



Wing Damage Estimation

using SliceLearn, a deep learnt shape model



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Wing Damage Estimation with SliceLearn

Learning a shape model for reconstructing damaged
bumblebee wings

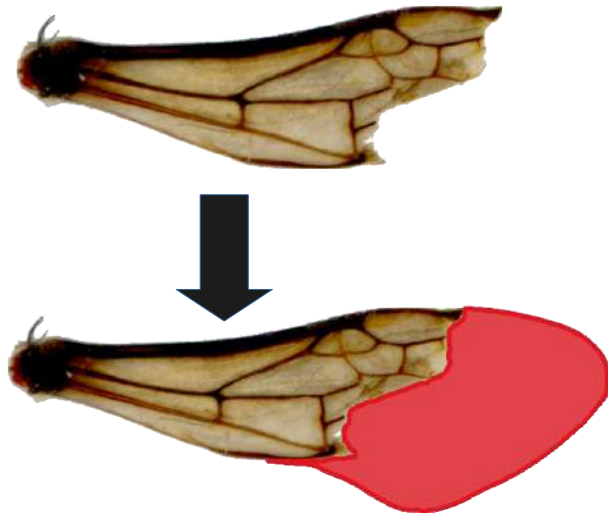
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The problem: learning shape variations to infer what is missing

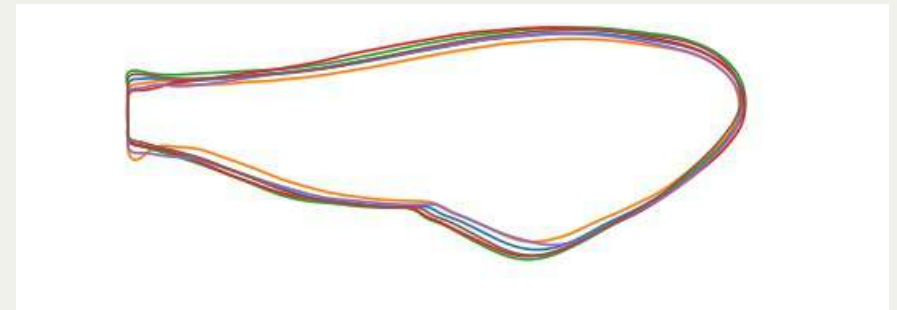
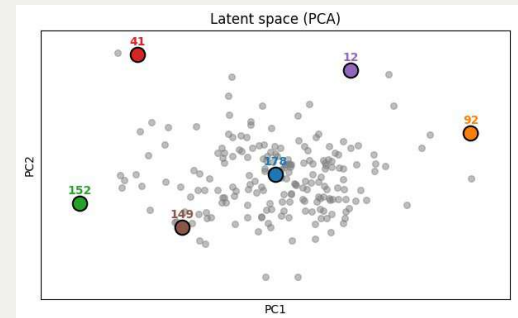
The biological perspective

Wing damage is associated with a variety of ecological indicators, ie age, but **estimating damage** is difficult due to the shape variation



