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CIBM Center for Biomedical Imaging

Improving reliability in fetal brain MRI analysis

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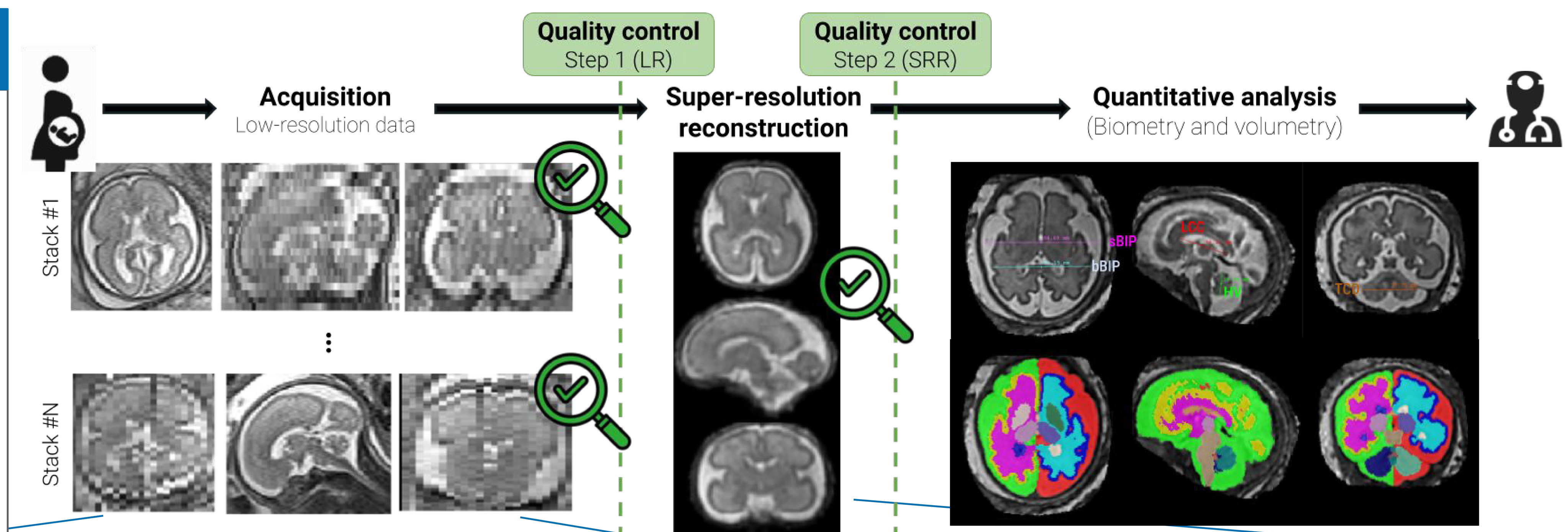
Context

- Complex acquisition and processing pipeline in fetal brain MRI
- Heterogeneous data and domain shifts



Question

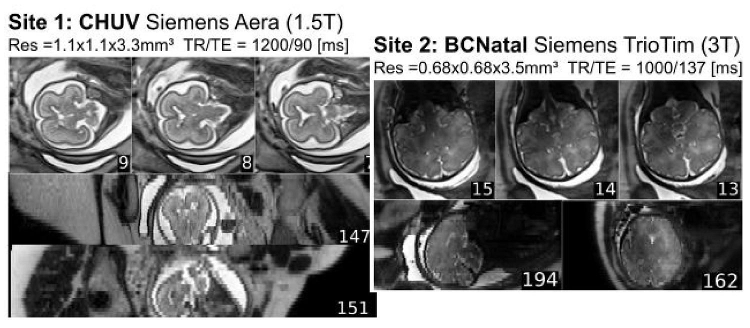
How can we ensure reliability at every step of the pipeline?

1. Quality control
2. Analysis of biases and reproducibility

Tackling domain shifts with FetMRQC [2]

The problem. Heterogeneity across scanners and sites → Machine learning models fail to generalize [1].

