

**Brian Cornet
DSC 498
Dr. Donghui Yan
Final Capstone Presentation**

December 2nd, 2020

Part 1:
Bri comes up with a bunch of ideas

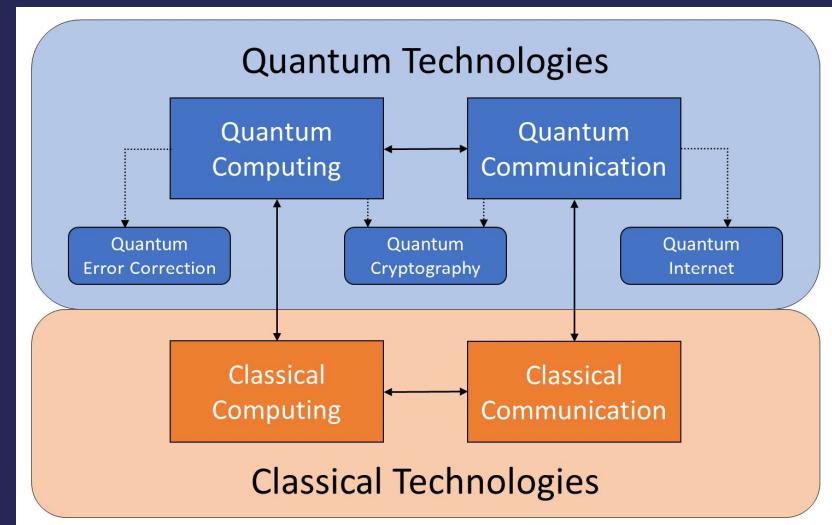
Initial Proposals

- Quantum Tech. Survey
- Raw Image Scanner
- MIPS Decompiler
- Rules Analyst
- Socialization Helper
- Help-A-Professor
- Resources and Challenges

Quantum Tech. Survey

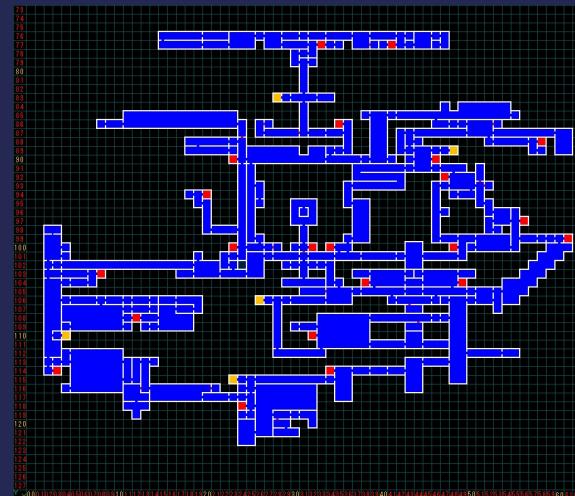
- Collect details on published research on quantum technologies (IEEE, commercial, etc.)
- Harmonize data set for analysis: contributors, dates, tags, etc.
- Determine high-focus areas based on time, region, methods, impact factor, industry

Document Title	Authors	Author Affiliations	Publication Title
Generalized and Differential Likelihood Ratio Tests with Quantum Signal S. Yan; R. Malaney; J. Yuan	School of Engineering, Macquarie ICASSP 2019 - 2019 IEEE International Conference on Acoustics, Speech and Signal Processing, 2019, pp. 1-5, doi: 10.1109/ICASSP40776.2019.8851853		
Extending Gradient Echo Memory Using Machine Learning and Single Phc A. Leung; A. Tranter; K. Paul; J. Everett; P. V. Department of Quantum Scienc 2018 Conference on Lasers and Ele			
Mechanical Fault Diagnosis Method Based on Machine Learning Z. Nan			
Infinite probabilistic latent component analysis for audio source separation K. Yoshii; E. Nakamura; K. Itoyama; M. Goto Kyoto University; Kyoto Univer 2017 IEEE 27th International Conference on Acoustics, Speech and Signal Processing, 2017, pp. 4170-4174, doi: 10.1109/ICASSP.2017.7953620			
Compositional Modeling of Partial Discharge Pulse Spectral Characteristics P. C. Baker; B. Stephen; M. D. Judd			
Security Verification of Artificial Neural Networks Used to Error Correcting M. Niemic; M. Mehic; M. Voznak			
A Discrimination Based Artificial Immune System for Classification K. Igawa; H. Ohashi			
Ensemble Method for Privacy-Preserving Logistic Regression Based on H. J. H. Cheon; D. Kim; Y. Kim; Y. Song			
Constructions of quantum BCH codes based on finite fields of odd charac Y. Gao; Y. Xiao; Y. Tao			
Free Electron Qubits O. Reinhardt; C. Meichel; M. Lynch; I. Kamini-Techion-Israel Institute of Te 2019 Conference on Lasers and Electro-Optics, 2019, pp. 1-3, doi: 10.1109/CLEO-CIO48393.2019.8830003			
Meta-learning within Projective Simulation A. Makmaf; A. A. Melnikov; V. Dunjko; H. J. Institute for Theoretical Physic IEEE Access			
Text categorization by fuzzy domain adaptation V. Behboodi; J. Lu; G. Zhang			
Self-adaptive chaos quantum clonal evolutionary programming Yangyang Li; Licheng Jiao; Fang Liu			
Probabilistic Transfer Factor Analysis for Machinery Autonomous Diagnos J. Wang; R. Zhao; R. X. Gao			
Probabilistic Computing with Binary Stochastic Neurons A. Z. Pervaisz; S. Datta; K. Y. Camsari			
Quantum Computation in Robotic Science and Applications C. Petschnigg; M. Brandstätter; H. Pichler; JOANNUM RESEARCH, Institut 2019 International Conference on Robotic Computing, 2019, pp. 1-6, doi: 10.1109/ROBOTCO50000853			
Improving the Accuracy of Low Level Density Functional Theory Calculati T. Gao; D. Pu; H. Yu; Y. Lu; H. Li; Z. Su	Sch. of Comput. Sci. & Inf. Technol 2010 International Conference on Computer Science and Information Technology, 2010, pp. 1-4, doi: 10.1109/CSIT.2010.5539002		
Evolution of Quantum Computing Based on Grover's Search Algorithm P. Shrivastava; K. K. Soni; A. Rasool	Computer Science Engineering 2019 10th International Conference on Computer Science and Engineering, 2019, pp. 1-4, doi: 10.1109/CSENG50000853		
Network Representation Learning: A Survey D. Zhang; J. Ying; X. Zhou; C. Zhang	Centre for Artificial Intelligence: IEEE Transactions on Big Data		
Fast tracking of hidden objects with single-pixel detectors S. Chan; R. E. Warburton; G. Gariepy; Y. Altn Institute of Photonics and Qua Electronics Letters			
Robust supervised learning based on tensor network method Y. W. Chen; K. Guo; Y. Pan	Institute of Cyber-Systems and 2018 33rd Youth Academic Annual Conference, 2018, pp. 1-4, doi: 10.1109/YAC3340000.2018.8430001		
Self-Tuning Fiber Laser S. L. Brunton; X. Fu; J. N. Kutz	Department of Applied Mathe IEEE Journal of Selected Topics in Signal Processing		
Signature Infrared Bacteria Spectra Analyzed by an Advanced Integrative S. Ji; D. H. Jeong; M. Hassan; I. K. Iliev	Department of Computer Scier IEEE Journal of Selected Topics in Signal Processing		
An Efficient Algorithm to Compute a Quantum Probability Space M. Melucci	University of Padua, Padua, PD IEEE Transactions on Knowledge and Data Engin		
A Study on GPS GDOP Approximation Using Support-Vector Machines C. Wu; W. Su; Y. Ho	Department of Electrical Engin IEEE Transactions on Instrumentation and Measurement		
Diagnosis of Neuromuscular Disorders using DT-CWT and Rotation Forest A. Subasi	Univ. of Alberta, Edmonton, AB IEEE Transactions on Instrumentation and Measurement		
Deep Abstraction and Weighted Feature Selection for Wi-Fi Impersonation M. E. Aminanto; R. Choi; H. C. Tanuwidajaja; School of Computing, Korea AC IEEE Transactions on Information Forensics and Security	Electromyographic (EMG) sign IEEE Transactions on Instrumentation and Measurement		
Inductive User Preference Manipulation for Multimedia Retrieval D. Zellhäfer	Database & Inf. Syst. Group, Br 2010 Second International Conference on Database and Information Systems, 2010, pp. 1-6, doi: 10.1109/ICDDBI.2010.5539002		
Quantum Photonic Neural Networks G. R. Steinbrecher; J. P. Olson; D. Englund; J Research Laboratory of Electro 2019 Conference on Lasers and Electro-Optics, 2019, pp. 1-3, doi: 10.1109/CLEO-CIO48393.2019.8830003	Nanyang Technological Univers IEEE Transactions on Neural Networks and Learning Systems		
Toward the Optimization of Normalized Graph Laplacian B. Xie; M. Wang; D. Tao	Inst. of Stat. Sci., Acad. Sinica, "2010 Ninth International Conference on Statistical Science, 2010, pp. 1-6, doi: 10.1109/ICSS.2010.5539002		
Machine Learning Optimization of Surface-Normal Optical Modulators fo S. Bianconi; S. Wheaton; M. Park; I. Hassani	Department of Electrical Engin IEEE Journal of Selected Topics in Signal Processing		
A Probabilistic Graphical Model of Quantum Systems C. Yeang	Inst. of Stat. Sci., Acad. Sinica, "2010 Ninth International Conference on Statistical Science, 2010, pp. 1-6, doi: 10.1109/ICSS.2010.5539002		



