

TEXT CROPPING SYSTEM

Group #5

Sponsored by: Dr. Amy Lerner Giroux

Group Members



VINCENT CARDAMAN
IMAGE STITCHING AND
BRIGHTNESS MANIPULATION



MIGUEL SEVERINO
PYTESSERACT AND GUI
IMPLEMENTATION



JACOB RODRIGUEZ
DEFINITION DETECTION AND
CROPPING



BRIAN SMITH
IMAGE DEWARPING AND
DOCKER

Project Goals

- Digitize Samuel Johnson's "*A Dictionary of the English Language*"
 - 1755 and 1773 versions
 - One of the most influential dictionaries
- Correct faulty scans and text warping
- Implement computer vision
 - OpenCV
- Solution could be used for future document preservation
 - Government archives, Museums, Universities

find houses, and allowing one man to every house, who could have any three in the government, (the rest, consisting of women, children and servants) and making other obvious abatements, these tyrants, if they had been careful to adhere together, might have been a majority even of the people collective.

Swift on the contests in Adams and Rames.
4. The cause of abating; extenuation.
As our advantages towards practicing and promoting piety and virtue were greater than those of other men; so will our excuse be less, if we neglect to make use of them. We cannot plead in abatement of our guilt, that we were ignorant of our duty, under the prepossession of ill habits, and the want of a wrong education.

Atterbury's Sermons.
ABATEMENT, in law.
The act of the abator; as, the abatement of the heir into the land, before he hath agreed with the lord. The affection or passion of the thing abated; as, abatement of the writ. *Coed.*
ABATEMENT, (with heralds) is an accidental mark, which being added to a coat of arms, the dignity of it is abated, by reason of some stain or dishonourable quality of the bearer. *Dict.*
ABATER, *n. f.* The agent or cause by which an abatement is procured.

Motives of scrupulousness: expressed oils of ripe vegetables, and all preparations of such; as of almonds, paltachos, and other nuts. *Abatement on diet.*
ABATOR, *n. f.* [a law-term.] One who intrudes into houses or land, that is void by the death of the former possessor, as yet not entered upon or taken up by his heir. *Dict.*

ABATUDE, *n. f.* [old records.] Any thing diminished. *Bailey.*
ABATURE, *n. f.* [a hunting term.] Those springs of grass which are thrown down by a stag in his passing by. *Dict.*
ABA, *n. f.* The yarn on a weaver's warp; a term among clothiers. *Chambers.*

ABBA, *n. f.* [Heb. אבא] A Syriac word, which signifies father. *Chambers.*
ABBACY, *n. f.* [Lat. *abbatia*.] The rights or privileges of an abbot. See **ABBEEY**.

According to Felinus, an *abbacy* is the dignity itself, since an abbot is a term or word of dignity, and not of office; and, therefore, even a secular person, who has the care of souls, is sometimes, in the canon law, also styled an abbot.

Abijiff's Parergon Juris Canonici.
ABBESS, *n. f.* [Lat. *abbatissa*, from whence the Saxon *abubyrre*, then probably *abbatess*, and by contraction *abbess* in Fr. and abbess, Eng.] The superior or governess of a nunnery or monastery of women.

They fled
Into this abbey, whither we pursued them;
And here the abbess shuts the gate on us,
And will not suffer us to fetch him out. *Shaksf. Comedy of Errors.*

I have a sister, *abbess* in Torcerus,
Who lost her lover on her bridal-day. *Dryd. D. Scuff.*
Constantia's heart was so elevated with the discourse of Father FRANCIS, that the very next day she entered upon her vow. As soon as the solemnities of her reception were over, we retired, as it is usual, with the *abbess* into her own apartment.

Abijiff's Speech, N^o 164.
ABBEEY, or **ABBY**, *n. f.* [Lat. *abbatia*; from whence probably first **ABBACY**; which see.] A monastery of religious persons, whether men or women; distinguished from religious houses of other denominations by larger privileges. See **ABBOT**.

With easy roads he came to Leicester;
Lodg'd in the *abbey*, where the reverend abbot,
With all his convent, honourably receiv'd him. *Shaksf. Henry VIII.*

ABBEEY-LUBBER, *n. f.* [See **LUBBER**.] A slothful loiterer in a religious house, under pretence of retirement and austerity. 'Tis no Father Dominic, no huge overgrown *abbey-lubber*; this is but a diminutive sucking friar. *Dryd. Sp. Fr.*

ABBOT, *n. f.* [in the lower Latin *abbas*, from אבא father, which sense was implied; so that the abbots were called *patres*, and *abbesses matres monasterii*. Thus Fortunatus to the abbot PATERNUS: *Nominis officium jure, Paternus, gerit.*] The chief of a convent, or fellowship of canons. Of these, some in England were mitred, some not: those that were mitred, were exempted from the jurisdiction of the diocesan, having in themselves episcopal authority within their precincts, and being also lords of parliament. The other sort were subject to the diocesan in all spiritual government. *Coed.*
See **ABBEEY**.

ABBOT, See **ABBEEY**.
ABBOTSHIP, *n. f.* The state or privilege of an abbot. *DiG.*
To **ABBREVIATE**, *v. a.* [Lat. *abbreviare*.]
1. To shorten by contraction of parts without loss of the main substance.

It is one thing to *abbreviate* by contracting, another by cutting off.
The only invention of late years, which hath any way contributed towards politeness in discourse, is that of *abbreviating* or reducing words of many syllables into one, by lopping off the rest. *Swift's Introduction to gentler conversation.*

2. To shorten, to cut short.
Against this opinion we may very well set the length of their days before the food; which were *abbreviated* aiter, and in half this space contracted into hundreds and threefores.

Brown's Vulgar Errors, b. vi. c. 6.
ABBREVIATION, *n. f.*
1. The act of abbreviating.
2. The means used to abbreviate, as characters signifying whole words.

Such is the propriety and energy of expression in them all, that they never can be changed, but to disadvantage, except in the circumstance of using *abbreviations*.

Swift's Introduction to gentler conversation.
ABBREVIATOR, *n. f.* [Lat. *abbreviator*, Fr.] One who abbreviates, or abridges.

ABBREVIATURE, *n. f.* [Lat. *abbreviatura*, Lat.]
1. A mark used for the sake of shortening.
2. A compendium or abridgement.

He is a good man, who grieves rather for him that injures him, than for his own suffering; who prays for him, that wrongs him, forgiving all his faults; who sooner shows mercy than anger; who offers violence to his appetite, in all things endeavouring to subdue the flesh to the spirit. This is an excellent *abbreviature* of the whole duty of a Christian.

Taylor's Guide to devotion.
ABBREUVOIR, [in French, a watering-place. This word is derived by *Menage*, not much acquainted with the Teutonic dialects, from *abbithars* for *abbithers*; but more probably it comes from the same root with brew. See **BRUW**.] It signifies, among masons, the joint or juncture of two stones, or the interstice between two stones to be filled up with mortar. *Dict.*

A, B, C.
1. Is taken for the alphabet; as, he has not learned his *a, b, c.*
2. Sometimes for the little book by which the elements of reading are taught.

To **ABDICATE**, *v. a.* [Lat. *abdica*.] To give up right; to resign; to lay down an office.

Old Saturn, here, with upcast eyes,
Beheld his *abdicated* sices. *Abijiff.*
ABDICATION, *n. f.* [*abdicatio*, Lat.] The act of abdicating; resignation; quitting an office by one's own proper act before the usual or stated expiration.

