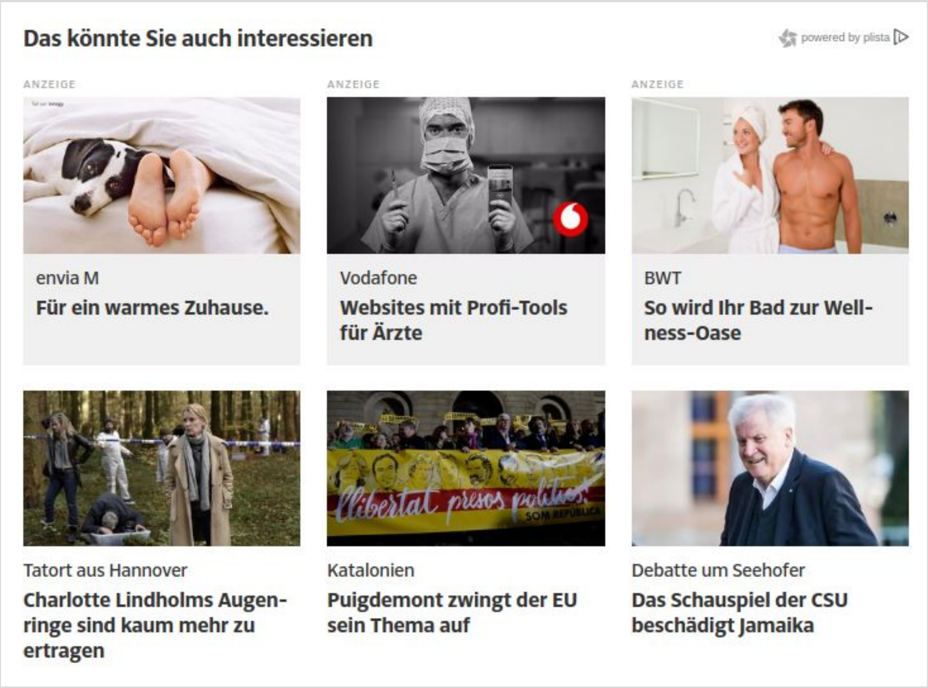
# ML meets Ad Creation –

## NLP und Bilderkennung für native Ads

**Malte Pietsch – PAW '17**

- Problem
- Solution
- Learnings

# Problem domain: Native ads on news sites




## Key facts

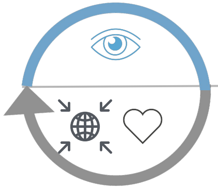
- Widget below or beside article
- Recommendations for articles & ads
- > 3000 Publishers, worldwide
- Click-through-rate (CTR) = Clicks / Impressions

# How to improve ad performance?


## What drives a click?

- User's context
- Personal interests
- Appealing text & image

## Focus of this talk



**Optimized Ads: Smart AdCreator**

Optimized Delivery: Recommender System


CLICK OR NO CLICK
powered by plista

CLICK OR NO CLICK

plista

# Round 1

CTR

NO CLICK

**Treppenlifte 2015 - Preise und Kaufberatung**
Treppenlifte aller Hersteller finden und vergleichen! ✔neu ✔gebraucht ✔ leasen ✔ mieten

0.02 %

CLICK

**Länger Zuhause wohnen bleiben?**
Treppenliftlösung für nahezu jede Treppe finden. Jetzt kostenlos informieren!

0.06 %

CLICK OR NO CLICK

plista

# Round 2

**CTR**

**Hamburg zeigt wie´s geht:Arztpraxen werden digital**
Weniger Papierkram. Mehr Zeit. 75% weniger Befundanfragen von Kollegen. Dokumente
Patienten-Smartphones übergeben - einfach mit LifeTime.

CLICK

0.20 %

**Hamburg zeigt wie´s geht:Arztpraxen werden digital**
Weniger Papierkram. Mehr Zeit. 75% weniger Befundanfragen von Kollegen.
Patienten-Smartphones übergeben - einfach mit LifeTime.

NO CLICK

0.11 %

Problem

Solution

- Approach
- Model Selection
- Feature Engineering
- Deep dive: Image recognition
- Product: Smart AdCreator prototype

Learnings

# Approach: Predict ΔCTR and provide actionable insights

- Historic data from 2014-2017 (~150k german ads)
- Train a model that ...
  - **predicts** the difference in CTR of similar ads
  - **explains** the prediction w.r.t features
  - **recommends** how to improve the ad

$$\frac{CTR_{ad} - \mu(CTR_{ad})}{\sigma(CTR_{allAds})}$$

**Actionable insights**

Predictive performance

# Model selection: It’s a trade-off

| White Box | Black box |
|---|---|
| **Models:** Variations of lin. regression | **Models:** XGBoost, DNNs … |
| ⊖ Predict | ⊕ Predict |
| ⊕ Explain | ✗ Explain |
| ⊕ Recommend | ✗ Recommend |

