

Problem

Pelvic organs such as the bladder, rectum or prostate, have highly variable shapes, due to their soft and flexible tissues and varying filling. Recent clinical work suggests that these variations might affect the accuracy of radiation therapy treatments of patients with prostate cancer. Within the context of adaptive radiotherapy, the robust design of radiotherapy treatment planning requires the analysis of large shape cohorts of pelvic organs.

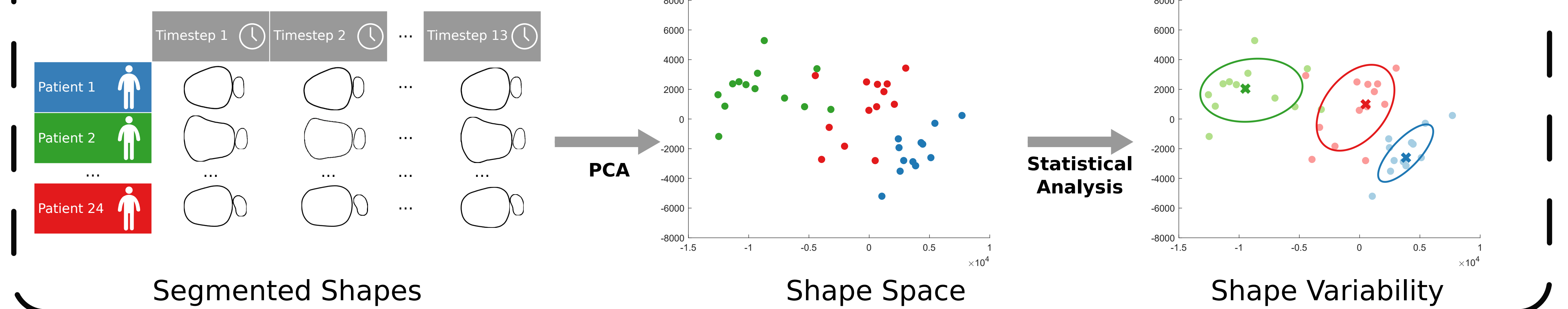
Challenges

We propose a novel visual tool that aims at supporting researchers in their analysis of segmented pelvic organs across multiple patients and across the whole treatment process. To this regards, we focus on two important tasks:

- (T1)** Global Exploration and Analysis of Shape Variations across a Cohort of Patients
- (T2)** Local Exploration and Analysis of Shape Variations of individual Patients and Organs

