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Estimation of Left Ventricle Ejection Fraction using Cardiac MRIs

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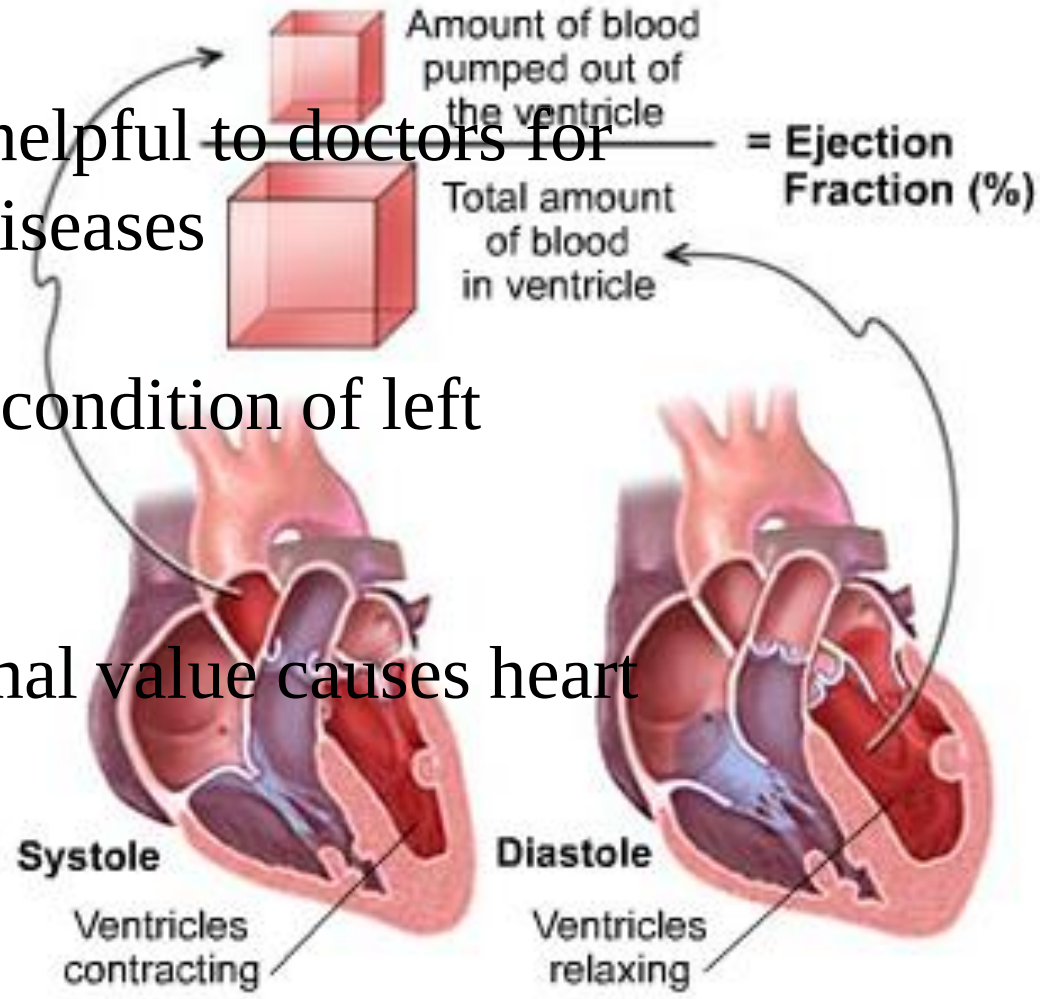
What is Ejection Fraction (EF) ratio?

- EF number is helpful to doctors for finding heart diseases
- It describe the condition of left ventricle
- EF below normal value causes heart failure

