

# Fine-Grained Visual Classification of Aircraft

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## Overview

<http://goo.gl/0NGIs>

<http://www.robots.ox.ac.uk/~vgg/data/fgvc-aircraft/>

## FGVC-Aircraft

A new dataset for fine-grained visual classification of airplane models. It contains:

- 10,000 images with hierarchical model annotations
- Tasks, evaluation protocols, baselines

## ImageNet challenge

Part of the ImageNet 2013 FGVC challenge.

## Dataset construction ideas

- Data sourced from expert hobbyists (*spotters*).

## Content

## Aircraft images

10,000 aircraft images spanning 100 aircraft model variants.

Each aircraft is annotated with:

- A hierarchical model label: variant, family, manufacturer
- Bounding box

## Tasks and evaluation

- Three tasks: recognise an aircraft variant, family and manufacturer.
- Design on **trainval**, evaluate once on **test**
- Report class-normalised average classification accuracy on test set .

## Remarks

- *Remove embedded copyright notice before running your classifiers!*
- Test annotations will be released after the FGVC ImageNet challenge.

## About Aircraft

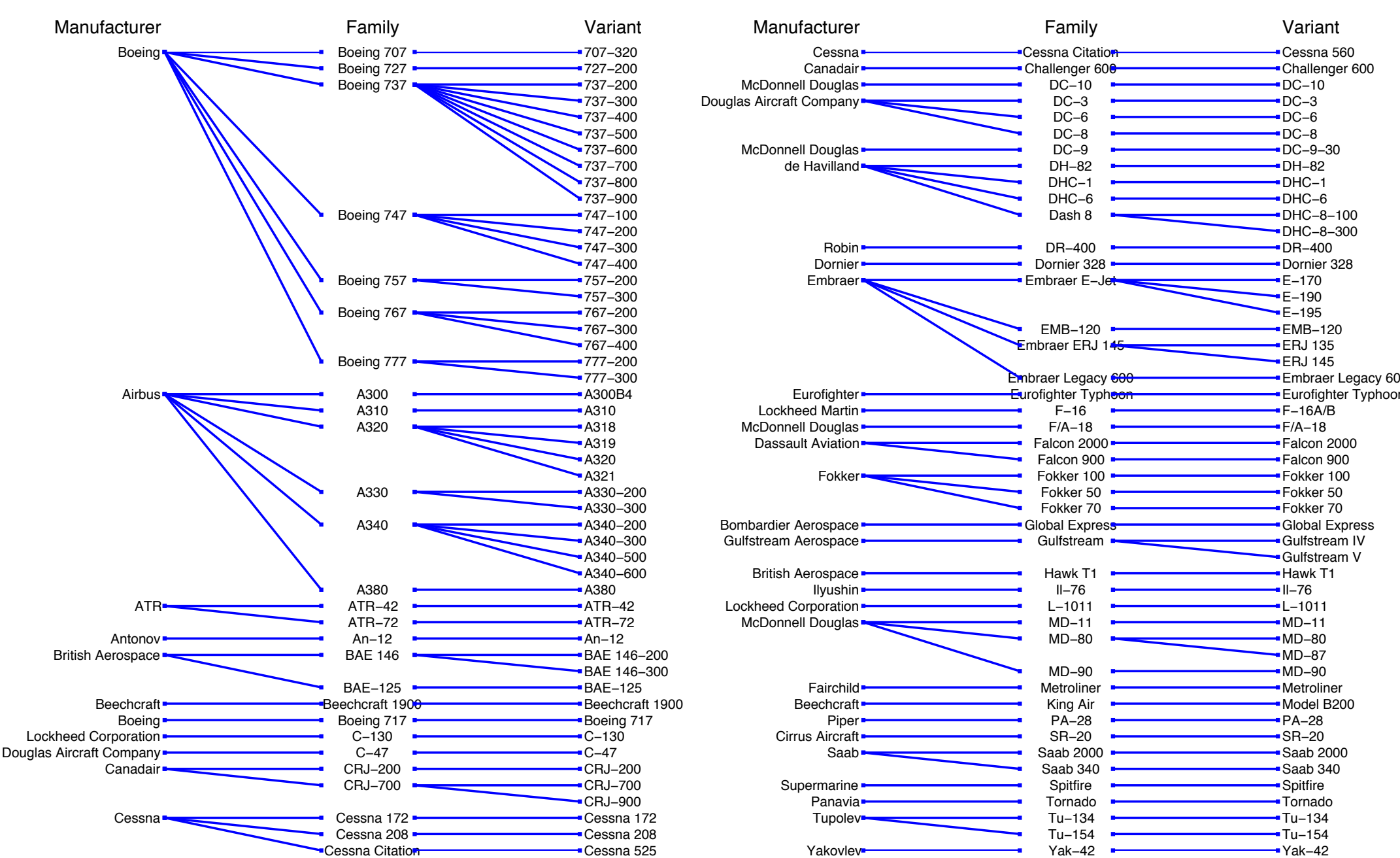
Aircraft have several interesting properties:

- Not as deformable as the animals often used in FGVC
- **Design variations.** Thousands of different models:
  - ▶ technology (jet, glider, propellor, ...)
  - ▶ size (from hand-made to cargo)
  - ▶ purpose (passenger, cargo, training, fighter, ...)
- **Structural variations.** Variable number and topology of wings, wheels, engines, etc.
- **Historical style variations.** From biplanes to jets.
- **Liveries.** Livery reflects airliner.