Raw Image Scanner

- Create system that accepts an image as a template and compares it to a camera image
- Include generating text lists or tables, filling templates, or highlighting differences
- Provide image correction for flawed camera images



MIPS Decompiler

- Convert MIPS Assembly language code into popular modern languages
- Revert decompiled or modified code back into MIPS Assembly
- Examine compatibility with use on modern hardware

The screenshot shows a software interface for decompiling MIPS assembly code into Java. On the left, there's a list of assembly instructions. In the center, there are two panes: one for "Hex Encoding" showing the raw binary bytes corresponding to the assembly, and another for "Java" showing the decompiled Java code. The Java code is a class with methods for loading halfwords and words from memory.

MIPS Assembly:

```
[0x00185E94] lui r3,0x8019
[0x00185E98] lbu r3,0x38d8(r3)
[0x00185E9C] nop
[0x00185EA0] sll r2,3,0x01
[0x00185EA4] addu r2,r2,r3
[0x00185EA8] sll r2,2,0x02
[0x00185EAC] lui r1,0x8006
[0x00185EB0] addu r1,r2
[0x00185EB4] lbu r4,0x2eb0(r1)
[0x00185EB8] or r2,r0,0x00F
[0x00185EBC] andi r3,r4,0x00F
[0x00185EC0] pme r3,r2,0x00185ef0
[0x00185EC4] nop
[0x00185EC8] lui r2,0x8019
[0x00185ECC] lh r2,0x38ce(r2)
[0x00185ED0] nop
[0x00185ED4] sll r3,2,0x01
[0x00185ED8] addu r3,r3,r2
[0x00185EDC] srl r2,3,0x1f
[0x00185EE0] addu r3,r3,r2
[0x00185EE4] sra r3,r3,0x01
[0x00185EE8] lui r1,0x8019
[0x00185ECC] eh r3,0x38ce(r1)
[0x00185EF0] lui r2,0x8019
[0x00185EF4] lw r2,0x2d94(r2)
[0x00185EF8] nop
[0x00185EFc] lhu r1,0xnnnn(r2)
```

Hex Encoding:

Address	Value
1980033C	D8386390
19800340	00000000
19800344	40100300
19800348	21104300
1980034C	80100200
19800350	0680013C
19800354	21082200
19800358	BD2E2490
1980035C	0F000234
19800360	FF008330
19800364	08006214
19800368	00000000
1980036C	1980023C
19800370	CE384284
19800374	00000000
19800378	40180200
1980037C	21186200
19800380	C2170300
19800384	21186200
19800388	43180300
1980038C	1980013C
19800390	CE3823A4
19800394	1980023C
19800398	942D428C
1980039C	00000000
198003A0	9nnnn29n

Java:

```
    return 0;
}

public short loadHalf(int startAddress) {
    if (startAddress + 1 < rawData.length) {
        int val = 0x0000ff00 & (rawFileData[startAddress] << 8);
        val = val | (0x00000ff00 & (rawFileData[startAddress + 1]));
        return (short) val;
    }
    System.err.println("Error: Address 0x" + String.format("%02X", startAddress) + " runs out of bounds of file");
    return (short) 0;
}

public int loadWord(int startAddress) {
    if (startAddress + 3 < rawData.length) {
        int val = (rawFileData[startAddress] << 24);
        val = val | (0x0ff0000 & (rawFileData[startAddress + 1] << 16));
        val = val | (0x000ff000 & (rawFileData[startAddress + 2] << 8));
        val = val | (0x00000ff00 & (rawFileData[startAddress + 3]));
        return val;
    }
    System.err.println("Error: Address 0x" + String.format("%02X", startAddress) + " runs out of bounds of file");
    return 0;
}
```

Rules Analyst

- Interpret rulesets of various sports or games from source rulebooks through text parsing
- Create model for ML using supervised/unsupervised learning
- Determine impact of rule changes in style of professional-level play

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
1	Name	Season	Team	Pos	GP	G	A	P	PPG	PIM/GP	TOI/GP	PIM/TOI	Pen Drawn	Pen Taken	Net Pen	Pen Drawn/60	Pen Taken/60	Minor	Major	Match	Mst	G Mst	
2	Evander Kane	20192020 SIS	L	64	26	21	47	122	1:54	19:32	9.8	18	38	-20	0.86	1.82	-0.96	30	4	0	3	1	0
3	Brendan Lemieux	20192020 NYR	L	59	6	12	18	111	1:52	12:52	14.6	32	28	4	2.53	2.21	0.32	18	5	0	5	0	0
4	Brady Tkachuk	20192020 OTT	L	71	21	23	44	106	1:29	18:56	7.9	47	35	12	2.1	1.56	0.54	28	4	0	3	0	0
5	Brenden Dillon	20192020 SJ,WSH	D	69	1	13	14	104	1:30	19:27	7.8	17	38	-21	0.76	1.7	-0.94	32	4	0	2	0	0
6	Barclay Goodrow	20192020 SJ,TBL	C	70	8	18	26	97	1:23	15:55	8.7	26	29	-3	1.4	1.56	-0.16	21	5	0	3	0	0
7	Nick Ritchie	20192020 ANA,BOS	L	48	9	12	21	97	2:01	14:08	14.3	2	27	-25	0.18	2.39	-2.21	21	1	0	3	2	0
8	Nazem Kadri	20192020 COL	C	51	19	17	36	97	1:54	17:25	10.9	24	31	-7	1.62	2.09	-0.47	25	3	0	3	0	0
9	Erik Gudbranson	20192020 PIT,ANA	D	51	4	5	9	95	1:51	19:21	9.6	10	23	-13	0.61	1.4	-0.79	15	3	0	5	0	0
10	Tom Wilson	20192020 WSH	R	68	21	23	44	93	1:22	18:16	7.5	30	35	-5	1.45	1.69	-0.24	29	5	0	1	0	0
11	Nicolas Deslauriers	20192020 ANA	L	59	7	6	13	92	1:33	9:46	15.9	17	21	-4	1.77	2.18	-0.42	6	14	0	1	0	0
12	Brad Marchand	20192020 BOS	L	70	28	59	87	82	1:10	19:27	6	45	33	12	1.98	1.45	0.53	30	2	0	1	0	0
13	P.K. Subban	20192020 NJD	D	68	7	11	18	79	1:09	22:07	5.3	13	30	-17	0.52	1.2	-0.68	27	1	0	2	0	0
14	Garnet Hathaway	20192020 WSH	R	66	9	7	16	79	1:11	10:46	11.1	36	24	12	3.04	2.02	1.01	17	5	1	1	0	0
15	Ross Johnston	20192020 NYI	L	32	3	1	4	78	2:26	7:59	30.5	12	18	-6	2.82	4.23	-1.41	9	6	0	3	0	0
16	John Hayden	20192020 NJD	C	43	3	1	4	77	1:47	9:42	18.4	10	19	-9	1.44	2.73	-1.29	11	5	0	2	1	0
17	Matthew Tkachuk	20192020 CGY	L	69	23	38	61	74	1:04	18:18	5.9	34	23	11	1.61	1.09	0.52	17	4	0	2	0	0
18	Joel Edmundson	20192020 CAR	D	68	7	13	20	72	1:03	18:26	5.7	16	29	-13	0.77	1.39	-0.62	26	2	0	1	0	0
19	Pat Maroon	20192020 TBL	L	64	9	14	23	71	1:06	12:24	8.9	17	20	-3	1.28	1.51	-0.23	13	5	0	2	0	0
20	Brendan Smith	20192020 NYR	D	62	3	5	8	71	1:08	11:06	10.3	17	20	-3	1.48	1.74	-0.26	13	5	0	1	1	0
21	Corey Perry	20192020 DAL	R	57	5	16	21	70	1:13	13:43	9	18	24	-6	1.38	1.84	-0.46	20	2	0	1	1	0
22	Ryan Hartman	20192020 MIN	R	69	9	11	20	69	1:00	12:15	8.2	23	26	-3	1.63	1.84	-0.21	22	3	0	0	0	0
23	Zack Kassian	20192020 EDM	R	59	15	19	34	69	1:10	15:39	7.5	10	22	-12	0.65	1.43	-0.78	17	3	0	2	0	0
24	Kyle Clifford	20192020 LAK,TOR	L	69	7	10	17	68	0:59	11:11	8.8	16	20	-4	1.24	1.55	-0.31	13	6	0	0	1	0
25	Wayne Simmonds	20192020 NJD,BUF	R	68	8	17	25	66	0:58	14:55	6.5	13	22	-9	0.77	1.3	-0.53	18	2	0	1	1	0
26	Nikita Zadorov	20192020 COL	D	64	4	9	13	65	1:00	17:46	5.7	9	27	-18	0.47	1.42	-0.95	25	1	0	1	0	0
27	Austin Watson	20192020 NSH	L	53	6	8	14	65	1:13	11:37	10.6	13	18	-5	1.27	1.75	-0.49	10	7	0	1	0	0
28	Alexander Edler	20192020 VAN	D	59	5	28	33	62	1:03	22:37	4.7	13	27	-14	0.58	1.21	-0.63	26	0	0	1	0	0
29	Nick Foligno	20192020 CBJ	L	67	10	21	31	62	0:55	18:40	5	12	21	-9	0.58	1.01	-0.43	16	4	0	0	1	0
30	Ben Chiarot	20192020 MTL	D	69	9	12	21	61	0:53	23:08	3.8	6	25	-19	0.23	0.94	-0.71	23	1	0	1	0	0
31	Jacob Trouba	20192020 NYR	D	70	7	20	27	61	0:52	22:33	3.9	18	22	-4	0.68	0.84	-0.15	18	3	0	0	0	1
32	Zdeno Chara	20192020 BOS	D	68	5	9	14	60	0:52	21:00	4.2	14	23	-9	0.59	0.97	-0.38	19	4	0	0	0	0