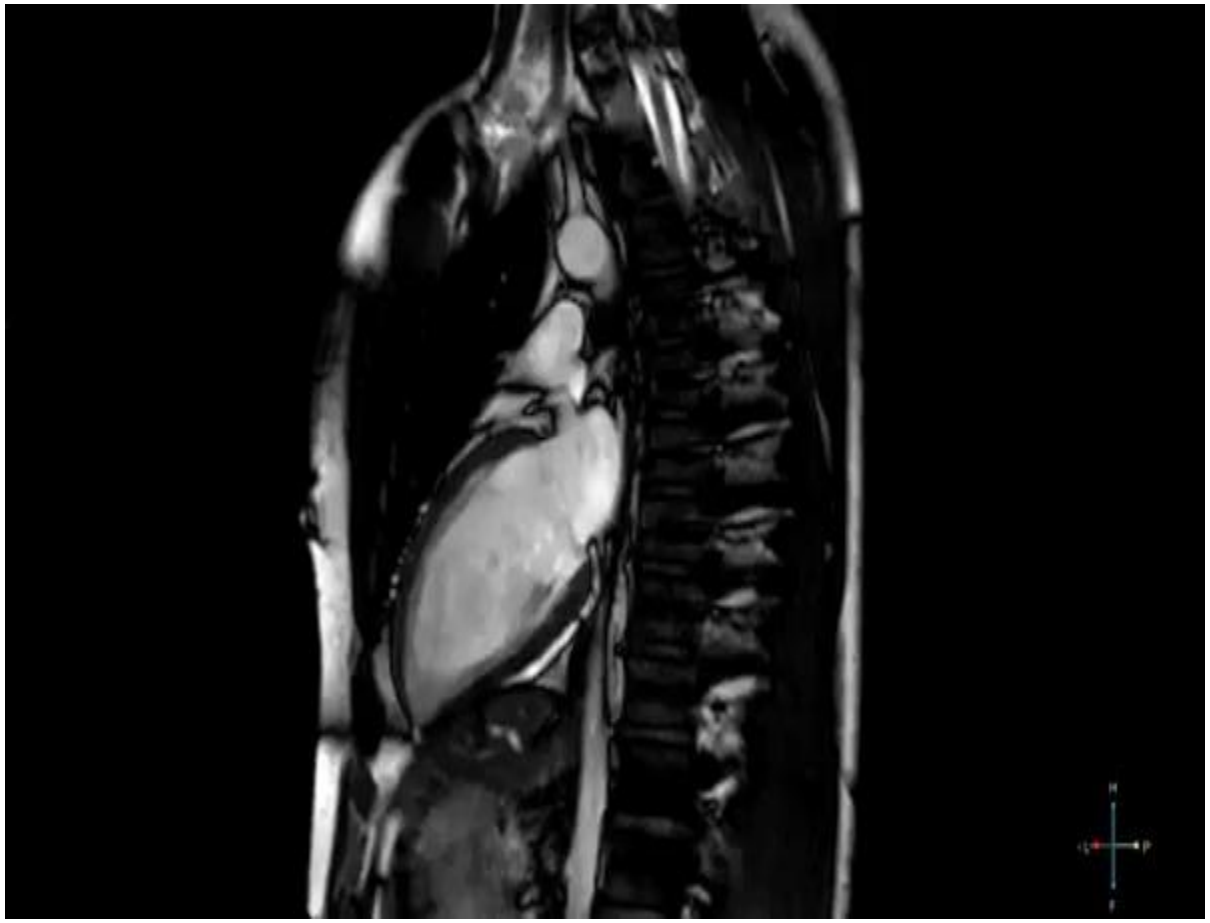


Reference:

https://rehabilitateyourheart.wordpress.com/2013/03/19/do-you-know-your-hearts-ejection-fraction/

Challenges

- Heart is non rigid body
- Heart is moving organ
- Occlusion due to presence of other organs in images
- Less illumination variations between walls and blood

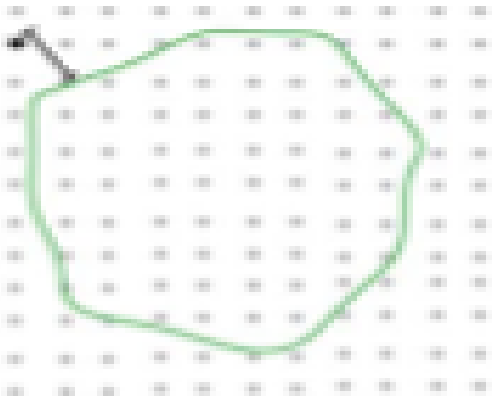


Reference:

