Consensus Recommendations for Radiation Therapy Contouring and Treatment of Vulvar Carcinoma

Gaffney, D. K., King, B., Viswanathan, A. N., Barkati, M., Beriwal, S., Eifel, P., . . . Bosch, W. (2016). Consensus Recommendations for Radiation Therapy Contouring and Treatment of Vulvar Carcinoma. International Journal of Radiation Oncology*Biology*Physics, 95(4), 1191-1200. doi:10.1016/j.ijrobp.2016.02.043

Project 4: Anomaly Detection for Treatment Planning and Learning Health System in Radiotherapy
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Mentors: Todd McNutt, Pranav Lakshminarayanan

Project Review

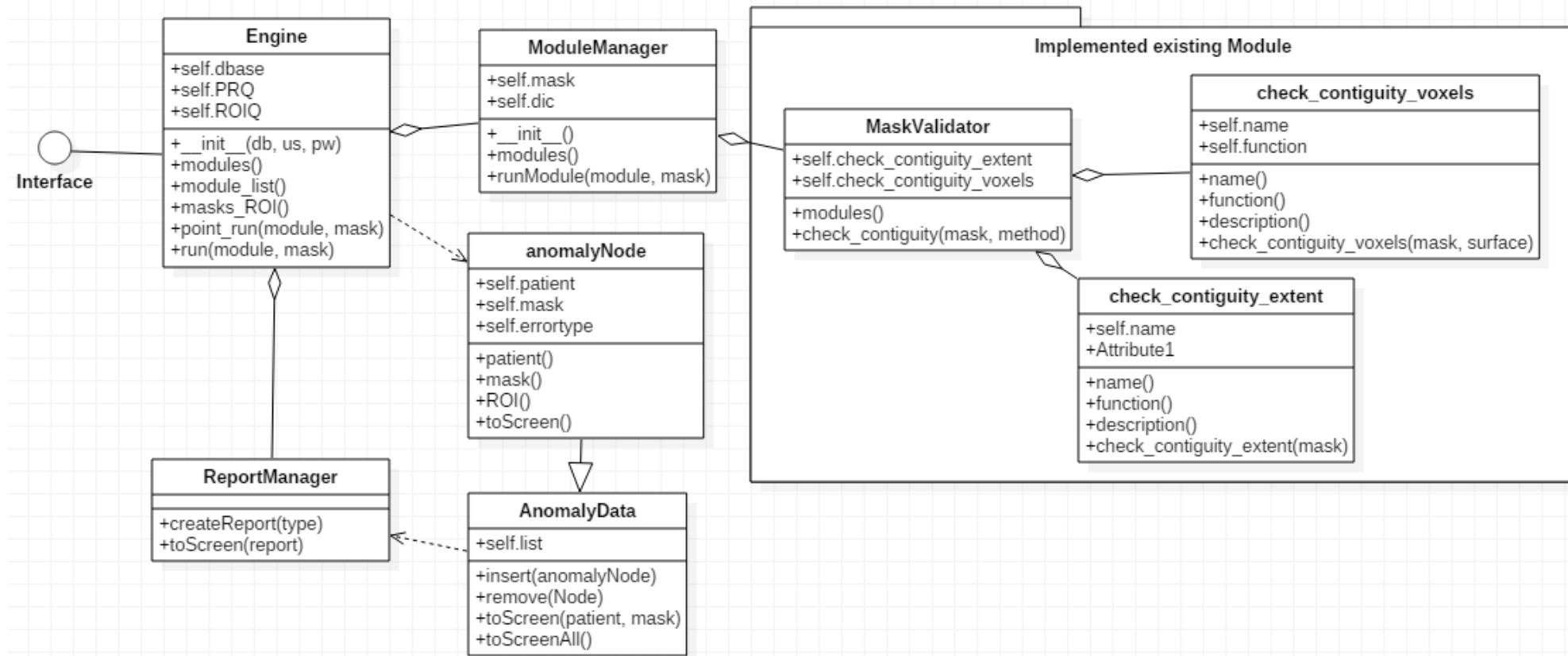Anomaly Detection for Treatment Planning and Learning Health System in Radiotherapy

Primary deliverable:

Build framework for software that will allow modular automatic integrity checking of contour models.

Secondary deliverable:

Develop integrity models that determine images with anomalous features with high confidence.