SECTION 4 – TYPES OF PENALTIES


SECTION 4 – TYPES OF PENALTIES

Rule 15 – Calling of Penalties

15.1 **Calling a Penalty** - Should an infraction of the rules which would call for a minor, major, misconduct, game misconduct or match penalty be committed by a player of the side in control of the puck, the Referee shall immediately blow his whistle and penalize the offending player.

Should an infraction of the rules which would call for a minor, major, misconduct, game misconduct or match penalty be committed by a player of the team not in control of the puck, the Referee shall raise his arm to signal the delayed calling of a penalty. When the team to be penalized gains control of the puck, the Referee will blow his whistle to stop play and impose the penalty on the offending player.

When a player, Trainer, Manager, coach or non-playing Club personnel is ejected from the game for a violation of the playing rules, that individual must vacate the players' bench area and may not, in any manner, further participate in the game. This includes directing the team from the spectator area or by radio communications. Any violations shall be reported to the Commissioner.

Refer to Reference Tables – Table 1 – Summary of Penalties to Coaches and Non-playing Club Personnel (page 138) for a list of infractions specific to those individuals.

Socialization Helper

- Create platform to encourage online interaction among friends/family
- Analyze usage habits to help users deal with loneliness and depression
- Devise security and privacy methods to deter improper use

Big Super Bowl Browns Paul 08/10/2020
man i was lookin at things on amazon for home decor and it really made me wanna move out
lol

caitlin 🐶 08/10/2020
me every day

veeli 08/10/2020
Get you an apartment with doggy permission
I think my depression is cured now
The way people look at you when you have a dog is CRAZY

caitlin 🐶 08/10/2020

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Biotechnology

Why do you feel lonely? Neuroscience is starting to find answers.

A neuroscientist's hunt for loneliness could help us better understand the costs of social isolation.

by Adam Piore September 4, 2020

Help-A-Professor

- Dean of CAS Prof. Pauline Entin and Prof. Shannon Jenkins:
 - Comparing online vs. in-person learning methods
- Prof. Keivan Sadeghzadeh:
 - “Predictive Models for Preventable Readmission for Mental Patients Using Socioeconomic Disadvantages” [Ongoing Project]
 - “Detecting and Predicting Medical Errors in Cancer Screening Process” [New Project]
 - “Mental Health Service Supply and Demand in the Post-Pandemic Healthcare” [New Project]



Entin (top-left);
Jenkins (bottom-left);
Sadeghzadeh (right).

Resources and Challenges

- Resources:
 - HTML parsing for web data, Optical Character Recognition (OCR)
 - R, MATLAB, Python, Java, C++, SQL, Assembly language tools as needed
 - Viewers like you!
- Challenges:
 - Machine learning methods in Spring 2021
 - Artificial intelligence methods TBA
 - Physical limitations during pandemic

What could have been:



veeli 11/20/2020

Random streaming question, I'd like to read books aloud on twitch. Is there a program where I can open a pdf of a book, read the text on the microphone, and it would be highlighted on the computer as I read it word by word?



Bri 11/20/2020

@veeli I was lookin for something like that today, didn't find anything explicitly but that's definitely something that could exist right now



veeli 11/20/2020

@Bri thanks. I found some programs that sound sort of what I'm looking for, but not quite. Going to try them out later



Bri 11/20/2020

yeah I looked at stuff for teachers since that seemed like the most likely way to find something
I don't think it'd be hard to make with speech recognition software and some quick and dirty program

What could have been:

8:22 PM actually I wish I could go back to about two months ago before I picked my capstone
I'd just do this

SpeechRecognition 3.8.1

`pip install SpeechRecognition`

Latest version | Released: Dec 5, 2017

Library for performing speech recognition, with support for several engines and APIs, online and offline.

Navigation

- Project description
- Release history
- Download files

Project links

- Homepage

Statistics

Github statistics:
★ Stars: 5,254
🍴 Forks: 1,825
⌚ Open issues/PRs: 195

View statistics for this project via [Libraries.io](#), or by using our public dataset on [Google BigQuery](#).

Meta

License: BSD License (BSD)

Author: Anthony Zhang (Uber) 

speech, recognition, voice, sphinx, google, wit, bing, api, houndify, ibm, snowboy

Project description

pip v3.8.1 status stable python 2.7 | 3.3 | 3.4 | 3.5 | 3.6 license gplv3 build failing

Library for performing speech recognition, with support for several engines and APIs, online and offline.

Speech recognition engine/API support:

- CMU Sphinx (works offline)
- Google Speech Recognition
- Google Cloud Speech API
- Wit.ai
- Microsoft Bing Voice Recognition
- Houndify API
- IBM Speech to Text
- Snowboy Hotword Detection (works offline)

Quickstart: `pip install SpeechRecognition`. See the "Installing" section for more details.

To quickly try it out, run `python -m speech_recognition` after installing.

Project links:

- PyPI
- Source code
- Issue tracker

Library Reference

The library reference documents every publicly accessible object in the library. This document is also included under [reference/library-reference.rst](#).

See [Notes on using PocketSphinx](#) for information about installing languages, compiling PocketSphinx, and building language packs from online resources. This document is also included under [reference/pocketsphinx.rst](#).

Bri 11/20/2020 instead I'm doing image recognition to help people track their Animal Crossing furniture

veeli 11/20/2020 If I could become a coding wizard, I would finally have self esteem
Oh okay well
I also like that
I like coding used for fun, niche things

Bri 11/20/2020 yeah absolutely
that's what like all of my coding ends up being
how to cheat at playstation

Bri 11/20/2020 that's all of em
yeah I have a bunch of school projects and then damage calculators for Monster Hunter and Dark Souls
super useful stuff

(I still wanna do this)

Part 2:
Bri goes with the Raw Image Scanner idea

Raw Image Scanner – Outline

- **Objectives:**
 - **Create** system that accepts an image as a template and compares it to a camera image
 - **Include** generating text lists or tables, filling templates, or highlighting differences
 - **Implement** image correction for flawed camera images (skewing, reflection, warping, etc.)
- **Tools:**
 - Optical Character Recognition (OCR) using libraries such as PyTesseract
 - Image comparison algorithms for image blocks using libraries such as PylImageSearch
 - Decoding algorithms for various formats (JPEG, GIF, PNG, TIF, AVI, MPEG, MP4, MOV, WEBM, etc.)
- **Challenges:**
 - No formal machine learning courses until Spring 2021 (for image correction)
 - Physical limitations during pandemic (for experimentation)

Raw Image Scanner – Concept

- Comparable to commonly used technology for scanning checks, license plates, QR
- Typically for specific patterns or professional usage



Raw Image Scanner – Design

- Intended for users to collect any kind of data quickly and automatically
- Ideal for when digital data doesn't exist or can't be easily accessed



Final Fantasy Tactics (Sony PlayStation)

The image for the character on the right contains 36 variables.

Without a means of accessing the raw data, a human would need to compile the visible data by hand (takes about 2-3 minutes).

