

VoxLogicA: Voxel-based Logical Analyser

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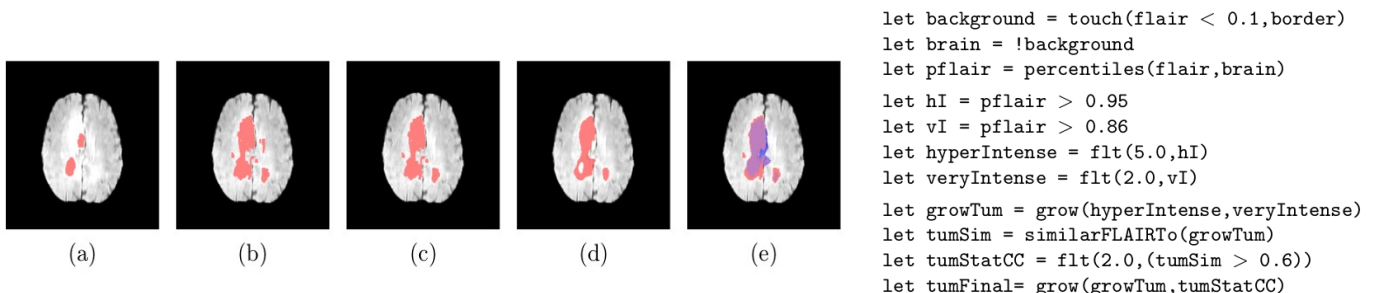
Purpose of the Software

VoxLogicA [1] is a free and open source, multi-platform tool, catering for a novel approach to image segmentation, bringing in ideas from formal methods in software engineering, rapid-development, and declarative programming languages, that have been successful in other domains.

In a few lines of code, complex analyses can be specified, translating domain knowledge into logical properties. For instance, in brain tumor segmentation, logical properties encode facts such as "the oedema touches the tumor", or "the tumor contains hyperintense areas; furthermore, very intense areas that are very close to hyperintense ones, are part of the tumor". Such properties are extremely effective at filtering noise in automated analysis.

The logical core is extended by including imaging primitives, e.g., texture similarity or image normalisation. The language is "a query language for image analysis". Its innovation potential can be compared to that of the "Structured Query Language" SQL, that revolutionised automated data analysis, by permitting queries on large datasets to be designed by experts of the domain to which the data belongs, instead of computer programmers.

In related work [2], circa 200 3D cases of brain tumor from the BRATS challenge have been contoured for radiotherapy, with average DICE score of 0.88 (GTV) and 0.90 (CTV), using a short (10 lines) logical specification, that runs in about 10 seconds per case on a standard desktop machine. The procedure can be explained very easily, and it is amenable to improvement by the community. No machine learning was needed to obtain such results, although the two methods could be combined on a by-need basis.



Methods/Implementation

VoxLogicA reuses methods from "model checking", a branch of Computer Science devoted to the fully automated analysis of software. Logical specifications are automatically turned into parallel execution plans. Tasks of the execution plan are then run using the Insight Toolkit (ITK). 2D and 3D NIFTI, jpg and png images can be loaded and saved. Multimodal analysis is also made easy by the tool; several images from different modalities can be loaded, and related to each other via logic formulas.

Features illustrated at the Exhibit

We shall illustrate the interface and basic functionality of the tool, showing how to program and execute logical specifications of image analysis procedures, both on simple 2D test cases and on 3D images from the glioblastoma case study.

[1] <https://github.com/vincenzoml/VoxLogicA>

[2] Belmonte, Ciancia, Latella, Massink, Springer, 2019

https://link.springer.com/chapter/10.1007%2F978-3-030-17462-0_16

(preprint <https://arxiv.org/abs/1811.05677>)

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