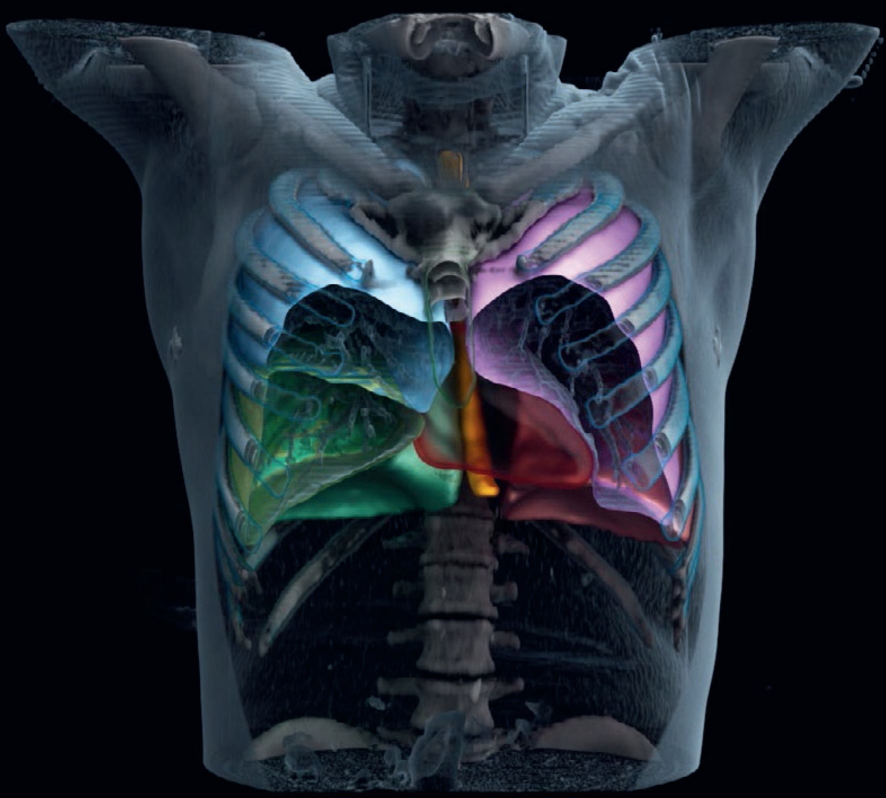
Customer Experience

AI-Rad Companion Organs RT

The power of automated contouring at CCGM Montpellier

siemens-healthineers.com/ai-rad-companion



Rendering not generated in the AI-Rad Companion Organs RT

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Challenges with Organs at Risk (OAR) contouring

In many institutions, OAR are contoured manually and as a result, valuable staff resources are tied up, turning OAR contouring into a cost and time intensive task. In addition, inter-observer variability can make it difficult to achieve consistent contouring results and operators need to be trained on common contouring guidelines. Considering staffing issues such as high turnover rates, OAR contouring still posses a challenge for many institutions.

In the last decade, various automatic contouring solutions have been introduced to address these challenges. However, the results may not be clinically useful for the RT professionals leading to significant editing or redoing of the contours.

Figure 1: Manual contouring is a time consuming process requiring considerable effort which often leads to significant variability and inconsistency between users during the radiotherapy planning process.

AI-Rad Companion Organs RT – Overview

Automatic contouring for AI-Rad Companion Organs RT

What is AI-Rad Companion Organs RT?
AI-Rad Companion Organs RT is a an AI-based solution that provides radiation oncology professionals with automatic contouring of organs at risk, which is input to their radiation therapy planning via the teamplay digital health platform. The images acquired at the CT scanner are sent to AI-Rad Companion Organs RT to be processed, and then the RTStruct (DICOM) results can be pushed directly to the treatment planning system or first reviewed in the AI-Rad Companion Organs RT interface.

AI-Rad Companion Organs RT provides organs at risk contours using deep-learning (AI) algorithms for various body regions, including head and neck, thorax, abdomen, and pelvis. It also supports the use of organ template configurations that can be aligned with institutional protocols; this may save time and improve standardization in clinical workflows.

What are the key benefits?
By leveraging Artificial Intelligence (AI) to generate OAR contouring, AI-Rad Companion Organs RT, enables high quality OAR contouring to drive standardization with AI-powered algorithms. These benefits can potentially free up staff to spend more time on other tasks and help to simplify radiotherapy planning workflow.

