

Measuring Image Quality

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Measuring Quality

What

- Identify and measure attributes of an image that can be used to determine whether the perceived quality meets the expectations of the organization.

Measuring Quality

Why

- Should be part of any document processing system
- Guarantee consistency
- Useful for identifying upstream process problems
 - Manual
 - Automated

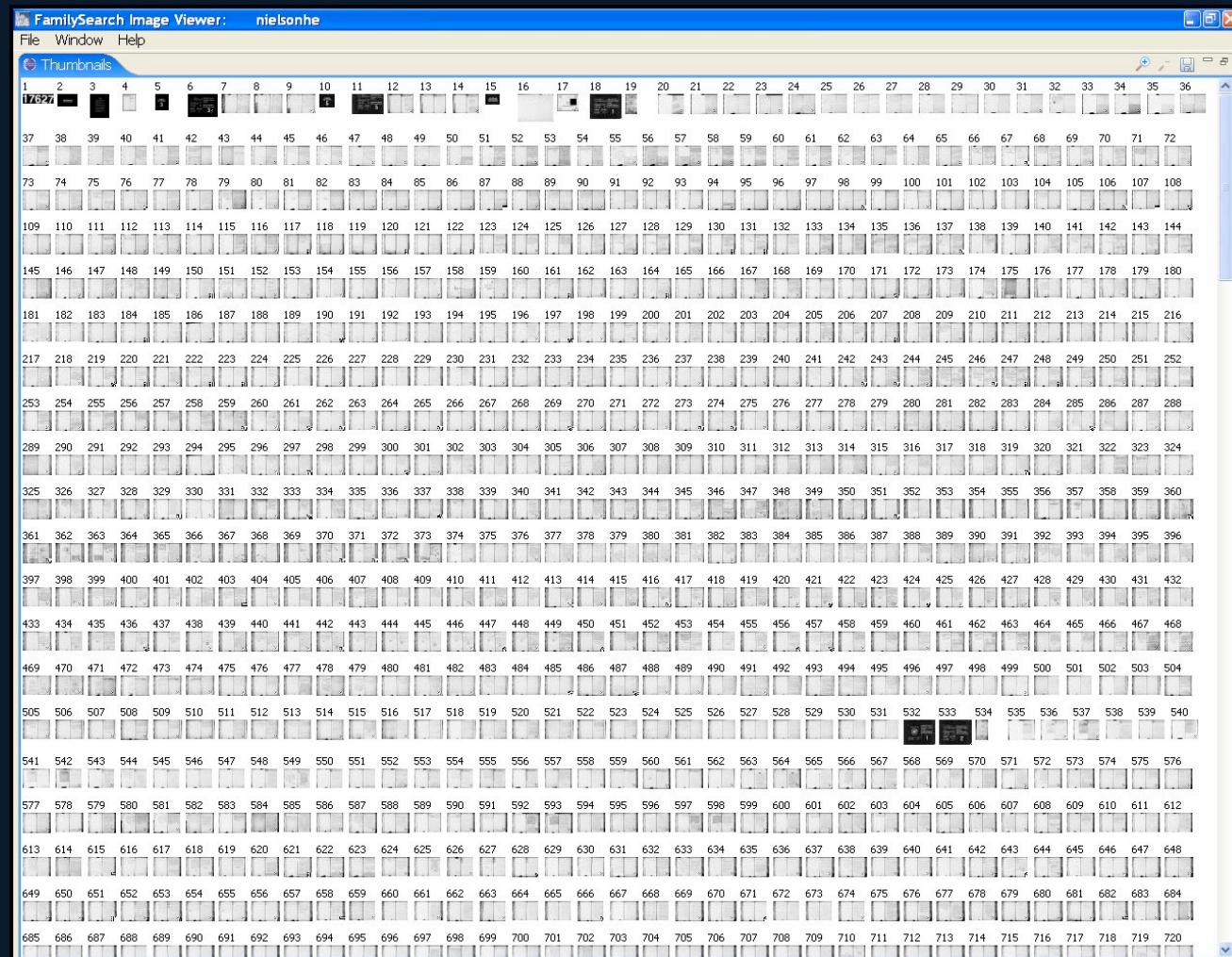
Measuring Quality

How

- Subjective
 - Easy to do
 - Not always predictable nor consistent
- Objective
 - Predictable and consistent
 - Hard to measure