# Model selection: It's a trade-off

| White Box | Black box (+heuristic) |
|---|---|
| **Models:** Variations of lin. regression | **Models:** XGBoost, DNNs … |
| | **Heuristics:** LIME, eli5 ... |
| ⊖ Predict | ⊕ Predict |
| ⊕ Explain | ⊖ Explain |
| ⊕ Recommend | ⊖ Recommend |

- Elastic Net for MVP
- Now: switching to XGBoost + Eli 5

# Feature engineering: Text, image and structured data

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ABCDEFGHIJKLM
NOPQRSTUVWXYZ

Freeling
DBPedia Spotlight

Retrained Inception v3
Kairos

One-hot encoding

Lemmas
NER
POS

Objects
Age
Gender
Faces

IAB channel
Ad format

# Deep Dive: Customized multilabel image recognition

ABCDEFGHIJKLM
NOPQRSTUVWXYZ

Freeling

DBPedia Spotlight

Lemmas NER
POS

**Retrained Inception v3**

**Objects:**

- *P(bike) = 0.85*
- *P(sky) = 0.79*
- *P(rocks) = 0.4*
- ....

One-hot encoding

IAB channel

Ad format

# Deep Dive: Your choice

## Option A: Convolution Basics


## Option B: Inception module

# Deep Dive (A): Convolutional basics

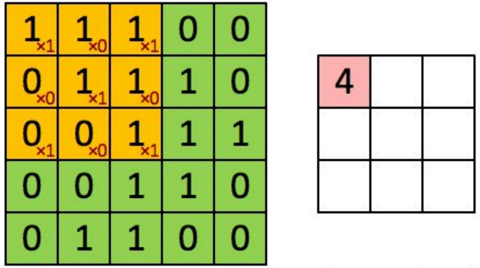
1. Transform image to matrix

| | | | | |
|---|---|---|---|---|
| 1 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 0 | 0 | 1 | 1 | 1 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 1 | 0 | 0 |

2. Define a filter (= feature detector)

| | | |
|---|---|---|
| 1 | 0 | 1 |
| 0 | 1 | 0 |
| 1 | 0 | 1 |

3. Move filter over matrix and calculate dot product to get a feature map



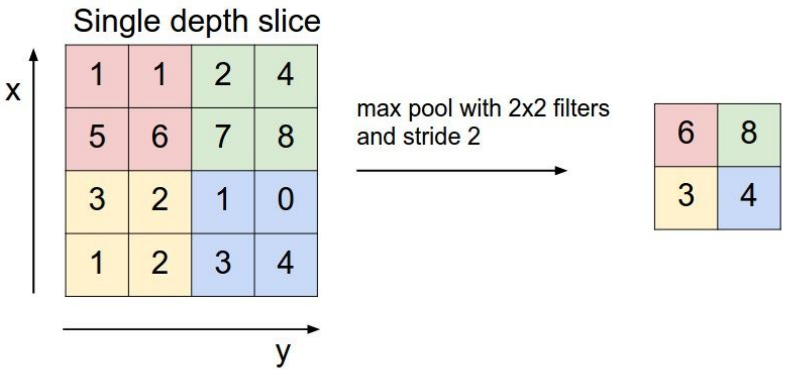

Image

Convolved Feature

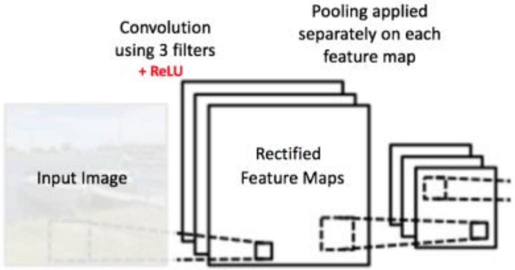

Sources:
http://deeplearning.stanford.edu/wiki/index.php/Feature_extraction_using_convolution
http://cs.nyu.edu/~fergus/tutorials/deep_learning_cvpr12/