## Hierarchical Aircraft Models

Aircraft models are often indistinguishable from exterior view of the vehicle. Thus a four-level hierarchy was built, comprising:

1. **Model.** May not be visually distinguishable and is not used in the dataset.
2. **Variant.** A grouping of models that are *guaranteed to be visually distinguishable* (although it may be challenging!).
3. **Family.** A grouping of variants with clear differences.
4. **Manufacturer.** A grouping of families based on their manufacturer.

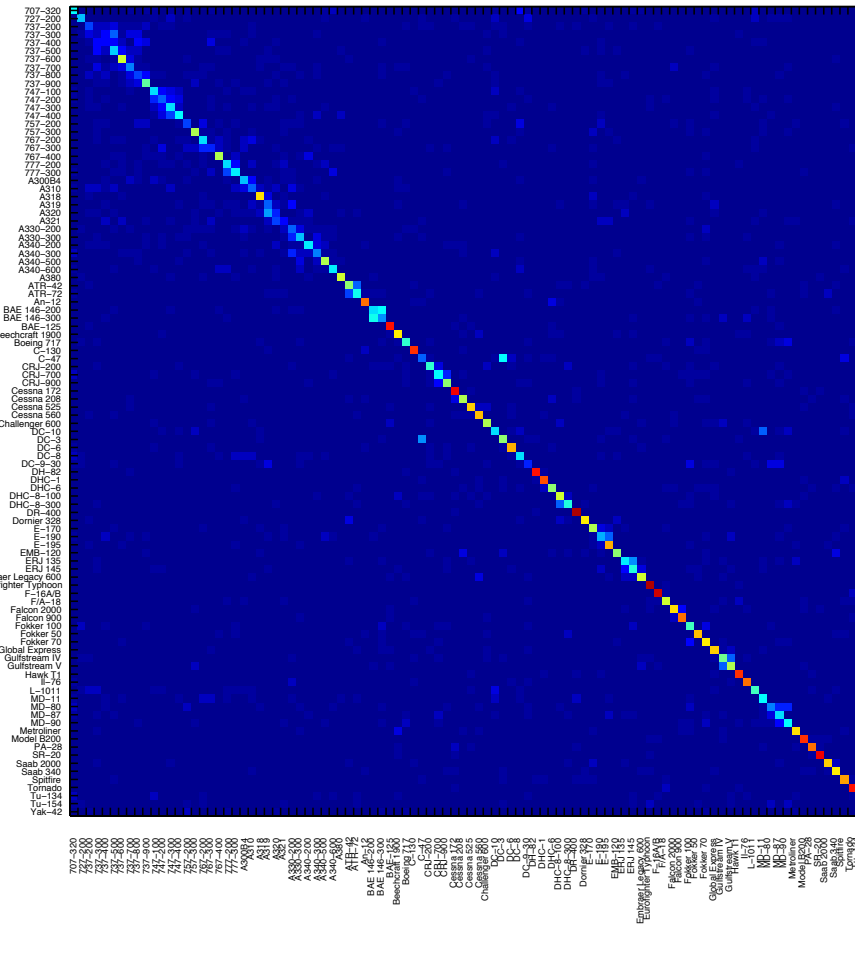


## Baselines

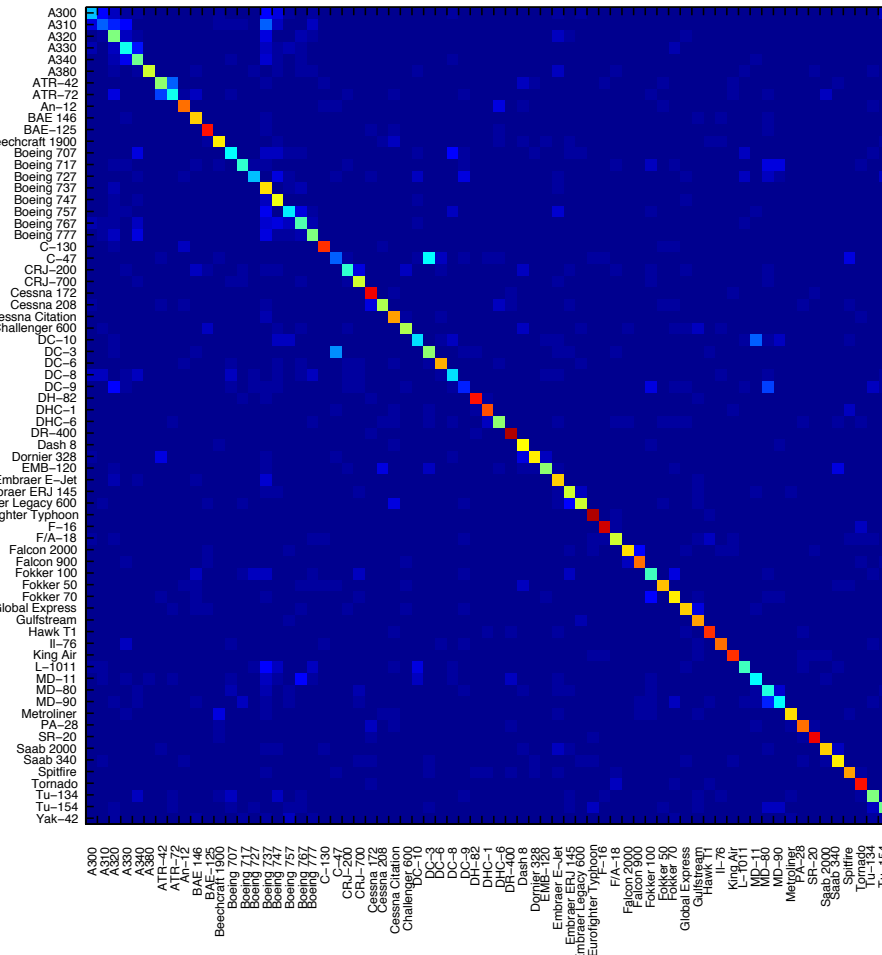
Baseline classification results with state-of-the-art BoVW implementation (VLFeat.org):

Model	Acc	Model	Acc	Model	Acc
DR-400	94.1	DHC-8-100	57.6	ERJ 135	35.3
Eurofighter Typhoon	94.1	Embraer Legacy 600	57.6	747-100	33.3
F-16A/B	90.9	F/A-18	57.6	747-300	33.3
Cessna 172	88.2	757-300	54.5	767-200	33.3
SR-20	88.2	767-400	54.5	777-200	33.3
BAE-125	84.8	A340-500	54.5	BAE 146-200	33.3
DH-82	84.8	Cessna 208	54.5	DC-10	33.3
Tornado	84.8	Challenger 600	54.5	DC-8	33.3
C-130	81.8	E-170	54.5	MD-87	33.3
Hawk T1	81.8	Gulfstream V	54.5	737-500	32.4
Model B200	81.8	ATR-42	51.5	727-200	30.3
DHC-1	78.8	CRJ-900	51.5	A300B4	30.3
Il-76	76.5	EMB-120	51.5	A330-300	30.3
An-12	75.8	DC-3	50.0	E-190	29.4
Falcon 900	75.8	DHC-6	50.0	BAE 146-300	26.5
PA-28	75.8	Tu-134	48.5	737-700	24.2
Spitfire	70.6	Gulfstream IV	47.1	A340-300	24.2
DC-6	69.7	Tu-154	47.1	MD-80	23.5
E-195	69.7	737-900	45.5	A310	21.2
Cessna 560	67.6	Fokker 100	42.4	A319	21.2
Fokker 50	67.6	L-1011	42.4	A330-200	21.2
Cessna 525	66.7	Boeing 717	41.2	C-47	21.2
