



Evaluating Binarization for OCR















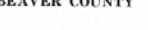





Donald B. Curtis
MyFamily.com, Inc.



Genealogical Data Extraction

- Keying data from digital images is costly.
- OCR can be cost-effective for machine-printed documents.
- OCR projects can be delivered much more quickly than keyed projects.

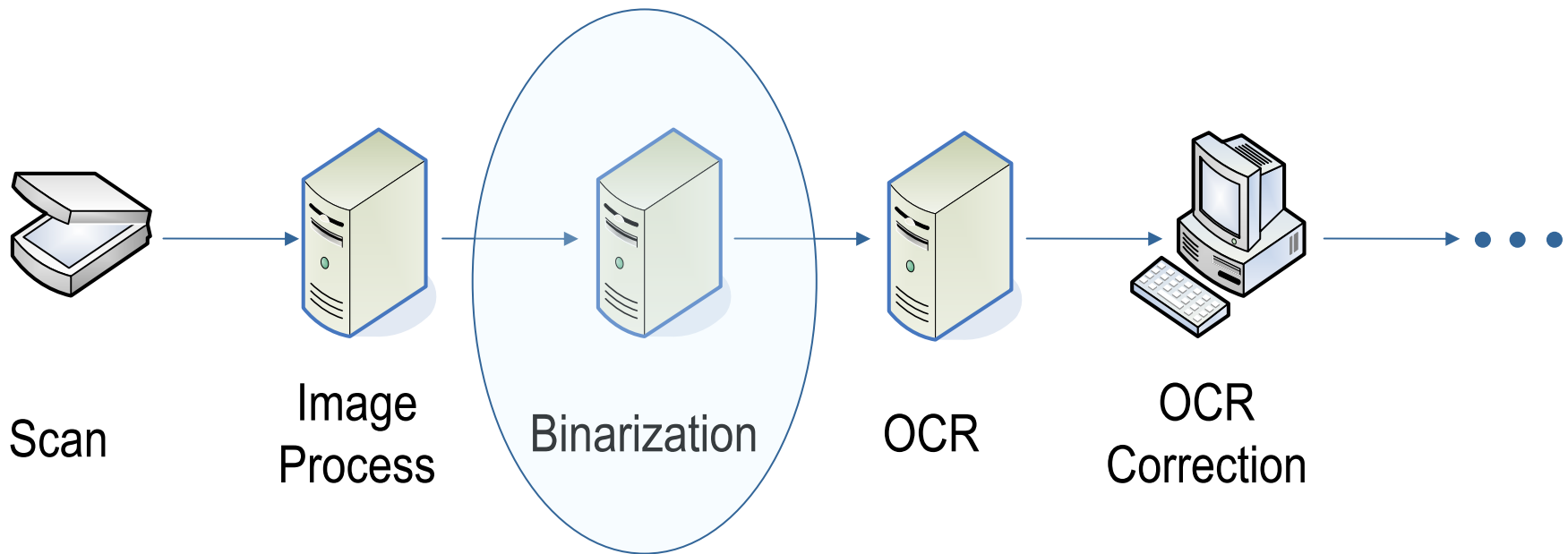
☆ ☆ ☆ YOUNG AMERICAN PATRIOTS ☆ ☆ ☆

 	<p>BELL, THOMAS ARTHUR P1M, Navy. Age 20. Entered Serv. June 28, 1943. Sampson, N. Y.; Japan. Awarded Am. Rib., As-Pac Rib., Commendation Rib., WWII Vic-Med. Disch. March 20, 1946. Attended Beaver Falls HS. Protestant. Son of Mr. and Mrs. Frank Bell. Husband of Dorothy Hutton Bell, 3810 Third Ave., Beaver Falls, Pa.</p>
 	<p>BENACQUISTO, ERNEST D. Sgt., Army. Age 22. Entered Serv. March 19, 1943. Cpl. Stoneham, San Luis Obispo; Pts. Meade, McClellan; Hawaii; N. Guinea; Philippines; Korea. Awarded GCM, Comb. Inf. Badge, As-Pac Rib., 1 BS. Ar. Hld., Phil. Lib. Rib. Disch. Dec. 22, 1945. Attended Aliquippa HS. Catholic. Son of Mr. and Mrs. Daniel Benacquisto, 140 First Ave., Aliquippa, Pa.</p>
 	<p>BENNETT, ROBERT W. T/5, Army. Born Oct. 13, 1917. Entered Serv. July 7, 1945. Cpl. Claiborne, Patrick Henry; Italy; N. Africa. Wounded in Italy June 6, 1944. Awarded PH, GCM, EAME Rib., 2 BS. Disch. Nov. 14, 1945. Attended Kiski Prep. Protestant. Son of Mr. and Mrs. J. Purl Bennett, Indiana, Pa. Husband of Katherine D. Bennett, 1945 Washington Ave., Monaca, Pa.</p>
 	<p>BERRY, VIRGIL C. Sgt., Army. Age 27. Entered Serv. June 24, 1941. Pts. Benning, Bragg, Custer; Cp. Atterbury. Awarded GCM, Am. Rib., Am. Def. Rib., WWII Vic-Med. Disch. Jan. 27, 1945. Attended Jonesboro, Tenn. School. Protestant. Son of Mr. Floyd Berry, Jonesboro, Tenn. Husband of Sue A. Berry, 107 Linmar Place, Aliquippa, Pa.</p>
