Image Super Resolution

Group 8

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Our Mission

Create an mobile AI program that can enhance the resolution of blurry and low-resolution images

Functionality

Efficiency

- Running Time
  - Feature Construction
  - Train
  - Super Resolution

Performance

- PSNR

$$PSNR = 20\log_{10}(MAX_I) - 10log_{10}(MSE)$$

Our Approach

Baseline Model

- Feature
- Cross Validation
- Training
- Super Resolution
  - **Vectorization**
  - **Parallelization**

Improved Model

- Feature
  - **Key point detection**
- Cross Validation
  - **Label Information**
- Training
- Super Resolution

Data

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Baseline Model

Boosted Decision Stumps - GBM

Feature Construction

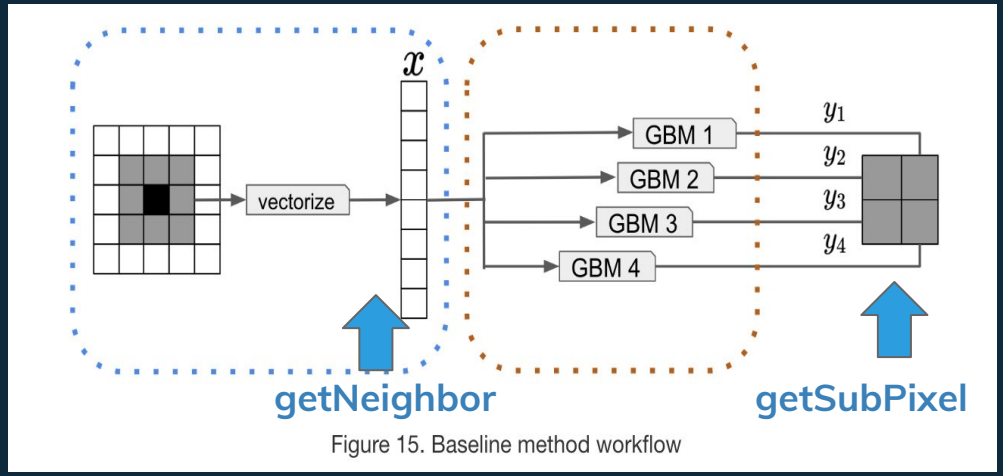
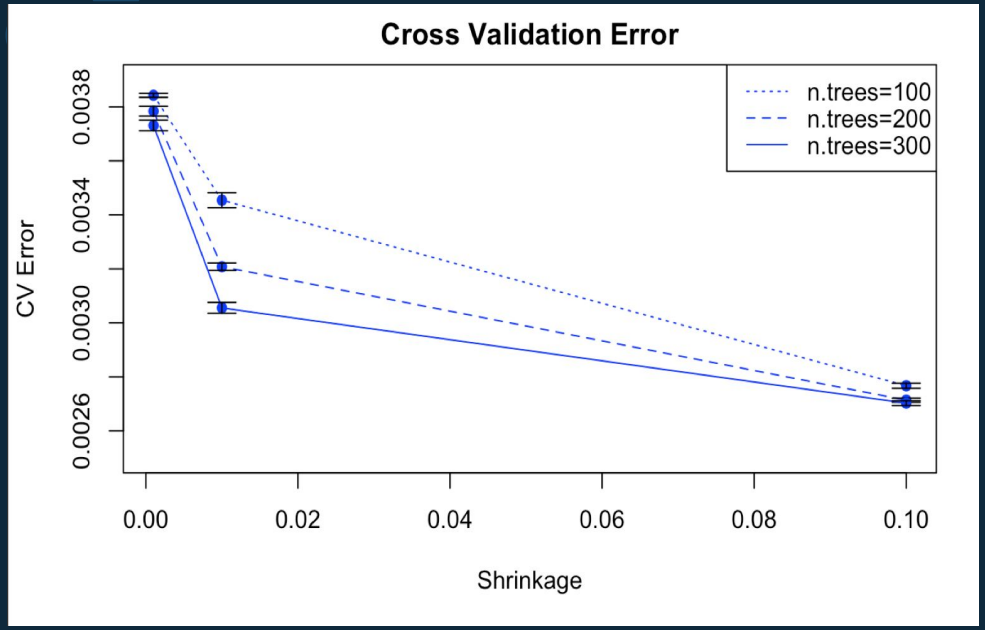


Figure 15. Baseline method workflow

- **Uniformly** sample 1000 points
- Zero Padding
- Two helper functions **apply** on sampled points
  - getNeighbor
  - getSubPixel

Cross Validation



- Method
  - Five-Fold Cross Validation
- Tuning Parameters
  - Shrinkage
  - Number of trees
- One Standard Error Rule
  - **Shrinkage = 0.1**
  - **Number of trees = 200**

Train & Super Resolution

Parallelization

- Fitting and prediction on 12 models (4 sub pixels * 3 channels)
- Super Resolution on test images
- *Packages: doMC, plyr*

