

# **Birdsnap: Large-scale Fine-grained Visual Categorization of Birds**

## **– Supplemental Material –**

Thomas Berg<sup>1</sup>, Jiongxin Liu<sup>1</sup>, Seung Woo Lee<sup>1</sup>, Michelle L. Alexander<sup>1</sup>, David W. Jacobs<sup>2</sup>, and Peter N. Belhumeur<sup>1</sup>

<sup>1</sup>Columbia University

<sup>2</sup>University of Maryland

We include the following supplemental material:

1. Examples of the generated field mark illustrations described in Section 8 of the paper are shown in Figures 1-6 of this document.
2. The one-vs-most classifiers are contrasted with the one-vs-all classifiers by showing the ranked results from both for several query images in Figures 7-12 of this document.

### **1. Field Mark Illustrations**

Figures 1-6 show the field mark illustrations described in Section 8 of the paper. The web site shows one of these illustrations for each species and each of its top five most similar species. On the website, the images in each row change every few seconds, illustrating the same feature on a different pair of birds.



Figure 1. Differences between the Great Egret and the Snowy Egret. The Great Egret has a yellow bill, a corner of the mouth that extends back past the eye, and a longer, more slender neck.

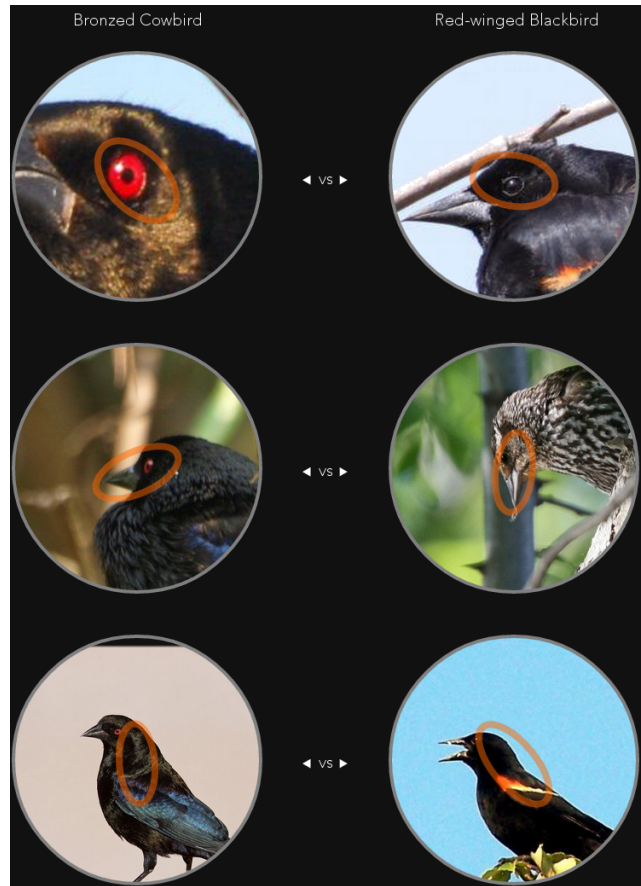


Figure 2. Differences between the Bronzed Cowbird and the Red-winged Blackbird. The Bronzed Cowbird has a red eye, a slightly stubbier and more curved bill, and red markings on the wing.