https://imgur.com/gallery/GHbGULW

State of the art

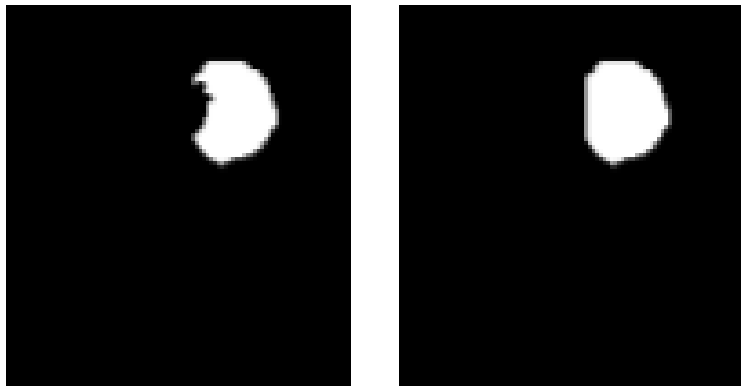
- Thresholding and active contour [Lynch et al. 2008]



- Deep learning for volume estimation [Tan et al. 2017]

However

- Prior heart shape is required



- Segmented dataset is required for model training

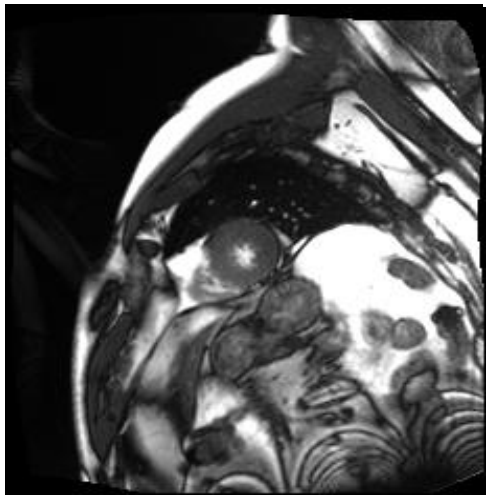
Contributions

1. Segment the Left Ventricle of heart and count the number of pixels in each slice for blood volume

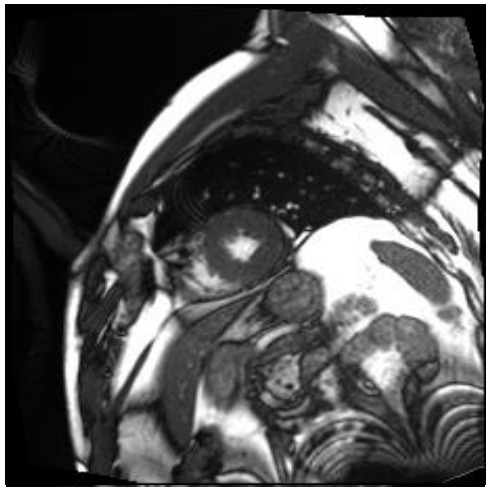
2. Estimation of Left Ventricle systole/diastole blood volume by applying different regression models

