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Comparison of PET Textural Metrics in Different Platforms based on Phantom Studies

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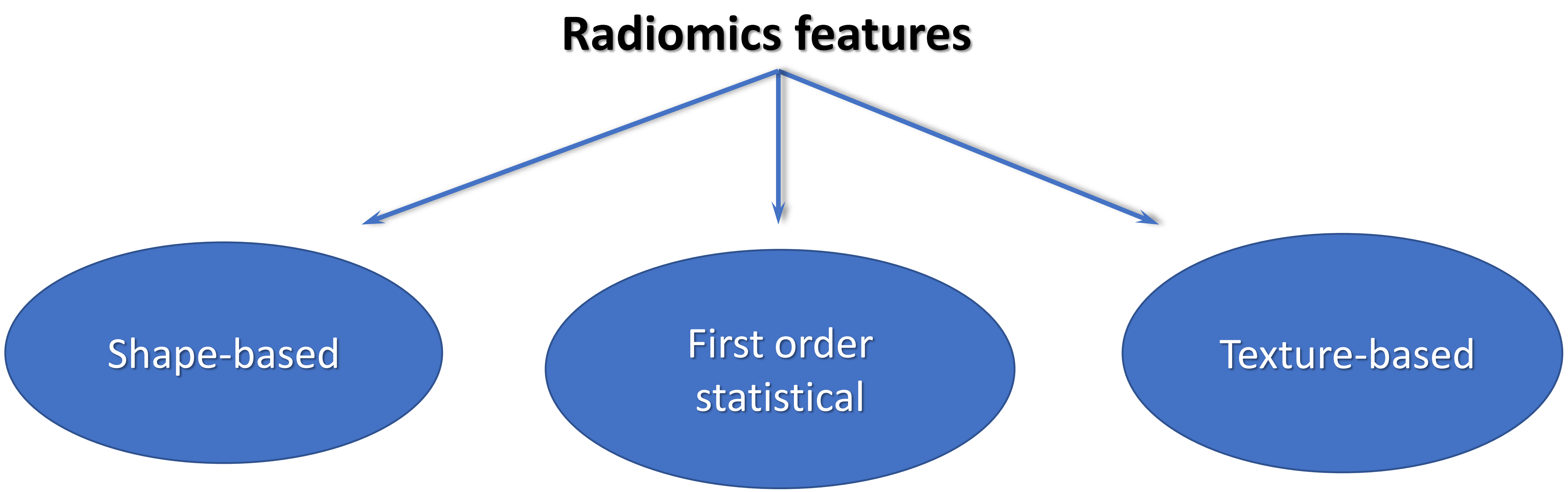
1. Background-Aim

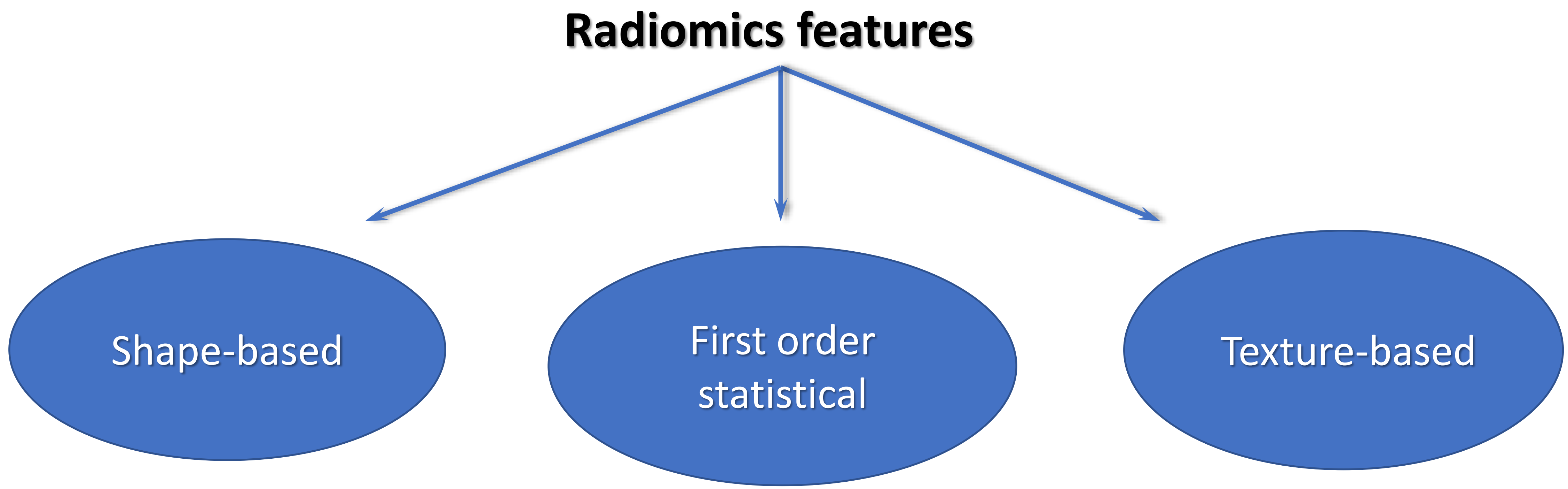
- **Radiomics** aims to extract quantitative and reproducible information from diagnostic images that are crucial for treatment planning and cancer prognosis.