What if a computer could recognize the values formed by the pixels?

ID	Name	Job	CHP	MHP	CMP	MMP	...	Acc	Set1	Set2	React	Support	Move
7	Agrias	Holy Knight	559	559	81	81	...	Bracer	Holy Sword	White Magic	Auto Potion	Attack UP	Teleport

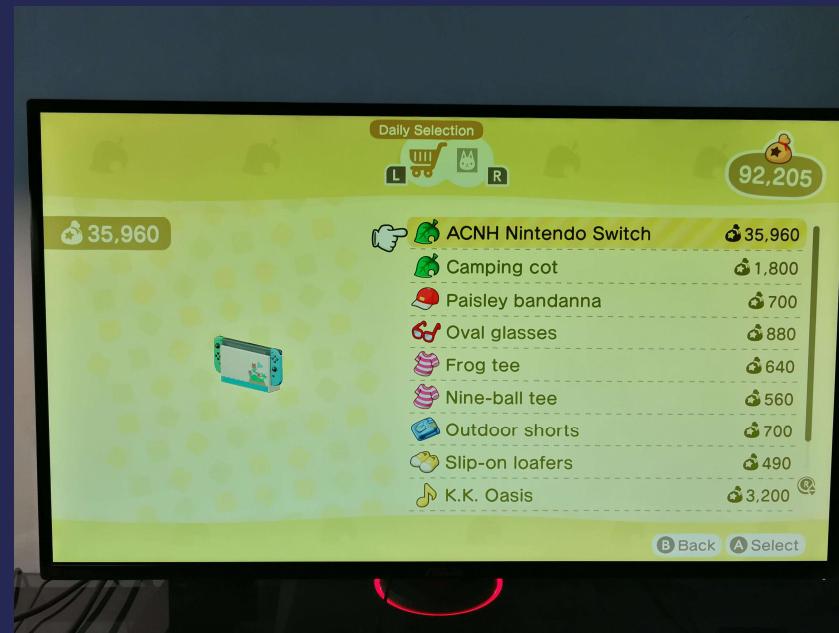
[1 rows x 35 columns]

Example – Text Parsing Lists

The user inputs a screenshot containing a simple list.

The text is parsed and added to a list. New items may be added to the same list, and it may be saved or exported as needed.

* This screenshot has much more text than what was collected. It may be necessary for the user to determine a pattern to the collection process.



Animal Crossing: New Horizons (Nintendo Switch)

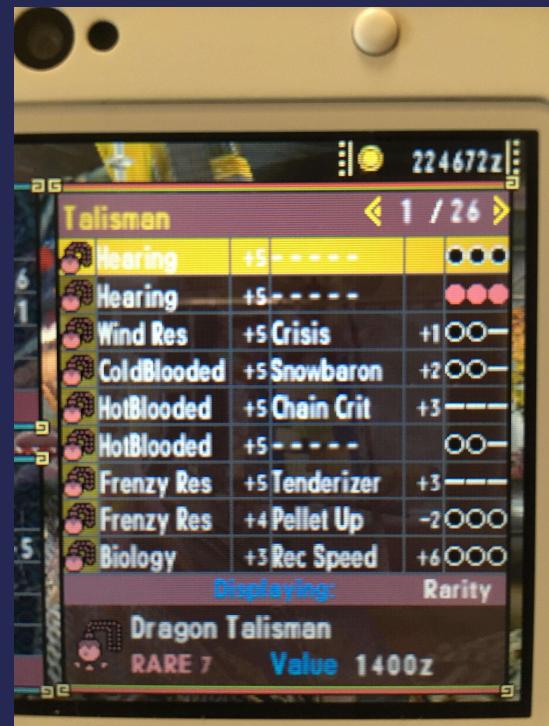
ACNH Nintendo Switch
Camping cot
Paisley bandanna
Oval glasses
Frog tee
Nine-ball tee
Outdoor shorts
Slip-on loafers
K.K. Oasis

Example – Text Parsing Tables

The user inputs a screenshot containing a table.

The text is parsed and added to a table. New items may be added to the same table, and it may be saved or exported as needed.

* The top line is difficult to read, and the second line has different colors for its 5th column. Visual differences may require the user to define their importance.



Monster Hunter Generations (Nintendo 3DS)

Hearing	+5	- - - - -		000
Hearing	+5	- - - - -		000
Wind Res	+5	Crisis	+1	00-
ColdBlooded	+5	Snowbaron	+2	00-
HotBlooded	+5	Chain Crit	+3	---
HotBlooded	+5	- - - - -		00-
Frenzy Res	+5	Tenderizer	+3	---
Frenzy Res	+4	Pellet Up	-2	000
Biology	+3	Rec Speed	+6	000

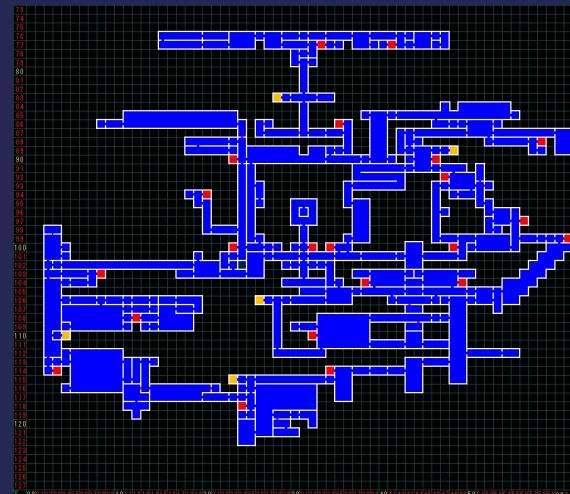
Example – Find Differences in Matrices

The user inputs a screenshot of a map they're exploring **A**. They know they're missing two squares but don't know which.



Castlevania: Symphony of the Night (Sony PlayStation)

An image of the completed map **B** is provided to compare against. **A** must be skewed to fit a similar shape.



The missing two squares are identified based on the differences between the two images, or **B - A**.



Example – Find Differences in Sets

The user inputs a screenshot of a screen that changes its structure, adding every character's name/portrait to a partial list **A**.



Super Smash Bros. Ultimate (Nintendo Switch)

A screenshot of the final roster is added next, which creates the complete list **B**.

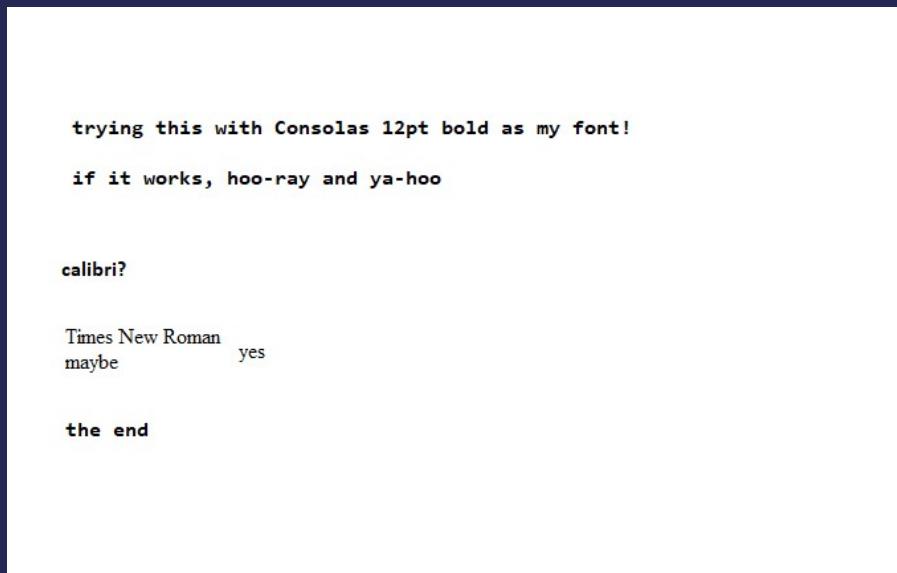


The missing characters are identified based on what's in the complete list but not the partial list, or **B - A**.



Part 3: Bri plays with Tesseract OCR and PyTesseract

Simple Test with MSPaint and Normal Fonts



trying this with Consolas 12pt bold as my font!
if it works, hoo-ray and ya-hoo
calibri?