3. Comparative study of regression models based on subject's age and gender

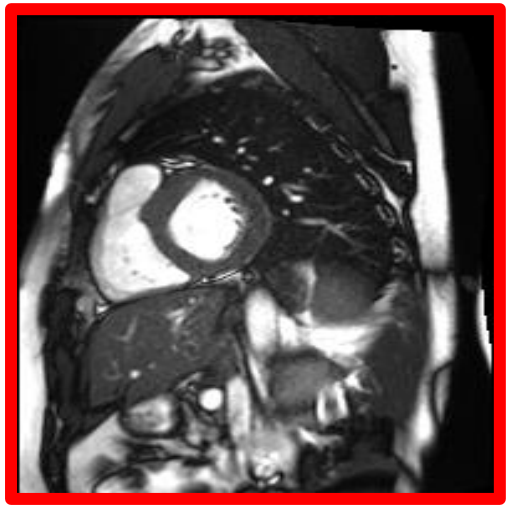
Left Ventricle Segmentation



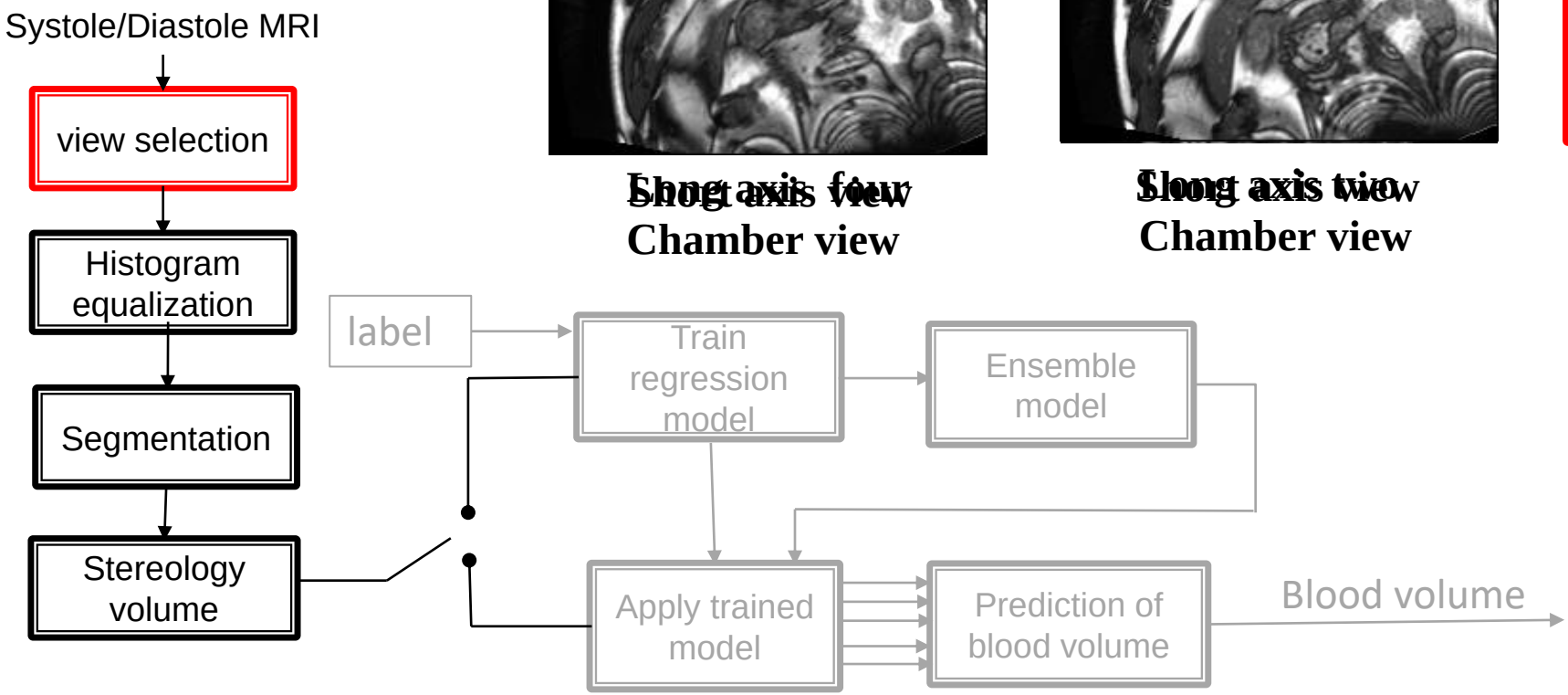
Long axis four Chamber view

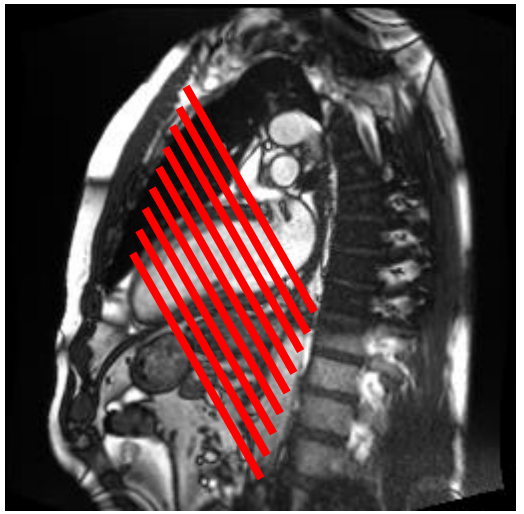


