Automatic treatment planning implementation using a database of previously treated patients

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Purpose/Objectives

- Using a database of prior patient dose and shape relationships allows for the prediction of dose on future patients.
- Automatic planning improves the speed of treatment planning by providing a good initial plan for the dosimetrist to start from
- Database driven solutions improve quality by predicting the lowest known achievable critical structure dose from prior patients
- Safety is improved by showing suggesting solutions that are more realistic
- Toxicity and other planning data can be recorded to improve plan selection

Materials/Methods

- A patient population of 53 patients from 3 institutions is contained within the database
- Dose and structure data is available for 46 patients from 2 institutions.
- Prior planning information is stored in an Microsoft SQL Server 2005 relational database.
- Automated scripts written in Python and connected to Pinnacle 9.4
- The database schema is designed to collect dose, structure, and toxicity information

Figure 1: Database schema. Database contains planning, dose and structure data for each patient. Raw dose and shape relationship points are stored in the database for maximum flexibility in lookup.

- To provide consistent structure naming in the database, a software tool is used to rename structure names to a standardized naming scheme.

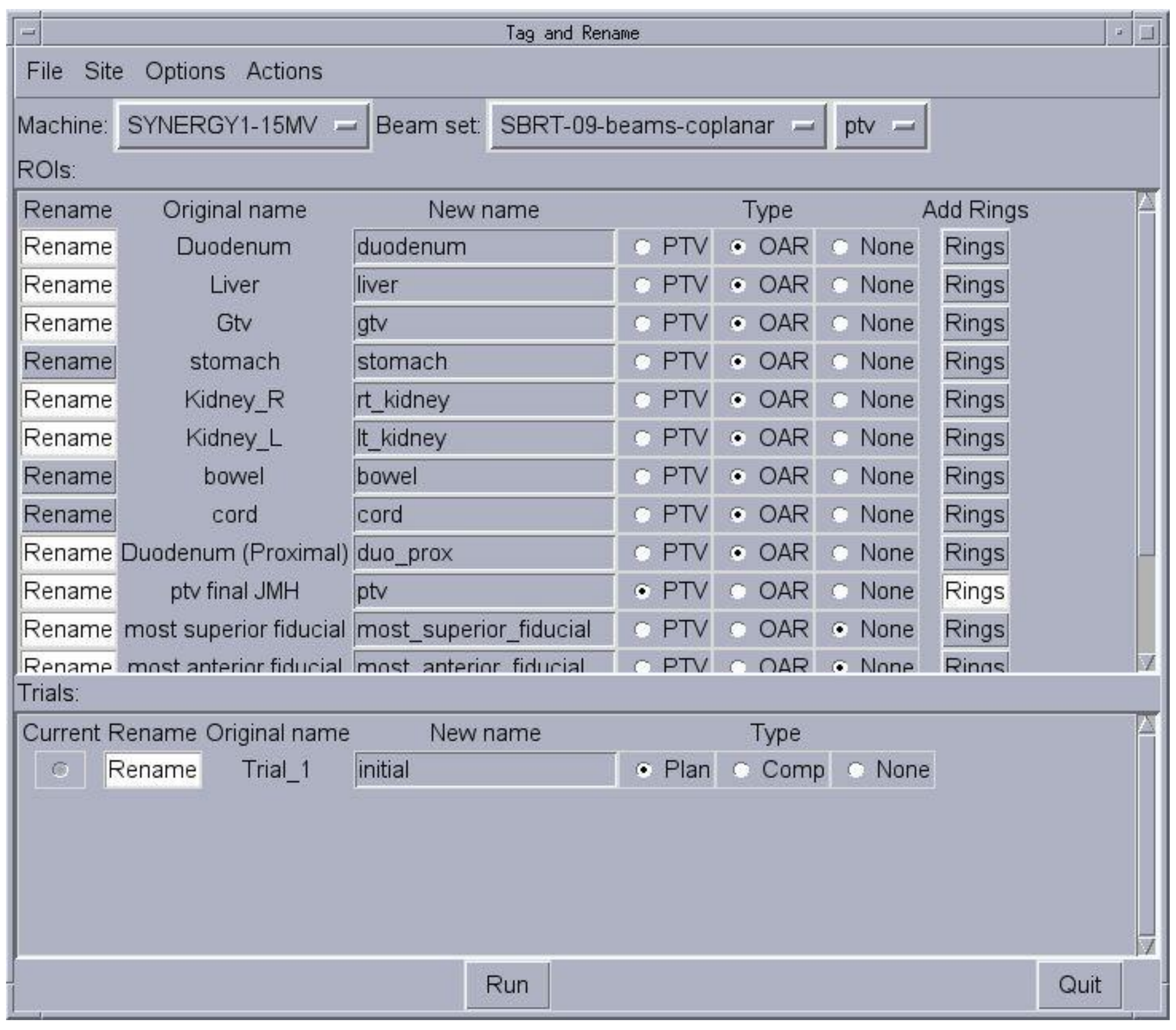

