource integration, scalability) was met by Cytomine[2], a software that was consequently chosen for further exploration.

To this day eight projects (e.g. collections of digital Whole Slide Images (WSI)) have been created for teaching purposes and are used in dedicated courses. The projects comprise 123 WSIs and students have been spending a total of 51 hours consulting the images.

The feature to create individual annotations within the WSIs has so far been extensively used by students (see Figure 2A), educators and student tutors alike (total number of annotations: 1096, 191, 330; respectively).

References

1. Hamilton PW, Wang Y, McCullough SJ. Virtual microscopy and digital pathology in training and education. APMIS 2012; 120: 305-15. DOI: 10.1111/j.1600-0463.2011.02869.x
2. Raphaël Marée et al., Collaborative analysis of multi-gigapixel imaging data using Cytomine, Bioinformatics, Volume 32, Issue 9, 1 May 2016, Pages 1395–1401, DOI: 10.1093/bioinformatics/btw013

WSIs present within the project have been viewed by students (see Figure 2) over 2122 times to date.

Based on the preliminary data (n=30) of our structured feedback survey, students' user experience was satisfying or neutral in 96.7% (very satisfied 70.0%, satisfied 26.7%) and 3.3%, respectively. No dissatisfaction was observed.

Furthermore, 96.6% of students reported a positive impact of the solution on comprehending the presented content (strong 63.3% and scant impact 33.3%, no impact 3.3%). No negative impact was reported by the students.

Features that were liked the most by students are listed in Figure 3.

Lastly, based on the feedback from students, educators and student tutors the software platform could easily accommodate up to 91 users per hour by the provided resources in a seamless way during peak times. No disruptions of the courses, due to technical malfunctioning of the platform, were observed.

Conclusion/Outlook

The implemented solution is designed as a digital platform that can be used for interactive learning which enables (self-) evaluation of students' learning progress.

Based on the usage statistics and the structured feedback we received, the platform has proven to be ideally suited for the academic educational setting. However, the integration of Shibboleth and Moodle is needed to exploit the full potential of the platform. This would allow the development of new didactical methods designed to increase the recall, in the context of pattern recognition, and morphological understanding of individual students by means of Machine Learning and Artificial Intelligence Systems.