# Deep Dive (A): Convolutional basics

5. Apply Max Pooling to reduce dimensionality of feature map




6. Add multiple filters and train the weights

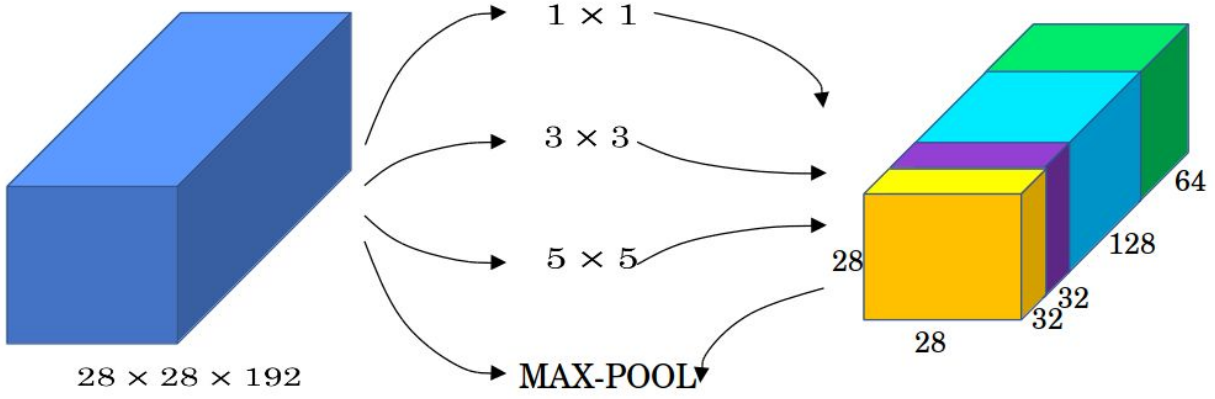



Sources:
http://cs231n.github.io/convolutional-networks/
https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/

# Deep Dive (B): Inception Block

**Problem** Which filter size shall we use in the CNN layers?

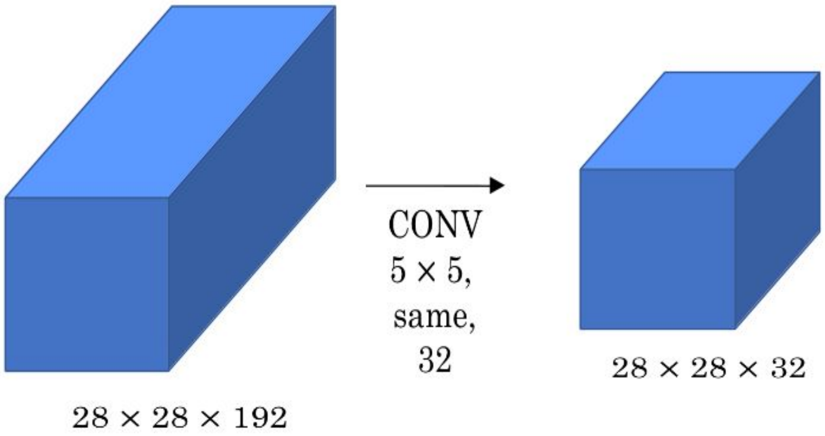
**Idea** Apply different ones, concatenate results and let the model decide




Source: Szegedy et al., 2015: "Going deeper with convolutions"
Figure from Coursera course "Convolutional Neural Networks" by Andrew Ng

# Deep Dive (B): Inception Block

**Problem** Computational costs are exploding ⟶ 120 Mio. Multiplications

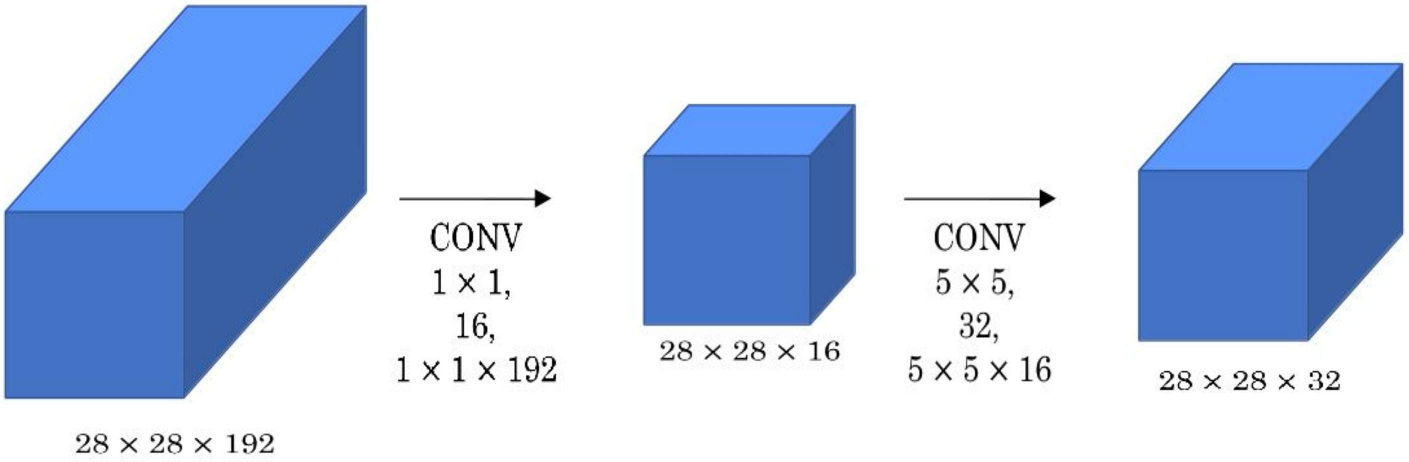



Source: Szegedy et al., 2015: "Going deeper with convolutions"
Figure from Coursera course "Convolutional Neural Networks" by Andrew Ng