Vectorization

- Recover 3D array of generated HR images

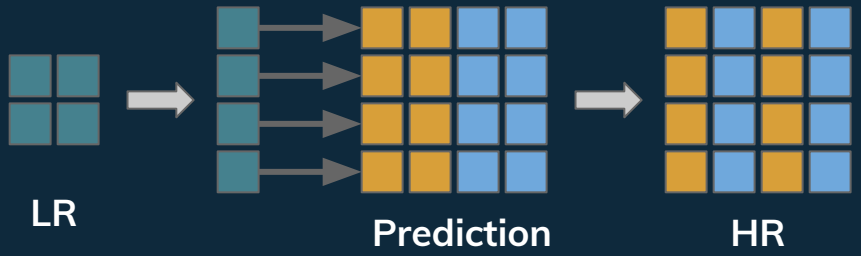


Figure: Idea of Vectorization

Model Evaluation

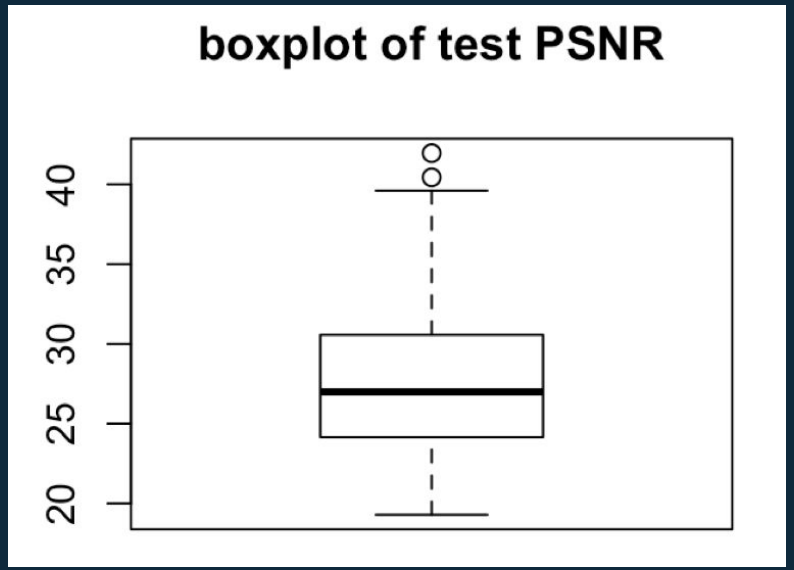
Running Time

	Feature	Training	Super Resolution
Total Time (s)	172	1157	467
Time Per Image (s)	0.14	0.96	1.56

* Time may vary on different computers

Model Evaluation

Performance



Min	19.29
Mean	27.68
Max	41.95

Example

PSNR=31.15

True Image

Baseline Model

Example

PSNR=25.70

True Image

Baseline Model

Example

PSNR=36.35

True Image

Baseline Model

How to Improve?

Key Point Detection

Shannon's Sampling Theorem

For better sampling efficiency, we should have a higher sample rate for high frequency signals, where color changes drastically.

Feature Construction

Uniformly Sample 1000 Points ➡ Sampling with Weights

Example

Figure: Squared Error (GBM)

Figure: High Pass Laplacian Filter

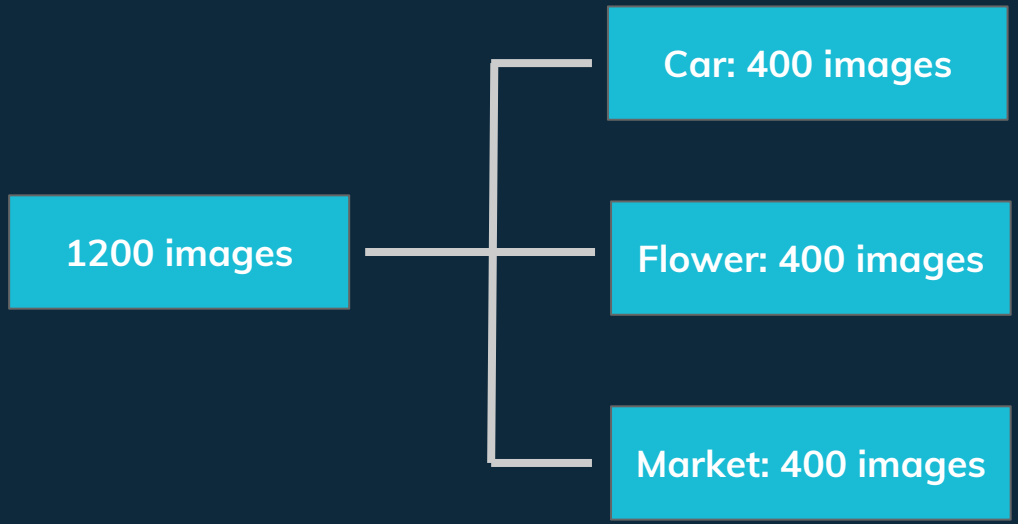
Example

Figure: Squared Error (GBM)