 	<p>BETKE, ALBERT HAROLD Pfc., Army. Born Sept. 14, 1924. Entered Serv. Mar. 25, 1943. Cpl. Robinson; Africa; Italy. Wounded in Italy Jan. 22, 1944. Awarded PH, GCM, EAME Rib., 3 BS, Pres. Unit Cit. Disch. Nov. 26, 1945. Attended Beaver Falls HS. Protestant. Son of Mr. and Mrs. Louis Betke, 1622 Sixth Ave., Beaver Falls, Pa.</p>
 	<p>BETTONI, ALBERT JOSEPH T/5, Army. Age 28. Entered Serv. May 23, 1943. Ft. Easton; England; France; Germany; Belgium; Holland. Awarded GCM, EAME Rib., 4 BS. Disch. Jan. 1, 1946. Attended Lincoln HS. Catholic. Son of Mr. and Mrs. Elpidio Bettoni. Husband of Yolanda Casciato Bettoni, Box 48, Racine, Pa.</p>
 	<p>BIELICH, MICHEOL Pfc., Army. Age 32. Entered Serv. Jan. 20, 1941. Ft. Sam Houston; Cpl. McCoy, Shanks; Ireland; Wales; France; Germany; Belg.; Czech. Awarded Am. Def. Med., Comb. Inf. Badge, PH, Dist. Unit Cit., 2 BS. Wounded in Normandy June 15, 1944. Disch. Sept. 30, 1945. Attended Independence HS. Greek Orthodox. Son of Mr. and Mrs. Rude Bielich, R. D. #1, Aliquippa, Pa. Husband of Alice Z. Bielich, 112 Walnut St., Aliquippa, Pa.</p>
 	<p>BIGELOW, CHARLES V., JR. ABM 5/C, Navy. Age 22. Entered Serv. March 3, 1943. Sampson, Norfolk, Newport, Edenton; Africa; England; Iceland; Newfoundland; Italy. Awarded Am. Rib., EAME Rib., 5 BS, GCM. Disch. Feb. 10, 1946. Attended Huntingdon HS. Protestant. Son of Mr. and Mrs. Charles V. Bigelow Sr., Aliquippa, Pa. Husband of Margaret Bigelow, 1102 Main St., Aliquippa, Pa.</p>
 	<p>BOAK, JAMES ALBERT Pfc., Army. Age 22. Entered Serv. Dec. 22, 1942. Cp. Croft; England; France; Germany; Belgium. Awarded GCM, EAME Rib., 4 BS, Occup. Med. Disch. Jan. 11, 1946. Attended Beaver Falls HS. Protestant. Son of Mrs. and the late Mr. James M. Boak, 1706 Sixth Ave., Beaver Falls, Pa.</p>
	<p>BOOK, MARCEL ERNEST T/4, Army. Born Oct. 29, 1916. Entered Serv. Feb. 19, 1942. Ft. Bragg; Hawaii; Solomons; Phil. Is. Awarded As-Pac Rib., 3 BS, Phil. Lib. Rib. Disch. Oct. 1, 1945. Attended Beaver Falls HS. Catholic. Son of Mr. and the late Mrs. Stanley Book, 1900 Fourth Ave., Beaver Falls, Pa.</p>

