Cloud computing of anatomical similarity

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PURPOSE: In image-guided interventions, anatomical structures are typically derived from medical images by means of segmentation. In applications, such as radiation therapy, finding the previously computed treatment plan which shares the most similar anatomy with the current patient helps to determine the optimal treatment plan parameters. This, however, requires a performance-heavy and typically lengthy computation. We propose to use the cloud to find the most similar anatomical structure set, in order to decrease computation time by performing the similarity analyses in parallel.

METHODS: The similarity analysis computation was performed on Amazon Web Services (AWS) Elastic Cloud Compute instances, using 3D Slicer and SlicerRT. 3D Slicer (www.slicer.org) is an open source platform for medical image analysis and visualization and SlicerRT (www.SlicerRT.org) is a radiation therapy research extension for 3D Slicer [1]. The AWS Simple Storage Service and Simple Queue Service were also used, for storage of the previously created studies and messaging between the local computer and the instances, respectively. The anatomical data used in this work were CT scans and structure sets from radiation treatment studies. To find the study in the database most similar to the study under comparison, the CT from the comparison study was registered to the CTs from each study in the database, and the resulting transformation was applied to the structure set from the comparison study. The Dice coefficient was computed for pairs of matching contoured structures from each study.

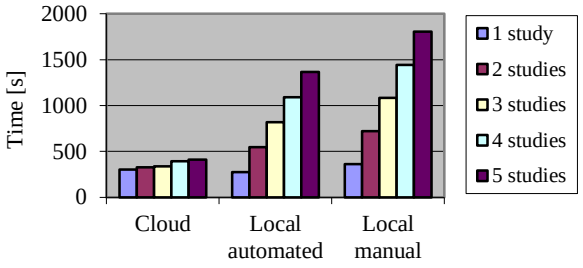

Figure 1. Length of time for treatment plan selection on different setup configurations. Local automated is the local computer using the automated workflow, and local manual is the local computer using the manual workflow.

RESULTS AND DISCUSSION: The system was tested on five simulated datasets. A patient CT with pre-contoured structure set was transformed by random known parameters, to create five different but similar patient studies. Each study was presented to the system as the study under comparison and in each case the system returned the correct result. The computation time was measured for three different setup configurations, for one to five studies (Fig. 1). The different setups were using the cloud, using the local computer with an automated workflow for computing the similarity, and using the local computer and manually performing the comparison using the SlicerRT graphical user interface. The cloud had the smallest computation time of the three setup configurations for two or more studies to be compared to. The computation time for the cloud grew by 27.5 seconds on average, which would produce an estimated computation time of less than 10 minutes for 10 comparison studies.

CONCLUSION: This system presents a new use of the cloud with a system for finding the structure set with the greatest anatomical similarity to a given set. The decrease in computation time was significant when compared to similarity computations performed solely on the local computer. For this proof-of-concept work, contour comparison was used to determine similarity, however as contouring is a time-consuming process, in the future raw anatomical data in the image intensity domain will be compared. The new study, in all likelihood, will show that using the cloud allows for even much greater reduction rates in computation times.

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