Neither doth it appear how a prince's *abdication* can make any other sort of vacancy in the throne, than would be caused by his death; since he cannot *abdicate* for his children, otherwise than by his own consent in form to a bill from the two houses. *Swift on the Sentiments of a Church of England man.*

ABDICATIVE, *adj.* That which causes or implies an *abdication*. *Dict.*

ABDITIVELY, *adj.* [from *abdo*, to hide.] That which has the power or quality of hiding. *Dict.*

ABDOMEN, *n. f.* [Lat. from *abdo*, to hide.] A cavity commonly called the lower venter or belly: It contains the stomach, guts, liver, spleen, bladder, and is within lined with a membrane called the peritonaeum. The lower part is called the hypogastrium; the foremost part is divided into the epigastrium, the right and left hypochondria, and the navel; 'tis bounded above by the cartilago eniformis and the diaphragm, sideways by the short or lower ribs, and behind by the vertebrae of the loins, the bones of the coxendix, that of the pubes and os sacrum. It is covered with several muscles, from whose alternate relaxations and contractions in respiration, digestion is forwarded, and the due motion of all the parts therein contained promoted, both for secretion and expulsion. *Quincy.*

The *abdomen* consists moreover of parts containing and contained. *Wijeman's Surgery.*

ABDOMINAL, *adj.* relating to the abdomen.

ABDOMINOUS, *adj.* relating to the abdomen.

To **ABDUCE**, *v. a.* [Lat. *abducere*.] To draw to a different part; to withdraw one part from another. A word chiefly used in physic or science.

And if we *abduce* the eye unto either corner, the object will not duplicate; for, in that position, the axis of the cones remain in the same plain, as is demonstrated in the optics delivered by Galen. *Brown's Vulgar Errors, b. iii. c. 201.*

ABDUCT, *adj.* Muscles abduct, are those which serve to open or pull back divers parts of the body; and their opposites being called adduct.

ABDUCTION, *n. f.* [*abductio*, Lat.]
1. The act of drawing apart, or withdrawing one part from another.

2. A particular form of argument.

ABDUCTOR, *n. f.* [*abductor*, Lat.] The name given by anatomists to the muscles, which serve to draw back the several members.

In pursuance of this theory, he supposed the constrictors of the eyelids must be strengthened in the supercilious; the *abductors* in drunkards, and contemplative men, who have the same steady and grave motion of the eye.

Archibishop and Pope's Martinus Scriblerus.

Average Page

- Guide word at top of column
- Definitions spanning each column

ABORI'GINES. *n. f.* [Lat. The earliest inhabitants of a country ; those of whom no original is to be traced ; as, the Welsh in Britain.

To ABO'RT. *v. n.* [aborto, Lat.] To bring forth before the time ; to miscarry. *Dict.*

ABO'RTION. *n. f.* [abortio, Lat.]

1. The act of bringing forth untimely.
2. The produce of an untimely birth.

His wife miscarried ; but as the *abortion* proved only a female foetus, he comforted himself, that, had it arrived to perfection, it would not have answered his account.

Arbuthnot and Pope's Martinus Scriblerus.

Behold my arm thus blasted, dry and wither'd,
Shrunk like a foul *abortion*, and decay'd,
Like some untimely product of the seasons,
Robb'd of its properties of strength and office.

Rowe's Fane Shore.

Parts of a definition

- Each orange box is an entry
- Yellow box is a headword (beings every entry)

Extraneous Information

- These parts of the page are to be excluded from the definition

A B J

A B J

4. To continue in the same state.
The fear of the Lord tendeth to life; and he that hath it shall abide satisfied.

Prov. xix. 23.

Those who apply themselves to learning, are forced to acknowledge one God, incorruptible and unbegotten; who is the only true b
heavens, from w
in heaven and ea
There can be

2. Contemptible,

I was at fir
The troden h

3. Without hope

The rarer thy

By how much from the top of wond'rous glory,
Strongest of mortal men,

To lowest pitch of *abject* fortune thou art fall'n.

Milton's Samson Agonistes.

We see man and woman in the highest innocence and perfection, and in the most *abject* state of guilt and infirmity.

Addison. Spectator, N^o 273.

VOL. I.

4. Destitute, mean and despicable; used of actions.

To what base ends, and by what *abject* ways,
Are mortals urg'd thro' sacred lust of praise?

Pope's Essay on Criticism.

The rapine is so *abject* and profane,

Guide words [top]: index to first and last words on page

Signature mark [bottom]: says where page fits into book

Press figure [bottom]: identifies worker who set type

Catchword [bottom right]: gives the first word on the next page;

helps put pages in order

were apprehended, he might not be taken from thence to the usual trial of law, but confessing his fault to the justices, or to the coroner, gave his oath to forsake the realm for ever, which was called *abjuration*.

There are some *abjurations* still in force among us here in England; as, by the statute of the 25th of king Charles II. all persons that are admitted into any office, civil or military,

C

mult

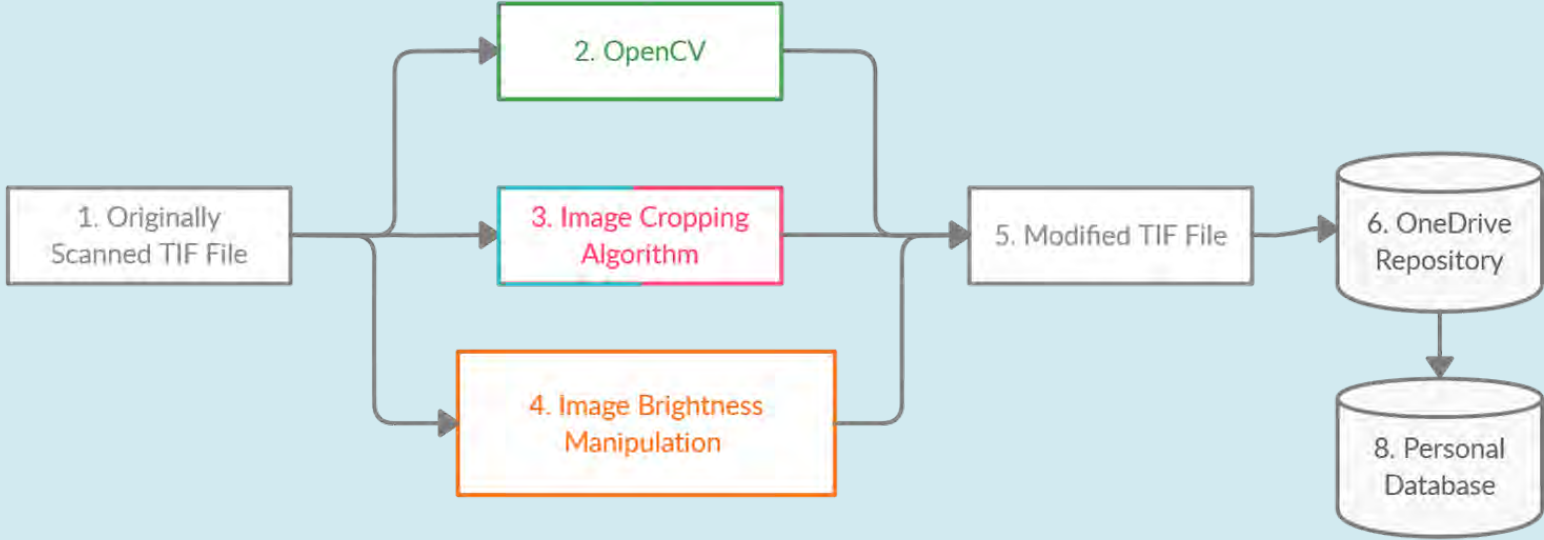
Project Requirements

- Analyze each full page image for page level rotation and correct for it
- Parse each page into word-level image files based on the headwords
- Analyze the word-level images for rotation and correct for it
- Combine multi-part word images into single files of common width to keep text size common between the parts
- Adjust contrast and brightness of multi-part words to make the image more uniform
- Name the resultant file based on our standard naming conventions and save in a directory structure arranged by edition (1755/1773) and beginning letter of the word