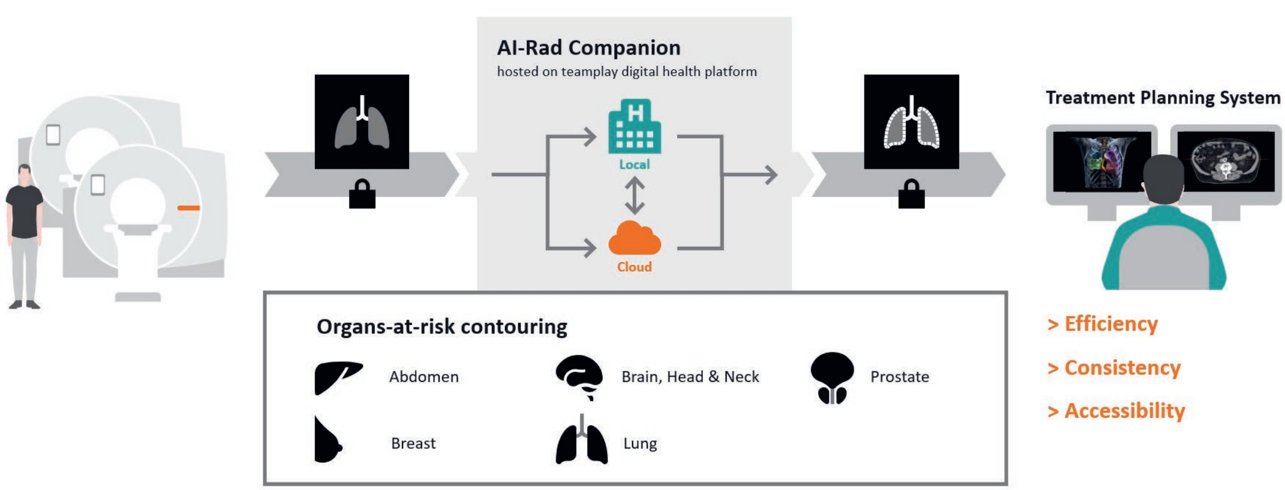

Figure 2: AI-Rad Companion Organs RT, seamlessly integrates into your hospital environment – and your workflows.

AI-Rad Companion Organs RT is not commercially available in all countries. Future availability cannot be ensured.