Times New Roman

maybe yes.

the end

♀

Raw string text:

'trying this with Consolas 12pt bold as my font!\nif it works, hoo-ray and ya-hoo\nncalibri?\n\nTimes New Roman\n\nmaybe yes.\n\nthe end\n\n\x0c'

Full Clean Test 1 (Animal Crossing)



ers @YPacanthostesa |

@Back @Select

♀

Raw string text:

'ers @YPacanthostesa | \n\n@Back @Select\n\x0c'

Partial Clean Test 1 (Animal Crossing)

Acanthostega
Amber
Ammonite
Ankylo skull
Ankylo tail
Ankylo torso
Anomalocaris
Archelon skull
Archelon tail

Acanthostega

Archelon tail

♀

Raw string text:

'Acanthostega\n\nArchelon tail\n\n\x0c'

Single Clean Test 1 (Animal Crossing)

Anomalocaris

Anomalocaris

♀

Raw string text:

'Anomalocaris\n\x0c'

Full Clean Test 2 (Monster Hunter)



Raw string text:

Partial Clean Test 2 (Monster Hunter)

Sharpness	+5	Critical Up	+4	
Blunt	+2	Critical Up	+5	
Crit Draw	+5	Chain Crit	-1	
Sheathing	+10	Snowbaron X	+1	
Sheathing	+9	Sharpness	-4	
Sheathing	+5	Expert	+10	
Sheathing	+5	Tenderizer	+4	
Sheathe Sharpen	+10	Dreadqueen X	+2	
Sheathe Sharpen	+7	Expert	+8	

Tg	Secrets
ert	BUCS
Sheathing	Baie os
SE)	be)
Sheathing	a a
Sheathing	Saal
Sheathe Sharpen	a
Sheathe Sharpen	al
+2 Critical Up	Br Ot
+5 Chain Crit	cele
Baio cig	Ss) ad
SSL tak	♀
Sen	

Raw string text:

'Tg\n\nert\nSheathing\nnSE)\nSheathing\nnSheathing\nnSheathe Sharpen\nnSheathe Sharpen\nn\n+2 Critical Up\nn+5 Chain Crit\nnBaio cig\nn'+
'SSL tak\nnSen\nnSecrets\nnBUCS\nn\nBaie os\nn\nbe)\nna a\nnSaal\nna\nnal\nnBr Ot\nncele\nnSs) ad\nn\x0c'

Single Clean Test 2 (Monster Hunter)

Sheathing +10 Snowbaron X +1 00 -

Sheathing +10 Srowboron X Saad
♀

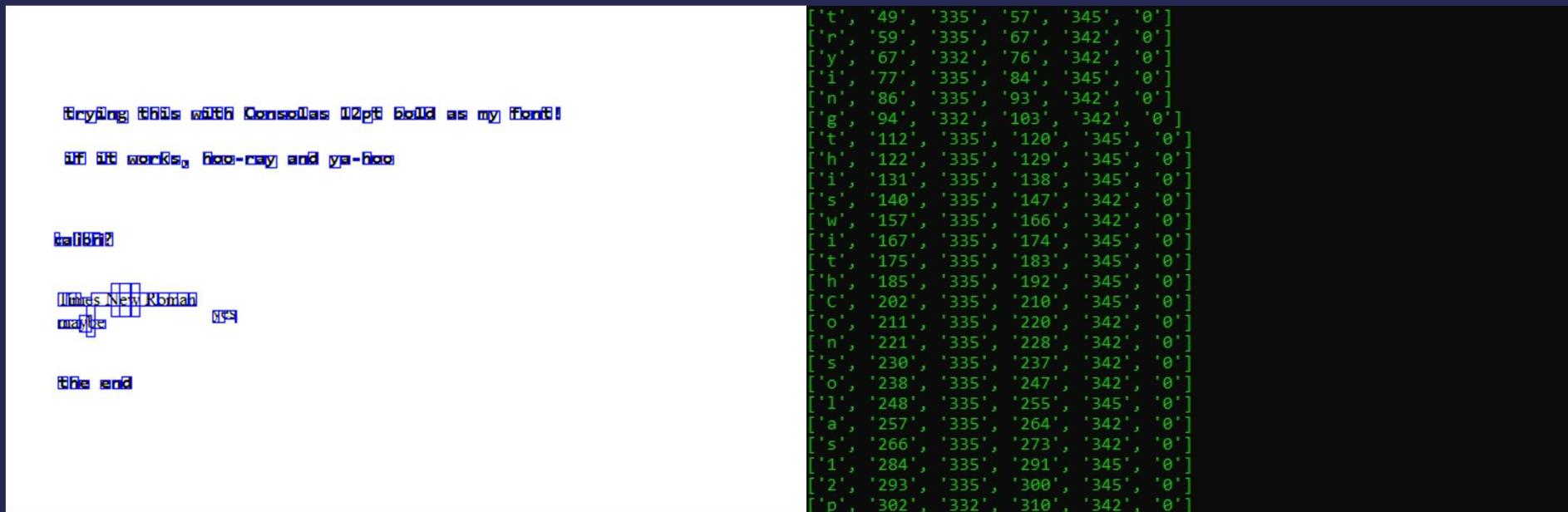
Raw string text:

'Sheathing +10 Srowboron X Saad\n\x0c'

Part 4:
Bri tries to see what Tesseract sees

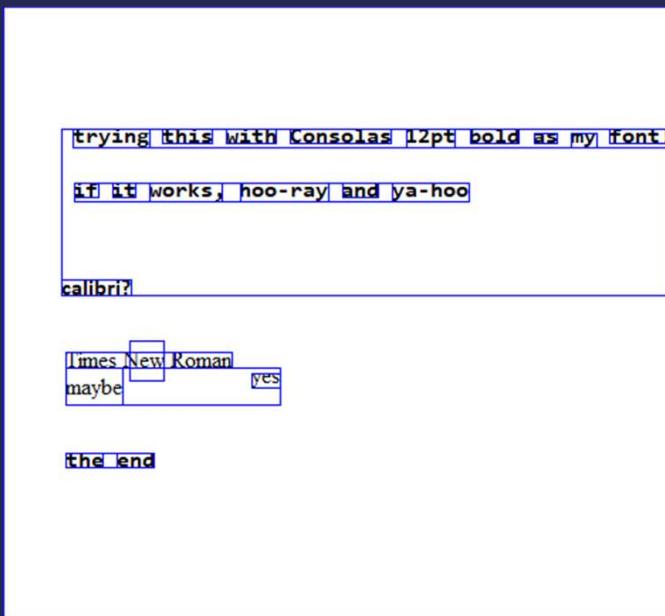
Simple Character Scan

Representation of Character Locations



Simple Word Scan

Representation of Word Locations



Data from pytesseract.image_to_data()

```
[1, '1', '0', '0', '0', '0', '0', '0', '679', '431', '-1', '']
[2, '1', '1', '0', '0', '0', '41', '86', '428', '117', '-1', '']
[3, '1', '1', '1', '0', '0', '41', '86', '428', '117', '-1', '']
[4, '1', '1', '1', '1', '0', '49', '86', '420', '13', '-1', '']
[5, '1', '1', '1', '1', '1', '49', '86', '54', '13', '93', 'trying']
[5, '1', '1', '1', '1', '2', '112', '86', '35', '10', '96', 'this']
[5, '1', '1', '1', '1', '3', '157', '86', '35', '10', '93', 'with']
[5, '1', '1', '1', '1', '4', '202', '86', '71', '10', '92', 'Consolas']
[5, '1', '1', '1', '1', '5', '284', '86', '34', '13', '91', '12pt']
[5, '1', '1', '1', '1', '6', '329', '86', '34', '10', '96', 'bold']
[5, '1', '1', '1', '1', '7', '374', '89', '16', '7', '96', 'as']
[5, '1', '1', '1', '1', '8', '400', '89', '18', '10', '96', 'my']
[5, '1', '1', '1', '1', '9', '427', '86', '42', '10', '96', 'font!']
[4, '1', '1', '1', '2', '0', '50', '124', '278', '13', '-1', '']
[5, '1', '1', '1', '2', '1', '50', '124', '17', '10', '93', 'if']
[5, '1', '1', '1', '2', '2', '77', '124', '16', '10', '94', 'it']
[5, '1', '1', '1', '2', '3', '103', '124', '51', '13', '93', 'works,']
[5, '1', '1', '1', '2', '4', '167', '124', '62', '13', '92', 'hoo-ray']
[5, '1', '1', '1', '2', '5', '239', '124', '25', '10', '93', 'and']
[5, '1', '1', '1', '2', '6', '274', '124', '54', '13', '90', 'ya-hoo']
[4, '1', '1', '1', '3', '0', '41', '192', '49', '11', '-1', '']
[5, '1', '1', '1', '3', '1', '41', '192', '49', '11', '57', 'calibri?']
[2, '1', '2', '0', '0', '0', '44', '243', '117', '11', '-1', '']
[3, '1', '2', '1', '0', '0', '44', '243', '117', '11', '-1', '']
[4, '1', '2', '1', '1', '0', '44', '243', '117', '11', '-1', '']
```

Block Character/Word Scan 1 (ACNH)