BEAVER COUNTY
[126]



OCR Process Flow



- Binarization is required for OCR.

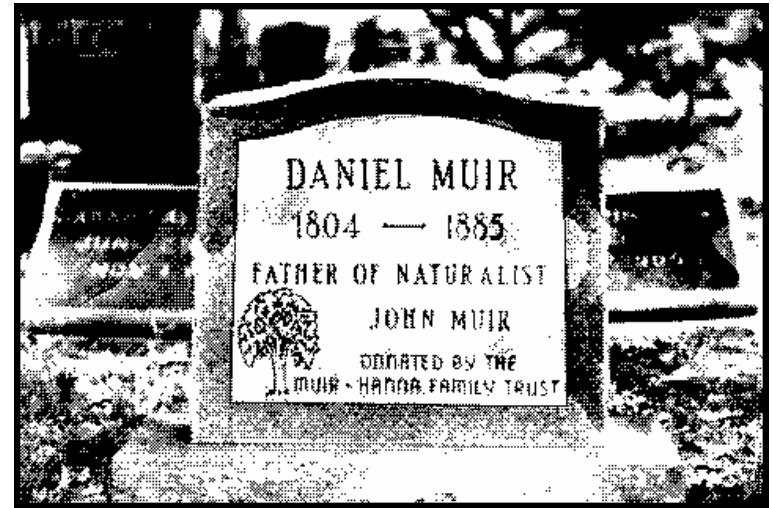


Binarization

- The process of converting a color or grayscale image to a bitonal (black-and-white) one.



Binarization

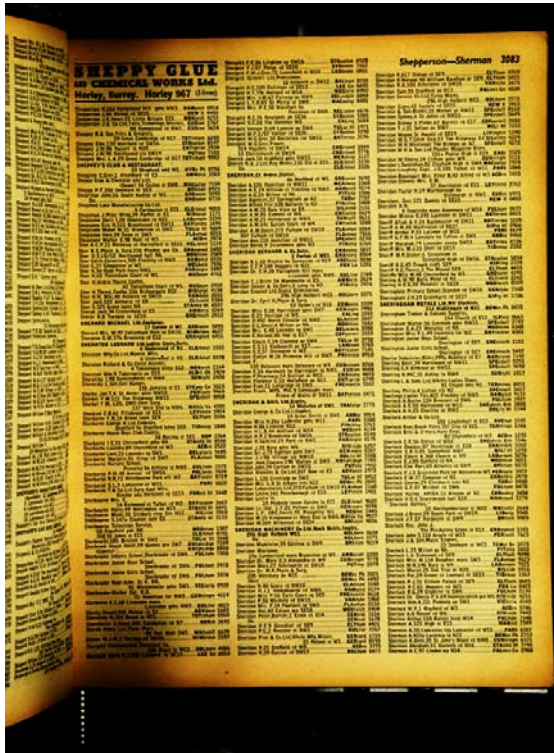




Diffusion Dithered



Global Threshold



- Thresholding is turning black every pixel whose brightness/intensity is below a threshold and turning the remaining pixels white.