Design Approach

- Load image(s) into the program
- Split pages into left and right columns
 - Allows for easier image dewarping
- Dewarp image
- Identify headwords at the beginning of each entry
 - Each entry begins with a capital letter and is followed by definition
- Split each word into its own file
 - If definition spans column or page stitch together
- Save

7. Executable File



Group Member Key

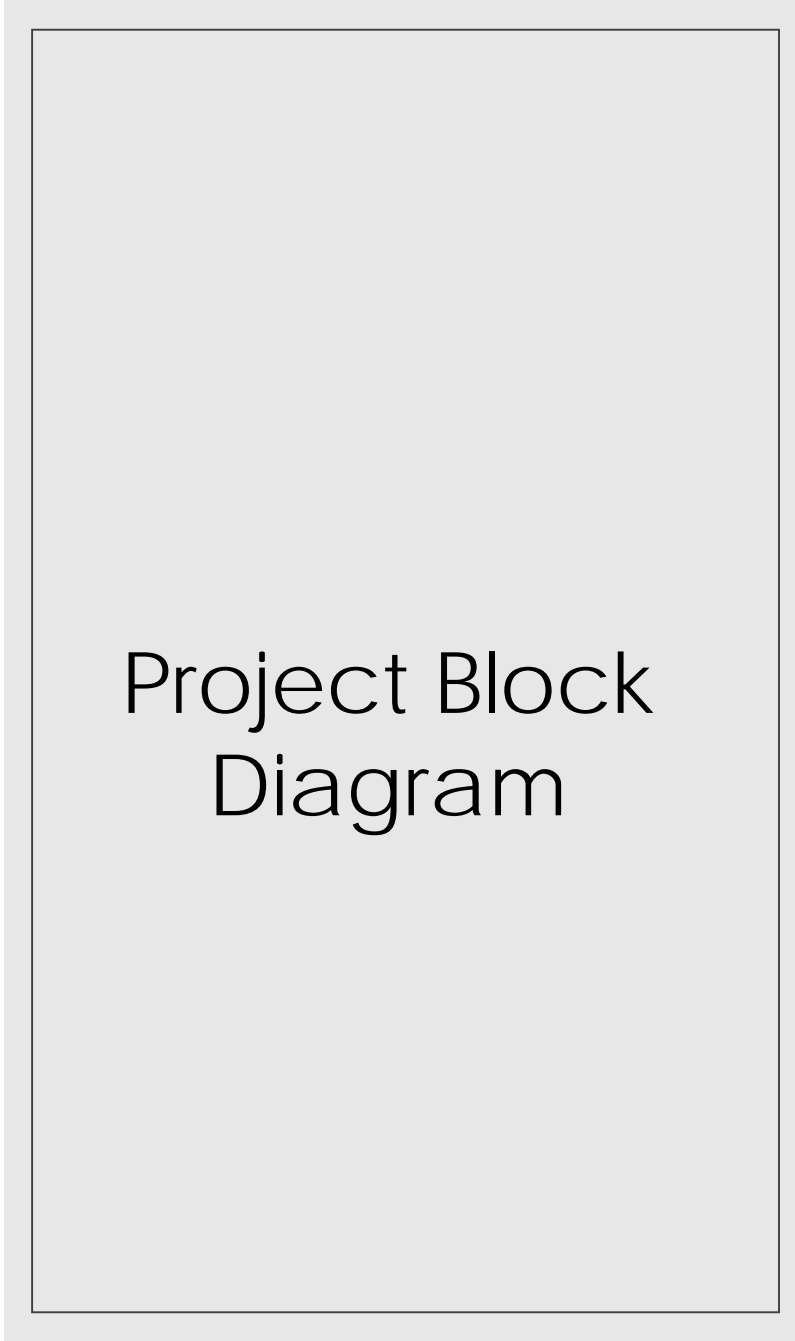
Brian

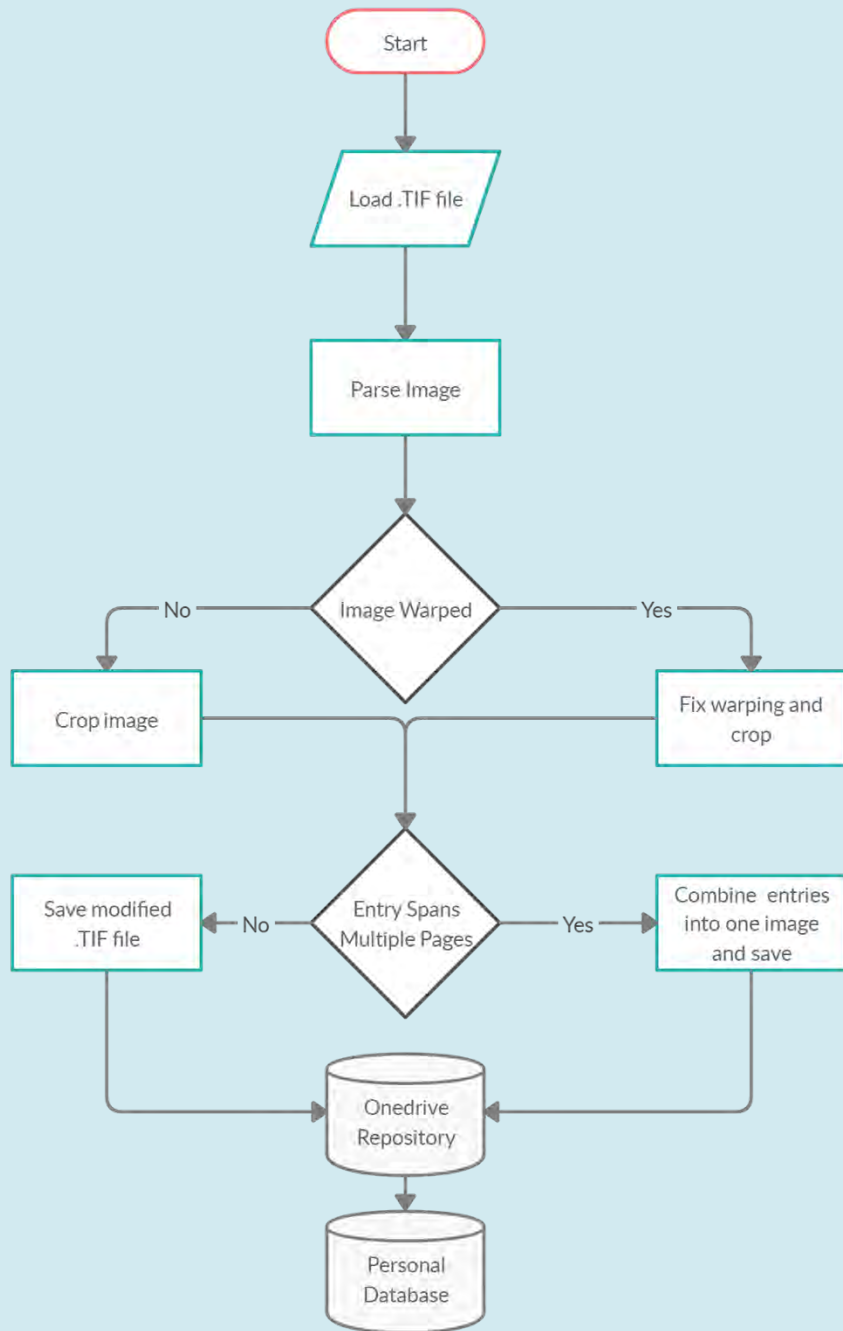
Jacob

Miguel

Vincent

Everyone





Program Execution Flowchart

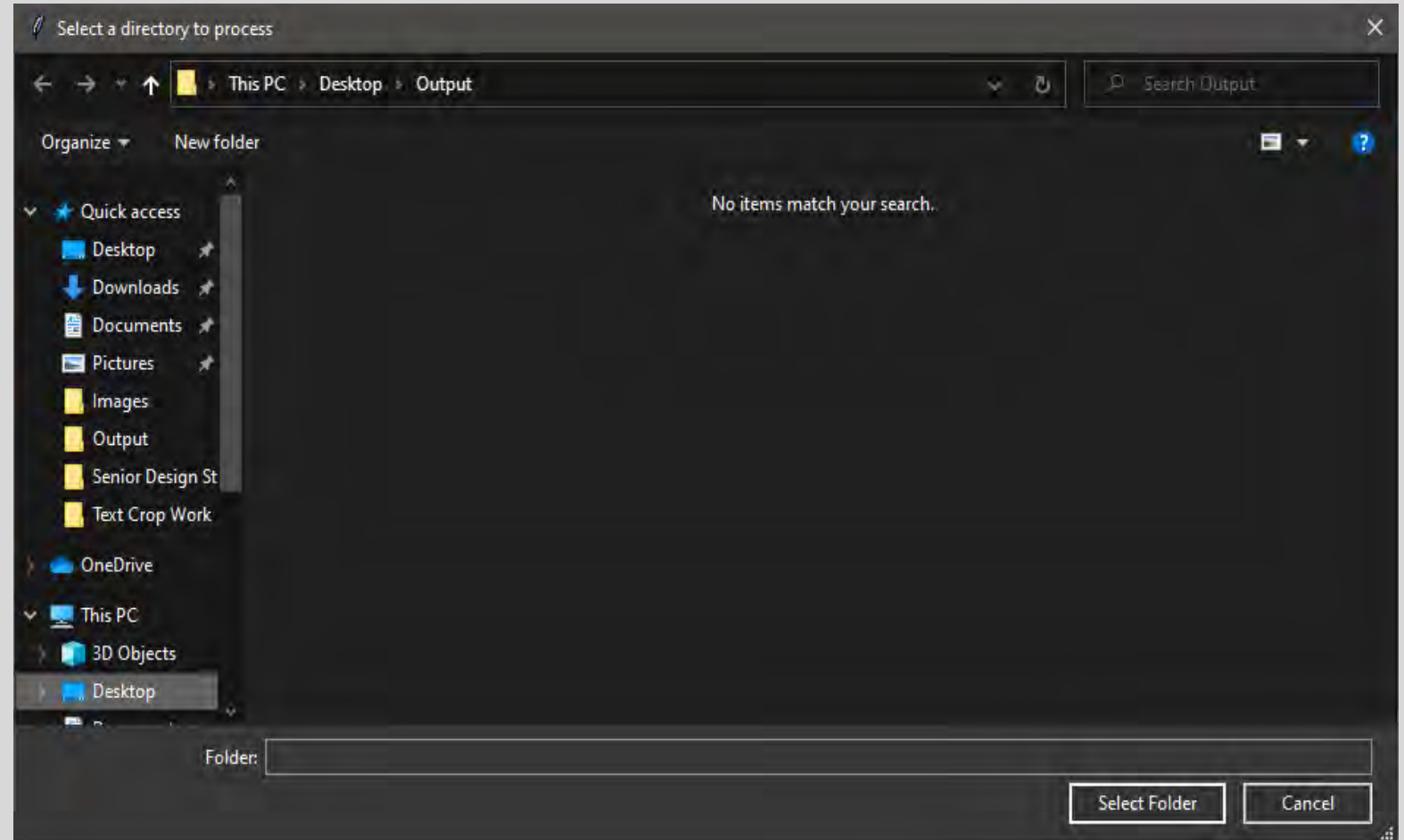
GUI

- 4 Functions
 - Choosing a directory
 - Choosing an image
 - Saving to a location
 - Process the images



GUI

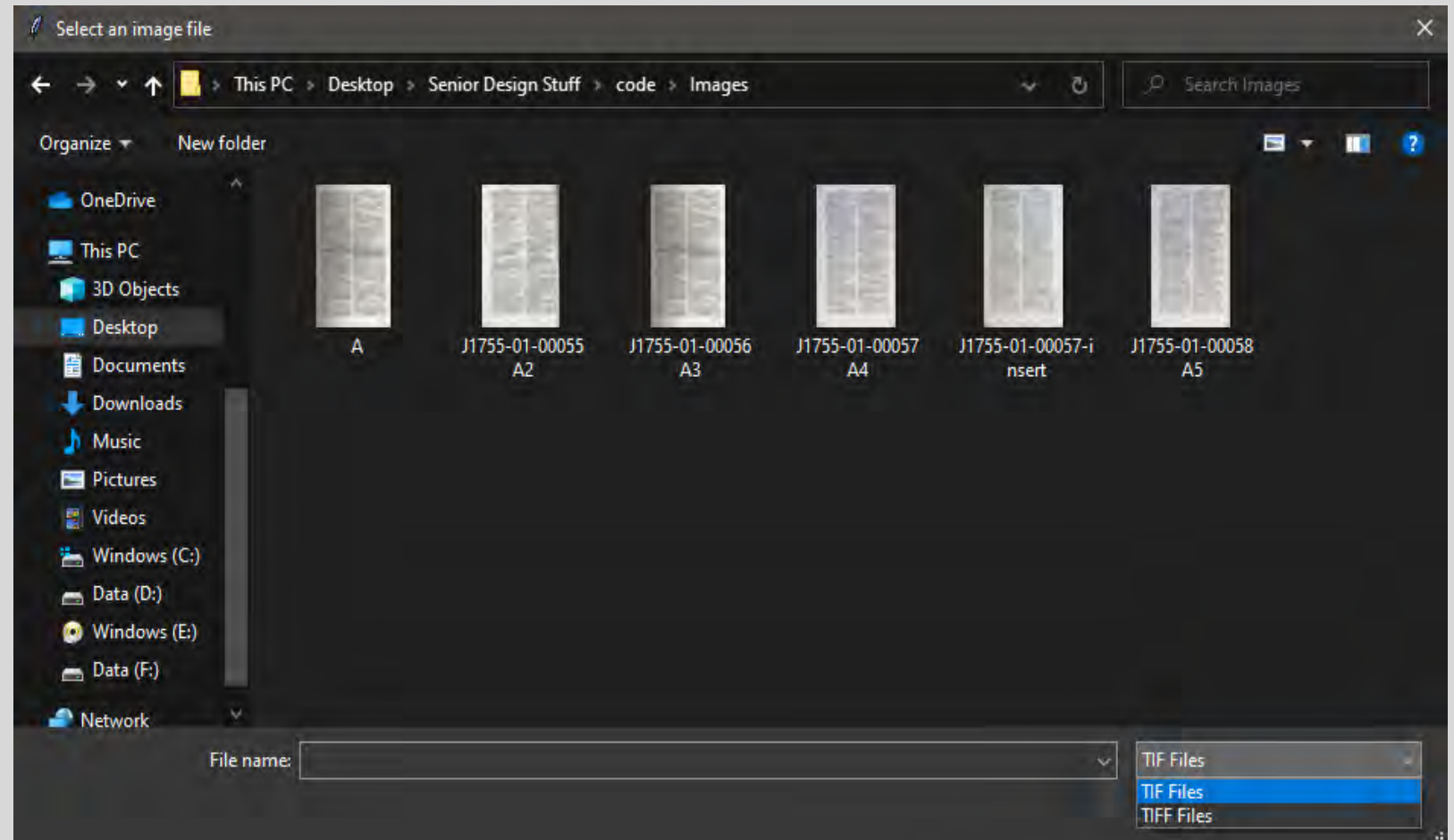
In this window, the user is able to select a directory of images to process.