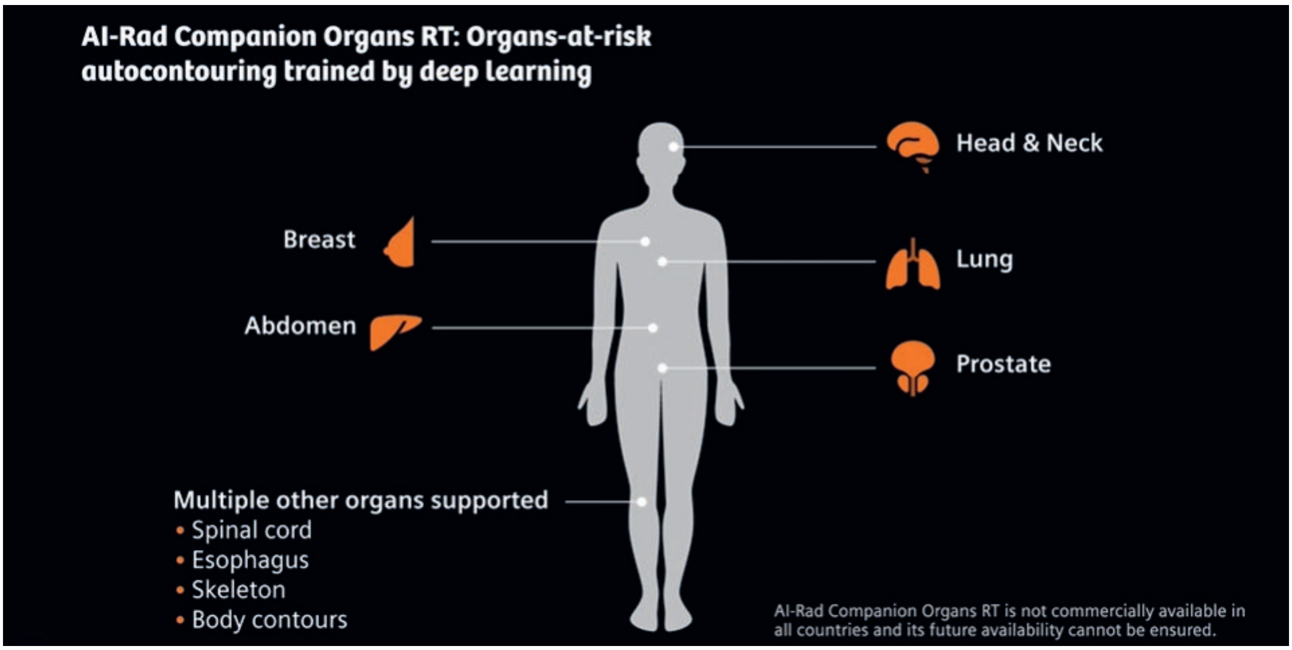

Figure 3: Overview of body parts and cancer sites that are supported by AI-Rad Companion Organs RT.

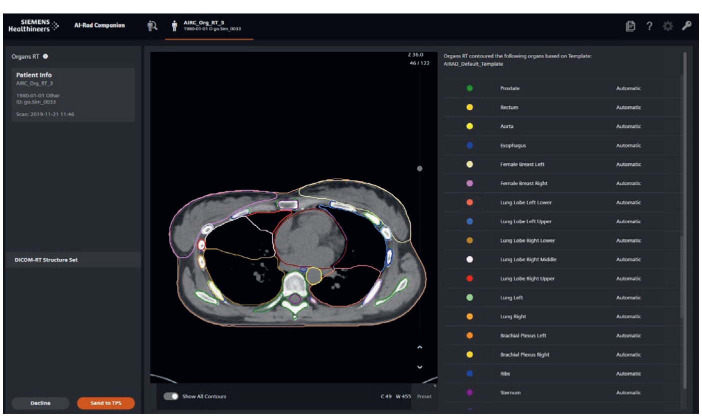

Figure 4: The result preview displays a contoured dataset of the thorax.

Courtesy: University Hospital Erlangen, Erlangen, Germany

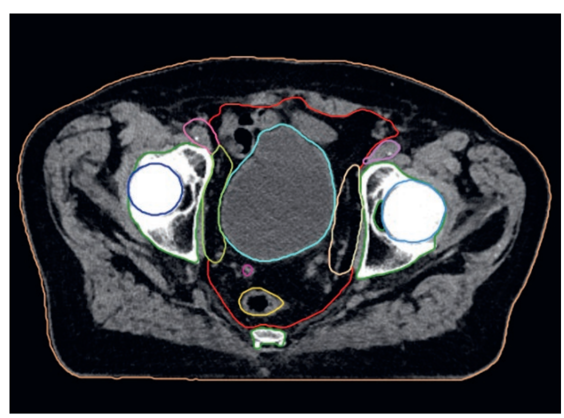

Figure 5: Exemplary visualization of a contoured region in the male pelvis.

Courtesy: University Hospital Erlangen, Erlangen, Germany

Automatic contouring for cancer therapy

In the last couple of years, not only has the cancer incidence rates increased, but so has the amount of patients receiving Radiation Therapy (RT). Up to two thirds of all patients with cancer will need RT treatment during the course of their disease [2].

Each patient arriving at the RT department requires a treatment plan. Contouring the organs-at-risk is the necessary first step in the process of treatment planning. Therefore, the increase in the number of patients puts significant pressure on radiotherapy staff responsible for OAR contouring results. In addition, effective treatment planning for cancer patients, requires high quality contours. Advances in technology and AI can potentially help automate repetitive tasks such as OAR contouring to reduce workload, save time and drive standardization using AI-powered algorithms.