Approach

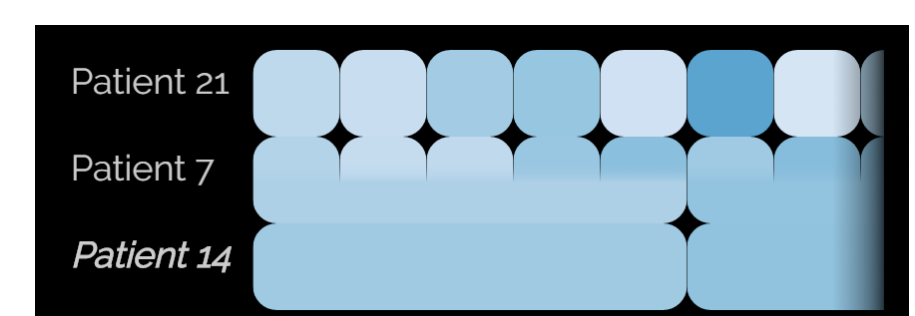
Shape Analysis



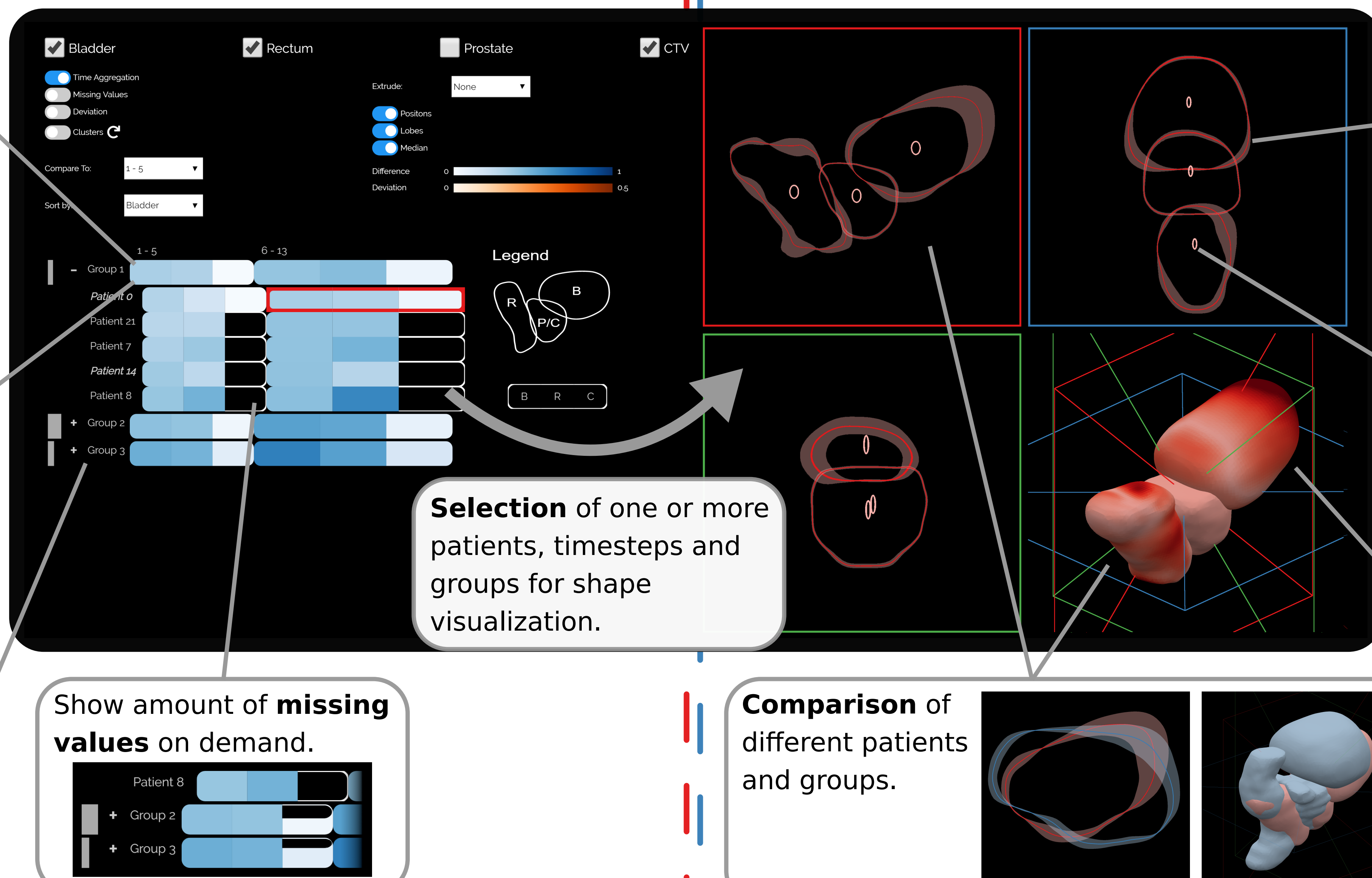
(T1) Cohort Visualization

Shape differences for one or multiple organs are calculated on a per-patient basis and shown in a **tabular representation**.

Aggregation of patients and timesteps.