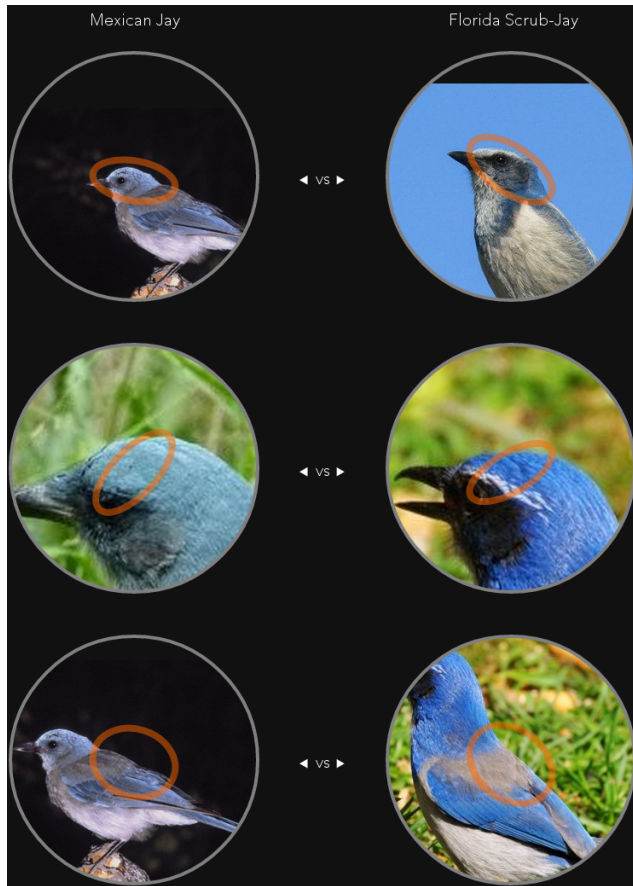


Figure 3. Differences between the Mexican Jay and the Florida Scrub Jay. The Mexican Jay lacks a white “eyebrow” and has less contrast defining the gray patch on its back.

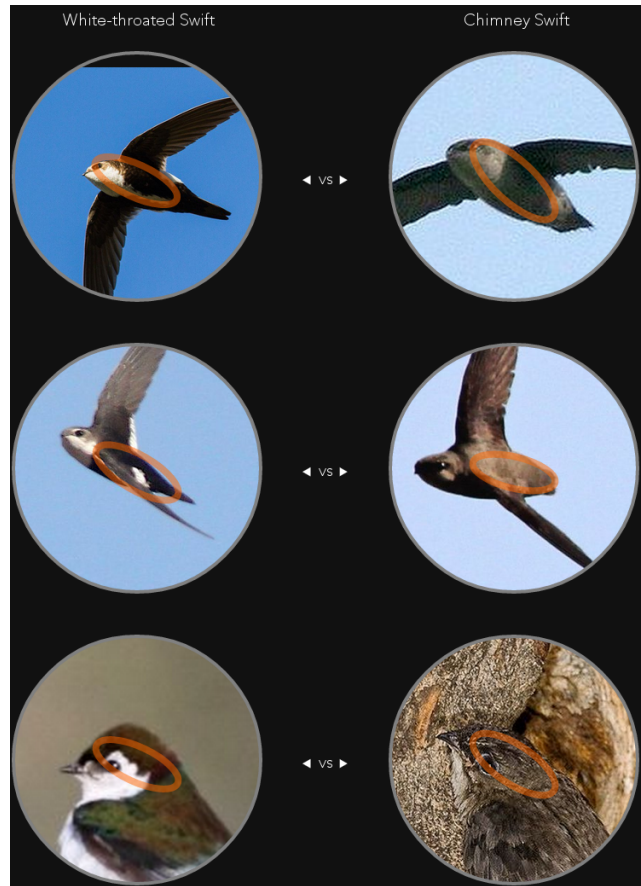


Figure 4. Differences between the White-throated Swift and the Chimney Swift. The White-throated Swift has white markings on the throat, on the trailing edges of the wings, and around the eyes.



Figure 5. Differences between the Canada Warbler and the Magnolia Warbler. The Canada Warbler lacks a white “eyebrow”, but has a yellow streak connecting the eye ring and the extending from the eye to the beak. It also has an unmarked gray wing.



Figure 6. The Canada Goose and Cackling Goose are very similar, but the Canada Goose has a longer neck (first feature) and slightly longer bill (third feature). The meaning of the second feature is unclear, and may be a spurious difference.