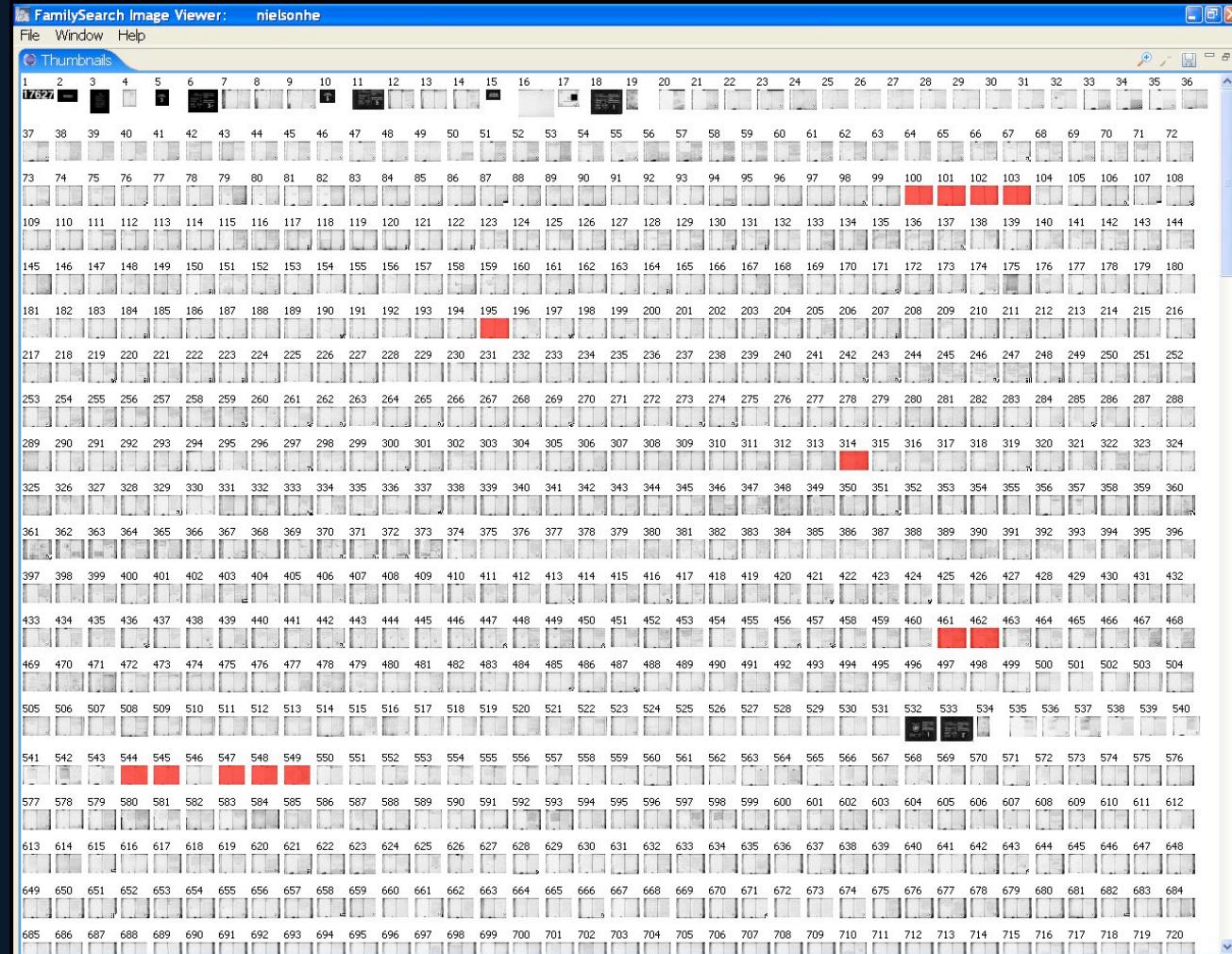
Audit

Brute Force



Audit

Exception Based



Contributing factors affecting quality

- State of original document
- Digitization
 - Resolution
 - Lighting
 - Exposure
 - Focus
- Post-processing
 - Rotation
 - Cropping
 - Contrast enhancement
 - Lossy compression

Quality Standards

DIRT (Digital Image Research Team)

- Composed of operational and development personnel
- Identify image attributes affecting quality
- Provide, where possible, metrics to measure those attributes
- Determine acceptable ranges for attributes
- Provide tools and training to facilitate consistent quality

Quality Standards

DIRT Specification

- Defines image attributes and desirable values for each
 - Tonal Range
 - Tonal Resolution
 - Even Exposure
 - Spatial Resolution
 - Contrast
 - Colorspace
 - Focus
 - Blur
 - File format
 - File name
 - Dimensions
 - Size
 - Complete Capture
 - Orientation
 - Skew
 - Fixity

Subjective Evaluation

- Direct Numerical Category Scaling
 - Subjects classify images into a number of categories
 - Usually use a numerical scale e.g. (1=Bad, 5=Good)
 - Subjects tend to use separate internal scales
 - Different “types” of images
 - Different types of distortion
- Functional Measurement Theory
 - Compares image qualities
 - Subjects indicate which image is preferred
 - More evaluations required
 - Each sampled image must be compared with every other sampled image

Subjective Evaluation

Jpeg Compression

- Sample images
 - Randomly selected
 - Includes image from both scanned microfilm and camera capture
 - Each image compressed at several predetermined settings
 - The original, uncompressed image is also included
- Images were presented randomly
- About 10% of the time a previously evaluated image is presented for reevaluation
- Each image was evaluated by 3 different subjects

Subjective Evaluation

Jpeg Compression

- Direct category scaling method
 - Asked to classify images on a scale of 1-5
- Zoom image 1-100%
- Pan around
- No time limit
- No calibration of monitors or ambient light

Subjective Evaluation

Jpeg Compression

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Quality Evaluator

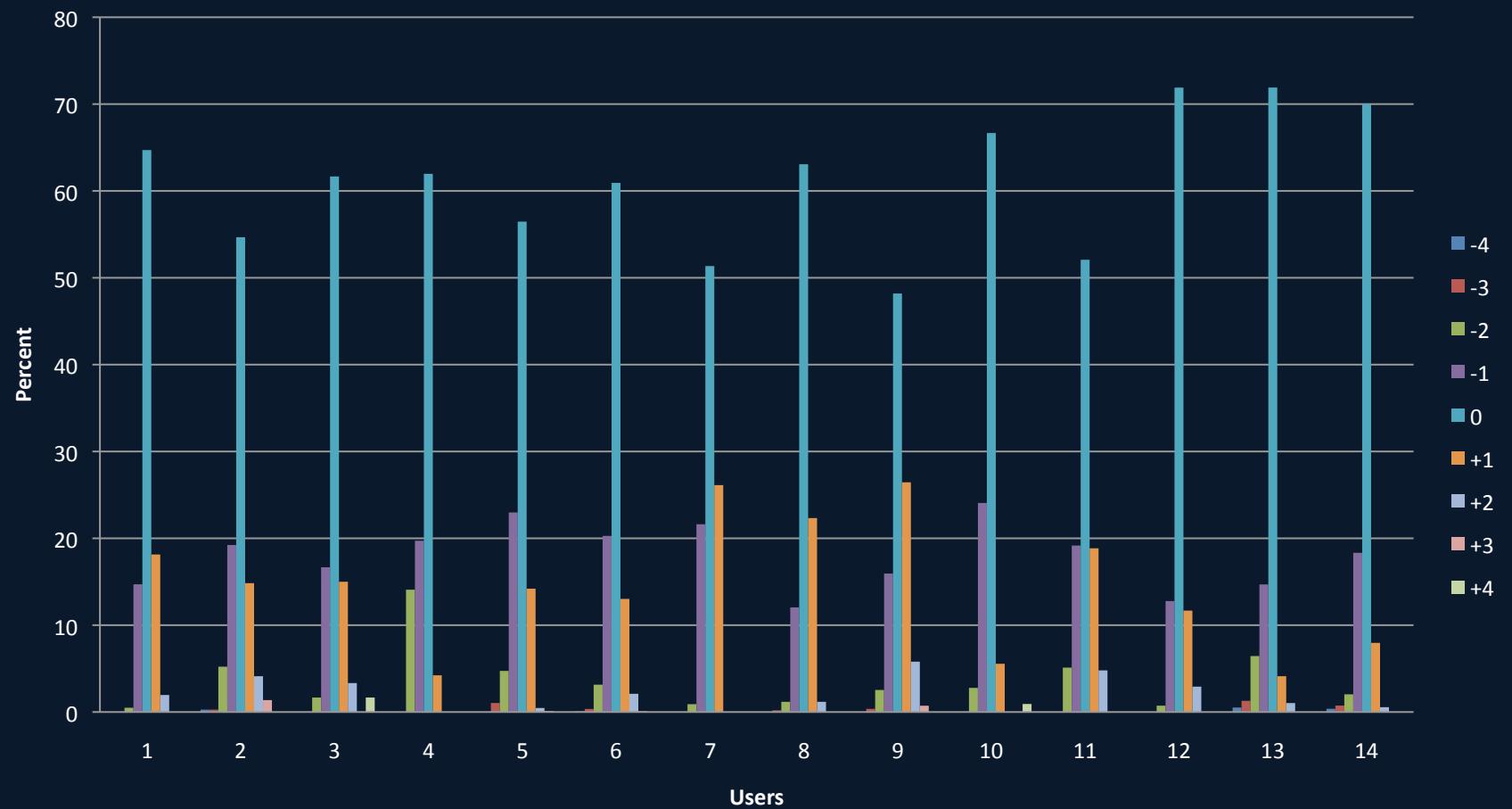
Quality: 1 (Worst) 2 3 4 5 (Best) [Next](#)

In the Supreme Court of the
Colony of Victoria In the Vice-King's Jurisdiction
In the Will and Testament of James Gurnett of Victoria late Esq. Englishman
in the Colony of Victoria deceased
An Account of Ernestina Seymour and Anna Stewart de la Roche named in and appointed
by the Will of the above named deceased.