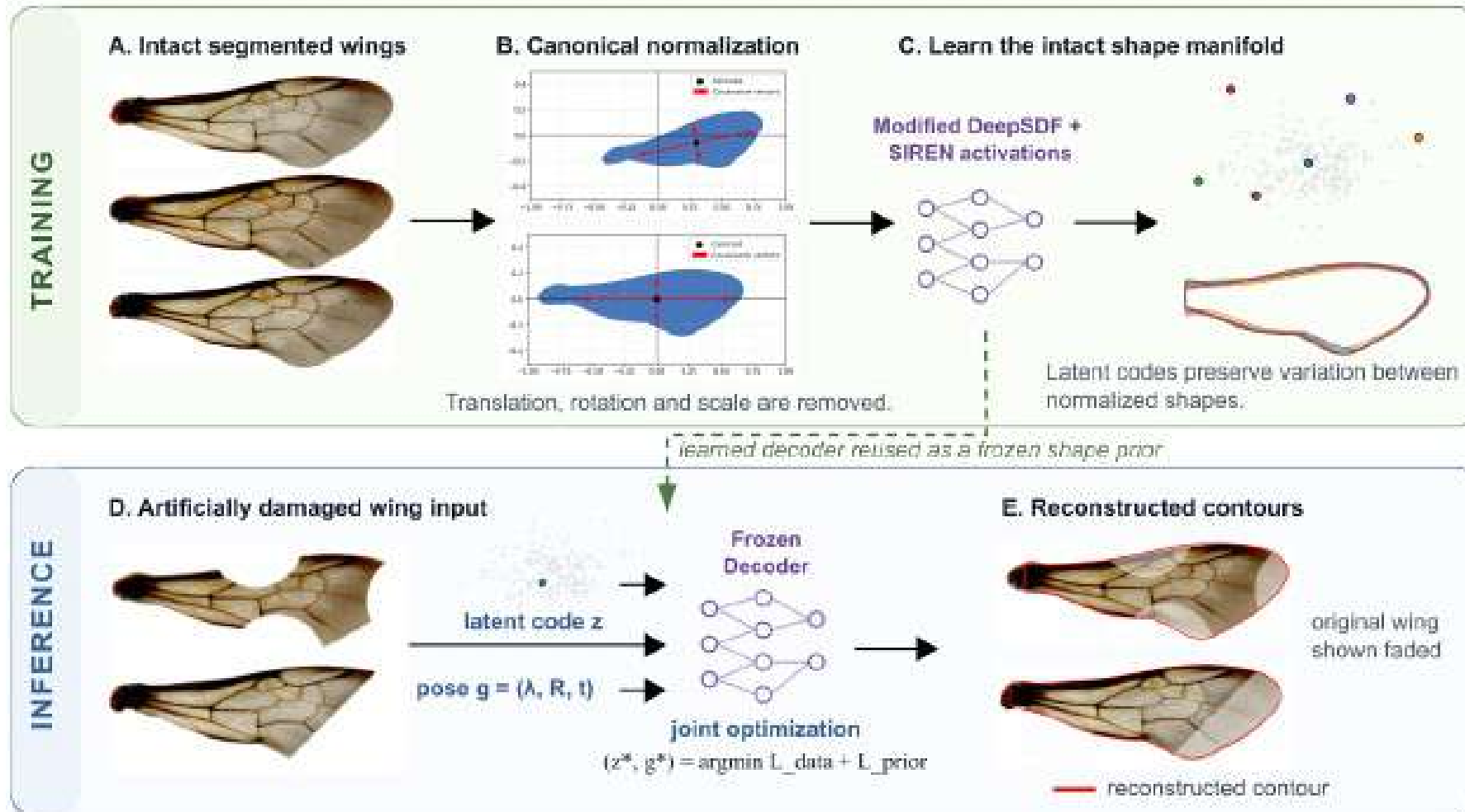
The mathematical perspective

Given a series of shapes with some non-linear association, can we **learn a model of the shape variation**



SliceLearn: learn the intact shape manifold

Train on normalized intact wings; at inference, jointly fit a plausible shape and its pose to the damaged observation.



The biological goal – inferring damaged on the live bee dataset

2 Datasets

Slides



- Standard POV
- Standard Lighting
- Full Wing Visible
- Used as training

Live Bee



- Variable POV
- Variable Lighting
- Wing partially obscured
- Object of interest

In order to test the theory of age vs damage

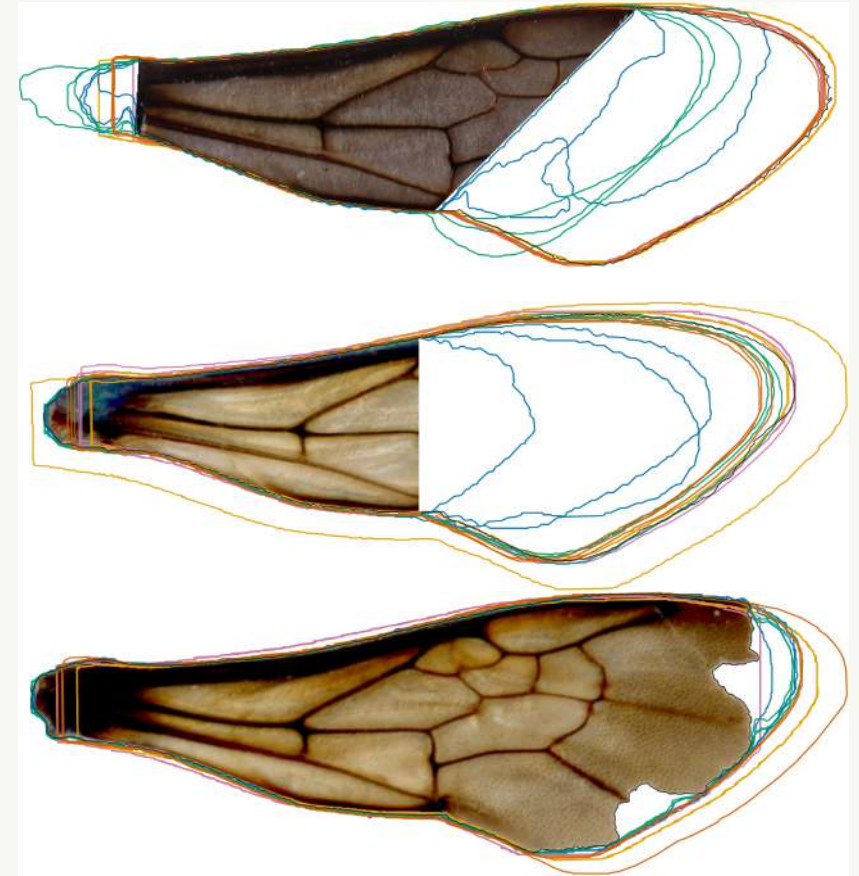
SliceLearn outperforms for new datasets, underperforms for in-distribution data

4 Results

- Slicelearn worse in-distribution estimation, but
- exhibits better generalization to new datasets
 - 44X fewer parameters than TransCNN-HAE

Mean Absolute Error

Model	Slides	Live Bees
TransCNN-HAE	2.30 ± 0.15	11.29 ± 6.56
Registration	3.79 ± 0.44	4.92 ± 2.37
SliceLearn	4.26 ± 1.90	2.69 ± 0.97



Registration (mask) TransCNN-HAE (mask) SliceLearn
Registration (segmentation) TransCNN-HAE (segmentation) Ground truth / observed damaged wing

Acknowledgments

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