Capstone Project Proposal

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Business Goals

Project Overview and Goal	
Project Overview and Goal What is the industry problem you are trying to solve? Why use ML/AI in solving this task? Be as specific as you can when describing how ML/AI can provide value. For example, if you're labeling images, how will this help the business?	*The National Audubon Society is a non-profit environmental organization that protects birds and bird habitats. The organization hosts bird counts throughout the Americas to collect regional data on various species.* Audubon volunteers have always manually compiled and reported bird counting data. One problem to be addressed is the time-consuming process to gather, compile, and report on hand-written bird counting submissions from a volunteers' region. **Decreasing the time and labor for reporting sessions will increase the regional volunteering participation.** A second problem to be addressed is the challenge of growing the number of birders for the future. Avid bird watchers participate frequently, but those who have little experience are less likely to contribute due to the knowledge required to accurately identify bird species. Less bird watchers ultimately leads to less data collected. **Decreasing the barriers to entry for new birders will increase the birder population.** Incorporating optical character recognition and computer vision could ease the challenges of contributing to national bird counts. ICR can be utilized in compiling and reporting the collected data back to the national registry through the current web portal and/or a mobile app. CV can be incorporated into a mobile app for bird counting to assist less experienced birders in identifying and labeling bird species. **Making it easier for volunteers to report data and new birders to contribute bird counts will increase the amount of data reported, decrease the amount of**

	time it takes to report and support the growth of the birding demographic for years to come.
Business Case Why is this an important problem to solve? Make a case for building this product in terms of its impact on recurring revenue, market share, customer happiness and/or other drivers of business success.	*Facts (as of 2016)* *- Birds have the highest wildlife watching rate (more than 19% higher than any other animal)* *- 45 million birders in the U.S. (down 4.25% from 2011)* *- Birding generated over $87.5 billion in output (down 18.5% from 2011)* *- Birding supports over 666,000 jobs* Continuing to support environmental education and conservation initiatives for our land is imperative to our future and the future of our co-habitants. The practice of bird watching is historically outside of the realm of technology, and in 2016 the U.S. Fish & Wildlife Service reported that 53% of birders are under the age of 55 (down 4% from 2011). In recent years, there have also been initiatives to increase the accessibility of birding for mobility-impaired individuals. Data tells us that birding is growing into a space of inclusivity, and generations with technological savvy are embracing the activity. To maintain the happiness, participation, and contribution of younger birding demographics, now and in the future, people will need access to modern devices that allow them to take part in a way that best suits their needs. Without the adoption of birding in younger generations, and without the participation of future volunteers, the data and knowledge gained from bird counting will be lost leaving us with less information around how to conserve our wildlife and our lands. **For Audubon, bird conservation is most of the company's work. The loss of birding could mean the decline of one of the largest environmental conservation organizations we have today, as well as lost national economic revenue and jobs.**
Application of ML/AI What precise task will you use ML/AI to accomplish? What business outcome or objective will you achieve?	*In 2016 I designed a mobile app concept to support the Audubon Christmas Bird Count and the needs of birders.* ICR will be implemented within the current reporting web portal, and in the mobile app will exist in the submission and the life list sections. The use of ICR supports the business objectives of making volunteering more accessible and enhancing the birding experience for

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novice and advanced bird watchers in the following ways:

1. Volunteers will no longer need to manually type up spreadsheets to report bird data. ICR will decrease time it takes volunteers to compile hand-written counting data.

2. Birders will be able to quickly upload bird counts from sessions where they didn't utilize the mobile app. ICR will convert their hand-written counts in the submission area of the app, with the ability to edit before submitting.

3. Birders will be able to upload their current hand-written life lists to their mobile app profile. Including this technology supports the growth of birding in younger generations in a way that's familiar to them.

CV will be implemented within the counting section of the mobile application. Users will provide the app access to their mobile camera; during their counting session they'll be able to capture images of birds that they can't identify through their own knowledge. The software will then classify the bird and the user will be able to input the rest of the required data. Utilizing CV during a count session supports the business objective of creating an accessible method of counting while assisting new birders in identifying species, which ultimately lessens the barrier of entry in order to grow the bird watching population for the future.

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Success Metrics

Success Metrics	Questions to answer
What business metrics will you apply to determine the success of your product? Good metrics are clearly defined and easily measurable. Specify how you will establish a baseline value to provide a point of comparison.	**Questions to answer** - Is our volunteer pool growing? - Are our events participation numbers growing? - Are we receiving more count submissions overall? Per event? - Are we covering more regions? **App usage** 1. Number of mobile app downloads -30, 60, 90, 180, 365 days 2. Number of app sign ups/profile creations

3. Number of bird count submissions through mobile app
      - Per each event
      - Are there more submissions YoY? Before vs. after app release?