- **Radiomic features** capture tissue and lesion characteristics alone or in combination with demographic and histological data could potentially benefit clinicians for therapy response and prognosis in various types of cancer.

- **Their determination are of maximum importance for clinicians!**



1. Background-Aim



ROI description such as the sphericity and volume.

Distribution analysis of individual voxels, such as mean value, median etc.

Quantitative assessment of tumor heterogeneity through tumor uptake with **Standardized Uptake Value (SUV)** and **Metabolic Tumor Volume (MTV)** factors.

For the purposes of this study, SUV and MTV indices are calculated with different, commercial (GE) and scientific (LifeX) tools, and they are eventually compared through experiments with NEMA IQ phantom.

2. Materials & Methods

SUV is defined as the measured radioactivity within the ROI that is normalized to the average radioactivity concentration in the body, following equation:

$$SUV = \frac{Concentration\ in\ Region\ of\ Interest}{\frac{Injected\ Activity(MBq)}{Patient\ Weight(kg)}}$$

1g~1ml

MTV is defined as the volume of tumor tissue that demonstrated metabolic activity at or above the calculated threshold of disease measurability.

Both are subject to reconstruction algorithms, clock accuracy and biological processes, such as plasma glucose levels, tumor type, motion artifacts and body size.

2. Materials & Methods

For the purposes of this study, we used:

PET-NEMA/IEC Body Phantom

GE Mi DR PET/CT Scanner

GE HealthCare

- ✓ AW VCAR, Commercial software product by GE Healthcare
- ✓ Intuitive User Interface
- ✓ Automatic segmentation and volumetric quantifications of tumors

LIFEx
Local Image Feature Extraction

- ✓ free and easy-to-use platform
- ✓ User-defined region of interest (ROI) or volume of interest (VOI)
- ✓ Automatic calculation of radiomic features

2. Materials & Methods

Phantom Preparation:

1. Stuff one quarter of NEMA IEC phantom with deionized water
2. Inject 53.67 MBq ^{18}F into the background volume
3. Use a new syringe to fill three spheres (diameter's: 22 mm, 13 mm and 10 mm respectively) of the phantom with the background activity
4. Fill the remaining background volume with deionized water until full

Image Reconstruction:

- VUE Point FX GE commercial algorithm
- 2 iterations
- 16 subsets*

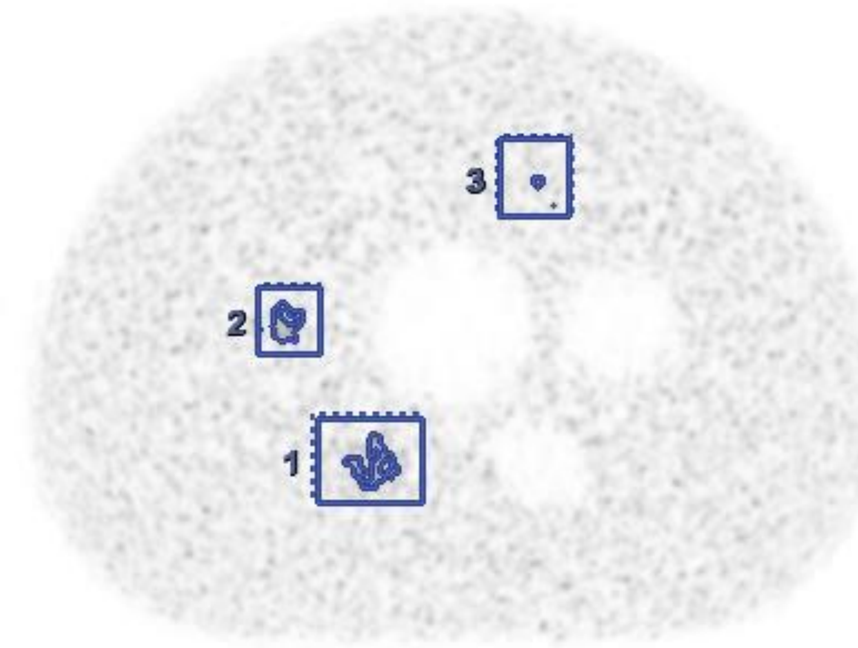
Import images to LifeX & GE AW platforms

Phantom Part	Radioactive Concentration (kBq/ml)
Background	5.3 *
Spheres	21.2
Sphere-to-Background Ratio	**4**