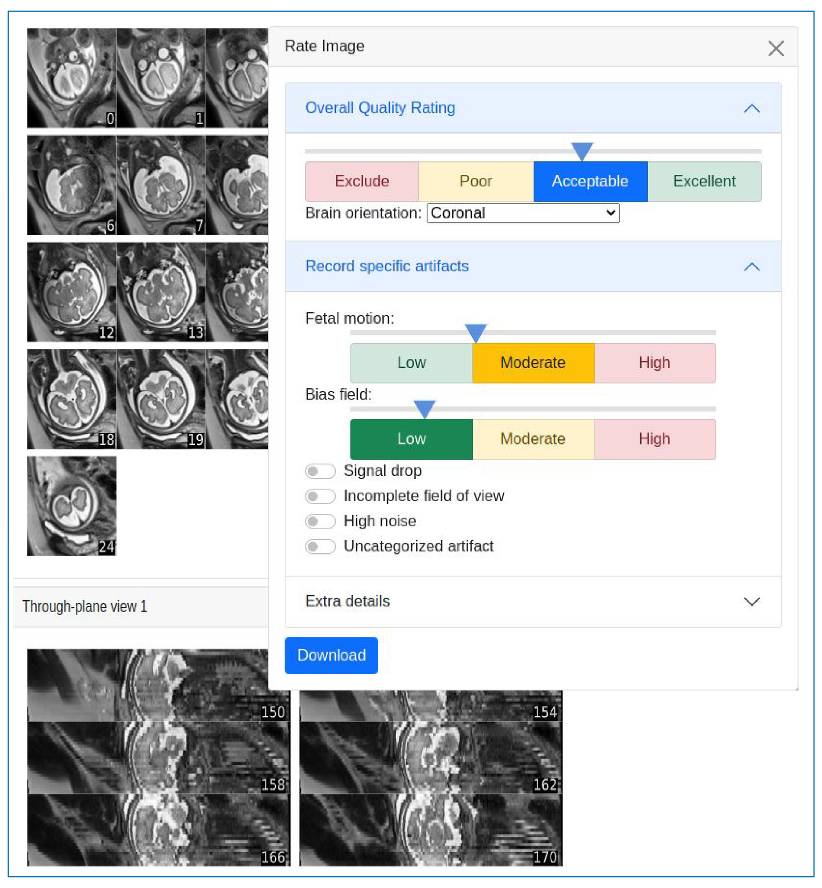
Our solution



Step 1. Standardized ratings.

Annotation interface and multiple raters [3]

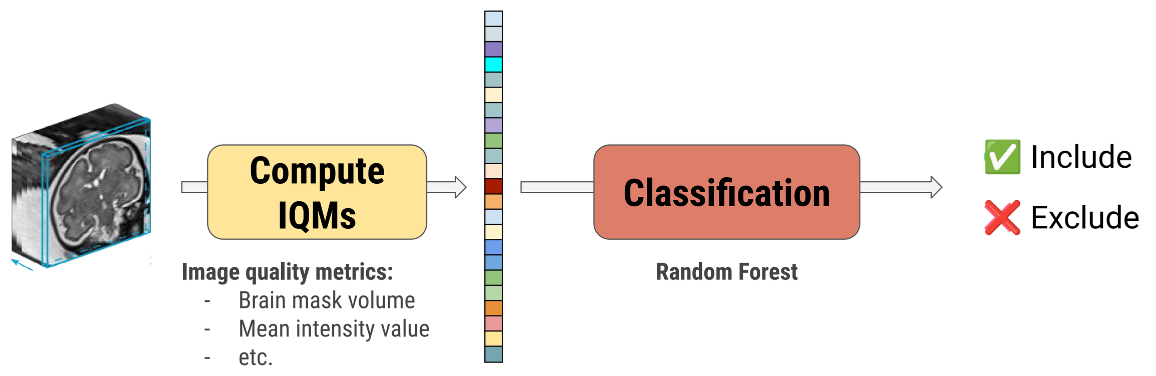
Result. Two experts annotated more than 1600 LR T2w scans from 13 scanners across 4 hospitals.



Annotation interface based on MRIQC [3]

Step 2. Automated prediction of quality.

Insight. Use a simple model. More complex models using nested cross validation and more sophisticated predictors failed to generalize out-of-domain.