Participation growth
1. Number of volunteers for events year over year (YoY)
2. Number of birders participating in each event YoY
      - Does this correlate with number of app sign ups?
3. Number of regions hosting events YoY
4. Number of total submissions overall? Per event?
      - In-app submissions vs. web portal submissions

Baseline values for comparison
If our metrics are higher than the following averages, the implementations have been successful. If any metrics are stagnant, the related features should be addressed through user interviews, research, and A/B testing:

- Average (avg.) number of volunteers (last 5 years)
- Avg. number of participants (last 5 years)
- Avg. number of participants per region (last 5 years)
- Avg. number of regions per year (last 5 years)
- Avg. number of volunteer submissions (last 5 years)
- Avg. number of total count submissions over a 1-year period (last 5 years)

Data

Data Acquisition	
Where will you source your data from? What is the cost to acquire these data? Are there any personally identifying information (PII) or data sensitivity issues you will need to overcome? Will data become available on an ongoing basis, or will you acquire a large batch of data that will need to be refreshed?	**ICR data** For ICR features, software can be purchased and implemented to be utilized in the web portal and the mobile app. PDFelement provides a Pro plan that costs $89 billed yearly. The initial implementation will require volunteers to manually redact PII from the ICR outputs. In the future, software integrations can be leveraged to automatically redact the PII information. **CV data** For CV features, software will need to be trained on about 2,059 bird species in various habits in North America. There is no data sensitivity, but the amount of data and time to train will make implementation expensive. Initial training will begin with an existing

	batch of data that includes bird species/common names, the regions they're generally associated with, and prelabeled images. The data would be sourced from within Audubon and The Cornell Ornithology Lab (business partners) for no monetary cost. Currently, Cornell and Audubon have digitized data on bird species by region, and Cornell's Merlin Bird-ID and eBird apps have labeled images taken by birders as well as professional photographers. Since the app has only 285 out of 2,059 species, the CV model will initially be trained on the 285 and will need to be trained ongoing as Cornell updates their database.
	Associated costs will be spent in time for training the CV model. Since Cornell and Audubon are already doing bird identification and classification research, data gathering costs are already in place in the form of employees conducting the research.
	Challenges A challenge to consider is the distance between Audubon and Cornell. It's unknown if the businesses work together regularly or share information freely. Another obstacle is the time and amount of data for the CV feature. 285 species are not enough to launch fully. A mitigation method would be to selectively launch the feature to regions with the most trained species.
Data Source Consider the size and source of your data; what biases are built into the data and how might the data be improved?	Because Audubon and Cornell only work within North America, there is a clear bias toward North American bird species. Since the app only contributes to a national database, as opposed to a global database, all bird species and regional data will exclude all information outside of the Americas. Another bias to consider is the scientific labeling of bird species. It's rare, but possible, that a type of bird may be recategorized by ornithology experts. In this scenario, model labeling would be outdated upon the new scientific data being accepted and published. In order to mitigate the issue, there should be regular model training to update label associations. Most likely the model would not need to be retrained on images, but the label would need to be converted before submission.
Choice of Data Labels What labels did you decide to	The labels are based off existing bird data related to scientific species names and regions. Since the data needs to match scientific databases, the models will

add to your data? And why did you decide on these labels versus any other option?	need to leverage only existing scientific species names, common bird names, and the regions they exist in. If the data does not match the criteria, they will not be accepted for national database submission. Leveraging the existing labeling scheme will keep models aligned with national database expectations. A challenge arises when new bird species are identified by scientists – there will surely be a time gap from new scientific findings and updated model training. To mitigate the issues, there should be a feature for manual bird counting entry within the app to account for any potential gaps.

Model

Model Building How will you resource building the model that you need? Will you outsource model training and/or hosting to an external platform, or will you build the model using an in-house team, and why?	CV model building will be outsourced to an experienced team. The data that the model needs to be trained on is public knowledge and contains no PII. For these reasons, the model training can be outsourced to a team that will train more efficiently and effectively. Outsourcing training will allow the current teams to focus on the ICR software integrations, building the mobile application, the feature roadmap, and integrating the CV model. Bringing a model training team in-house may be considered once mobile app is launched and the current model is fully performant with at least 30% of the species or regions trained. A cost analysis should be conducted before making this decision. The trained model can be hosted on a cloud platform with security integrations. The platform management and setup can be owned by Audubon and Cornell, seeing as they currently have these services. Access can be granted to the third-party model training teams.
Evaluating Results Which model performance metrics are appropriate to measure the success of your	ICR integrations are leveraging software that is proven to be performant in the metric of accuracy. Metrics may not be tracked internally, and volunteers will be responsible for reviewing and finalizing outputs for submission. Volunteers will have access to a reporting system when encountering ICR performance issues,

model? What level of performance is required?	which will be addressed with the third-party association. The F1 score should be tracked as a performance metric for the CV model. All factors (precision, recall, and accuracy) of the F1 score are equally important because the national database is utilized for scientific purposes. A minimum performance threshold will be set at 90% with the goal of reaching and maintaining an F1 score of 95-98% within a year of the feature's release date. Some regions may see higher performance than others due to time spent in model training and exposure to application usage.