Comparing Binarizers

Old Binarizer

THE SPAWN OF ONAN



A NETWORK OF CHUNNEL-SIZED AIR, fathomable as the global Internet ramifi and ceilings of the hotel and makes di suggest that hidden deep within that system grounds, Iron Age smithys, wretched prison chains, and writhing clumps of snakes. Randy not a closed loop—that it is somewhere conne sphere—because faint street smells drift in from they may take an hour to work their way int been living there for a couple of weeks, the sr an olfactory alarm clock. He sleeps to the smell the traffic conditions of Manila require that the unload only at night. Manila sprawls along a v is an infinite reservoir of mugginess, and beca thick and opaque and hot as a glass of milk udder, it begins to glow when the sun rises. A

New Binarizer

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- Different Binarization Algorithms produce different results.
- What is the best measure of binarization quality?



Comparing Binarizers

- Measure quality by counting OCR errors as per following procedure:
 1. Scan the content in grayscale.
 2. Binarize the grayscale images.
 3. OCR-process the binarized images.
 4. Compare the OCR results to the actual text.
 5. Tally the OCR errors.



Binarization Error Metrics

	Old Binarizer	New Binarizer
Added Chars	1128	43
Changed Chars	262	20
Deleted Chars	80	29
Total Errors	1470	92



Old Binarizer Results

Binarized Image

CRYPTONOMICON

21

believe that a Universal Turing Machine could show behaviors that we would construe as creative."

"Well, I don't know then . . . I'll try to keep my eye out for that kind of thing in the future."

But later, as they were riding back towards Princeton, he said, "What about dreams?"

"Like those angels in Virginia?"

"I guess so."

"Just noise in the neurons, Lawrence."

"Also I dreamed last night that a zeppelin was burning."

Soon, Alan got his Ph.D. and went back to England. He wrote Lawrence a couple of letters. The last of these stated, simply, that he would not be able to write Lawrence any more letters "of substance" and that Lawrence should not take it personally. Lawrence perceived right away that Alan's society had put him to work doing something useful—probably figuring out how to keep it from being eaten alive by certain of its neighbors. Lawrence wondered what use America would find for him.

He went back to Iowa State, considered changing his major to mathematics, but didn't. It was the consensus of all whom he consulted that mathematics, like pipe-organ restoration, was a fine thing, but that one needed some way to put bread on the table. He remained in engineering and did more and more poorly at it until the middle of his senior year, when the university suggested that he enter a useful line of work, such as roofing. He walked straight out of college into the waiting arms of the Navy.

They gave him an intelligence test. The first question on the math part had to do with boats on a river: Port Smith is 100 miles upstream of Port Jones. The river flows at 5 miles per hour. The boat goes through water at 10 miles per hour. How long does it take to go from Port Smith to Port Jones? How long to come back?

Lawrence immediately saw that it was a trick question. You would have to be some kind of idiot to make the facile assumption that the current would add or subtract 5 miles per hour to or from the speed of the boat. Clearly, 5 miles per hour was nothing more than the average speed. The current would be faster in the middle of the river and slower at the banks. More complicated variations could be expected at bends in the river. Basically it was a question of hydrodynamics, which could be tackled using certain well-known systems of differential equations. Lawrence dove into the problem, rapidly (or so he thought) covering both sides of ten sheets of paper with calculations. Along the way, he realized

OCR Results

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4 Added

11 Changed

1 Deleted



New Binarizer Results

Binarized Image

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OCR Results (No Errors)

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Binarization Differences

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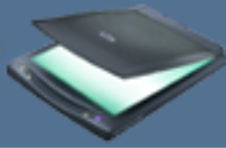
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Binarization Differences