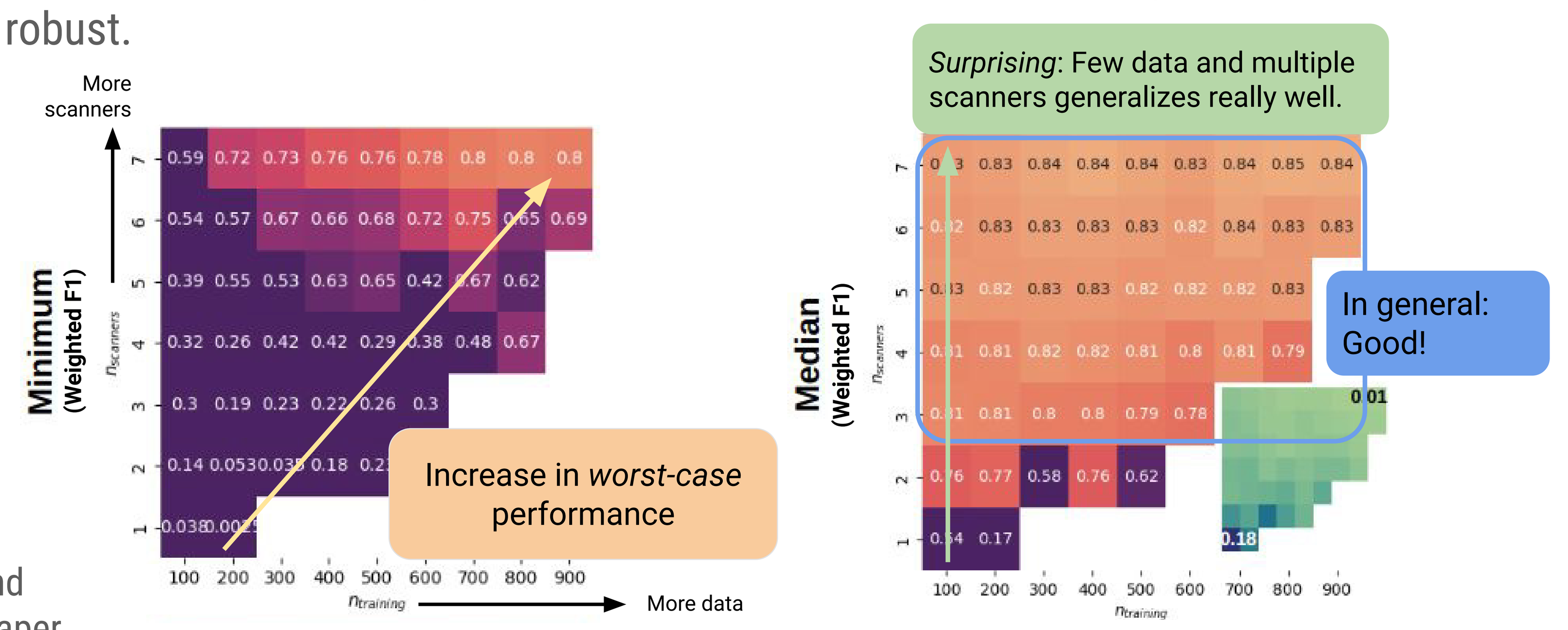


Step 3. Robust evaluation.

Use leave-one-site-out cross-validation and report worst-split performance with multiple metrics.

Experiment. How well can we expect to generalize given limited # of scanners and # of training data ?

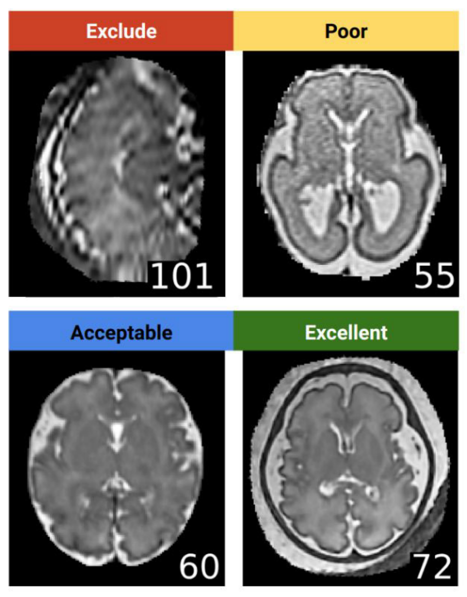
Insight. Heterogeneous data in training are key to a strong *median* generalization ability. More data helps make the model more robust.