Debit	Credit
By National Bank account on deposit	£ 0 0 0
and Bank of Victoria deposit	35 11 6
Bank of Victoria deposit on account of deposit	5 13 -
Locate rate of interest on former funds	7 - -
allowing no interest at time of death	7 10 0
Bank of New South Wales account of	16 3 11
National Bank account on deposit	31 8 6
Bank of Victoria	1 9 4
Bank of Victoria deposit on account of deposit funds	15 5 8
Commercial Bank	4 13 6
Locate rate of deposit receipts in National Bank and Bank of Victoria	30 9 -
Interest on deposit	2 12 5
	<i>A 125 11 10</i>
By Justice Court debts	35 0 8
	<i>L 125 4 8</i>
Debenture	
J. P. Hyde	Amount of account
Bank of Victoria	overbalance of account
"	allowance & interest on
Kennedy Morrison	over drawing posted to
John Gurnett	money due & demand
J. Gurnett	medical services
Mr. Stewart	money due & decreased
Mr. McLeod	overbalance in his favour
James Gurnett	allowing interest &
Mr. Rogers	not
Mr. Parker	allowing interest on
Mr. Parker	overbalance of account
Kennedy Morrison	over drawing of
Mr. Simpson	allowing interest to
	<i>Balance</i>
	<i>40 11 10</i>
J. M. Stewart for his Son	40 1 2
Mr. Anderson	40 1 2
Mr. Hall in trust for Mrs. Hartenbach	124 2 4
Subd. this 29th day of March 1838	<i>L 368 4 8</i>
Ernestina Seymour Anna Stewart	

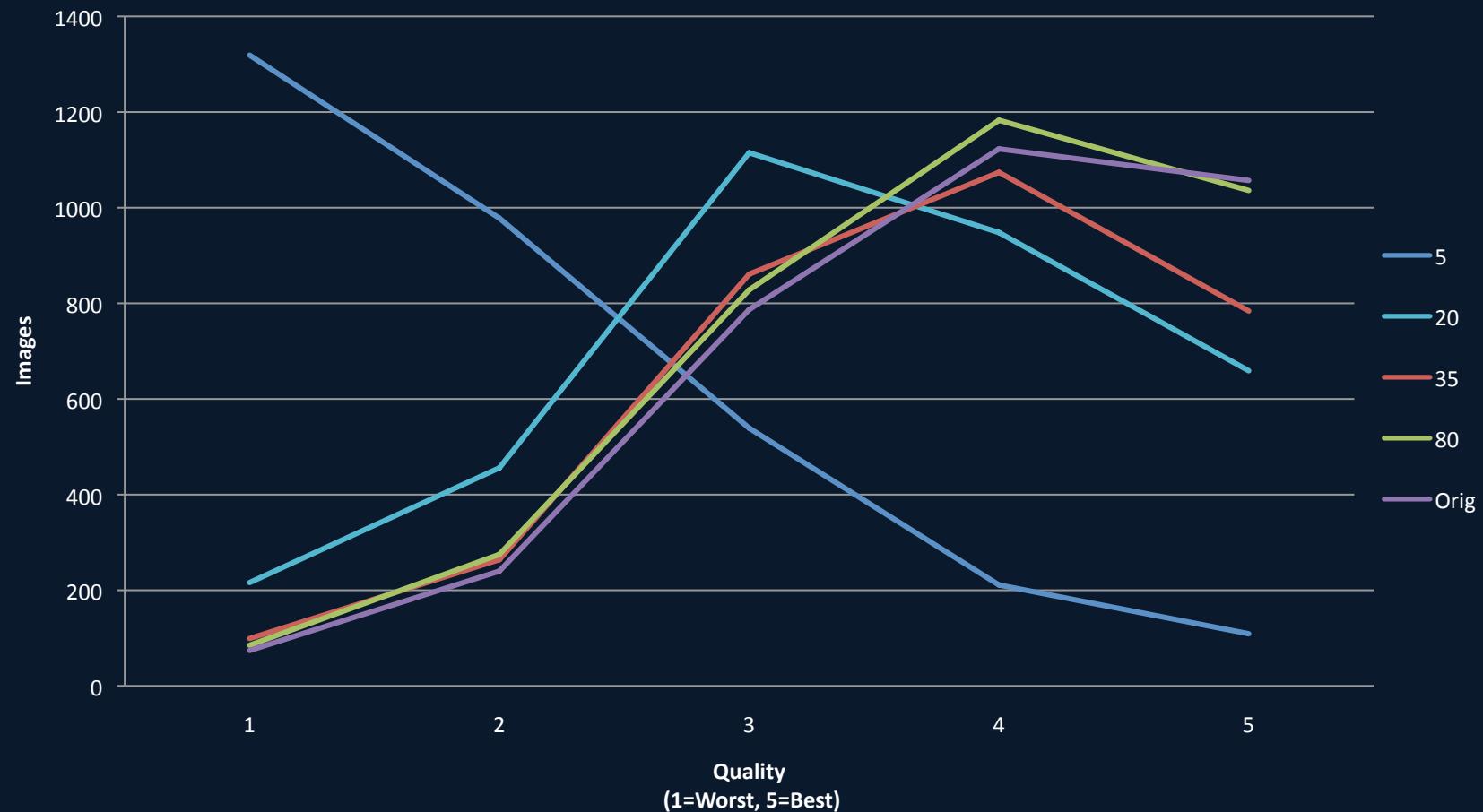
Subjective Evaluation

Consistency



Subjective Evaluation

Raw scores



Objective Measures

- No-Reference
 - No reference image available
 - “Blind” reference
- Reduced-Reference
 - Set of extracted features from reference image are used
- Full-Reference
 - A complete reference image is available