Increase in worldwide cancer cases expected
Total of new cases worldwide [3]

Percentage of cancer patients receiving radiation therapy
Up to 2/3 of cancer patients receive RT [4]

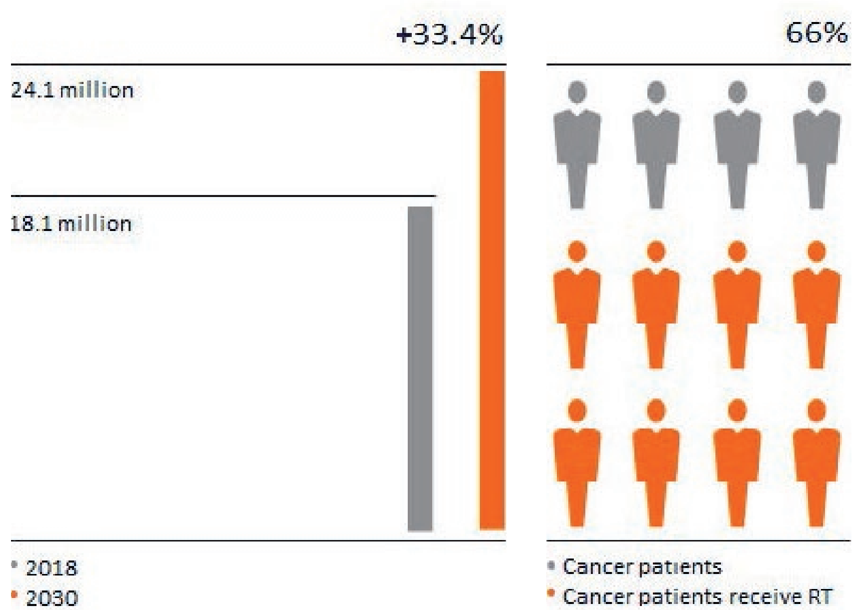

Figure 6: Cancer statistics and incidence predictions.

Automatic contouring with AI-Rad Companion Organs RT: a study with CCGM Montpellier

Overview

Improving therapeutic decision and treatment planning in radiation oncology
The manual delineation of organs at risk (OAR), is a time-consuming labor-intensive process prone to inter-observer variability. In addition, the ability to adapt radiation treatments during the therapy phase limits the optimal use of adaptive radiotherapy. Automating the contouring process, can be beneficial in optimizing workflows and enabling efficient radiation therapy planning in a patient care pathway. Effective treatment planning requires high quality contour results, to ensure a more precise dose distribution and optimization of radiotherapy treatments thereby sparing healthy OAR located near a tumor, from unnecessary radiation.

AI-powered automatic contouring
To analyze the AI-powered automatic contouring cloud based service of the AI-Rad Companion Organs RT, a clinical evaluation was conducted together with Oncology institution, Centre de Cancérologie du Grand Montpellier (CCGM) located in the southern region of France. The entire study was conducted over a five month period.

The aim of the clinical evaluation was to confirm that the results of automatic contouring were in line with the expectation from CCGM on the functionality of AI-Rad Companion Organs RT across three key areas:

- Time-savings using through automated organs at risk contouring
- Standardization with AI-powered algorithms for high-quality organs at risk
- Simplifying clinical workflow by automatically providing OAR contours to the Treatment Planning System (TPS)

*"Automatic contouring helps with increase precision which is highly beneficial for patients."**

Process & methods
The automated contours generated by AI-Rad Companion Organs RT were evaluated by two experienced board certified clinicians (a physician and physicist). An agreed upon study was defined where clinicians would analyze contours generated by AI-Rad Companion Organs RT of the Head & Neck, Thorax (Breast/Lung), Abdomen, Pelvis (Male/Female) and compare to contours generated by skilled personnel, according to CCGM's current standard clinical processes and provide feedback. A 4-point scale was used to judge the AI-Rad Companion Organs RT generated contours, where a rating of 4 is clinically usable, 3 – contours required minor edits, 2 – contours required major edits, and a rating of 1 is need to re-do. This scale was used to simplify contour grading. To determine time-savings, manual contouring times were assessed in a sample set of cases where the involved clinicians measured the time it took to manually contour the OARs.

*"The automatic contouring feature of the AI-Rad Companion Organ RT is life changing for us clinicians."**

Manual contouring tools such as interpolation were allowed. These times where then compared to the time spent in the automated OAR contouring to estimate time-savings.

** All quotes in this document are from Prof. Muraro.*
The statements by Siemens Healthineers' customers described herein are based on results that were achieved in the customer's unique setting. Because there is no "typical" hospital or laboratory and many variables exist (e.g., hospital size, samples mix, case mix, level of IT and/or automation adoption) there can be no guarantee that other customers will achieve the same results.