Acknowledgement
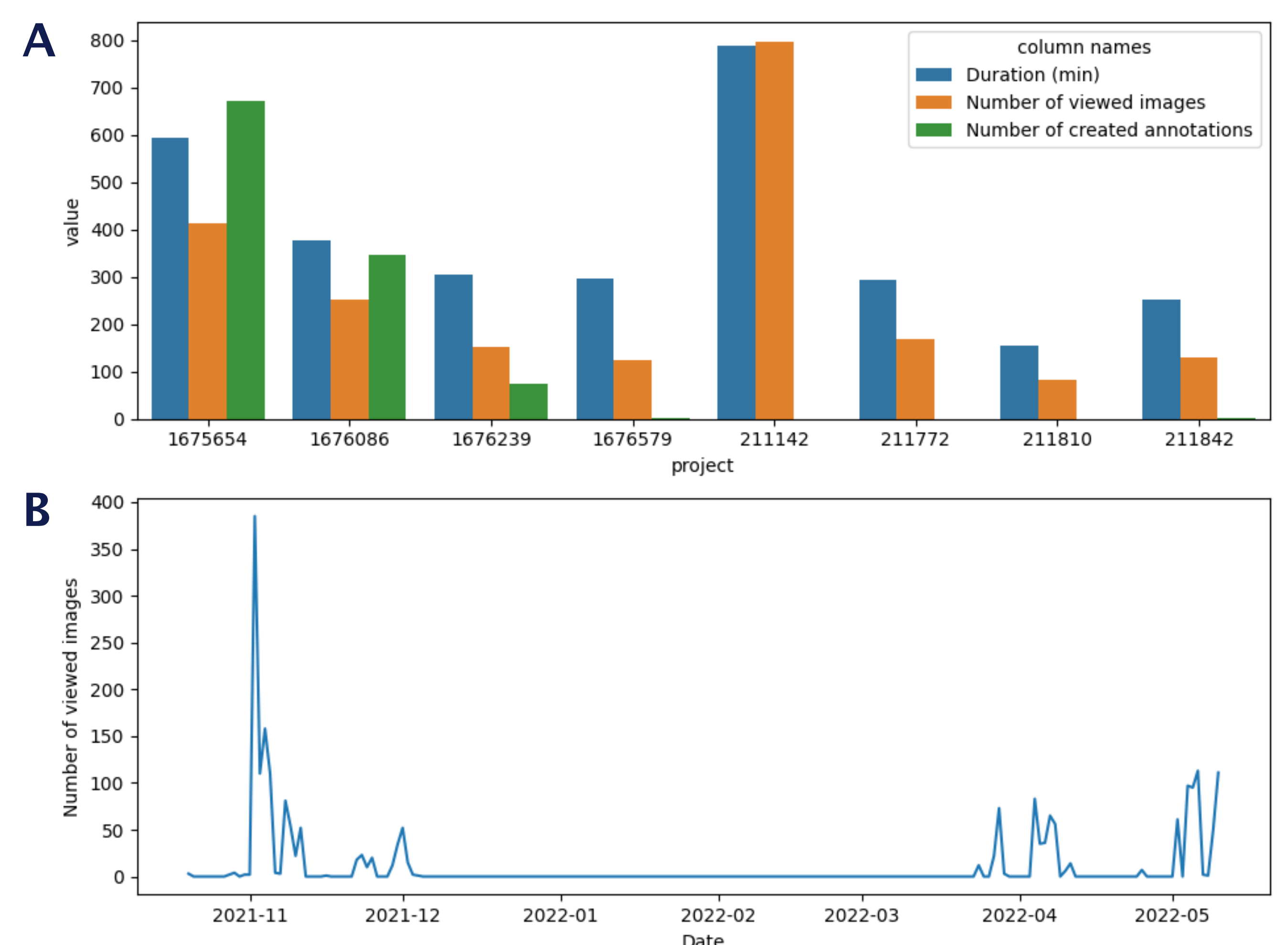
Figure 2: Sub-figure A depicts for each created project the cumulative sum of the duration students were consulting images in minutes (blue), the number of viewed images (orange) and the number of created annotations (green) of students from the creation of the individual project up to present. Sub-figure B depicts the cumulative number of images viewed daily by students since the establishment of the platform.
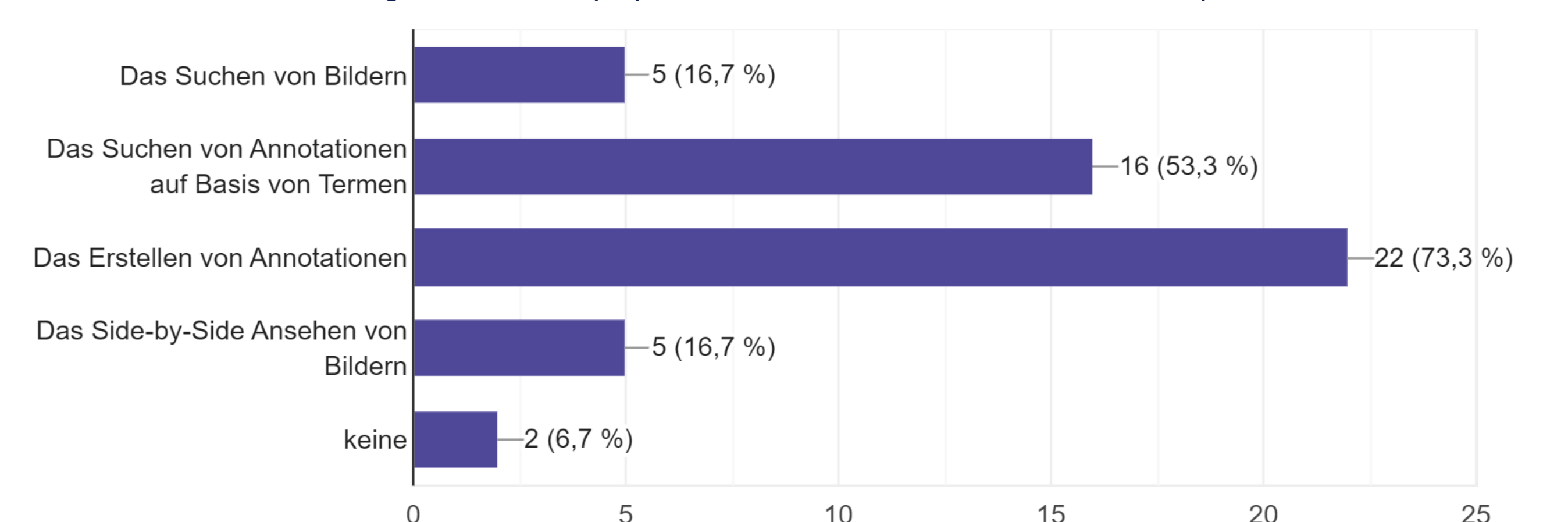
Figure 3: This figure depicts the answers to a question relating to the personal favorite features of the platform (multiple answers where possible) within the structured student survey (Original question, German: 'Welche Features von Cytomine haben Ihnen besonders gut gefallen? Mehrere Antworten sind möglich.' The possible answers, in English, from top to bottom, were: searching for images, searching for annotations on the basis of terms, creation of annotations, viewing images side-by-side, none;