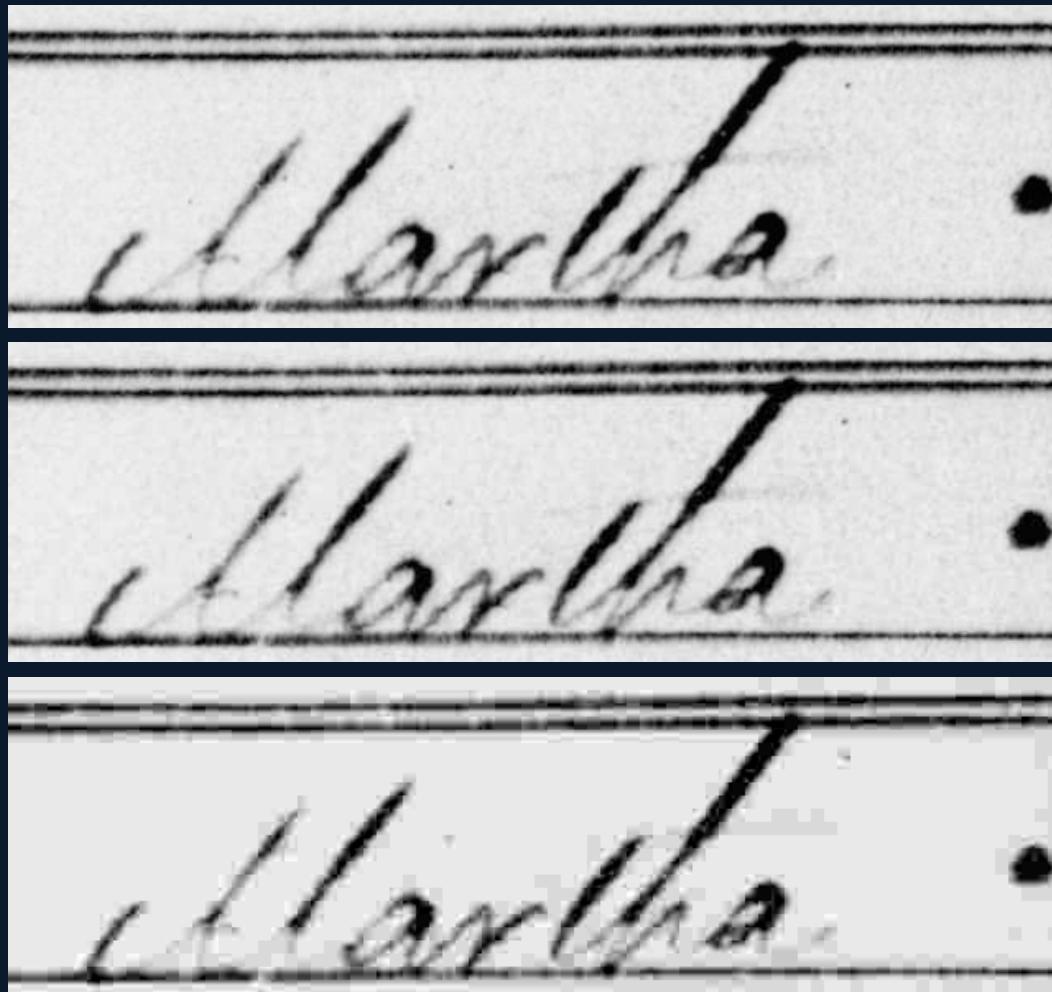
MSE

- Measures how much something changed but not how important that change is
- Ranges from 0 (exactly the same) to infinity