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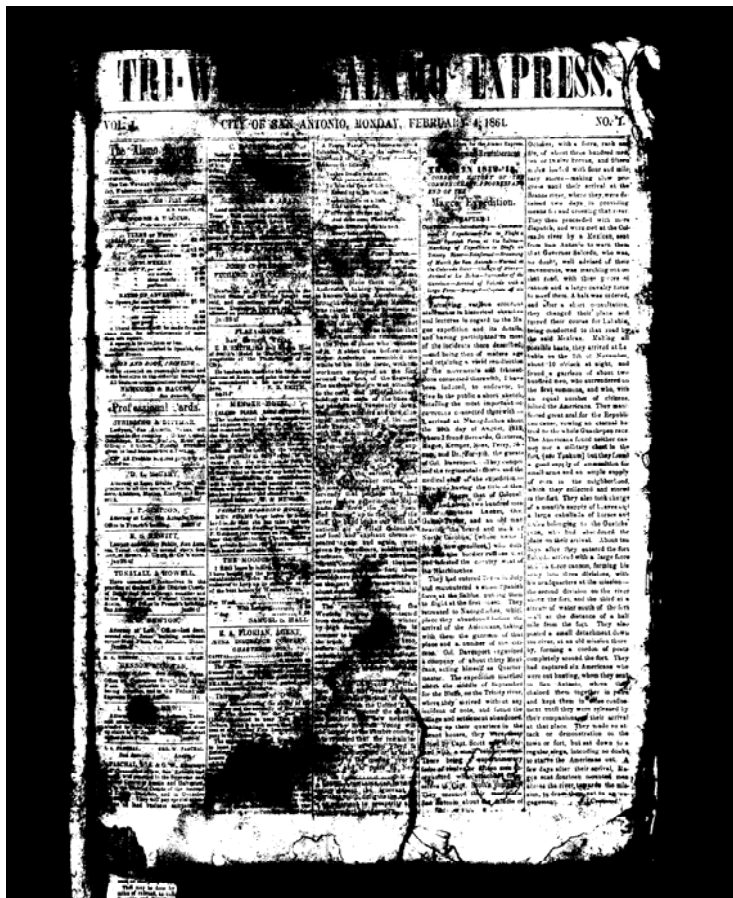
Damaged Document