Project Review

Paper Selection

- Important reference for one of mentor's (unpublished) papers
  - Aforementioned mentor's paper is direct precursor to our project

- Create recommendations for drawing contours
  - Manual version of what we are trying to accomplish

- Demonstrates a workflow we are trying to replace

Key Result

Expert oncologists were able to generate a set of consensus recommendations for contouring target volumes and treatment for vulvar cancer.

However, due to lack of clinical research evidence, the study also advocates to use a conservative and consistent approach and to tailor treatment to suit the individual needs of patients.

Radiation Therapy (RT)

- RT is a treatment that involves using high energy waves, such as x-rays, to damage and kill cancer cells.

- 3-Dimensional (3D) RT:
  - Take 3D image of the tumor
  - Design radiation beams to conform to tumor shape

- Intensity modulated RT (IMRT)
  - Use computer controlled linear accelerators to deliver radiation doses
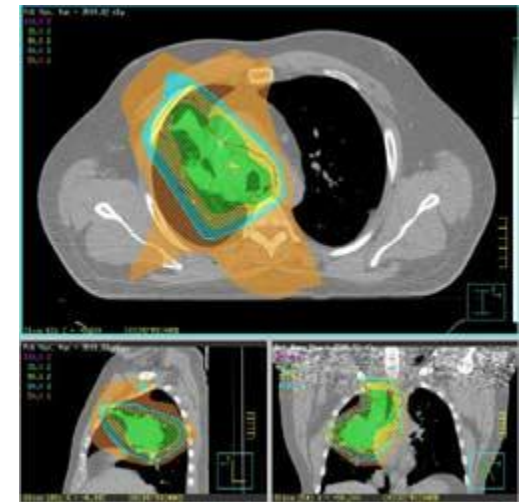
Vulvar Cancer

- Outer surface gynecologic neoplasm
  - Abnormal growth of tissue on the outer surface of female genital organs
  - Primarily on labia majora, labia minora, clitoris, and perineum
- 95% are squamous cell carcinoma (arising from the epithelium)
- <20,000 US cases per year
  - 5% of gynecologic malignancies
- Occurs mostly in older women, but also can occur in premenopausal as well.
- Causes include: HPV and lichen sclerosis

Vulvar Cancer

- Vulva and groin area has sensitive organs at risk (OARs)
- Due to physical structure, steep changes in radiation source-to-skin distance, thus hard to treat with 3D RT
- Use IMRT to improve avoidance of OARs

Methodology

Initial Survey

- Purpose: Establish initial contour recommendations
- Response:
  - 35 expert radiation oncologists
  - Identify areas of clinical controversy
- Areas of greatest agreement were inclusion of vulvar, inguinal, and pelvic nodes.
- Areas of initial controversy included delineation and inclusion of the "skin bridge," the width of the inguinal contour, the inclusion of skin above the inguinal nodes, and the superior border of the pelvic nodes.