$$MSE(\hat{\theta}) = E[(\hat{\theta} - \theta)^2]$$

$$MSE = \frac{1}{mn} \sum_{i=0}^{m-1} \sum_{j=0}^{n-1} (I(i, j) - K(i, j))^2$$

MSE



JPEG Quality

80

4.6

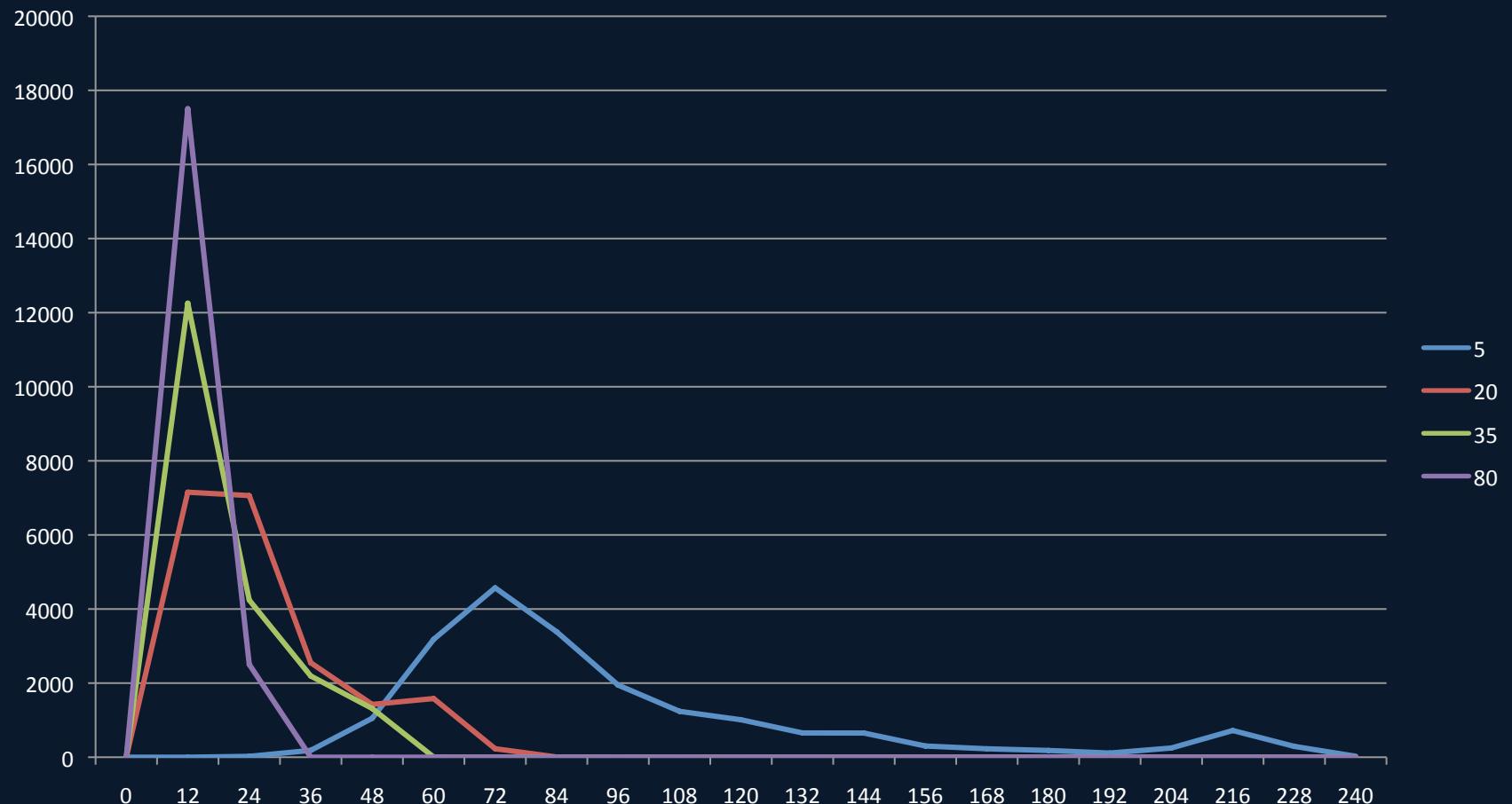
35

15.1

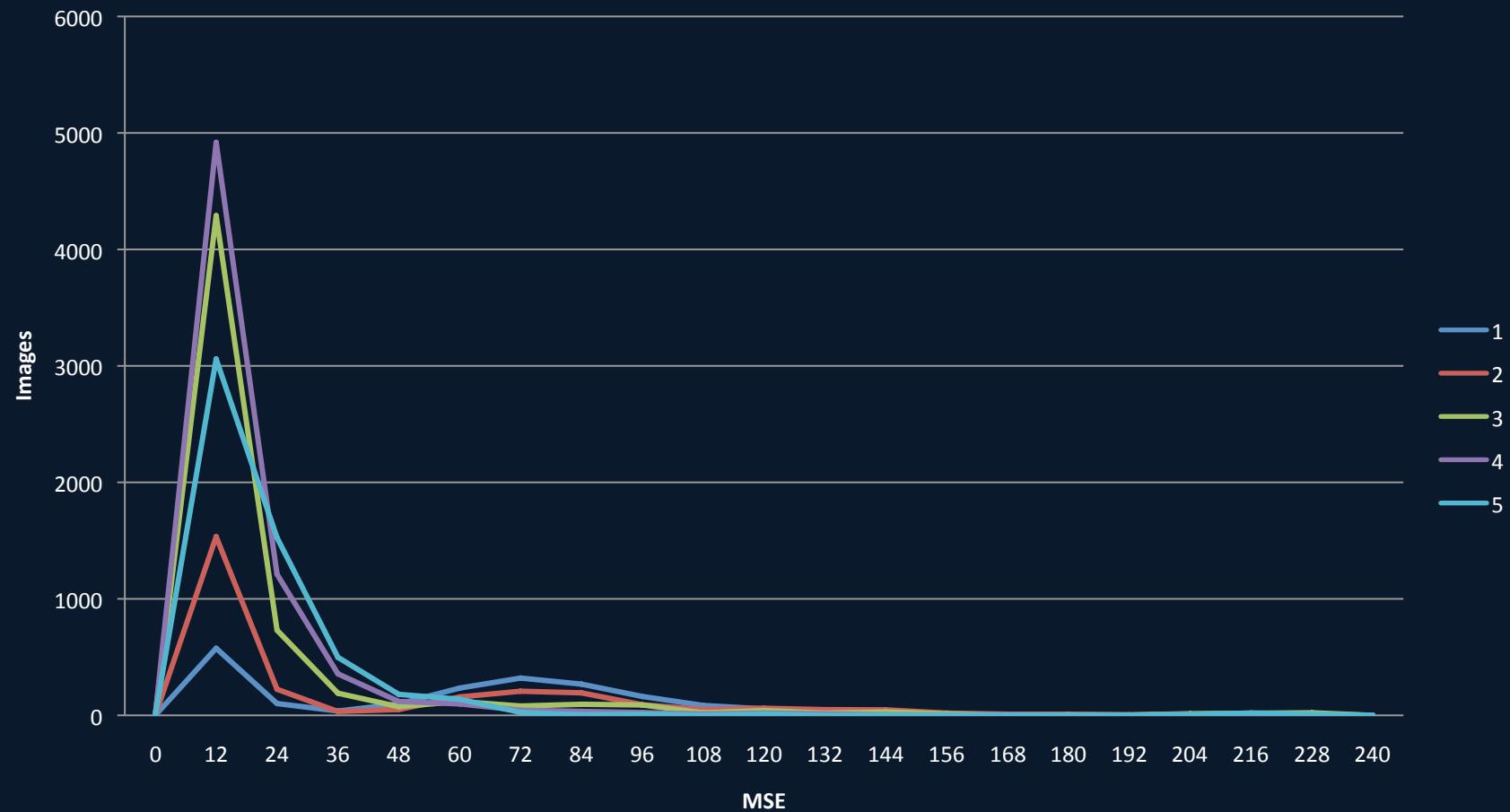
5

111.2

MSE



MSE vs. User Evaluation

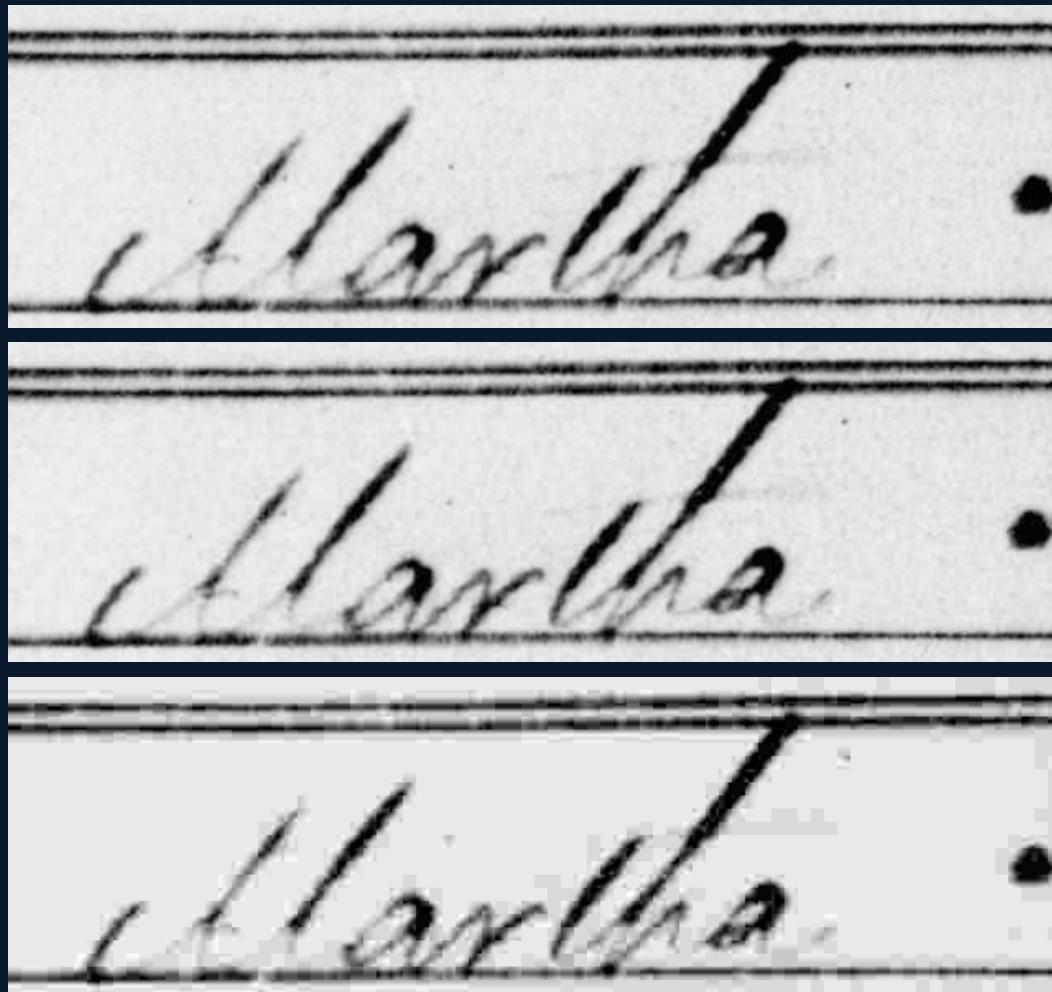


PSNR

- Ratio between the maximum possible power and the power of corrupting noise introduced by compression
- Measured using the logarithmic decibel scale
- Higher values, better quality
- Typical values 30-50db