Global Express	66.7	CRJ-200	41.2	747-200	20.6
Saab 2000	66.7	DHC-8-300	39.4	737-200	17.6
Yak-42	66.7	ERJ 145	39.4	737-800	17.6
A318	64.7	ATR-72	38.2	757-200	17.6
Falcon 2000	64.7	707-320	36.4	A320	15.2
Metroliner	64.7	747-400	36.4	767-300	14.7
Beechcraft 1900	63.6	CRJ-700	36.4	DC-9-30	14.7
Dornier 328	63.6	MD-11	36.4	737-400	12.1
Fokker 70	63.6	MD-90	36.4	A321	11.8
Saab 340	63.6	777-300	35.3	737-300	6.1
737-600	57.6	A340-200	35.3		
A380	57.6	A340-600	35.3	<b>Average</b>	48.69

Confusion matrix: Variant classification (48.69 % accuracy)



Confusion matrix: Family classification (58.48 % accuracy)



## Dataset construction

### Data collection

Images were obtained from aircraft spotter data available at [airliners.net](http://airliners.net), a very large, well curated repository.

We obtained permissions from 10 photographers to use their images (for *research purposes only!*).

### Data selection

- After downloading 70,000 images, the top 100 most common model variants were identified.
- For each variant, 100 images were selected by **maximizing diversity**. This was aimed at reducing sources of undesirable correlation, including similar photographer, time, airport, and airliner.
- Train, val, and test splits were then randomly sampled.

### Bounding box annotations and refinements

- Three bounding box annotations were collected for each image on Amazon Mechanical Turk.
- Intra-annotator consistency checks were sufficient to get clean bounding boxes and discard "bad" images (e.g. images of airplane interiors).

## Acknowledgments

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