# Deep Dive (B): Inception Block

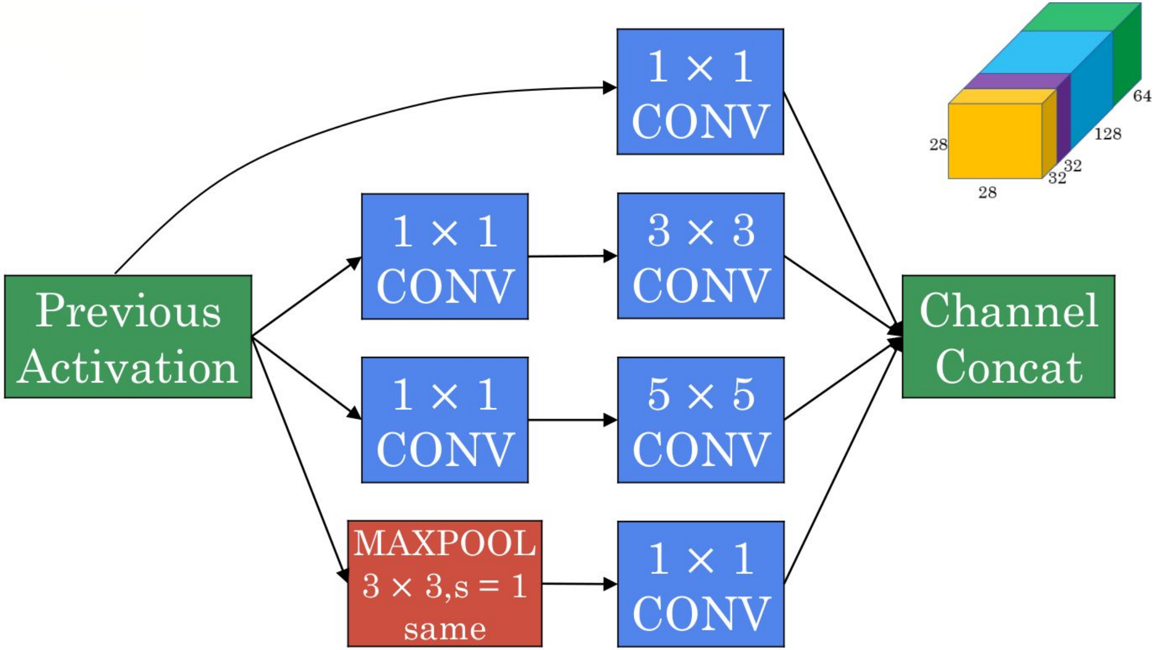
**Problem** Computational costs are exploding → 120 Mio. Multiplications

**Idea** Reduce dimensionality via clever factorization of convolutions → 12.4 Mio. Multiplications




Source: Szegedy et al., 2015: "Going deeper with convolutions”
Figure from Coursera course “Convolutional Neural Networks” by Andrew Ng

# Deep Dive (B): Inception Block




Source: Szegedy et al., 2015: "Going deeper with convolutions”
Figure from Coursera course “Convolutional Neural Networks” by Andrew Ng

# Deep dive: Transfer learning on Inception v3 Architecture

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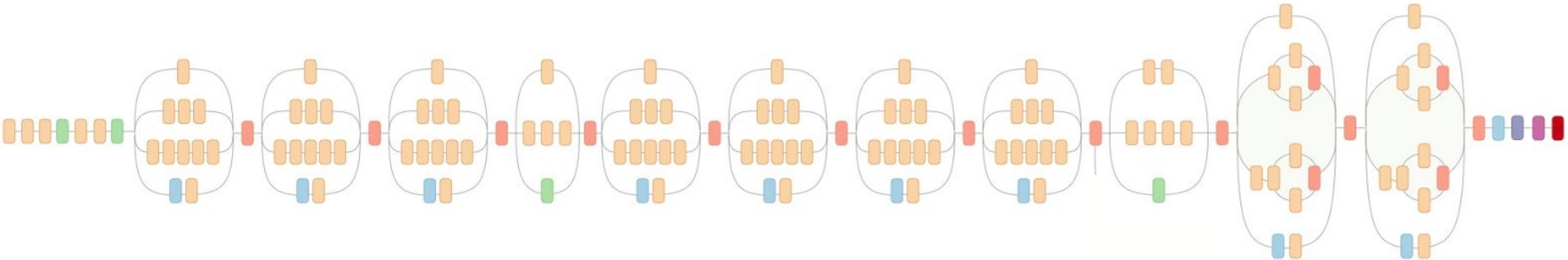
Source: http://knowyourmeme.com/memes/we-need-to-go-deeper