Acanthostega

Amber

Ammonite

Ankylo skull

Ankylo tail

Ankylo torso

Anomalocaris

Archelon skull

Archelon tail

Acanthostega

Amber

Ammonite

Ankylo skull

Ankylo tail

Ankylo torso

Anomalocaris

Archelon skull

Archelon tail

```
[ 't', '49', '335', '57', '345', '0' ]
[ 'r', '59', '335', '67', '342', '0' ]
[ 'y', '67', '332', '76', '342', '0' ]
[ 'i', '77', '335', '84', '345', '0' ]
[ 'n', '86', '335', '93', '342', '0' ]
[ 'g', '94', '332', '103', '342', '0' ]
[ 't', '112', '335', '120', '345', '0' ]
[ 'h', '122', '335', '129', '345', '0' ]
[ 'i', '131', '335', '138', '345', '0' ]
[ 's', '140', '335', '147', '342', '0' ]
[ 'w', '157', '335', '166', '342', '0' ]
[ 'i', '167', '335', '174', '345', '0' ]
[ 't', '175', '335', '183', '345', '0' ]
[ 'h', '185', '335', '192', '345', '0' ]
[ 'c', '202', '335', '210', '345', '0' ]
[ 'o', '211', '335', '220', '342', '0' ]
[ 'n', '221', '335', '228', '342', '0' ]
[ 's', '230', '335', '237', '342', '0' ]
[ 'o', '238', '335', '247', '342', '0' ]
[ 'l', '248', '335', '255', '345', '0' ]
[ 'a', '257', '335', '264', '342', '0' ]
[ 's', '266', '335', '273', '342', '0' ]
[ 'i', '284', '335', '291', '345', '0' ]
[ '2', '293', '335', '300', '345', '0' ]
[ 'p', '302', '332', '310', '342', '0' ]
```

```
[ '1', '1', '0', '0', '0', '0', '0', '428', '471', '-1', '' ]
[ '2', '1', '1', '0', '0', '0', '5', '8', '202', '27', '-1', '' ]
[ '3', '1', '1', '1', '0', '0', '5', '8', '202', '27', '-1', '' ]
[ '4', '1', '1', '1', '1', '0', '5', '8', '202', '27', '-1', '' ]
[ '5', '1', '1', '1', '1', '1', '5', '8', '202', '27', '90', 'Acanthostega' ]
[ '2', '1', '2', '0', '0', '0', '5', '435', '182', '22', '-1', '' ]
[ '3', '1', '2', '1', '0', '0', '5', '435', '182', '22', '-1', '' ]
[ '4', '1', '2', '1', '1', '0', '5', '435', '182', '22', '-1', '' ]
[ '5', '1', '2', '1', '1', '1', '5', '435', '130', '22', '92', 'Archelon' ]
[ '5', '1', '2', '1', '1', '2', '147', '435', '48', '22', '96', 'tail' ]
```

Line Character/Word Scan 1 (ACNH)

Anomalocaris

```
In [65]: showChars('acnh3.png')
['A', '2', '14', '24', '35', '0']
['n', '26', '14', '40', '31', '0']
['o', '43', '14', '60', '31', '0']
['m', '63', '14', '84', '31', '0']
['a', '75', '13', '90', '36', '0']
['l', '86', '13', '101', '31', '0']
['o', '104', '14', '127', '35', '0']
['c', '120', '13', '135', '36', '0']
['a', '130', '13', '144', '31', '0']
['r', '147', '13', '162', '31', '0']
['i', '165', '14', '181', '36', '0']
['s', '183', '13', '197', '31', '0']

In [66]: showWords('acnh3.png')
['1', '1', '0', '0', '0', '0', '0', '323', '45', '-1', '']
['2', '1', '1', '0', '0', '0', '2', '9', '195', '23', '-1', '']
['3', '1', '1', '1', '0', '0', '2', '9', '195', '23', '-1', '']
['4', '1', '1', '1', '1', '0', '2', '9', '195', '23', '-1', '']
['5', '1', '1', '1', '1', '1', '2', '9', '195', '23', '89', 'Anomalocaris']
```

Anomalocaris

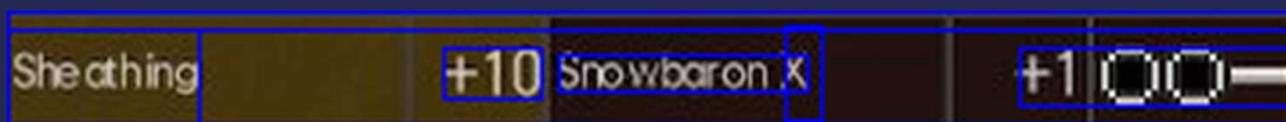
Block Character/Word Scan 2 (MHGU)

Sharpness	+5 Critical Up	+4 000
Blunt	+2 Critical Up	+5 000-
Crit Draw	+5 Chain Crit	+1 000
Sheathing	+10 Snowbaron X	+1 000-
Sheathing	+9 Sharpness	-4 000
Sheathing	+5 Expert	+10 0--
Sheathing	+5 Tenderizer	+4 0--
Sheathe Sharpen	+10 Dreadqueen X	+2 000-
Sheathe Sharpen	+7 Expert	+8 000-
Sharpness	+5 Critical Up	+4 000
Blunt	+2 Critical Up	+5 000-
Crit Draw	+5 Chain Crit	+1 000
Sheathing	+10 Snowbaron X	+1 000-
Sheathing	+9 Sharpness	-4 000
Sheathing	+5 Expert	+10 0--
Sheathing	+5 Tenderizer	+4 0--
Sheathe Sharpen	+10 Dreadqueen X	+2 000-
Sheathe Sharpen	+7 Expert	+8 000-

```
[ '1', '1', '0', '0', '0', '0', '0', '0', '359', '287', '-1', '']
[ '2', '1', '1', '0', '0', '0', '2', '42', '88', '236', '-1', '']
[ '3', '1', '1', '1', '0', '0', '2', '42', '25', '11', '-1', '']
[ '4', '1', '1', '1', '1', '0', '2', '42', '25', '11', '-1', '']
[ '5', '1', '1', '1', '1', '1', '2', '42', '25', '11', '32', 'Tg']
[ '3', '1', '1', '2', '0', '0', '2', '74', '88', '204', '-1', '']
[ '4', '1', '1', '2', '1', '0', '2', '74', '58', '11', '-1', '']
[ '5', '1', '1', '2', '1', '1', '2', '74', '58', '11', '10', 'ert']
[ '4', '1', '1', '2', '2', '0', '2', '106', '51', '12', '-1', '']
[ '5', '1', '1', '2', '2', '1', '2', '106', '51', '12', '38', 'Sheathing']
[ '4', '1', '1', '2', '3', '0', '2', '138', '51', '12', '-1', '']
[ '5', '1', '1', '2', '3', '1', '2', '138', '51', '12', '12', 'SE']
[ '4', '1', '1', '2', '4', '0', '2', '170', '51', '12', '-1', '']
[ '5', '1', '1', '2', '4', '1', '2', '170', '51', '12', '45', 'Sheathing']
[ '4', '1', '1', '2', '5', '0', '2', '202', '51', '12', '-1', '']
[ '5', '1', '1', '2', '5', '1', '2', '202', '51', '12', '81', 'Sheathing']
[ '4', '1', '1', '2', '6', '0', '2', '234', '88', '12', '-1', '']
[ '5', '1', '1', '2', '6', '1', '2', '234', '42', '11', '52', 'Sheathe']
[ '5', '1', '1', '2', '6', '2', '49', '234', '41', '12', '94', 'Sharpen']
[ '4', '1', '1', '2', '7', '0', '2', '266', '88', '12', '-1', '']
[ '5', '1', '1', '2', '7', '1', '2', '266', '42', '11', '37', 'Sheathe']
[ '5', '1', '1', '2', '7', '2', '49', '266', '41', '12', '92', 'Sharpen']
[ '2', '1', '2', '0', '0', '0', '121', '41', '107', '206', '-1', '']
[ '3', '1', '2', '1', '0', '0', '121', '41', '107', '206', '-1', '']
[ '4', '1', '2', '1', '1', '0', '130', '41', '78', '14', '-1', '']
[ '5', '1', '2', '1', '1', '1', '130', '41', '18', '14', '83', '+2']
[ '5', '1', '2', '1', '1', '2', '153', '42', '37', '11', '10', 'Critical']
[ '5', '1', '2', '1', '1', '3', '194', '43', '14', '11', '10', 'Up']
[ '4', '1', '2', '1', '2', '0', '130', '73', '74', '14', '-1', '']
[ '5', '1', '2', '1', '2', '1', '130', '73', '18', '14', '66', '+5']
```

```
[ 'T', '2', '234', '17', '245', '0']
[ 'g', '18', '234', '27', '243', '0']
[ 'e', '2', '202', '14', '213', '0']
[ 'r', '16', '202', '21', '212', '0']
[ 't', '25', '202', '52', '213', '0']
[ 's', '2', '169', '7', '181', '0']
[ 'h', '2', '170', '20', '181', '0']
[ 'e', '14', '169', '21', '181', '0']
[ 'a', '21', '169', '24', '181', '0']
[ 't', '22', '170', '31', '179', '0']
[ 'h', '32', '170', '37', '181', '0']
[ 'i', '35', '169', '42', '181', '0']
[ 'n', '39', '170', '46', '180', '0']
[ 'g', '47', '169', '53', '178', '0']
[ 'S', '2', '137', '10', '149', '0']
[ 'E', '2', '138', '31', '149', '0']
[ ')', '32', '137', '53', '149', '0']
[ 'S', '2', '105', '7', '117', '0']
[ 'h', '2', '106', '20', '117', '0']
[ 'e', '14', '105', '21', '117', '0']
[ 'a', '21', '105', '24', '117', '0']
[ 't', '22', '106', '31', '115', '0']
[ 'h', '32', '106', '37', '117', '0']
[ 'i', '35', '105', '42', '117', '0']
[ 'n', '39', '106', '46', '116', '0']
[ 'g', '47', '105', '53', '114', '0']
[ 'S', '2', '73', '7', '85', '0']
[ 'h', '2', '74', '20', '85', '0']
[ 'e', '14', '73', '21', '85', '0']
[ 'a', '21', '73', '26', '85', '0']
```