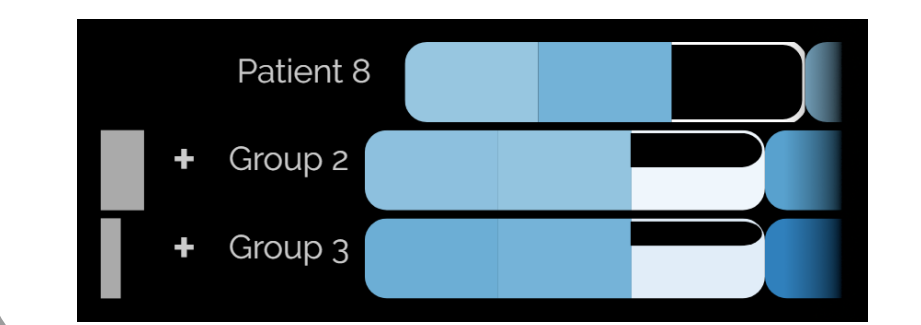


Sorting and Grouping of patients based on their average difference values or metadata like the occurrence of side-effects. **Histograms** indicate the patient distribution across groups.



Selection of one or more patients, timesteps and groups for shape visualization.

Show amount of **missing values** on demand.



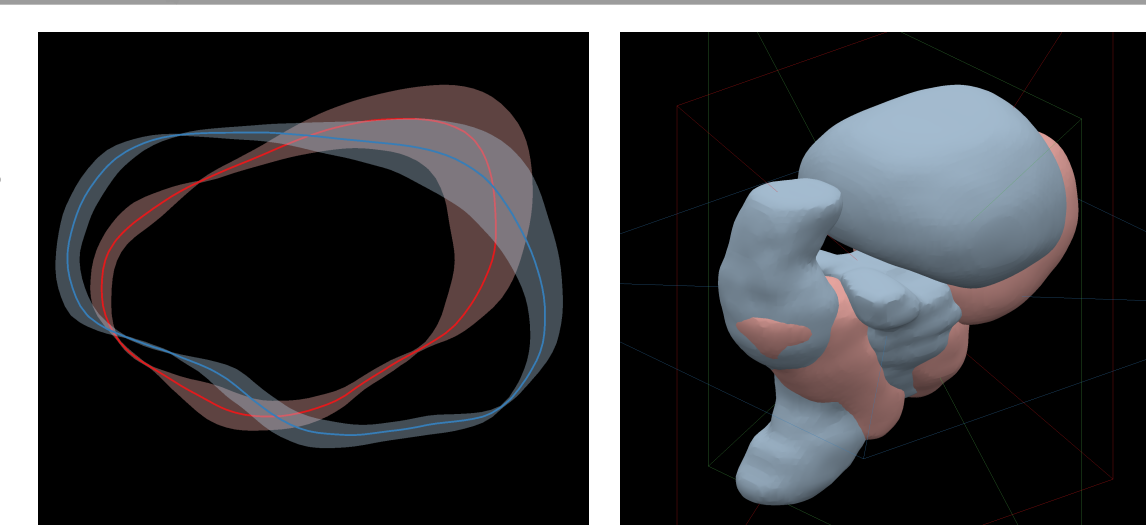
Shape Visualization (T2)

Aggregated **shape variations** are shown using a median contour and confidence bands in 2D slice views (sagittal, axial, coronal).

Position changes derived from the center point are indicated using ellipsoidal glyphs.

3D shape **overview** with plane indicators for slice views and color-coded shape variations.

Comparison of different patients and groups.



Results

Together with two researchers in medical physics, we explored different usage scenarios to see how well Pelvis Runner is able to support their workflow, including the exploration of shape variations for one or multiple organs, the identification of common shape types as well as the separate analysis of patients with and without treatment side-effects. The last scenario was of great interest for them as it could give "*indications of patients that will fail or that may develop toxicity at the beginning of the treatment*".

Future Work

For future work, the clinical researchers suggested functionality improvements, such as the possibility to perform precise measurements in the 2D anatomical views. Another possible user group we should include in future works are clinicians performing the dose planning for treatments. This group could benefit from a simplified, more guided version of the application. The Pelvis Runner is a first step towards the analysis of variability in multi-organ cohorts of prostate cancer radiotherapy patients.