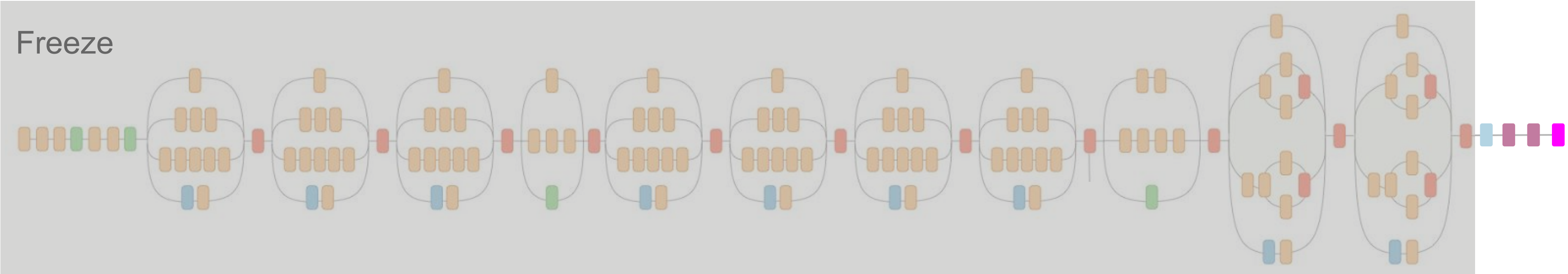
# Deep dive: Transfer learning on Inception v3 Architecture



- Convolution
- AvgPool
- MaxPool
- Concat
- Dropout
- Fully connected
- Softmax
- Sigmoid

Source: https://research.googleblog.com/2016/03/train-your-own-image-classifier-with.html

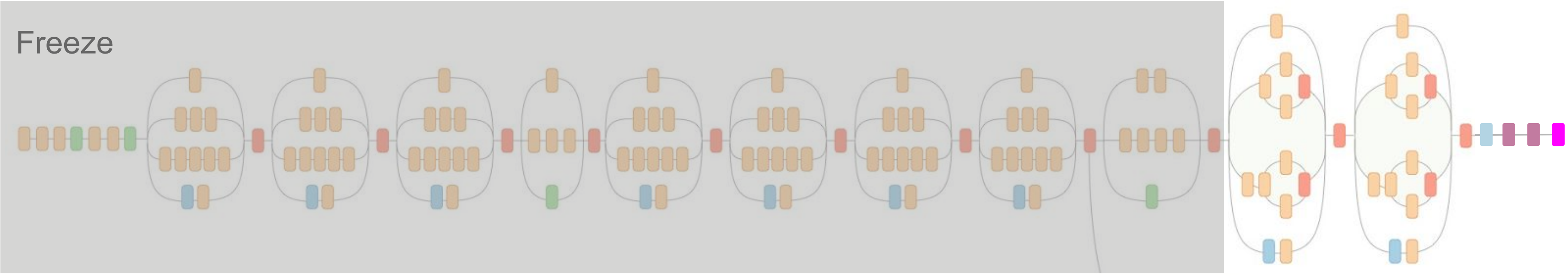
# Deep dive: Transfer learning on Inception v3 Architecture





Source: https://research.googleblog.com/2016/03/train-your-own-image-classifier-with.html

# Deep dive: Transfer learning on Inception v3 Architecture

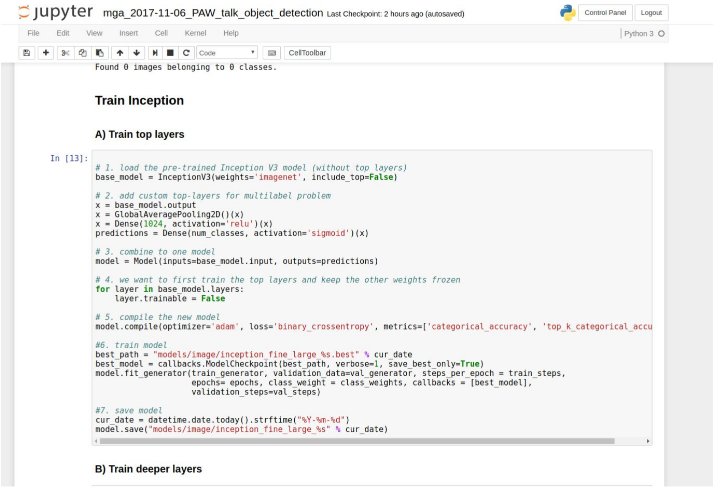




Source: https://research.googleblog.com/2016/03/train-your-own-image-classifier-with.html