## 2. One-vs-Most and One-vs-All Comparison

As described in Section 4 of the paper, and illustrated in Figure 3 of the paper, the one-vs-most classifiers are not only more often correct than one-vs-all classifiers, but also, whether correct or incorrect at rank one, produce a set of top-ranked species that are more consistently similar to the query image. Figures 7-12 demonstrate this with the top five results from both sets of classifiers for several query images. *I.e.* these figures are duplicates of Figure 3 in the paper, for different query images.



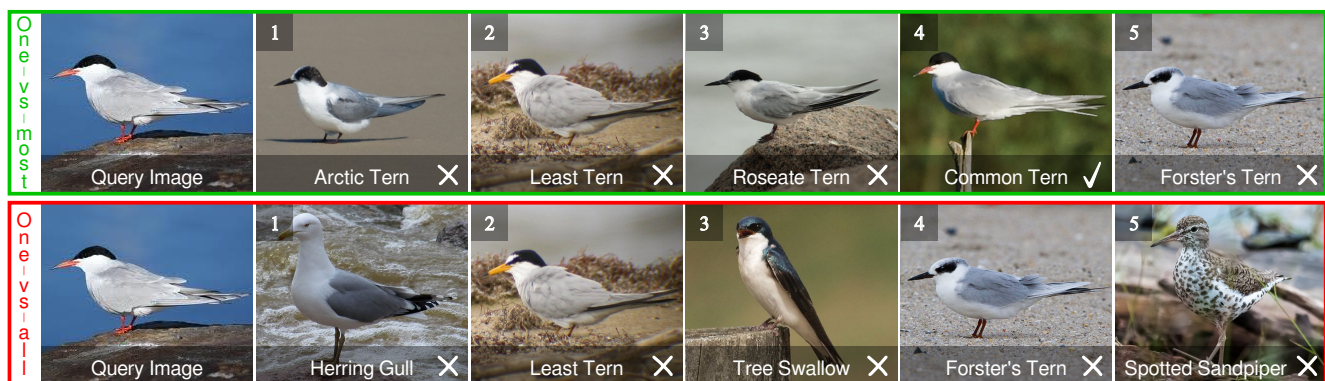


Figure 7. For this Common Tern query image, the one-vs-most classifiers return only terns in the top five, while the one-vs-all classifiers include a swallow and a sandpiper. The sandpiper is especially unlike a tern.

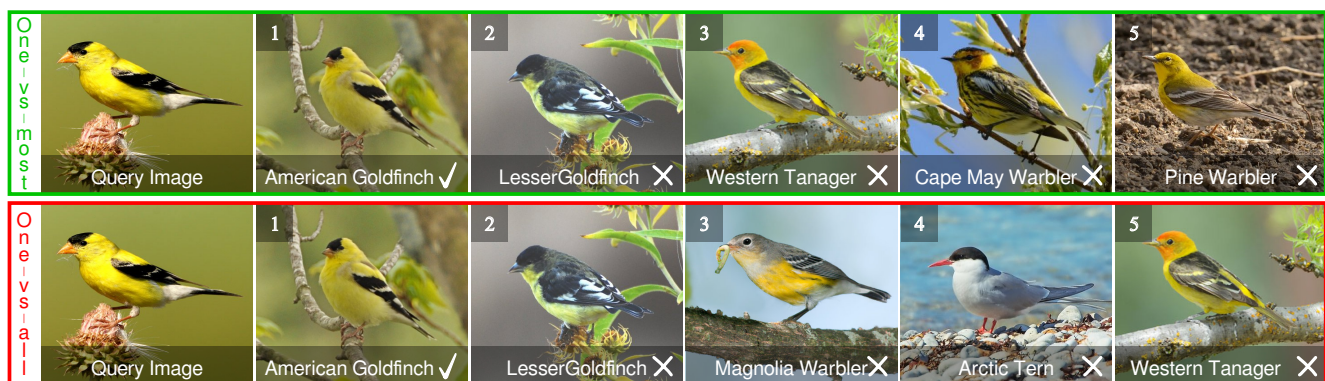


Figure 8. For this American Goldfinch query image, both sets of classifiers are correct at rank 1, but the one-vs-most classifiers return only yellow songbirds in the top five, while the one-vs-all classifiers include a tern.