Results & discussion

Of the OAR contours for combined regions generated by AI-Rad Companion Organs RT and evaluated by CCGM (N = 55), as shown in figure 7, 77% of generated contours required no edits and were clinically usable (rating = 4) and 95% of the generated contours were clinically usable or required minor edits (ratings 4 & 3).

The Thorax, male and female pelvis, received rating of greater than 95% results which include contours that are clinically usable or require minor edits.

Across all organs covered in this study, only 7–8% generated contours required a repeat with a must redo rating (rating = 1).

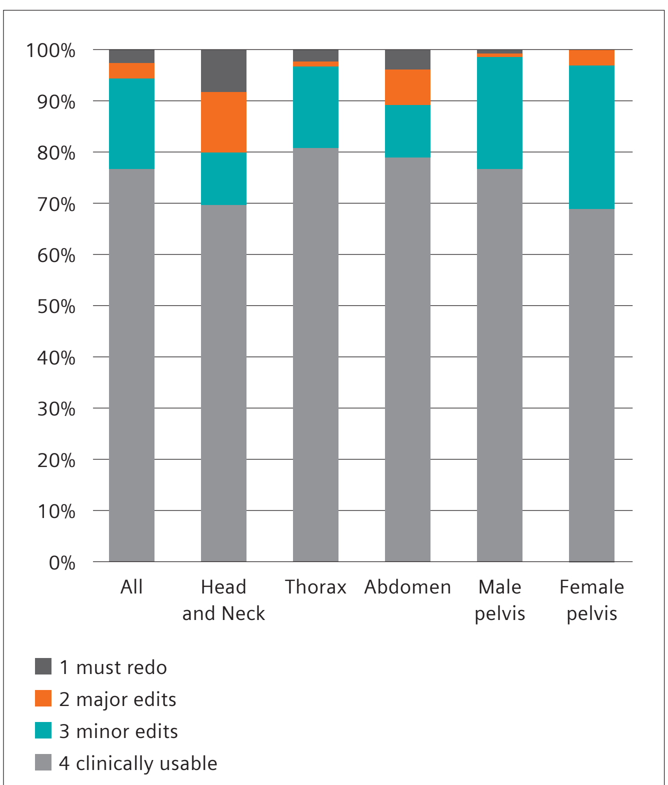

Figure 7: Contour ratings.

Summary

AI-Rad Companion Organs RT is designed to address the labor-intensive and time consuming segmentation of OARs which requires high quality results for optimal radiation therapy planning. Leveraging an AI based deep learning algorithm deployed in the cloud, AI-Rad Companion Organs RT is able to seamlessly perform automatic contouring for output to a treatment planning system in the form of DICOM RT structure set files (RTStruct).

Overall the results from the study with CCGM, showed acceptable outcomes in the automatic contouring of OARs using AI-Rad Companion Organs RT. The annotators evaluation showed that close to 77% of organ contours required no modification and 95% of the organs contoured were classified as either clinically usable or requiring minor edits.

The AI-Rad Companion Organs RT solution, supports a fully automated workflow with the potential for time-savings and increased standardization with the use of AI-powered algorithms for high quality organs at risk contouring. Time saved with automated OAR contouring may allow clinicians to be freed up to focus on other clinical tasks.

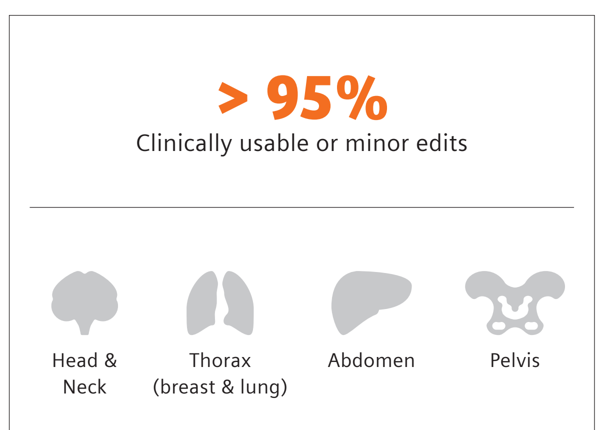

Figure 8: Organs in review.