# Deep dive: Transfer learning on Inception v3 Architecture

## Code Demo




https://github.com/tholor/paw_image_classification

# Smart AdCreator

Total Score:

Title:

6 Top Rotweine nur 39,90 €

Text:

Gratis Versand für Rotwein-Freunde - Genießen Sie 6 exklusive Weine aus ganz Europa . Jetzt bestellen .

Entities:

Europa

Title & Text Score:

Grammatical Score:

# Smart AdCreator

plista

Total Score:

Title:

6 | Top | Rotweine | nur | 39,90 | €

Top: 2.46
unglaublich: 2.6
einzigartig: 2.56
traumhaft: 2.53
erstklassig: 2.53
traum: 2.5
super: 2.5
himmlisch: 2.5
genial: 2.5
toll: 2.48

Text:

Grat | twein-Freunde | - | Genießen | Sie | 6 | exklusive | Weine | aus | ganz | Europa | . | Jetzt

best

Entiti

Eur

Title & Text Score:

Grammatical Score:

# Smart AdCreator

Total Score:

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6 Top Rotweine nur 39,90 €

Text:

Gratis Versand für Rotwein-Freunde - Genießen Sie 6 exklusive Weine aus ganz Europa . Jetzt bestellen .

Entities:

Europa

Place: 2.49

Location: 2.49

Title & Text Score:

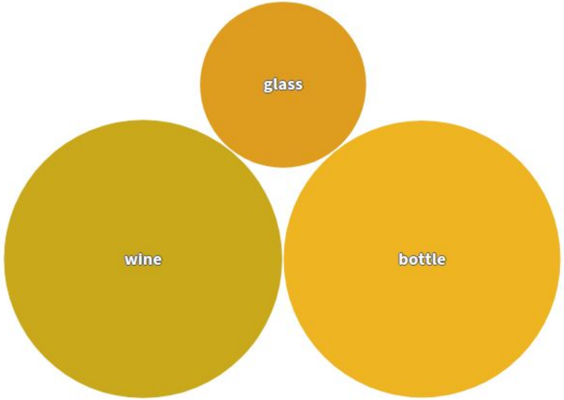
Grammatical Score:

# Smart AdCreator - MVP

**Images**

http://www.plista.com/global/img/pets/upload/6e14810f3accd57f48acd62e47cdeba8_500x500x0x0.jpg


Image Score:

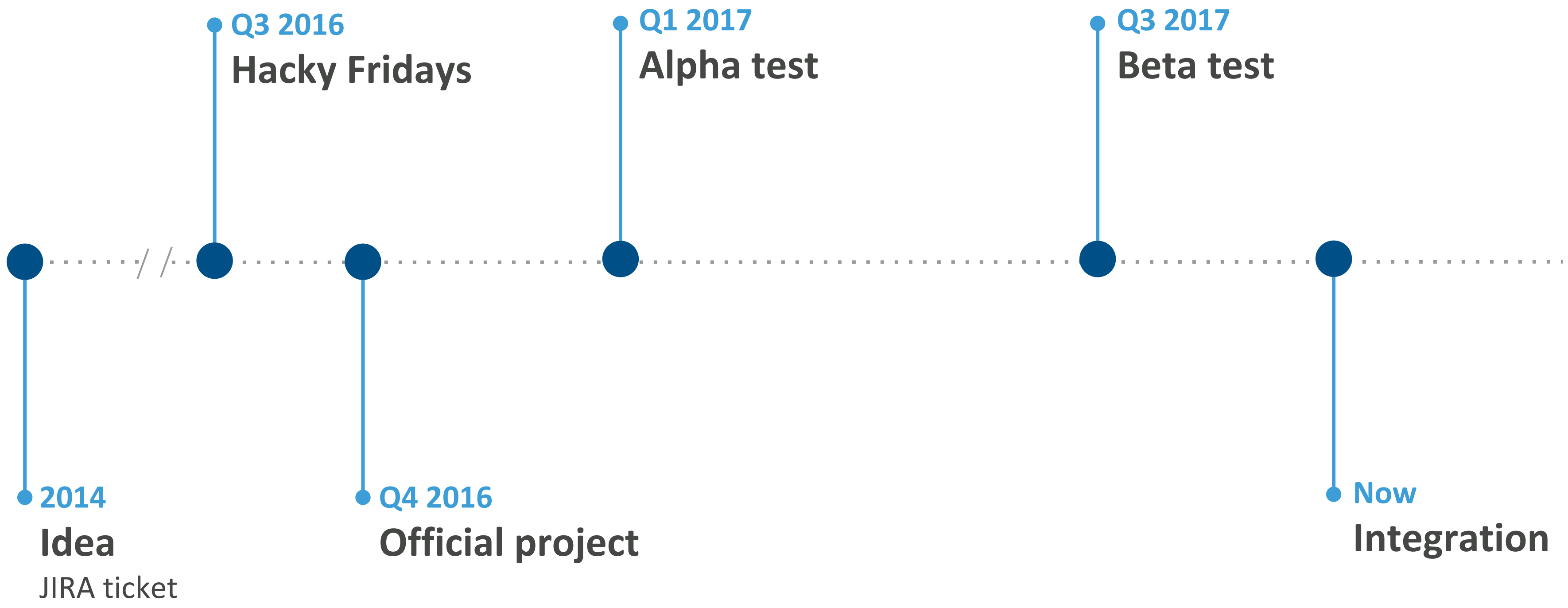


Problem

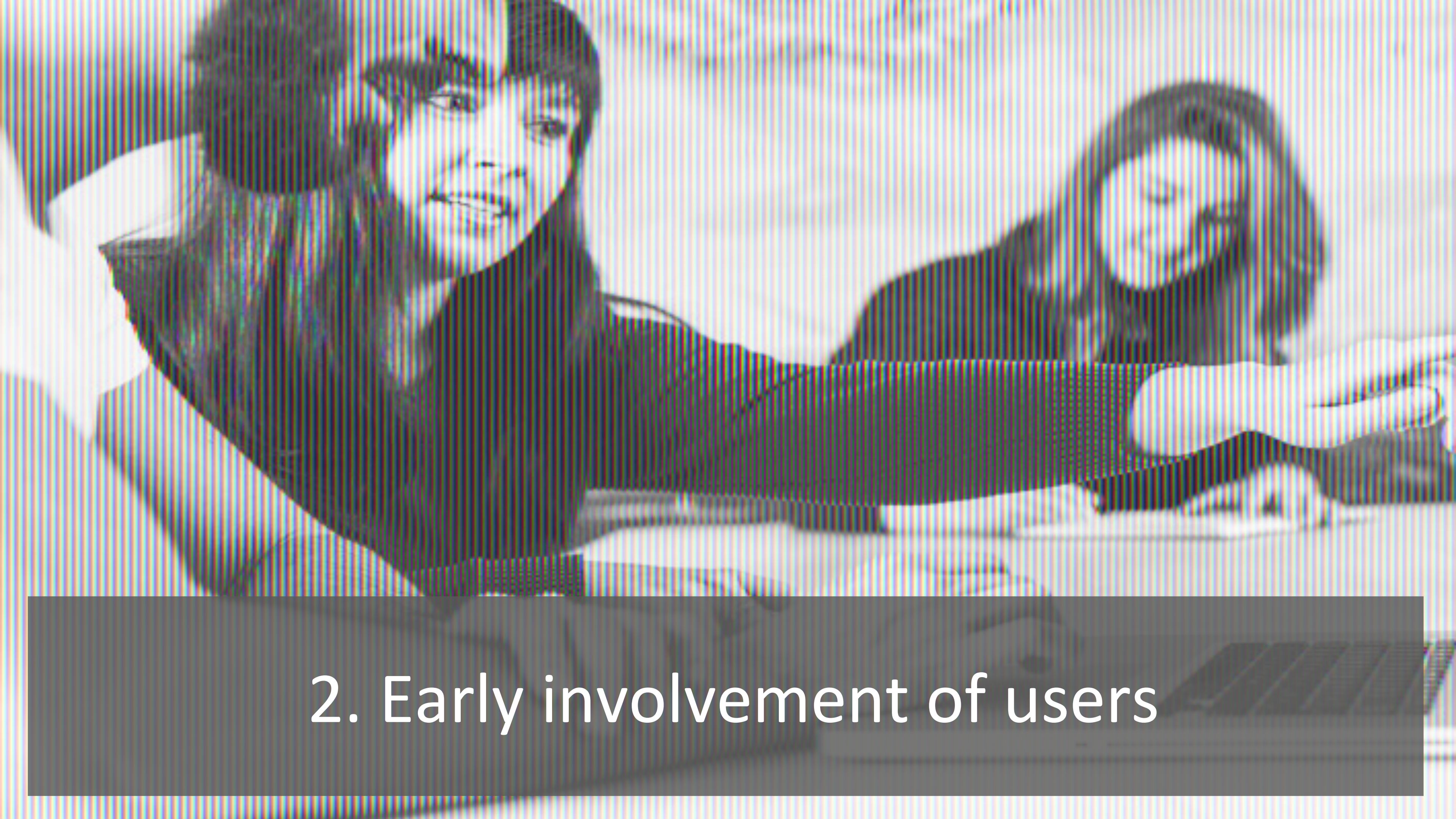
Solution

Learnings

# Timeline


2014
Idea
JIRA ticket
Q3 2016
Hacky Fridays
Q4 2016
Official project
Q1 2017
Alpha test
Q3 2017
Beta test
Now
Integration