GUI

In this window, the user is able to select a specific image.

The file filter could also be adjusted.



Output and PyTesseract OCR

Desired output is as follows:

- Each definition should be cropped to include every definition for a headword.
- Each entry must be saved into a .tif file under the following naming system:
 - So a complete file name would be "f1755-abacus.tif".
 - Multiple definitions would be appended with a "-#", # = occurrence
- PyTesseract will be used to read the headword and name the files as such.

File Naming Successes

ABATEMENT, in law.

The act of the abator ; as, the *abatement* of the heir into the land, before he hath agreed with the lord. The affection or passion of the thing abated ; as, *abatement* of the writ. *Cowel.*



f1755-ABATEMENT

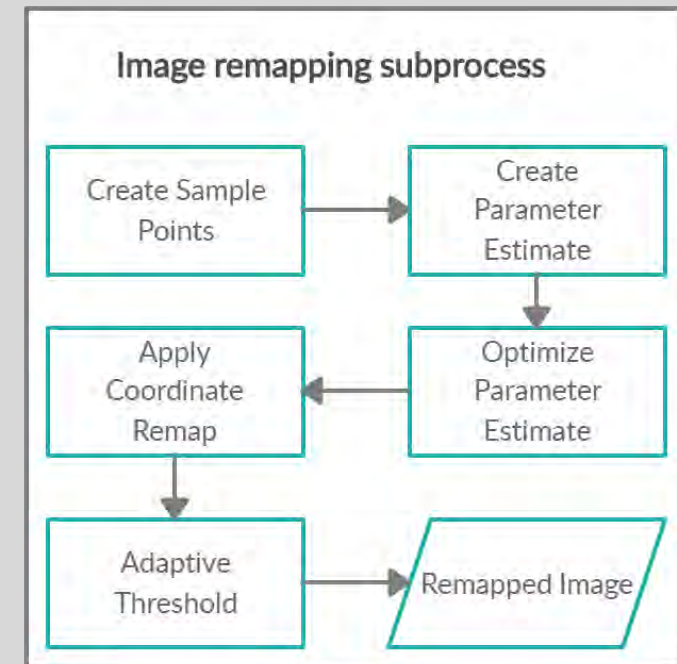
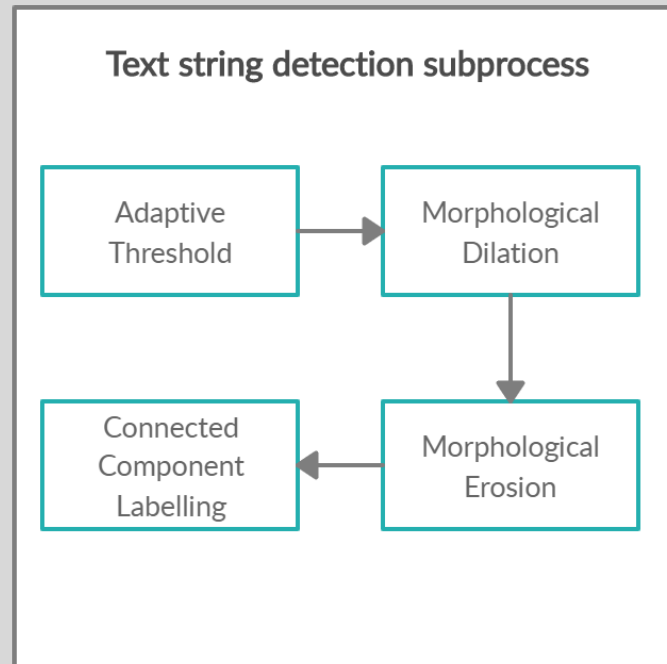
ABATEMENT, [with heralds] is an accidental mark, which being added to a coat of arms, the dignity of it is abased, by reason of some stain or dishonourable quality of the bearer. *Dict.*



f1755-ABATEMENT-0

Image Dewarping

- Two processes of the dewarping algorithm
 - Text span detection
 - Image remapping



Then as the first feature... command... upon.

A great part of... out of Ireland... nothing.

1. To clear, to acquit of a crime in a judicial sense.

Your... Our victory... enjoy not dominion...

2. To free from an engagement or promise.

3. To pronounce a man innocent in the criminal law.

4. To be free from a charge or accusation.

5. To be free from a charge or accusation.

6. To be free from a charge or accusation.

7. To be free from a charge or accusation.

8. To be free from a charge or accusation.

9. To be free from a charge or accusation.

10. To be free from a charge or accusation.

11. To be free from a charge or accusation.

12. To be free from a charge or accusation.

13. To be free from a charge or accusation.

14. To be free from a charge or accusation.

15. To be free from a charge or accusation.

16. To be free from a charge or accusation.

17. To be free from a charge or accusation.

18. To be free from a charge or accusation.

19. To be free from a charge or accusation.

20. To be free from a charge or accusation.

21. To be free from a charge or accusation.

22. To be free from a charge or accusation.

23. To be free from a charge or accusation.

24. To be free from a charge or accusation.

25. To be free from a charge or accusation.

These then being the... quality, as fish...

No sensible quality... found, can be sufficient...

The prince long time had... not, concerning...

And of that nature... either to be done or avoided.

1. Completely.

2. Without relation.

3. Without relation.

4. Without relation.

5. Without relation.

6. Without relation.

7. Without relation.

8. Without relation.

9. Without relation.

10. Without relation.

11. Without relation.

12. Without relation.

13. Without relation.

14. Without relation.

15. Without relation.

16. Without relation.

17. Without relation.

18. Without relation.

19. Without relation.

20. Without relation.

21. Without relation.

22. Without relation.

23. Without relation.

24. Without relation.

25. Without relation.

Image Dewarping cont.