Appendix

Training of AI-Rad Companion Organs RT algorithm

The AI-Rad Companion Organs RT algorithm is trained to leverage Deep Learning (DL) technology that enables supervised learning. By exploiting supervised and unsupervised deep learning methods, AI Rad Companion Organs RT algorithm is trained with high quality data annotated by experts to achieve robust performance.

In order to learn organ segmentation, a Deep Image-to-Image Network (DI2IN) is employed. It consists of a convolutional encoder-decoder architecture combined with a multi-level feature concatenation. A Generative Adversarial Network (GAN) is selectively used to regularize the training process of DI2IN by discriminating the prediction of the DI2IN from the ground truth. The model is selected in the epoch with the best performance on the validation set. A GAN uses two networks that compete against each other during the training process. The first network – the generator – tries to emulate a human drawn contour while the second network – the discriminator – tries to discriminate the prediction of the first network from the ground truth (human drawn contour). The information is then fed back to the respective networks. This iterative process ensures that during the training of the networks, the machine generated contours become virtually indistinguishable from the human drawn contours. For algorithm training, CT datasets were obtained for each body region from various radiation therapy and radiology departments in Europe and America.

Ground-truth contours were manually generated on these CT datasets by a team of experienced annotators overseen by radiation oncologists or radiologists. For this process, a consistent annotation protocol was set up beforehand based on widely accepted consensus guidelines such as the ones published by the Radiation Therapy Oncology Group (RTOG/NGR). The deep learning model for organs segmentation is trained with optimized CT data and corresponding ground truth segmentation following standardized annotation protocol.

AI-Rad Companion Organs RT employs an automatic contouring process where deep learning AI algorithms are used to provide organs at risk (OAR) contouring on CT images according to pre-selected structure templates. Structures with pre-defined attributes are stored within the organ database. The template configuration feature, defines the organs to be contoured and sets rules for the automatic selection of templates. The results of the automated contouring generated by AI-Rad Companion Organs RT, can be sent directly to a treatment planning system (TPS) thereby enabling a seamless workflow.

Understanding the mechanism behind automatic contouring of OARs

The automatic process of contouring OARs relies on a deep learning based model which consists of a two step approach as seen in Figure 9.

In the first step, the target organ region in the optimal input image is extracted using a trained Deep Reinforcement Learning network (DRL) [5]. The result is a cropped image of the target organ region. In the second step, the cropped image is used as input to create the contours. This step is based on a DI2IN [6]. The DI2IN was trained to its optimal performance in the Siemens Healthineers AI environment. The DRL algorithm also has the ability to detect multiple target regions.

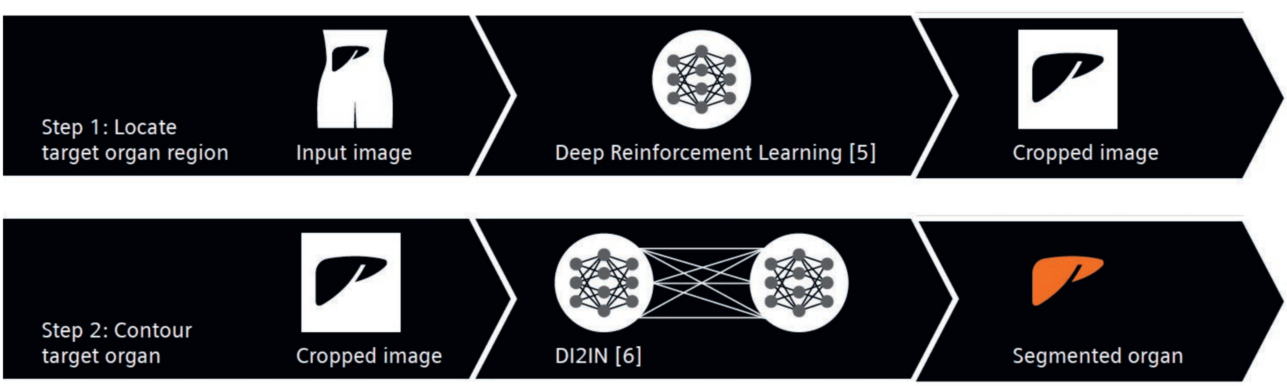

Figure 9: Two step algorithm for DL-based contouring.

Please note – the algorithm is not self-learning. Your data is not used for further training.

References

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