Long axis two Chamber view

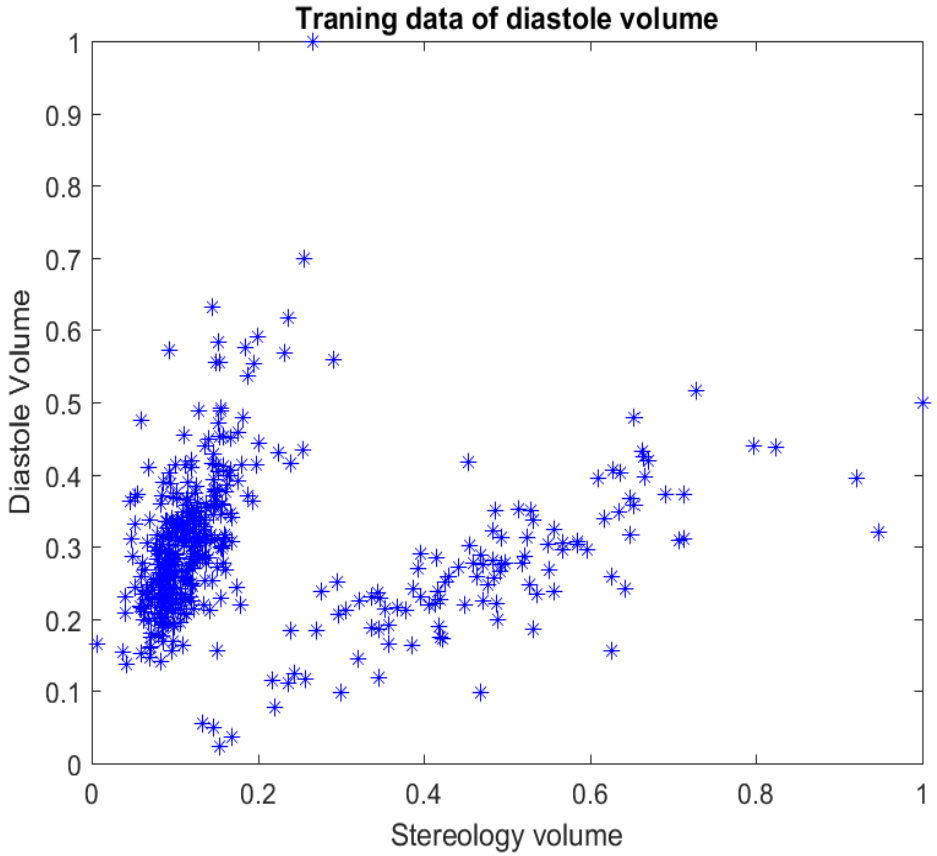


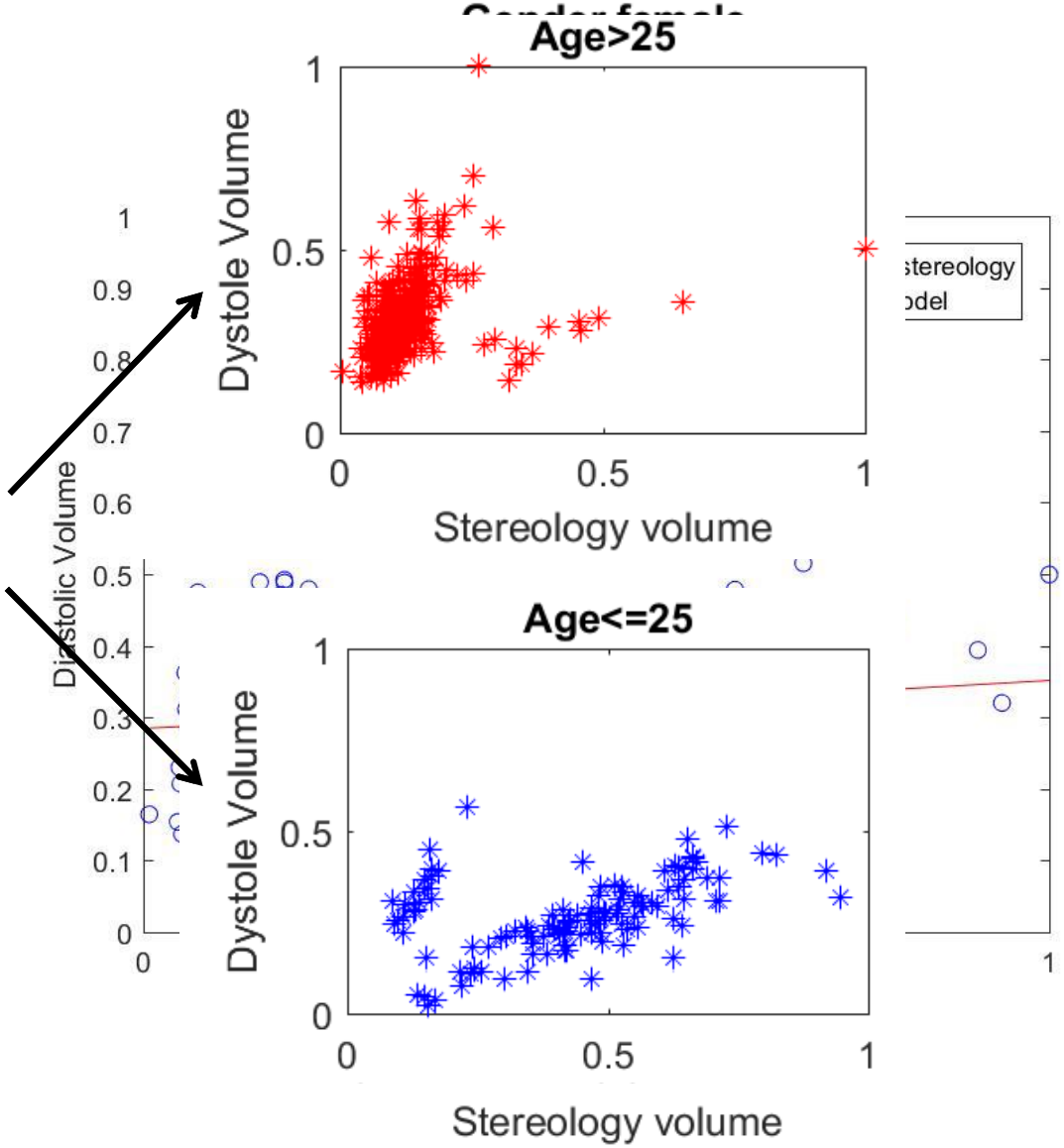
Short axis view





Comparative study





Results and Discussion

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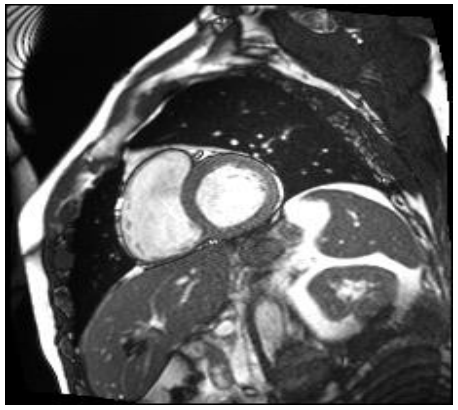
Dataset

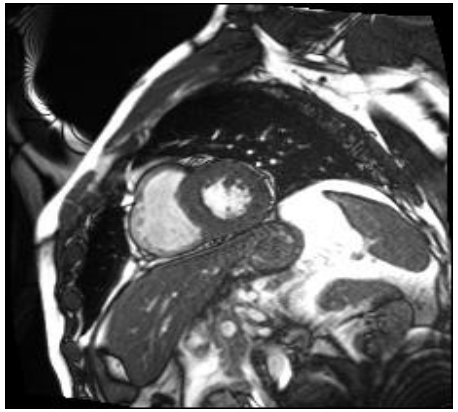
- Dataset is provided by National Institutes of Health and Children's National Medical Center
- We use 450 subjects data
- 270 subject use for training and 180 use for testing
- Only short axis views are utilized