More details and results in the paper

Towards more reproducible quality control [4]

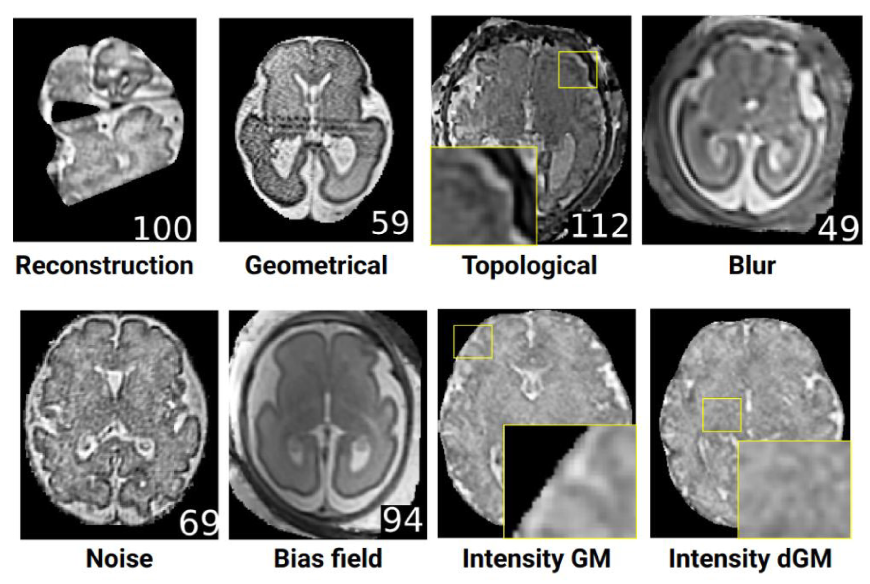
The problem. How reproducible are quality annotations from different raters? Can we make the quality rating depend on *specific* criteria rather than subjective assessment?



Step 1. A taxonomy of quality.

Super-resolution reconstruction can lead to various data quality.

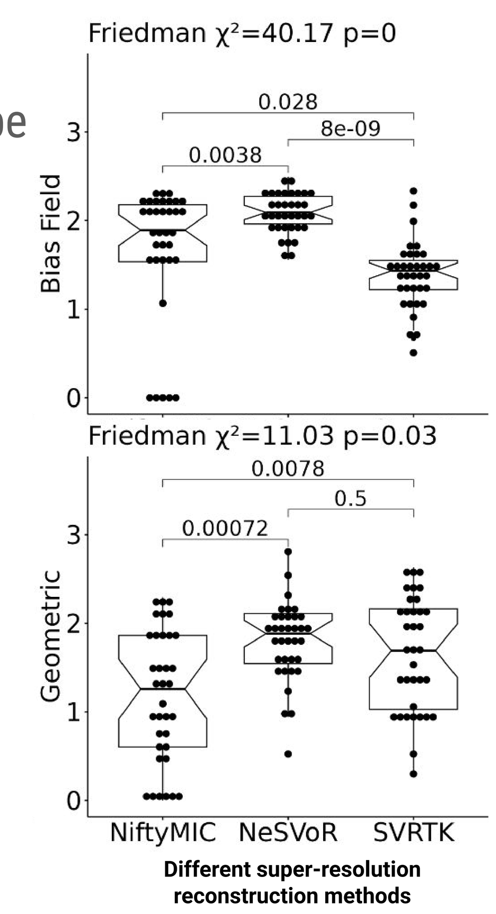
Data can feature very different *artifacts.*



Step 2. Multi-annotator rating.

105 reconstructions annotated twice by four raters.

Result.
1. The global quality score is highly reliable. Most specific criteria can be reliably rated.
2. The scores allow us to understand where different SRR methods underperform



More details and results in the paper

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References.
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[2] Sanchez T. et al. "FetMRQC: A robust quality control system for multi-centric fetal brain MRI." *MedIA* (2024)
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[4] Sanchez T. et al. "Assessing data quality on fetal brain MRI reconstruction: a multi-site and multi-rater study." MICCAI PIPPI Workshop (2024)