Figure 2: Renaming and planning tool

- Common alternative structure names are automatically mapped to standard names. Uncommon names can be renamed manually.
- Structures are grouped into PTV, OAR and None
  - PTVs and OARs are added to database
  - Structures marked as None are ignored
- The planning tool allows for typical plans to be rapidly generated from just the plan contours with several selectable options.
  - Adds ring structures
  - Combines common OARs
  - Places an isocenter in the center of the primary target
  - Sets a prescription based upon the selected plan type
  - Adds a pre-defined set of beam at a selected energy for a specified machine
  - Selects a dose grid that covers all relevant structures

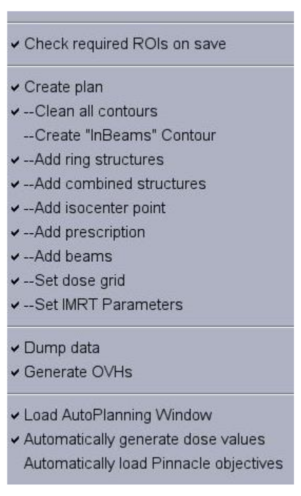

Figure 3: Planning options

- Software verifies required structures are present
  - Structures that are not contoured by the physician or are misnamed are identified
  - Duplicate structures in the mapping process are identified
  - User is prompted before the planning tool is started
- Overlap Volume Histograms are computed for each PTV-OAR combination

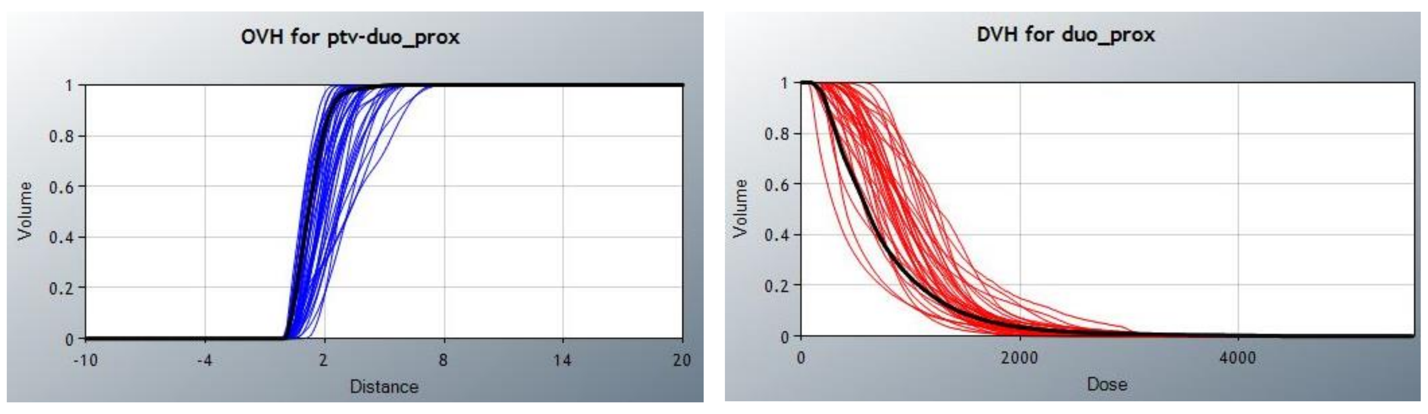

Figure 4: Overlap Volume Histograms represent relative volume of overlap of the OAR with the target as a function of expansion distance of the target. They can be read as Y% of the OAR is within X cm of the target. All patients with OVH curves left of the black line are harder to plan. The black DVH represents the same plan.

Materials/Methods (cont.)