$$PSNR = 20 \cdot \log_{10} \left(\frac{MAX}{\sqrt{MSE}} \right)$$

PSNR



JPEG Quality

80

41.5

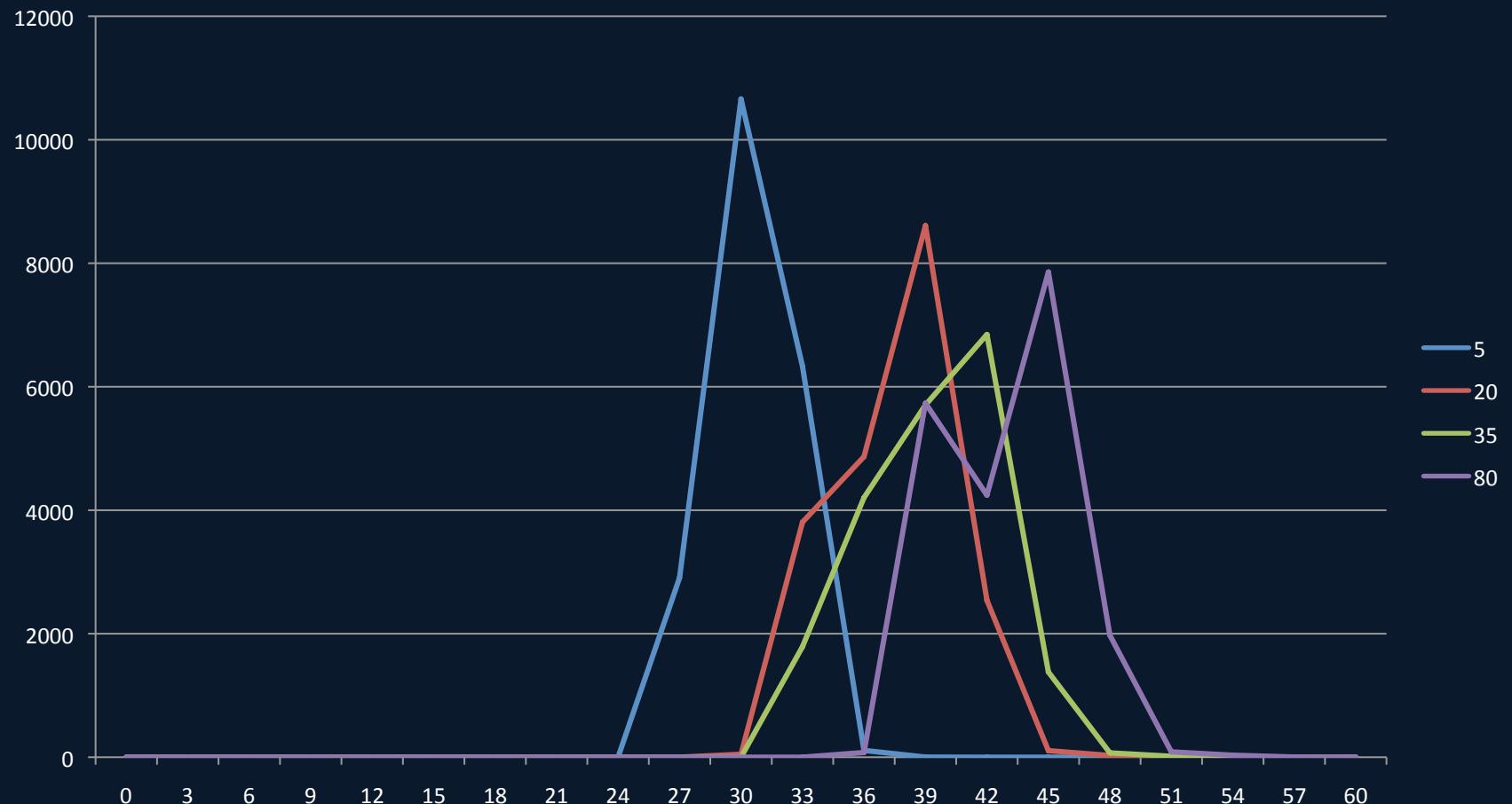
35

36.4

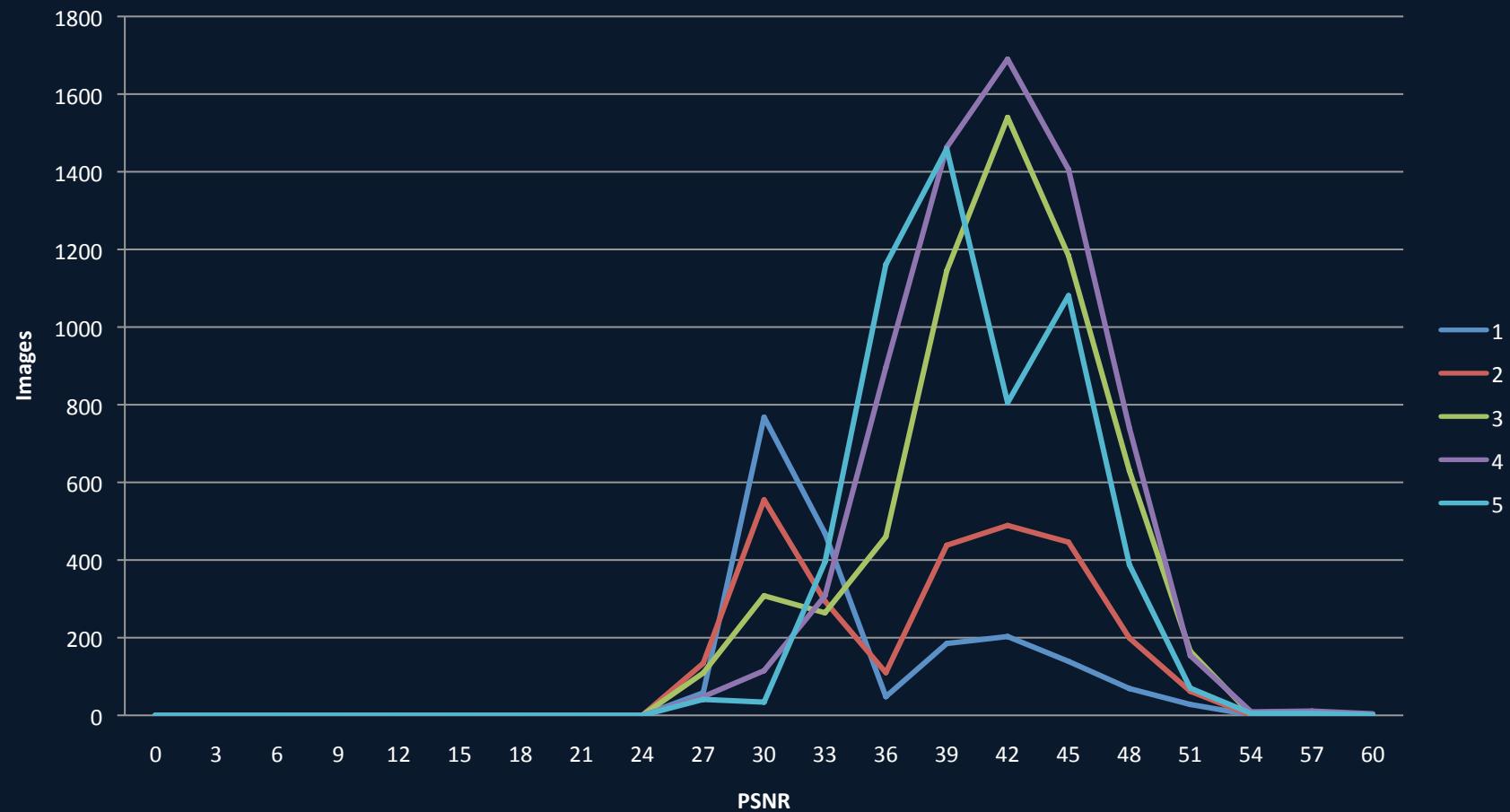
5

27.7

PSNR



PSNR vs User Evaluation



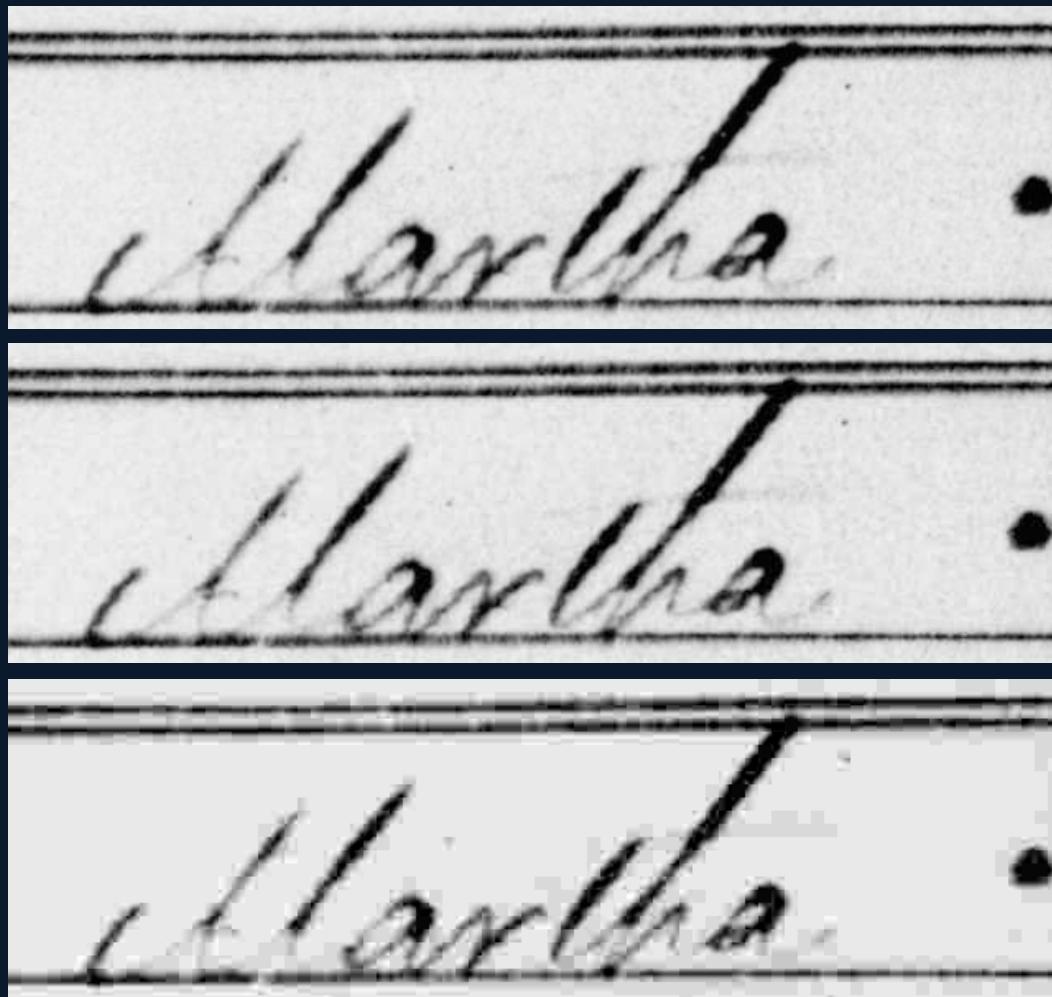
Universal Quality Index

- Proposed by Wang and Bovik (2002)

$$Q = \frac{4\sigma_{xy}\bar{x}\bar{y}}{(\sigma_x^2 + \sigma_y^2)[(\bar{x})^2 + (\bar{y})^2]}$$

- Attempts to measure:
 - Loss of correlation
 - Luminance distortion
 - Contrast distortion