- Identify contours
- Connects the contours into spans

A B S

These are the first figure... public that is... A great part of that... To be able to say... Without limitation or dependence... 1. To acquit... 2. To be absolute... 3. To be absolute... 4. To be absolute... 5. To be absolute... 6. To be absolute... 7. To be absolute... 8. To be absolute... 9. To be absolute... 10. To be absolute...

A B S

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Image Dewarping cont.

- Identify keypoints of text and apply coordinate remap

- An *humming* through their waxen city grows. *Dryden.* 1.
2. To make an inarticulate and buzzing sound.
I think he'll hear me: yet to bite his lip,
And *hum* at good Cominius, much unhearts me. *Shakefp.*
Upon my honour, fir, I heard a *humming*,
And that a frange one too, which did awake me. *Shakefp.*
The cloudy meffenger turns me his back,
And *hums*; as who fould fay, you'll rue. *Shakefp. Macbeth.* 2.
3. To pause in fpeaking, and fupply the interval with an audible emiffion of breath.
Having pump'd up all his wit,
And *hum'd* upon it, thus he writ. *Hudibras, p. iii.* 3
I ftill acquieft,
And never *hum'd* and haw'd fedition,
Nor fuffled treafon. *Hudibras, p. iii. cant. 2.*
The man lay *humming* and hawing a good while; but, in
the end, he gave up himfelf to the phyficians. *L'Efrange.*
Still *humming* on, their drowfy courfe they keep,
And lafh'd fo long, like tops, are lafh'd afleep. *Pope.* 4
4. To fing low.
The mufical accents of the Indians, to us, are but inarticulate *humming*s; as are ours to their otherwife tuned organs. *Glavo. Apol. Pope.*
Hum half a tune.
5. To applaud. Approbation was commonly expreffed in publick afsemblies by a *hum*, about a century ago.
- HUM. *n. f.* [from the verb.]
1. The noife of bees or infects.
To black Hecat's fummons
The fhard-born beetle, with his drowfy *hum*s,
Hath rung night's yawning peal. *Shakefppeare's Macbeth.*
Nor undelightful is the ceafelefs *hum*,
To him who mufes through the woods at noon. *Thomfon.*
2. The noife of buflling crowds.
From camp to camp, through the foul womb of night,
The *hum* of either army ftilly founds. *Shakefp. Hen. V.*
Tower'd cities pleafe us then,
And the bufy *hum* of men. *Milton.*
One theatre there is of vaft refort,
Which whilome of requests was call'd the court;
But now the great exchange of news 'tis hight,
And full of *hum* and buz from noon 'till night. *Dryden.*
3. Any low dull noife.
Who fat the neareft, by the words o'ercome,
Slept faft; the diftant nodded to the *hum*. *Pope's Dunciad.*

- But if night-roobers lit the well-ftor'd hive,
An *humming* through their waxen city grows. *Dryden.*
2. To make an inarticulate and buzzing found.
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Image Dewarping cont.

- Left is without rotation before dewarping
- Right has rotation applied before

Successes and Difficulties

- Successes:
 - Open source software solution
 - Worked well without modification
 - Easy to modify
- Difficulties:
 - Getting started
 - Minimal knowledge
 - Many programs found did not work
 - Debugging

Entry Cropping

How can the entries be isolated? Unique features.

- Unindented text is either a headword or a number denoting a new definition.
- Headwords are always capital letters only, except for when it starts with "To" (with other minor exceptions).
- Headwords are sometimes written in a larger font.
- Entries always span from the top of one headword to the top of the next. (Obvious, but necessary for determining bounding boxes. The width of the definitions is already determined through the column cropping.)

TO A'BNE'GATE. *v. a.* [from *abnego*, Lat.] To deny.
ABNEGAT'ION. *n. f.* [*abnegatio*, Lat. denial, from *abnego*, to deny.] Denial, renunciation.

The *abnegation* or renouncing of all his own holds and interests, and trusts of all that man is most apt to depend upon, that he may the more expeditely follow Christ.

Hammond's Praetical Catechism.

ABNODAT'ION. *n. f.* [*abnodatio*, Lat.] The act of cutting away knots from trees; a term of gardening. *Diēt.*

ABNO'RMOUS. *adj.* [*abnormis*, Lat. out of rule.] Irregular, mishapen. *Diēt.*

ABO'ARD. *adv.* [a sea-term, but adopted into common language; derived immediately from the French *à bord*, as, *aller à bord*, *envoyer à bord*. *Bord* is itself a word of very doubtful original, and perhaps, in its different acceptations, deducible from different roots. *Bord*, in the ancient Saxon, signified a *house*; in which sense, *to go aboard*, is to take up residence in a ship.]

In a ship.

Which, when far off, Cymocles heard and saw,
He loudly call'd to such as were *aboard*,
The little bark unto the shore to draw,
And him to ferry over that deep ford. *Fairy Q. b. ii. cant. 6.*
I made this answer, that he might land them, if it pleased him, or otherwise keep them *aboard*. *Sir W. Rawleigh's Essays.*

When morning rose, I sent my mates to bring
Supplies of water from a neighb'ring spring;
Whilst I the motions of the winds explor'd;
'Then summon'd in my crew, and went *aboard*.

Addison's Ovid's Metamorphoses. b. iii.

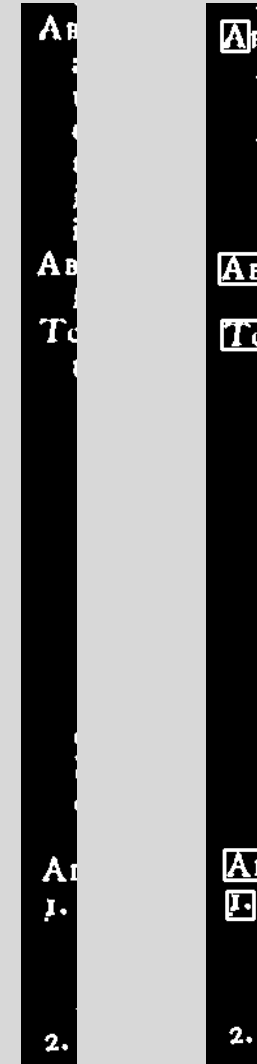
Entry Cropping

The first prototype for cropping the entries takes the very left side of a column and compares the size of everything there to determine if it is:

- A capital letter (A headword)
- A number (Additional definitions for a previous headword)

Challenges with this include some numbers being too large and some headwords being too small. This can be caused by a number of things including:

- The page was not flat on the scanner during the scanning process.
- Thresholding either including additional specks (shown on the 1), or failing to properly threshold a letter due to brightness of the image.
- The dewarping process modifying the size of the text.



Data on Entry Cropping

These results are from testing on five different (and fairly straight) columns.

Total Headwords and Numbers	Correctly Determined Headwords	Correctly Determined Numbers	False Negative Headwords	False Positive Numbers
97	49	30	11	7

Total Correct	Total Incorrect	Success Rate
79	18	81.4%

Entry Cropping Precision

- Knowing where the headwords are is only the first step to the problem, as cropping based on the headword will cut off any letters that are higher on the same line.
- Once a headword is found, the entire line must be checked to determine where the highest point is.
- Similarly, the end of the definition must be checked to determine where the lowest point in the definition is.