Evaluation measure

Root Mean Square Error (RMSE) use for evaluation



Diastole

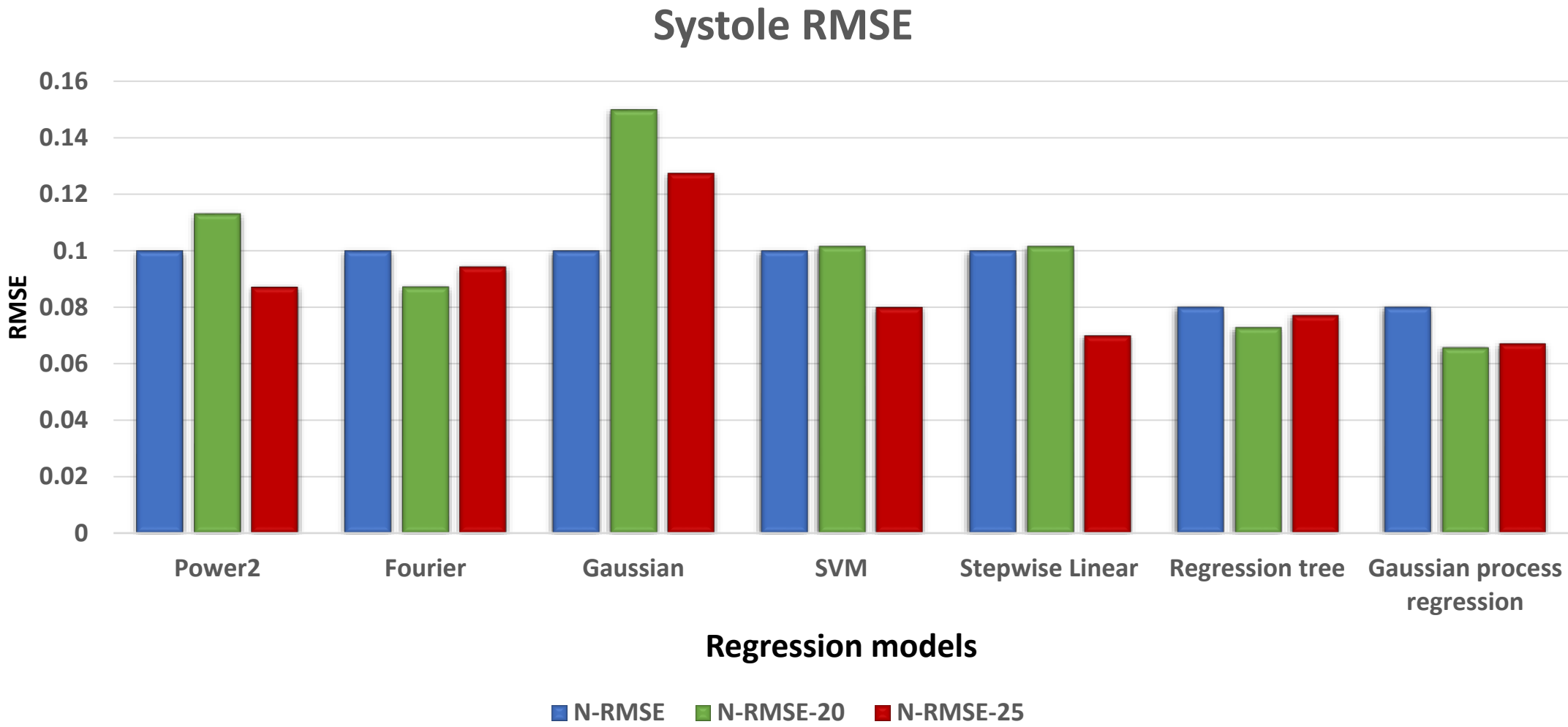


Systole

Reference:

https://www.kaggle.com/c/second-annual-data-science-bowl/data

Result and Discussion



RMSE

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)2}{n}}$$

where n is the total number of subjects, ˆ y_i is the model predicted volumes and y is the original volumes of systole and diastolic.

Result

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Approach	N-RMSE (ml)	Diastole-RMSE(ml)	N-RMSE (ml)	Systole-RMSE(ml)
Polynomial	0.1	56	0.07	39
Power2	0.1	56	0.07	39
Fourier	0.1	56	0.1	56
Gaussian	0.1	56	0.1	56
SVM	0.1	56	0.1	56
Stepwise Linear	0.1	56	0.1	56
Regression tree	0.12	45.4	0.08	45
Gaussian process regression	0.12	45.4	0.08	45

Reference:

Ensemble Models

Model name	N-RMSE (ml)	Diastolic-RMSE (ml)	N-RMSE (ml)	Systole-RMSE (ml)
Random forest	0.18	102	0.1	56
LSBoost	0.14	79	0.08	45

Reference:

Thank you.