Universal Quality Index



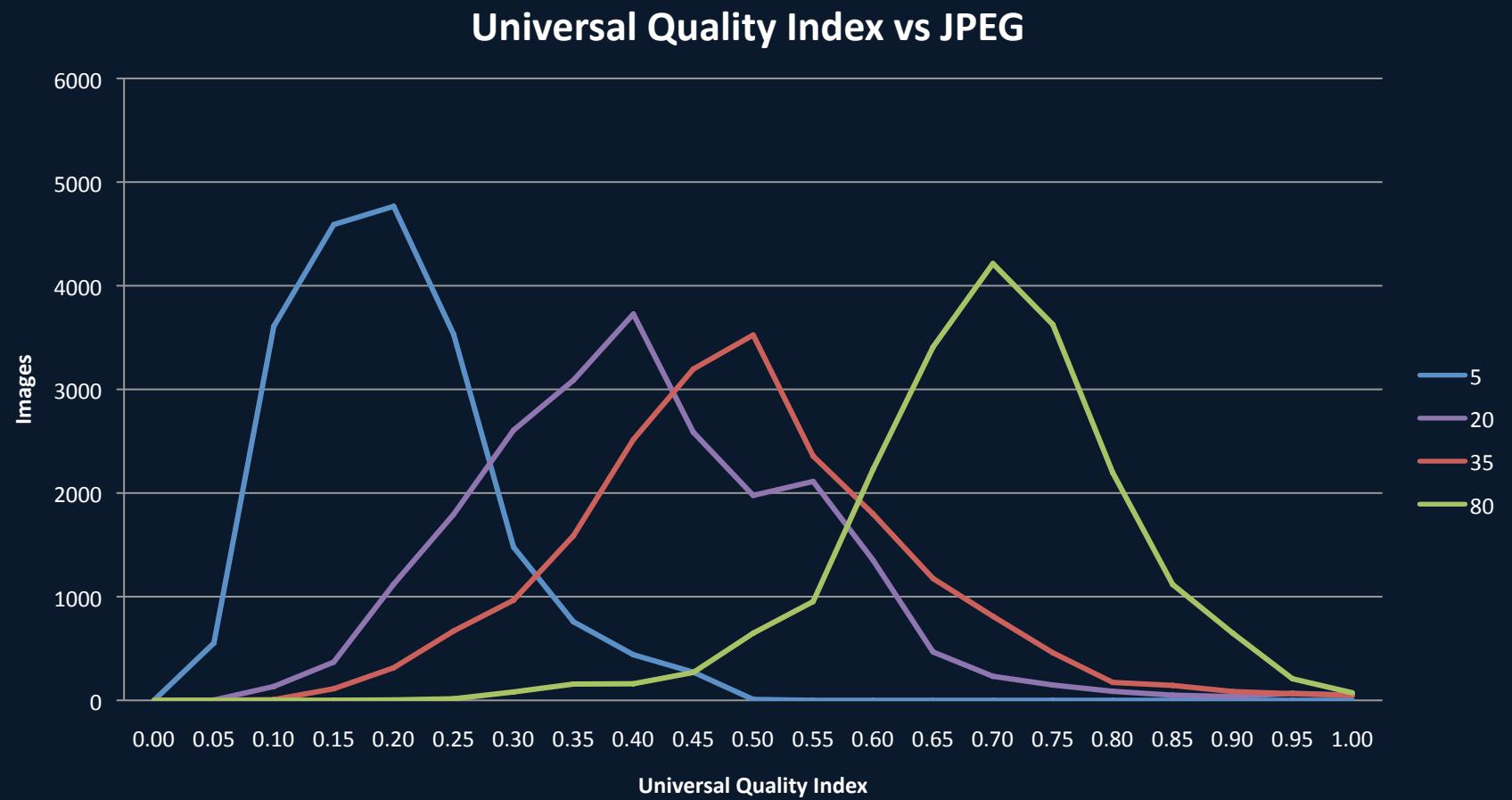
JPEG Quality

80 0.943

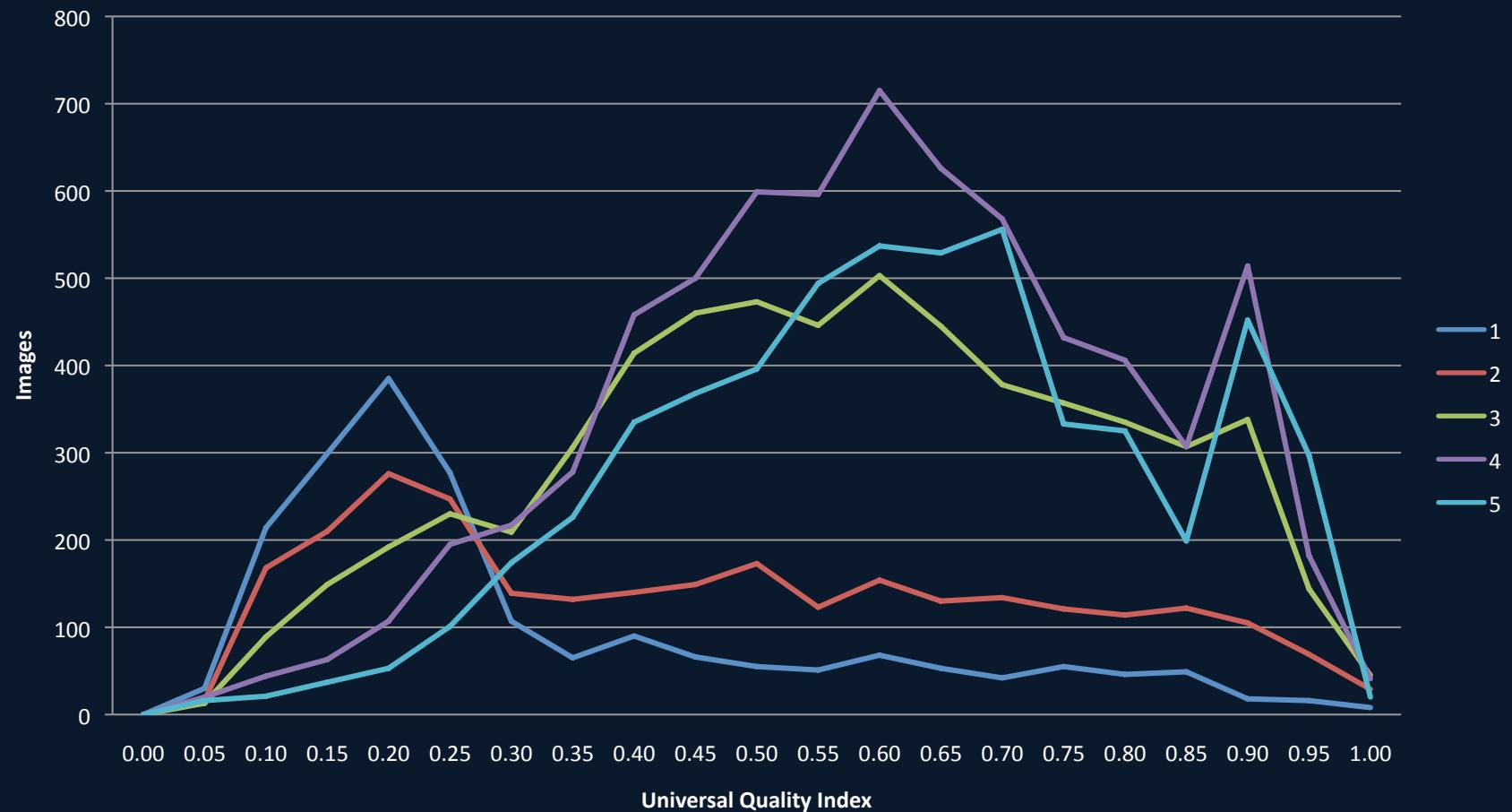
35 0.821

5 0.428

Universal Quality Index vs JPEG



UQI vs. User Evaluation



Conclusion

- Refine subjective results
- Correlate subject results to objective
 - Evaluate other published quality metrics
 - Define our own