A'BBEY-LUBBER, *n. f.* [See LUBBER.] A slothful loiterer in a religious house, under pretence of retirement and austeritv.
This is no Father Dominic, no huge overgrown *abbey-lubber*; this is but a diminutive fucking friar. *Dryd. Sp. Fr.*

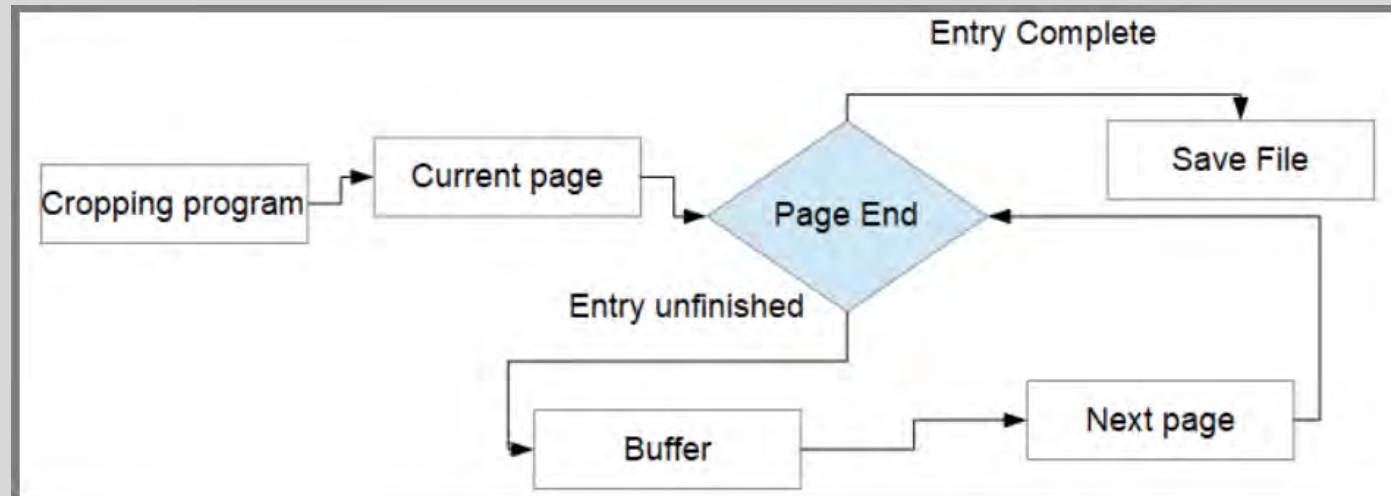
A'BBEY-LUBBER, *n. f.* [See LUBBER.] A slothful loiterer in a religious house, under pretence of retirement and austeritv.
This is no Father Dominic, no huge overgrown *abbey-lubber*; this is but a diminutive fucking friar. *Dryd. Sp. Fr.*

Image Stitching

- Not every entry in the book remains on a single page or column.
- To account for this, we have need of a stitching program to take two different pages and combine a cropped image from both

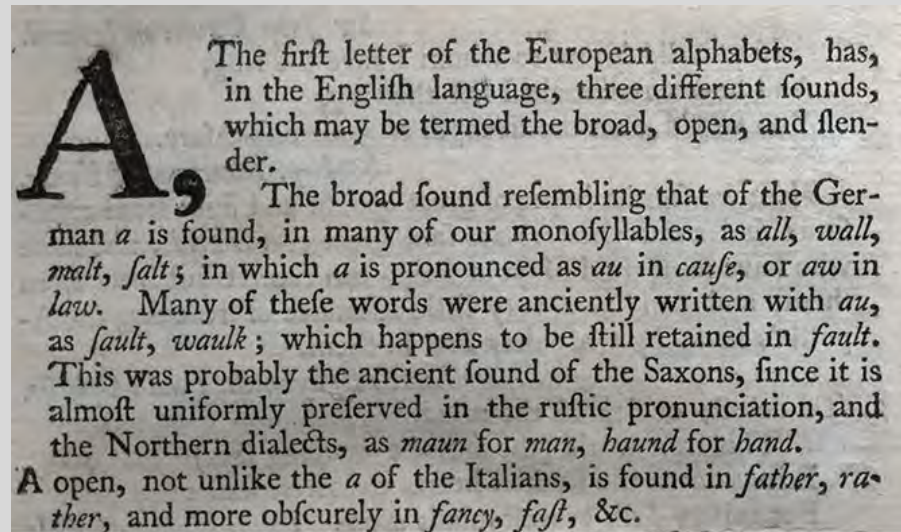
Image Stitching

- This will be done by adding onto the first image file. As the entry is cropped it will save into this file when it reaches the end of the entry, page, or column. If it is the end of the page it will repeat this process for the next page or column.



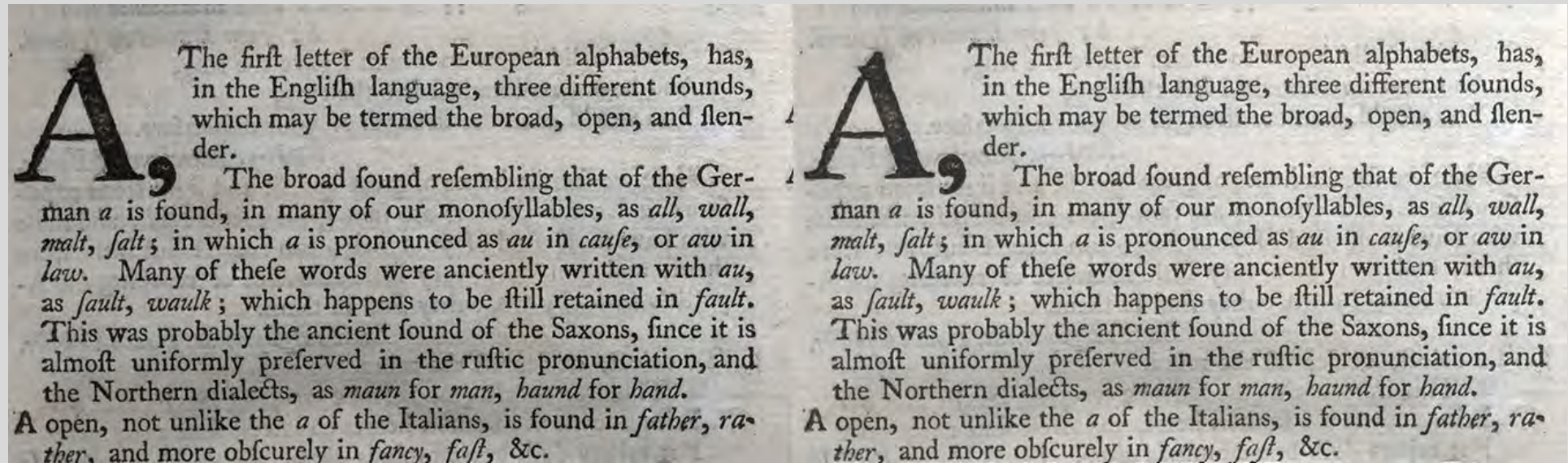
Brightness Manipulation

- Not all the pages retained the same background color through the years
- Some page backgrounds were darkened enough during scanning to hurt readability