Line Character/Word Scan 2 (MHGU)



```
[1, 1, 0, 0, 0, 0, 0, 0, '359', '33', '-1', '']
[2, 1, 1, 0, 0, 0, 0, 0, '5', '356', '26', '-1', '']
[3, 1, 1, 1, 0, 0, 0, 0, '5', '356', '26', '-1', '']
[4, 1, 1, 1, 1, 0, 0, 0, '5', '356', '26', '-1', '']
[5, 1, 1, 1, 1, 0, '5', '53', '26', '3', 'Sheathing']
[5, 1, 1, 1, 1, 2, '121', '10', '27', '14', '93', '+10']
[5, 1, 1, 1, 1, 3, '153', '12', '69', '10', '66', 'Snowboron']
[5, 1, 1, 1, 1, 4, '216', '4', '10', '26', '86', 'X']
[5, 1, 1, 1, 1, 5, '281', '10', '75', '16', '28', 'Saad']
```

```
[5, 0, '2', '9', '28', '0']
[h, 2, '11', '20', '22', '0']
[e, '12', '2', '20', '28', '0']
[a, '19', '2', '24', '28', '0']
[t, '22', '11', '31', '20', '0']
[h, '32', '11', '37', '21', '0']
[i, '39', '11', '46', '21', '0']
[n, '43', '2', '48', '28', '0']
[g, '47', '10', '53', '19', '0']
[+, '121', '10', '131', '21', '0']
[1, '133', '9', '137', '22', '0']
[0, '141', '9', '148', '23', '0']
[s, '153', '11', '159', '21', '0']
[r, '158', '11', '165', '21', '0']
[o, '160', '11', '171', '19', '0']
[w, '173', '12', '181', '19', '0']
[b, '179', '11', '187', '21', '0']
[o, '182', '11', '198', '21', '0']
[r, '192', '11', '200', '21', '0']
[o, '199', '11', '205', '19', '0']
[n, '206', '12', '222', '21', '0']
[x, '216', '3', '226', '29', '0']
[S, '281', '7', '286', '23', '0']
[a, '281', '10', '296', '22', '0']
[a, '304', '7', '338', '23', '0']
[d, '340', '13', '356', '17', '0']
```

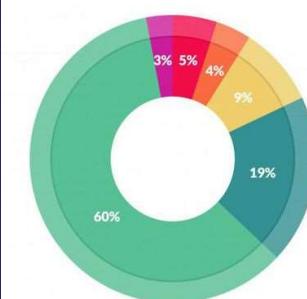
Part 5: Bri reviews image cleaning techniques

Clean Data is Happy Data

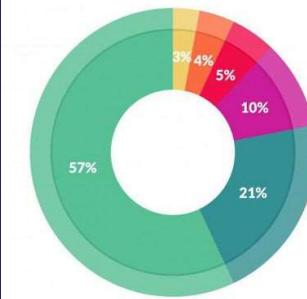
Improving the quality of the output

There are a variety of reasons you might not get good quality output from Tesseract. It's important to note that, unless you're using a very unusual font or a new language, retraining Tesseract is unlikely to help.

- Image processing
 - Rescaling
 - Binarisation
 - Noise Removal
 - Dilation / Erosion
 - Rotation / Deskewing
 - Borders
 - Transparency / Alpha channel
 - Tools / Libraries
 - Examples
 - Tables recognitions
- Page segmentation method
- Dictionaries, word lists, and patterns
- Still having problems?



What data scientists spend the most time doing



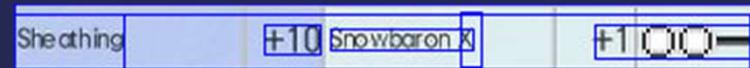
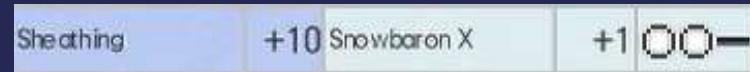
What's the least enjoyable part of data science?

Image Processing Techniques Explored

- **Inversion:** flips color bits – Tesseract prefers **dark on light** rather than **light on dark** text
 - **Lazy method:** scan once normally, then once inverted
 - **Smart method:** if the location of text is known, can simply deduce regional brightness
- This doesn't always improve the result!



'Sheathing +10 Srowboron X Saad\n\x0c'



'Shecthing +10 Srowboron X 410\n\x0c'

Image Processing Techniques Explored

- **Rescaling:** increases pixels per inch (DPI) – Tesseract works best at 300 DPI
 - There's an optimal pixel size range for any font, so we can try the image at different image sizes
 - Different resize methods may produce different results as well
- Can get pixel size based on initial parse, then adjust to optimal sizes for other fonts

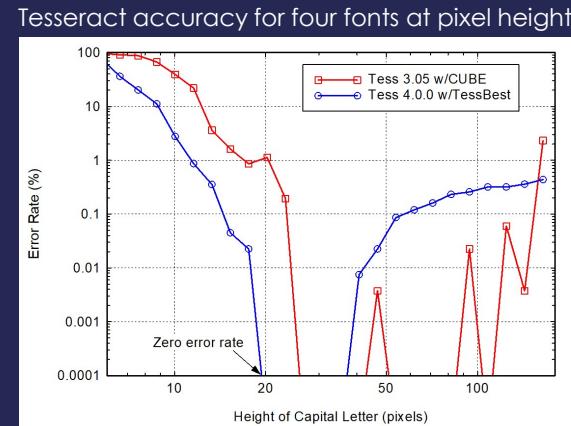
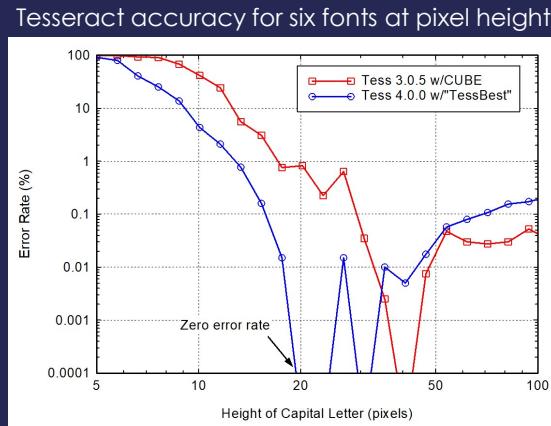


Image Processing Techniques Explored

- **Binarization:** set pixels to black or white based on brightness
 - **Bitplane method:** separate image into bitplanes and parse higher end
 - **Discrete wavelet transform method:** find edges by adjacent color differences, then fill areas
- May also help in recognizing block patterns for text that may be missed