Case Studies

- 14 physicians contoured 2 cases based on generated instructions

- Consensus contour: Yellow

- Modified consensus contour: Red

- Retraction: white + blue arrows
  - Low risk areas
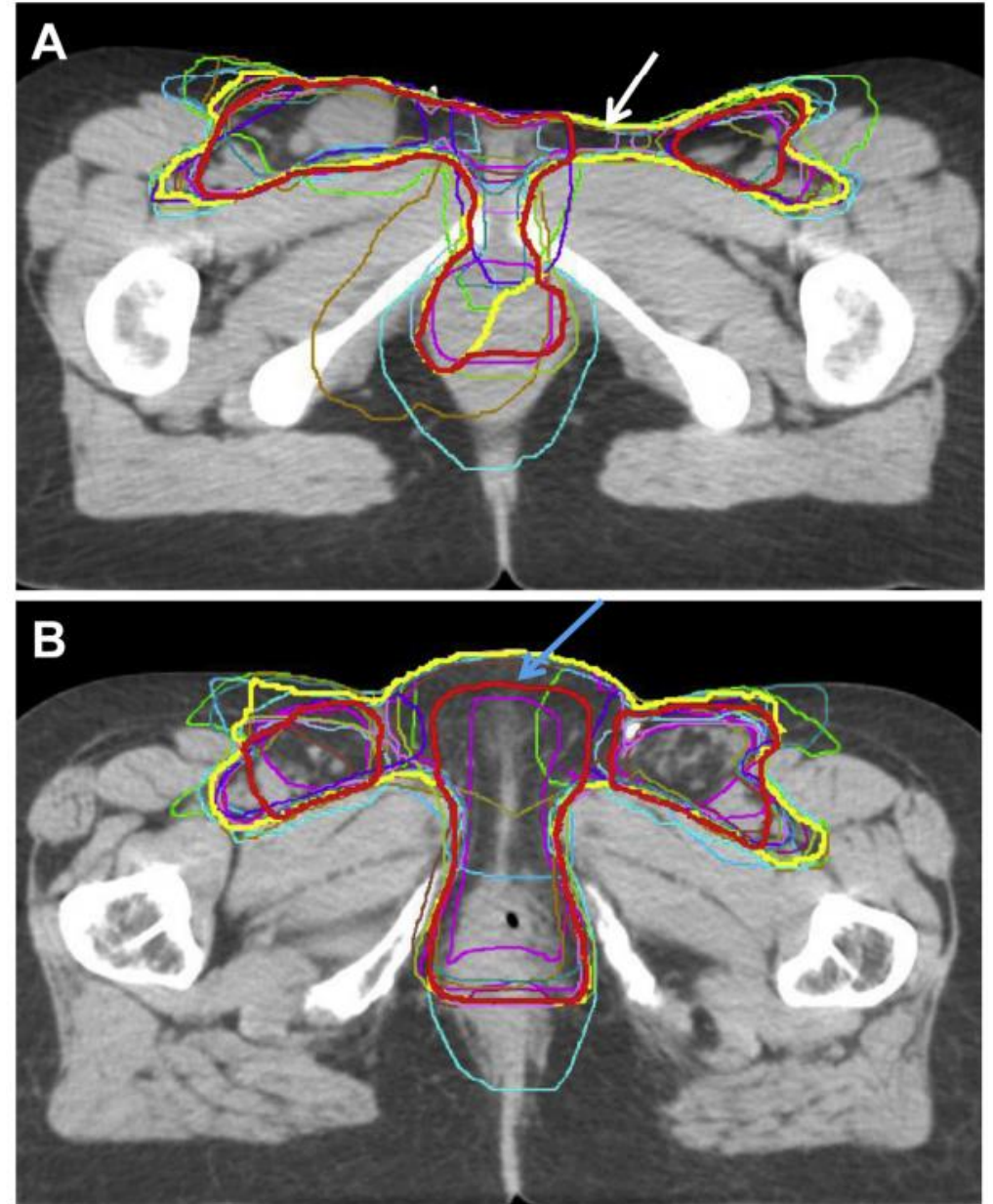
Consensus Recommendations

- Generate 95% confidence contour using computerized environment for radiation research (CERR) software

- Use expectation-maximization algorithm simultaneous truth and performance level estimation (STAPLE)
  - STAPLE can also identify consensus segmentation
  - Conformity indices (volume ratio), sensitivity, specificity

- Kappa statistic – inter-rater agreement for qualitative values

Results

Structure measure	Case 1 (14 contours)	Case 2 (14 contours)
Sensitivity	71.3%	64.8%
Specificity	99.1%	99.2%
Mean volume/minimum/maximum ($\pm$SD) (cc)	688.4/547.1/885.3 ($\pm$108.1)	811.3/327.9/1122.0 ($\pm$196.0)
STAPLE/intersection/union volume (cc)	806.8/234.1/1506.0	1085.0/158.2/1833.7
Kappa value	0.69	0.64

Table 1 Statistical analysis of contours

Abbreviation: STAPLE = simultaneous truth and performance level estimation.