- After OVHs have been calculated for each structure, the automatic planning tool allows for querying of the optimization objectives from the database
- The interface allows for selection from a predefined set of prescriptions
  - New prescriptions can be added by defining parameters in a comma separated value text file
- The query selects from the patients in the database those which have achieved a target dose greater or equal to the prescription target dose.
- For each structure, the patients which have the same or closer shape relationship between the target and structure is selected. The lowest achievable dose from this group is returned by the query

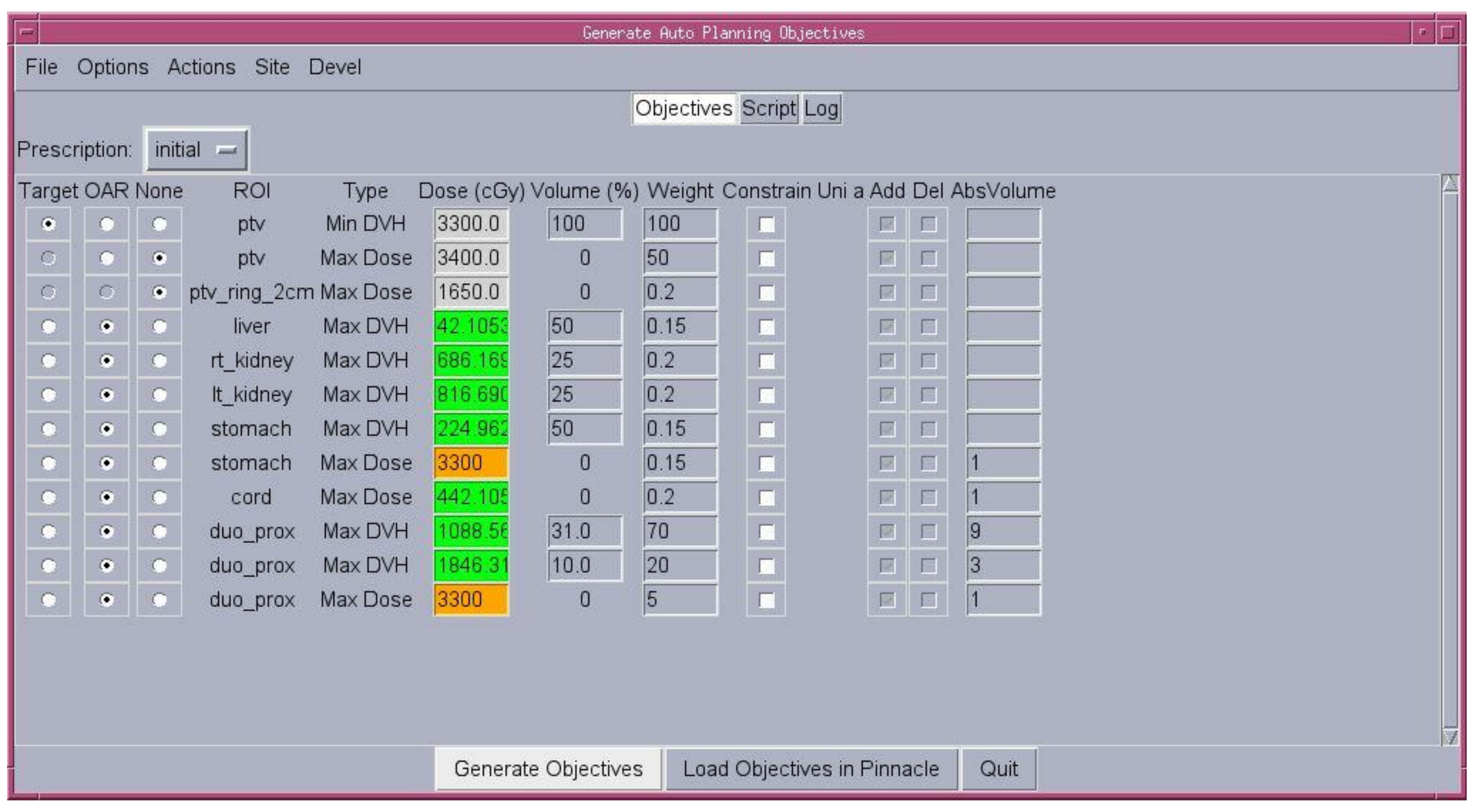

Figure 4: Auto planning objective lookup. Maximum dose points are queried from database. Successful lookups are colored in green, unsuccessful lookups in orange. Values can be manually adjusted especially in the case of unsuccessful lookups. Objectives can be automatically exported to Pinnacle or manually entered into a different planning system.