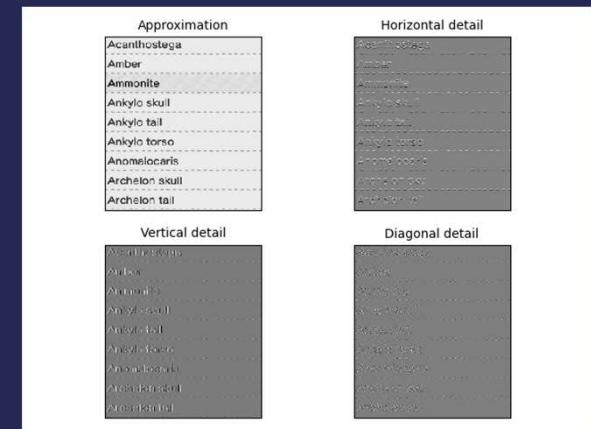
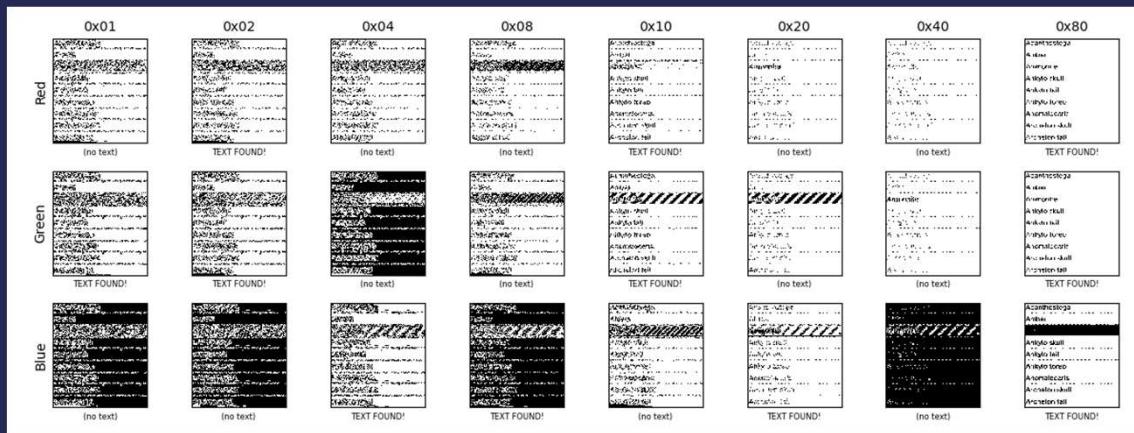


Image Processing Techniques to Try

- Noise removal:** removes random variations in brightness
- Dilation:** adds edge pixels to increase visibility of thin characters
- Erosion:** removes edge pixels for bold characters (e.g. bleeding)

Cattle	No..
Horses.....	No..
Sheep	No..
All other, including fowls	
Total	



Cattle	No..
Horses.....	No..
Sheep	No..
All other, including fowls	
Total	

Erosion

Noise removal

88 ΘΕΟΛΟΓΙΤΟΤ
θεῶν τὸν πλάνον διηγέρει; ἀναρπανὸν γὰρ τούτους ἔργονται
δὲ τῆς ἀνθρακοῦ ἀντίταλος μήτε θεῖος μήτε ἐμβόλος διή-
μονας τίνει, ἀλλὰ τὸν φεύγοντα διδοκούσαντος καὶ πονηροῦ
70 πατήσαντος τούτους δὲ Πλέκτων ἐν τῷ Τιματοῖ οὐδὲ φύεται
ἐδιατάντος φυσικοῦ τὸν γένος ποιητὴν εἰργάζεται πρὸς αὐτοὺς τοι-
λέγει· ἀδικεῖται μάλιστα οὐτοὶ ἐστοι οὐδὲ φύεται τὸ ποιητεῖν
οὐτοὶ μὲν δὲ λοιδοροῦσθε, τῆς τοῦτος βουλήσας πενοτεῖται·
καὶ τοι γε Οὐρανοὶ ταγαρτία δοκεῖ ἀδικεῖταις γὰρ αὐτοὺς
πανταχοὶ προσανομοῦσι· μᾶλλον δὲ τοῖς “φρεσκάδαντα” οὐδὲ
πίρην, αἴσθητα οἰνοῖς τούτοις ἀναφορίς εἰσι καὶ ἀδικεῖται τοι-
λασταῖται·

71 Τοσαῦτη παρὰ τοῖς ποιηταῖς καὶ φιλοσόφοις περὶ τῶν
οὐρανῶν μὲν καλούμενων δὲ θεῶν διαμάχην, τούτους καὶ
νέρες ἴδιοματα καὶ βανοὺς προσοποπούμενας καὶ θυσίας
ἔτιμοντας καὶ εἶδος τούτα καὶ επανομάτα τούτων τοῖς θεοῖς
καὶ τοῖς μίσταις δίδοντες διεγένεταις, θεῶν προσοποπούμεναν
τὰ περιώματα εἰδοῦλοι καὶ τὰ τῆς Φειδίου καὶ Πολυκλείτου
καὶ Προστίτους πήγαντα τῆς θεᾶς προστρέψαντας
τούτους δὲ τοῖς πλεῖστον μετρητούμενοντας
Κολοφόνιος τούτους φυσικοὺς μὲν οἱ βροτοὶ δοκούσι γεννά-
σθαι θεούς καὶ λοιποὺς τοις οὐρανοῖς φαντάρι τούτους τε·
καὶ πάλι· μᾶλλον δὲ τοι γεννάσθαι φύεται τὸ λογοτεῖται
γάρ τοι γένεσις καὶ ἡρα τελεῖται μάταιος εἰδοῦλος, ἵνατοι μὲν δὲ
τηνούσι βάτες δὲ τοι βανούσι δρούσας καὶ θεῶν ίδιας ἕρμορος
καὶ σύμμαχος ἑταῖρος, οἰλότητας καντός δέμας εἰγον τοι·

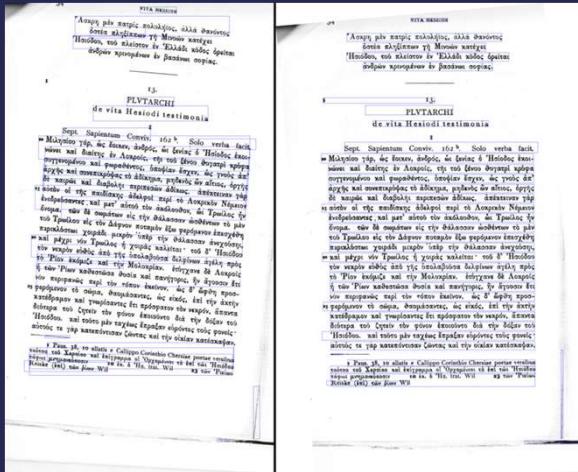
— 6—7: Eus. Pr. XI. 32, 2. — XIII. 18, 10 (Plat. Tim. p. 41B).
— 9—11: Hom. E. 341—342. J. 18—p. 89, 1; Clem. Str. V 14, 100
— Eus. Pr. XIII. 13, ss (Xenophan. fr. 14—10).

1 Κρηταῖος: Ἑρμῆς in ἔθιμοις corr. S. [..] 7.οὐτι: ὅτι BLS:
ὅτι V | ινθεσθαι M. corr. Mηρ: λινηθεσθαι. L. [..] 8 γε om.
BLMCV | λιναγαροῦ K: πανταχοῦ BL | λινεσθαι. codid. J. 9θ
(posteriore, loco); οὐδὲ BLMCV. | 10 πινουσαν codid. | 12 περι:
περι. V | 14 γεννάσθαι M | ἑρμόφαντο. BS: ἑδουμέναν K | καὶ θυσίας
τελευταν om. S, sed posuit infra, post λινεσθαι. | 15 ἐδὲ BL:
ἔρη. K | 17 γεννόμενα. MCV | 20 τοιαῦτα BL | φεροτ, M | 21, 5
αἰσθηταῖς ταῖς τοῦθισσαῖς. K | 22 εἰ: ὃ I. ε corr. | τοι: τι, V | ἔρη
K | 23 λογοτεῖται: ὃ διεργάται MSCV, 23, γεννεῖται MS | ἀπαν: M¹
οὐ: μεροῦ MSC | 24 δὲ om. V | σιδηταῖς BLS, sed corr. S

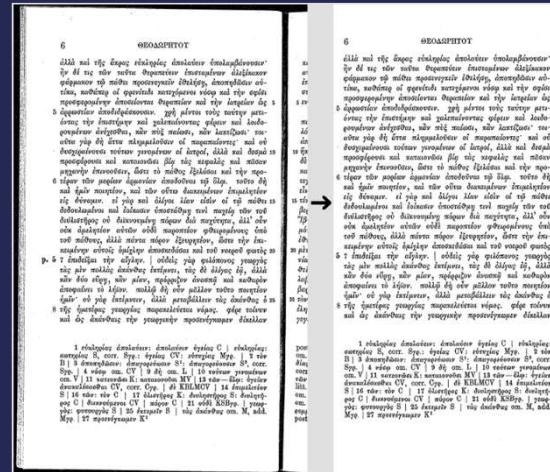
Image Processing Techniques to Try

- **Rotation:** rotates angled text to be aligned horizontally
 - **Border removal:** removes border pixels that may be misinterpreted as characters
 - **Border addition:** adds a solid color border to designate text area

Rotation



Border removal



Border removal

Doot doot

Doot doot

Part 6:
Bri plans ahead (kinda)

Future and Optional Tasks

- **Future tasks:**

- Experiment with off-screen (camera) images
- Implement unused processing techniques
- Consider auto-correction for English text

- **Optional tasks:**

- Implement picture comparison method in its entirety
- Completely abandon this project to work on PDF Read-along program
- Rest

(that's it)