3D Render
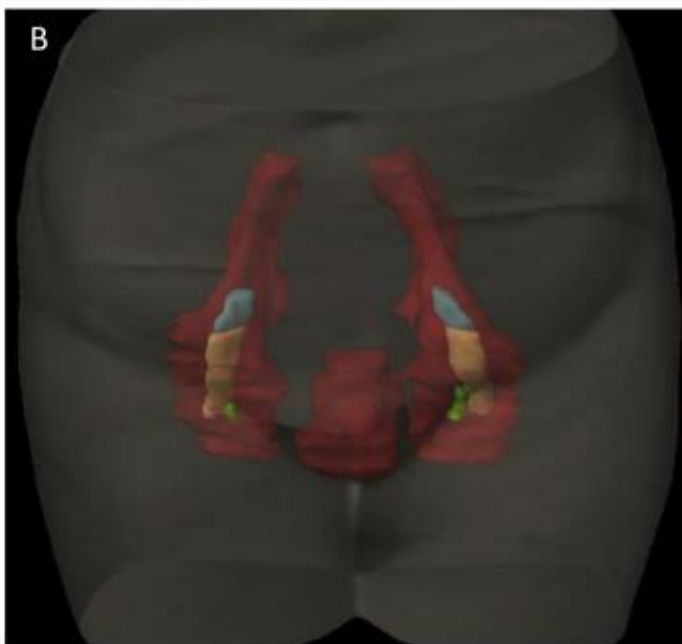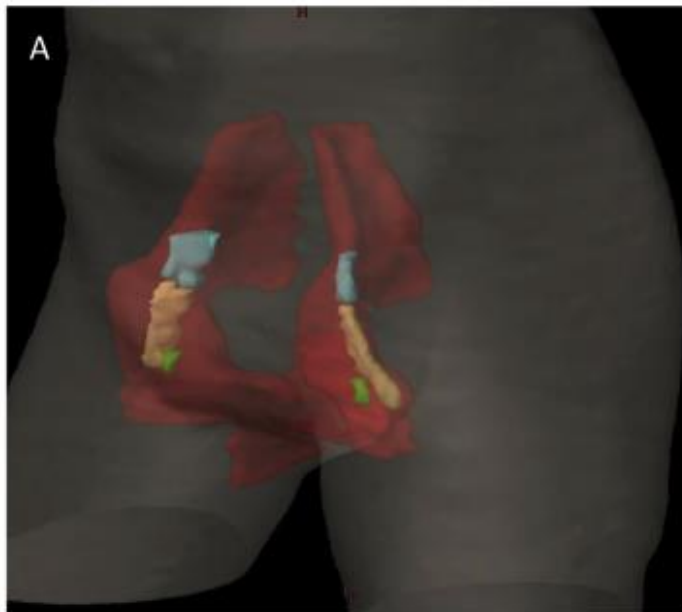
Results

- High specificity and moderate sensitivity
  - Physicians had higher confidence in which structures to exclude compared to which structures to include from the CTV
- 14 contours following recommendations have high level of agreement
  - Recommendations help clarify drawing contours
- 3D structure is complex and need more clinical evidence
  - Use recommendations with caution and be conservative

Assessment

Pros
- Clear explanation of recommendation generating process
- Realizes lack of clinical validation is a weakness
- Good presentation of results
- Included guidelines at the end

Cons
- Moderate sensitivity
- Study only looks at two cases
- Lack of clinical evidence

Relevance

- Important aspects of generating guidelines
  - Initial recommendations -> final recommendations
- How to analyze contours
  - Specificity, sensitivity
- How to improve integrity checking
  - Larger datasets for validation
- Possible integrity checks
  - Organ volume

Conclusions

- Provides reason for our project
  - Manual workflow
  - Small datasets
- Several interesting points for our design
  - Refinement
  - Statistics
- Possible directions for modules
  - Organ volume
- Overall, useful for project

Questions?

Simulation

- Patient position for simulation and treatment
- Bladder and rectal filling
- Placement of bolus and wire on scars

Locally advanced vulvar cancer

- Contouring of the primary vulvar region
- Lesions invading the vagina
- Lesions invading the anus or anal canal, bladder, or rectum
- Periurethral lesions
- Periclitoral lesions

Lymph nodes

- LN groups to be included in the CTV for primary vulvar lesions involving the vulva only or vulva and distal vagina, periurethral, or periclitoral

- LN groups to be included in the CTV for primary vulvar lesions involving the anus or anal canal

Postoperative vulvar cancer

- Vulvar primary (negative margins)
- Vulvar primary (close or positive margins)

Dose and chemotherapy

- Dose to Primary Vulva in Locally Advanced Case
- Dose to Primary Vulva in Postoperative Case
- Dose to uninvolved nodal regions
- Recommendations regarding dose to involved LNs
- Concurrent chemotherapy