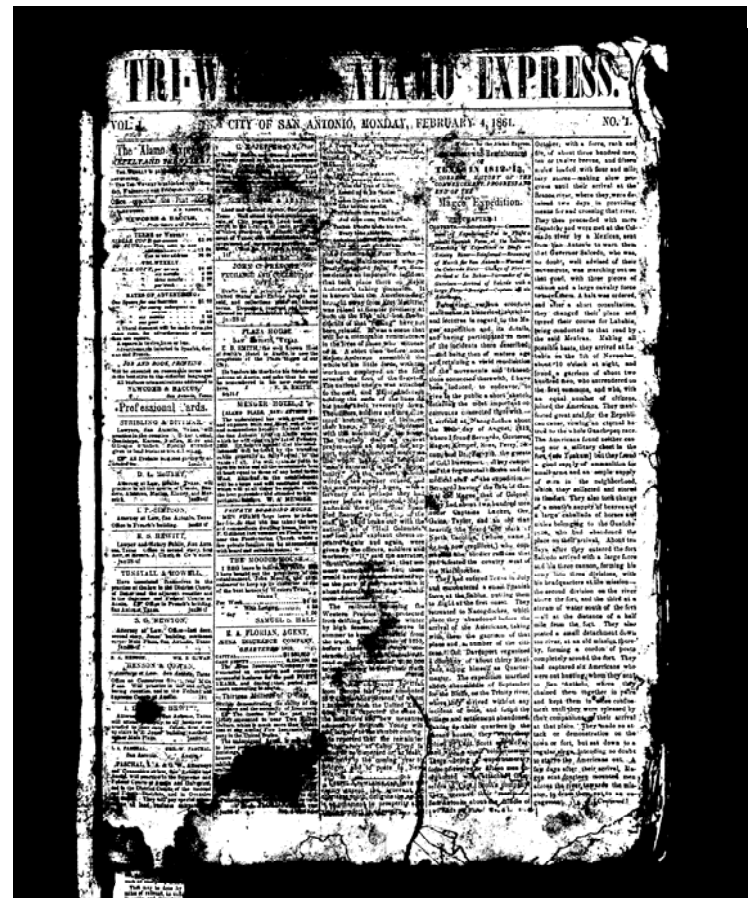


Binarization Differences

Binarizer 3



Binarizer 2





Binarizer Pre-Selection Methods

- Test binarizers on sample set, comparing results to actual data.
 - Cost of generating full data for sample set.
 - Good data accuracy metrics.
- Test binarizers on sample set, comparing results to each other and comparing differences to sample documents.
 - Only need actual data for differences.
 - No metrics for actual data accuracy.



Binarizer Run-time Selection

- Run multiple binarizers and run OCR on each resulting bitonal image.
- Calculate page confidence metric from OCR data and choose page output with greatest confidence.
- OR Choose on per-character basis using character confidence metrics.
 - E.g. 'D' with confidence 6, or 'O' with confidence 8.



Conclusion

- OCR is an important way to increase genealogical content production at low cost.
- Many binarizers exist; each has different characteristics.
- To maximize OCR quality for a project, the appropriate binarizer should be used.
- We will investigate several approaches for determining which binarization to use.



Q & A



Page 21 Grayscale

CRYPTONOMICON

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Soon, Alan got his Ph.D. and went back to England. He wrote Lawrence a couple of letters. The last of these stated, simply, that he would not be able to write Lawrence any more letters "of substance" and that Lawrence should not take it personally. Lawrence perceived right away that Alan's society had put him to work doing something useful—probably figuring out how to keep it from being eaten alive by certain of its neighbors. Lawrence wondered what use America would find for *him*.

He went back to Iowa State, considered changing his major to mathematics, but didn't. It was the consensus of all whom he consulted that mathematics, like pipe-organ restoration, was a fine thing, but that one needed some way to put bread on the table. He remained in engineering and did more and more poorly at it until the middle of his senior year, when the university suggested that he enter a useful line of work, such as roofing. He walked straight out of college into the waiting arms of the Navy.

They gave him an intelligence test. The first question on the math part had to do with boats on a river: Port Smith is 100 miles upstream of Port Jones. The river flows at 5 miles per hour. The boat goes through water at 10 miles per hour. How long does it take to go from Port Smith to Port Jones? How long to come back?

Lawrence immediately saw that it was a trick question. You would have to be some kind of idiot to make the facile assumption that the current would add or subtract 5 miles per hour to or from the speed of the boat. Clearly, 5 miles per hour was nothing more than the *average* speed. The current would be faster in the middle of the river and slower at the banks. More complicated variations could be expected at bends in the river. Basically it was a question of hydrodynamics, which could be tackled using certain well-known systems of differential equations. Lawrence dove into the problem, rapidly (or so he thought) covering both sides of ten sheets of paper with calculations. Along the way, he realized



Binarization Example

Old Binarizer

ICON

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Patrol had given Bobby Shaftoe his comrades, and so he resisted t the window. He already knew oulder to shoulder, ready to die his forearm: a dragon. His dirty made a rasping sound in the

Shaftoe said, pronouncing the

New Binarizer

ICON

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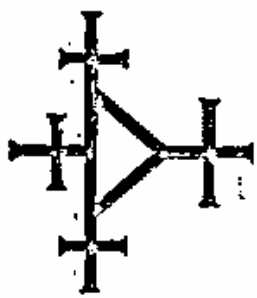
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Binarization Example

Old Binarizer

PEDESTRIAN

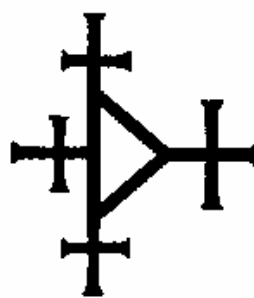


RESPECT THE
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trouble.

For the first couple
of walking. He walked

New Binarizer

PEDESTRIAN



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