*Injected activity and image reconstruction to simulate clinical practice

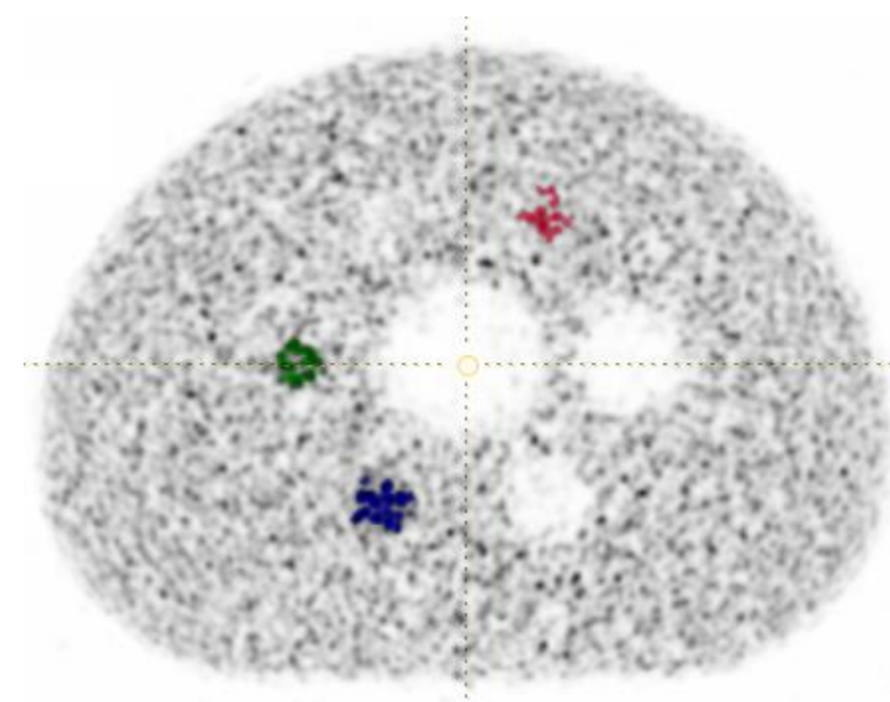
GE AW 3.2:

- Adaptive Threshold 42%
- ROIs set by the user in all views
- Isosurface-based calculation



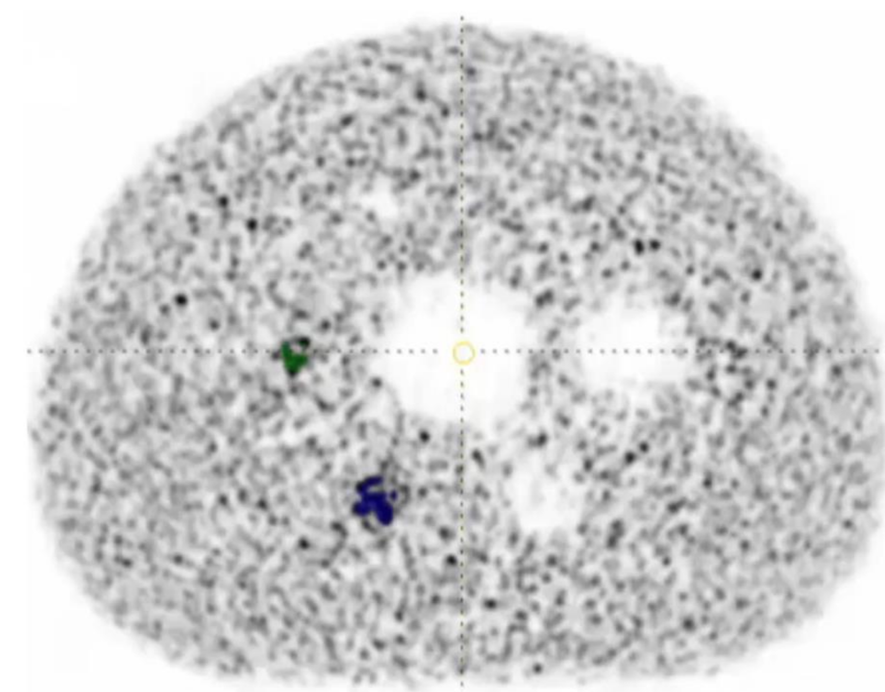
LifeX:

- Relative Threshold 42%
- No Adaptive Threshold mode
- ROIs set by the user
- Voxel-by-Voxel calculation



3. Results

	SUV_{max}	
Sphere	**GE AW 3.2**	**LifeX**
#1	7.92	7.06
#2	7.12	6.76
#3	6.13	4.23



MTV (cm^3)			RE(%)
Sphere	**GE AW 3.2**	**LifeX**	
#1	2.52	2.73	8.33
#2	1.22	1.31	7.38
#3	0.90	0.86	4.44

- SUV_{max} values range for different segmentation modes
- MTV relative errors <10%
- Small ROIs achieve smaller MTV values
- Self-normalization to each sphere, results in similar MTV values
- Adaptive threshold experiments may affect the results

4. Conclusions

- For larger spheres, the SUV_{max} values of the two softwares are closely aligned.
- Slight underestimation in the SUV_{max} value of the smaller spheres (LifeX), does not eventually affect the MTV values due to self-normalization.
- Limited variation of MTV values, with a relative error ~ 10%
- Both systems demonstrate similar MTV results, making them suitable for diagnostic purposes.
- Phantom experiments for β parameter (LifeX) determination in order to study adaptive threshold mode is required.
- Further investigation on clinical cases with respect to different kinds of tumors, radioisotopes and patient profiles needs to be studied.

5. References

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