Minimum Viable Product (MVP)

Design What does your minimum viable product look like? Include sketches of your product.	*Note: Some of the non-MVP features were considered and designed in the 2016 mobile app concept. Sketches and visual work for such features may already exist.* Click to view project PDF | Click to view 2016 work See "Roll-out" below for an explanation of the product build and launch plans.
Use Cases What persona are you designing for? Can you describe the major epic-level use cases your product addresses? How will users access this product?	There are two different user personas that the technology is meant for: 1. Initial ICR implementations are for avid birders that want to volunteer within the limits of their current life schedules. These individuals are experienced in birding, have participated in count sessions, but are reluctant to volunteer due to the time-consuming nature of manual reporting. 2. The mobile app with ICR and CV technology supports the younger and future demographics of birding. These individuals are custom to leveraging applications in their daily lives and partake in social activities in-person and online. **Epic-level use cases** For want-to-be volunteers, ICR allows them to report data without dedicating hours of time to manual entry.

Decreasing the amount of time reporting takes increases the size of the number of birders able to volunteer.

For want-to-be birders of younger and future demographics, CV and ICR allow them to contribute with less experience and maintain their birding practice in ways that are familiar to them. **Decreasing the barrier to entry and increasing accessibility will allow for more people to participate, which will in turn grow and support the future of the bird watching population.**

User access: Go-to-market roll-out
Go-to-market will consist of preliminary trials that include invited participants for testing. After testing, the application will be available in the Apple and Android app stores. The Audubon website, as well as any partner websites, will display a graphic for downloading the app. Any users subscribed to Audubon emails will receive an application launch email with links to download.

Roll-out

How will this be adopted? What does the go-to-market plan look like?

MVP build plan
The MVP version starts with implementing ICR into the current reporting web portal. Volunteers will be able to submit various image files of hand-written counts that utilize a counting form. The software will digitize the submission and provide editing access. The volunteer will then be able to review the data and submit the report.

The MVP version of the mobile app would include the ability to login, identify your counting region, join in scheduled Audubon count events, submit your session reports, and save your sessions to your app. ICR would be implemented within the submission area for users that utilized bird counting forms on any particular session.

Feature roadmap
A roadmap of features for the app would include the ability to start counting sessions outside of Audubon scheduled events, upload your life list with ICR to your profile, utilize CV during your bird counting sessions, and report rate birds in your selected region.

Long-term feature planning might include the ability for app users to share and view life lists from other birders,

share and view CV captures birds in your image gallery, utilize bird call sounds during sessions, reference and report rare and endangered birds in your region against a national or worldwide list, and browse recent Audubon blogs.

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Post-MVP-Deployment

Designing for Longevity How might you improve your product in the long-term? How might real-world data be different from the training data? How will your product learn from new data? How might you employ A/B testing to improve your product?	The ICR software will initially be output in an editable PDF format, which means volunteers will need to manually redact PII and convert the document to an Excel format (can be done with another tool or save as) before submitting to the database. In the future, this can be improved by integrating with software that automatically identifies PII when provided with specific document formats, while also outputting directly to Excel. The CV model will need to be trained on an ongoing basis involving HITL methods. As Audubon and Cornell collect and label more images, the model will need to be updated with more bird species. Although the model will be provided with images from birders and professional photographers, the live model will be taking in birder images of varying qualities within varying habitats. Before releasing new versions of the model, it will need to pass performance tests done by an internal team of birders utilizing test counts. The model can then be released to specific regions for further A/B testing to ensure performance for the new data and confirm no degradation for the original/older data. Training data should be split up regionally to ensure cleaner testing releases.

Monitor Bias	Within the feature a birder will be able to dismiss or report a model classification that they don't agree with. The user will be able to report the identification and provide a label they feel is more appropriate. The report will then be submitted to a data collection for review and mitigation with a HITL process.
How do you plan to monitor or mitigate unwanted bias in your model?	The models should always be trained with bird image data in various habitats during various seasons. Trainings should include images from varying devices.
	CV models should only be available in regions that have gone through thorough validation. The feature should be able to be assigned to specific regions with the ability to turn it off for others. Including this ability will mitigate inaccuracies that could be introduced in regions that do not have enough trained data.

Supporting Resources

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U.S. FISH AND WILDLIFE SERVICE. *2016 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation* [online]. April 2018. February 11, 2020. https://wsfrprograms.fws.gov/Subpages/NationalSurvey/nat_survey2016.pdf.

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