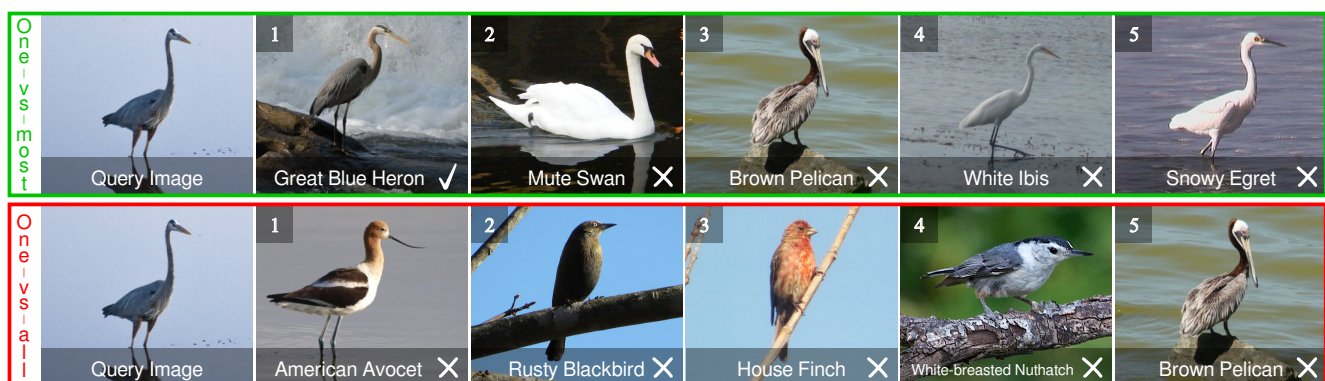


Figure 9. For this Great Blue Heron query image, the one-vs-most classifiers are correct at rank one, while the one-vs-all classifiers do not return the correct species in the top five. The one-vs-most classifiers also return only long-necked water birds, while the one-vs-all classifiers include three perching birds.



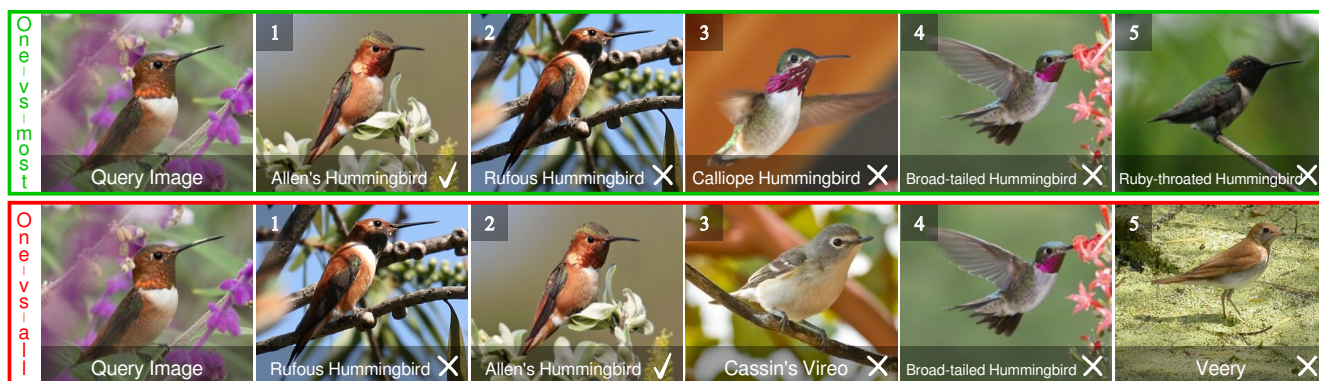


Figure 10. For this Allen's Hummingbird query image, the one-vs-most classifiers are correct at rank one and return only hummingbirds in the top five. The one-vs-all classifiers get the correct species at rank two, and include two non-hummingbirds in the top five.