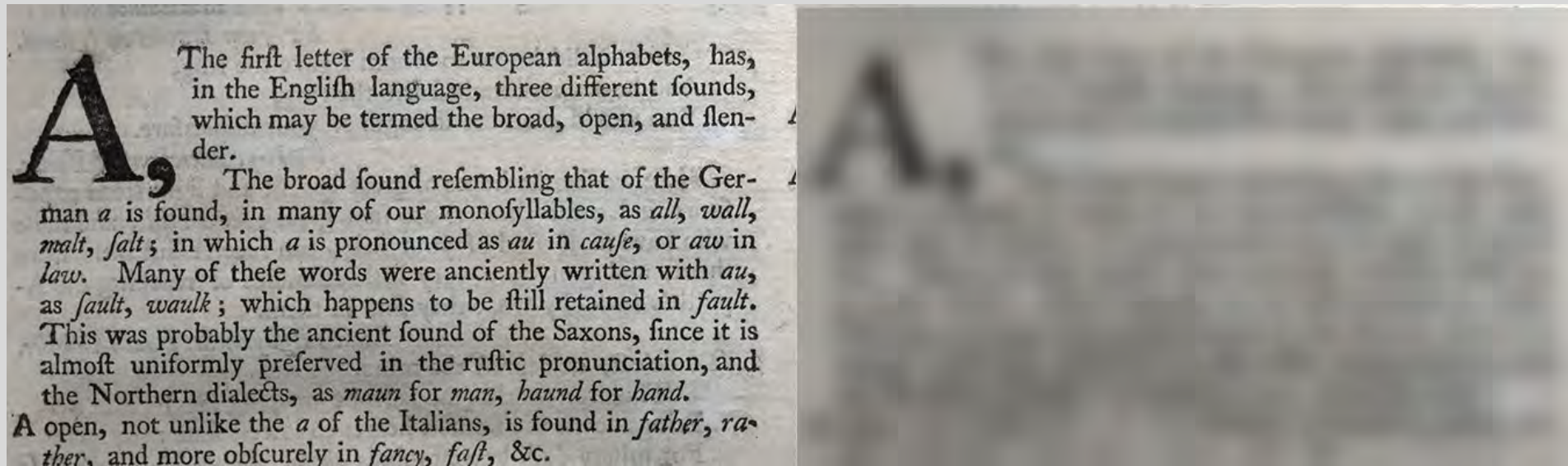
Brightness Manipulation

By adjusting the contrast on these pages we can achieve a more uniform background while making pages easier to read



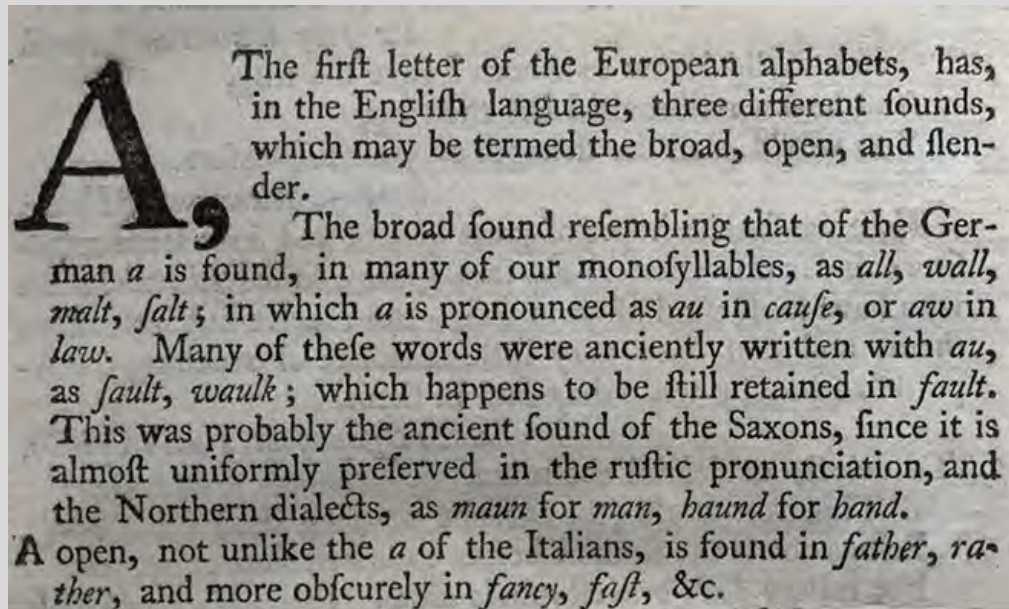
Unsharp masking

- To improve the readability of pages with blurring we use a technique called unsharp masking
- This creates a blurred copy of the image and applies it as a negative to sharpen the image



Complete image enhancement

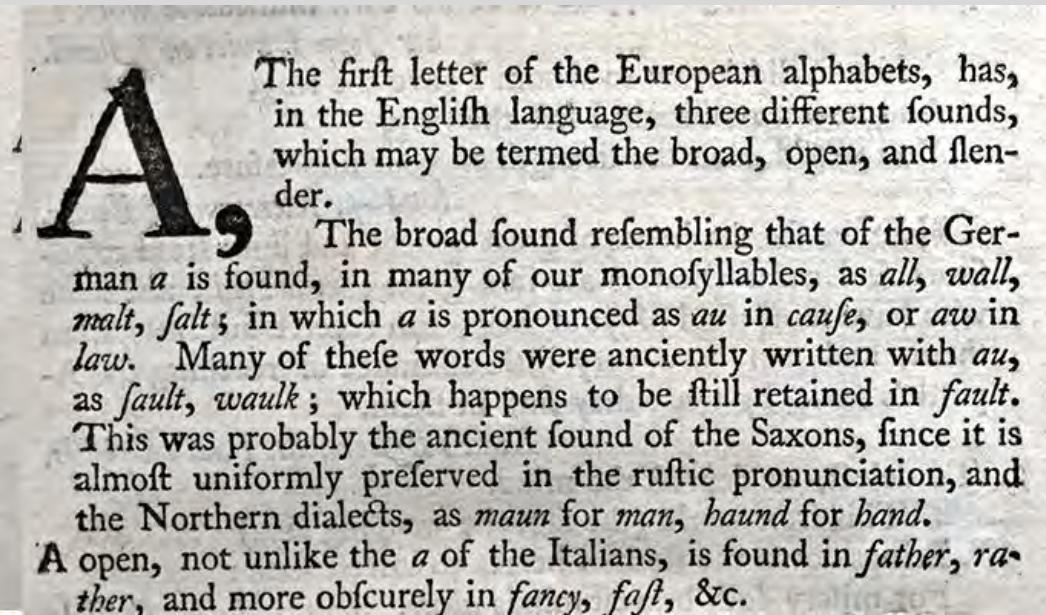
- Several pages have discolorations on them
- our program reduces this along with other noise elements to improve readability



A The first letter of the European alphabets, has, in the English language, three different sounds, which may be termed the broad, open, and slender.

The broad sound resembling that of the German *a* is found, in many of our monosyllables, as *all*, *wall*, *malt*, *salt*; in which *a* is pronounced as *au* in *cause*, or *aw* in *law*. Many of these words were anciently written with *au*, as *fault*, *waulk*; which happens to be still retained in *fault*. This was probably the ancient sound of the Saxons, since it is almost uniformly preserved in the rustic pronunciation, and the Northern dialects, as *maun* for *man*, *haund* for *hand*.

A open, not unlike the *a* of the Italians, is found in *father*, *rather*, and more obscurely in *fancy*, *fast*, &c.



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