Larger Pixel Value → Higher Probability in Sampling

Figure: High Pass Laplacian Filter

Label Information



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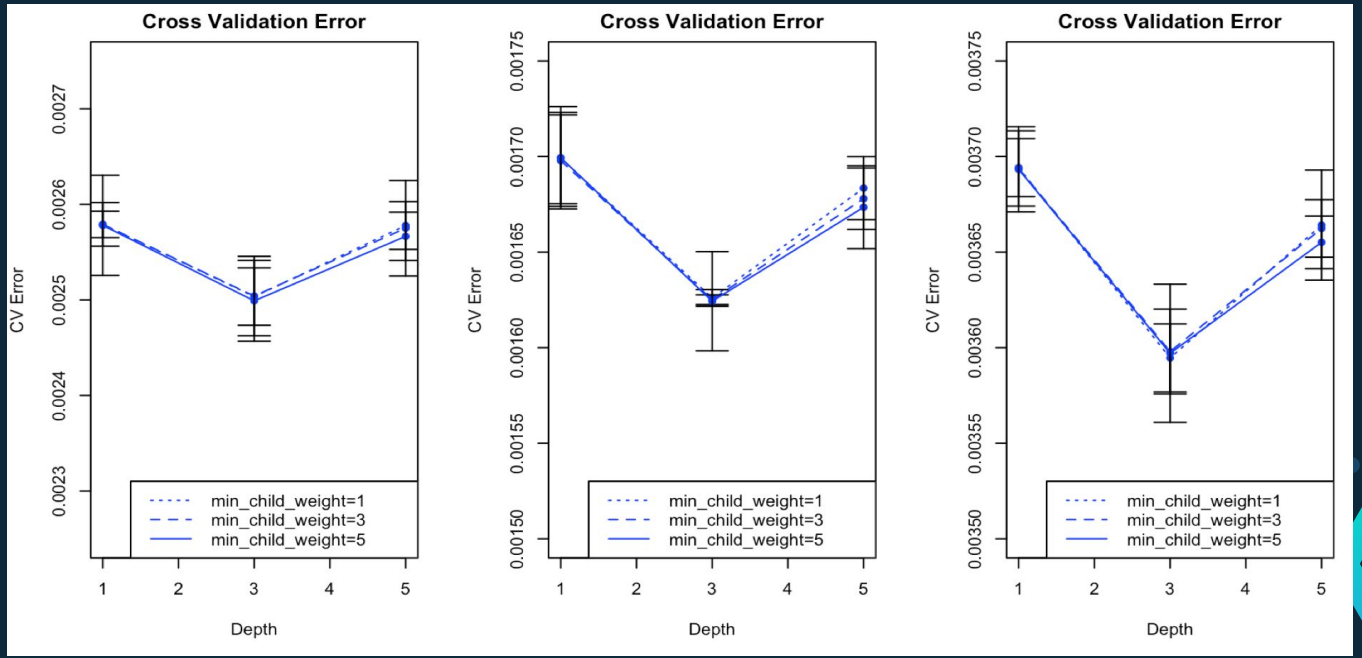
Improved Model

Gradient Boosting - XGBoost

Cross Validation



Car Flower Market

Model Evaluation

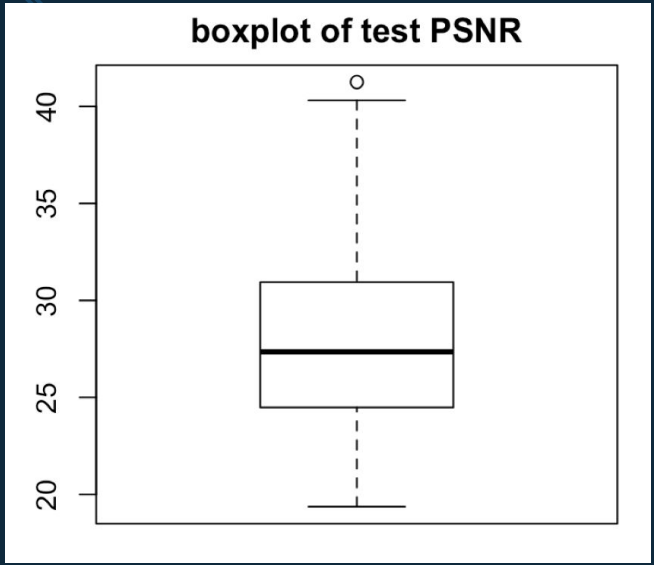
Running Time

	Feature	Training	Super Resolution
Total Time (s)	315	1293	767
Time Per Image (s)	0.26	1.07	2.55

* Time may vary on different computers

Model Evaluation

PSNR



	Overall	Car	Flower	Market
Min	**19.37**	19.81	22.15	19.37
Mean	**27.98**	28.25	30.23	25.44
Max	**41.25**	41.25	38.22	37.93

Example

PSNR=33.04

Improved Model

PSNR=32.14

Baseline Model

Example

PSNR=36.33

Improved Model

PSNR=34.70

Baseline Model

Model Comparison

	Baseline Model	Improved Model
Time for Feature Construction	172	315
Time for Training	1157	1293
Time for Super Resolution	467	767
Average Test PSNR	27.68	27.98
Average PSNR by Class	28.07 / 29.72 / 25.24	28.25 / 30.23 / 25.44

Thanks!

Any questions?