- Unsuccessful queries are from more difficult cases where there is no shape relationship in the database of equal or closer distance.
- To aid in plan evaluation, a tool to check protocol compliance is used

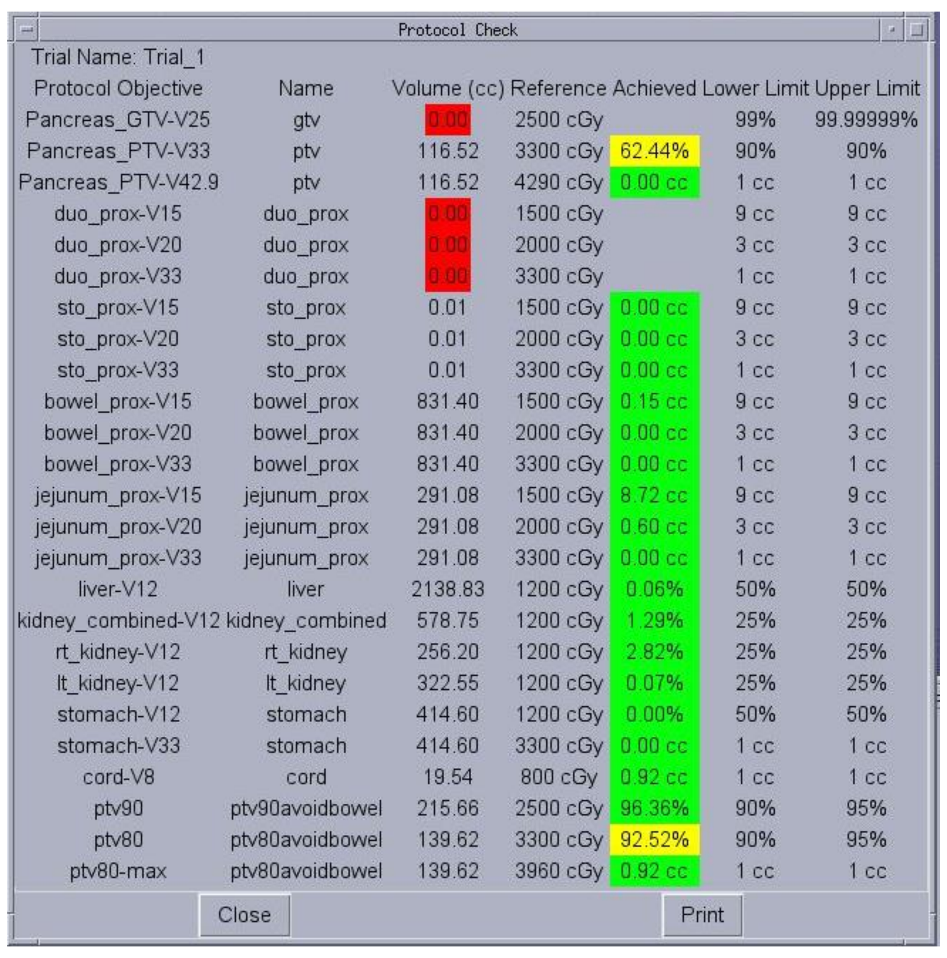

Figure 5: Protocol check interface. Color coded values indicate which objectives are achieved and which are not met. Volumes highlighted red indicate missing structures.

- Protocol objectives are defined in a comma separated values file and allow flexibility in defining protocol parameters including upper and lower limits on goals.
- Plans can be evaluated with a single click from the planning system and the resulting spreadsheet can be included in plan documentation
- Approved plans are added back to the database to improve the selection for future patients.

Results

- OVH calculation requires approximately 1.5 minutes for a pancreas SBRT plan
- With the current database population, each objective requires approximately 4 seconds to query from the database.
  - As the database grows, lookup time will increase
  - DVH and OVH features (typically relevant points) can be stored to improve lookup time
- Total additional time added to the planning process is 4 minutes.
- A typical plan optimization requires approximately 5 minutes.
- If at least one round of optimization is saved, use of this tool reduces the total time required for planning
- The automatic planning tool is currently being clinically used for all pancreas SBRT patients at this institution.

Conclusions

- The automatic planning tool allows for faster planning while improving safety and plan quality.
- Using an automatic planning tool allows for less experienced planners to generate high quality plans based upon prior patients.

Acknowledgements

Work supported by Philips Radiation Oncology Systems and the Commonwealth Foundation