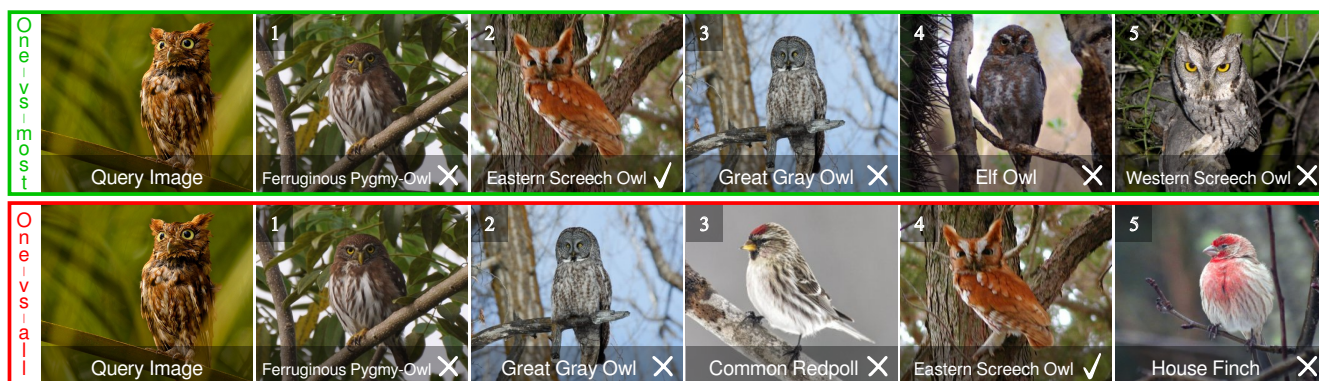


Figure 11. For this Eastern Screech-Owl query image, the one-vs-most classifiers return the correct species at higher rank than the one-vs-all classifiers, and return only owls in the top five. The one-vs-all classifiers include two perching birds in the top five.

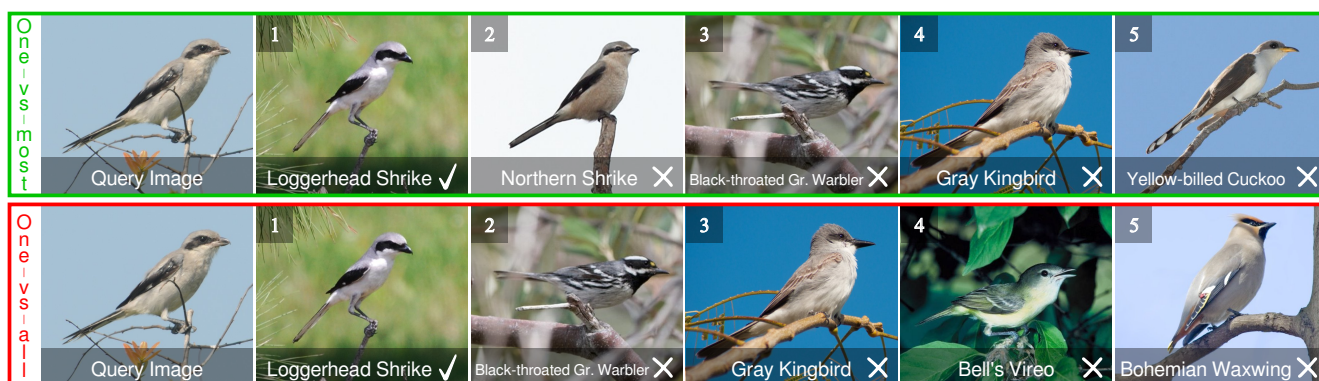


Figure 12. For this Loggerhead Shrike query image, both sets of classifiers are correct at rank 1, and return white-bellied, gray-backed birds in the top five. But only the one-vs-most classifiers return the Northern Shrike (the only other shrike in the dataset), and only the one-vs-all classifiers return the distinctively different Bohemian Waxwing.