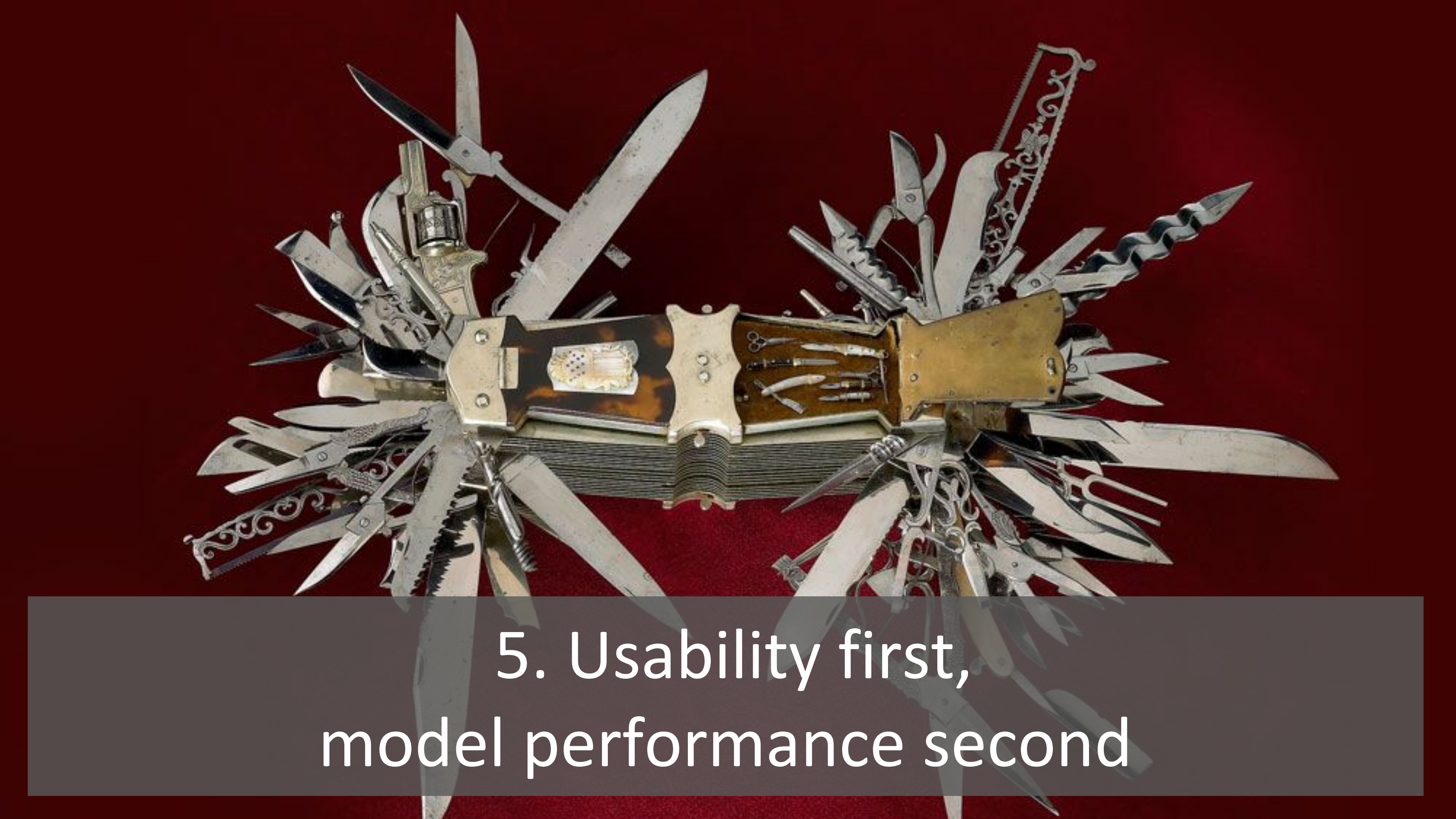

1. Dedicated time for experiments



# 2. Early involvement of users

# 3. Early commitment from management

# 4. Test & iterate fast, but don't compromise code quality



# 5. Usability first, model performance second

Thank you!
Questions?