Exploring temporal data analysis: Video-based classification of damaging behaviour in pigs using a combination of CNN and RNN

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Damaging behaviour-Tail biting

- Social abnormal behaviour in group of pigs
- Induces stress and pain
  - Reduced welfare of victim/ indicator of reduced welfare of performer
  - ➢ Affect on productivity
- Can result in infections and carcass loss
  - Requires treatment/ increased workload for farmer
  - ➢ Costly to pig industry

➢ Welfare and economic challenge

Tail-biting behaviour

- Only in domesticated pigs (Taylor et al., 2010)
  - Stressors common in production systems
- Multi-factorial origin
- Motivation
  - Impaired ability to satisfy basis behavioural needs (EFSA, 2007)
  - Situations connected to frustration, boredom or direct competition
  - ➢ Redirection of damaging behaviours towards pen-mates
- Sporadic
  - Only in some individuals, although raised in same environment

➢ Management challenge

Preventive measures

- Tail docking
  - Reduced attractiveness, harder to grab, increased sensitivity, and stronger pain reaction
  - Procedural and chronic pain and only symptomatic treatment
  - ➢ Routine tail docking prohibited by EU legislation

- Others
  - Enrichment
  - Removal of risk factors
  - ***Detection/ separation***

https://www.worldanimalprotection.org

https://easyfix.com/usa/environmental-enrichment-young-pigs/

Automated detection

Farm data
(productivity recordings, sensor, video,…)

Time/labour/cost intensive

Pictures © https://www.chicagotribune.com/, https://iconscout.com/

Project aim

- Monitoring and decision support system for farmer using deep learning
  - Using farms' own video surveillance
  - Estimate number of agonistic interactions within a pen
  - Notification to farmer

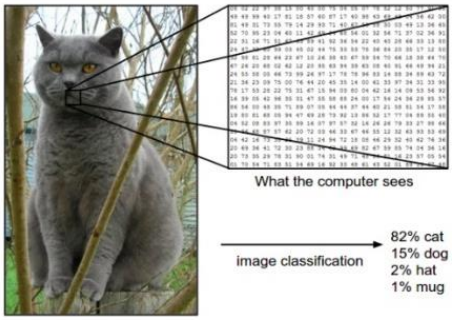
  - ➢ **Increase health, welfare, profitability**
  - ➢ **Reduce overall costs**

➢ Data assessment tool in research

  - ➢ Automated generation of primary data

Picture: https://www.feednavigator.com/Article/

Project set-up



- Deep learning approach

- Continuous behavioural data
  - Need to adjust for sequential data

2-step approach:

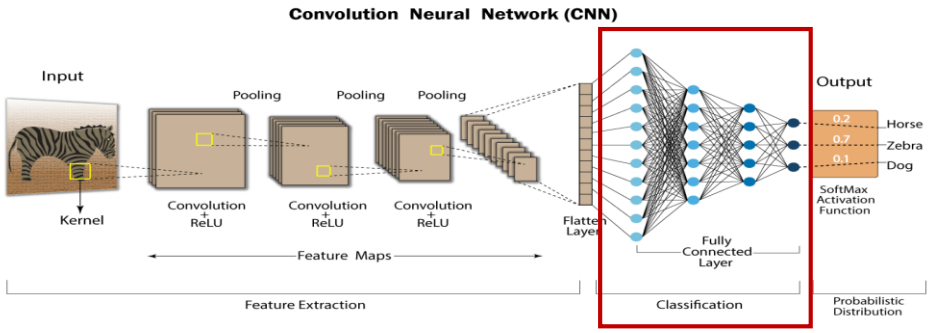
a) Image data input to a pre-trained convolutional neural network (CNN)
   a) Trained to extract relevant spatial features from data

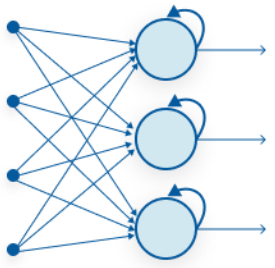
b) Features input to a recurrent neural network (RNN)
   a) Trained to take time series of extracted features as input and to provide a behaviour classification as output

CNN vs. RNN

- Image recognition (detection/classification)
- Processing pixel data
- Layered structure
  a) Feature extraction
  b) Classification (probabilistic distribution)
- Not for temporal information

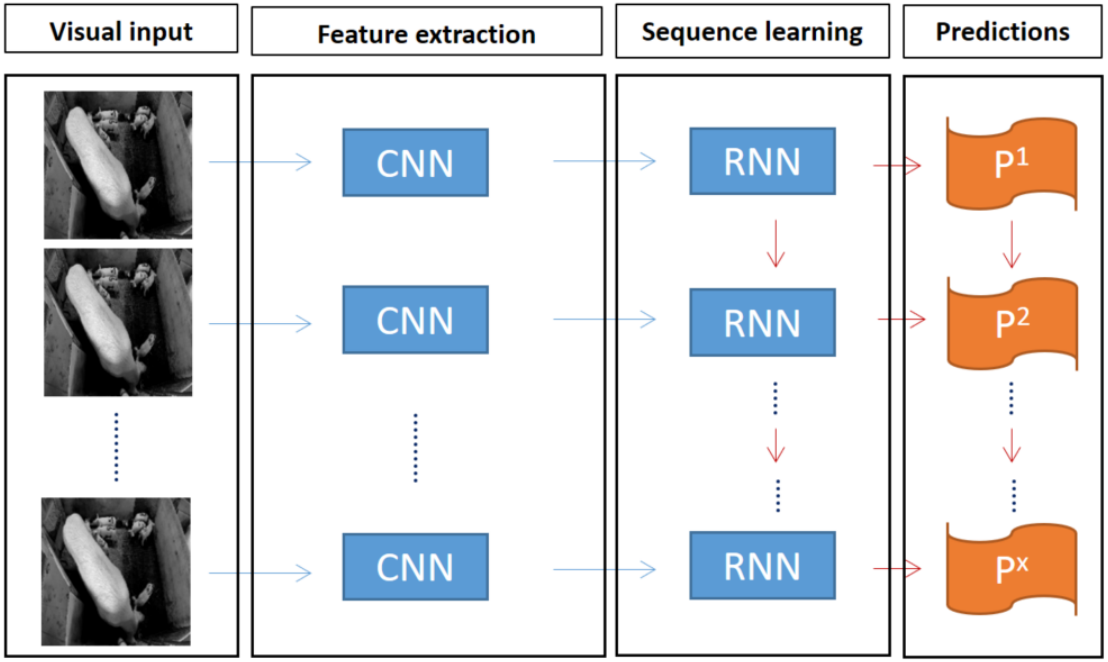
- Temporal/ sequential information
- Internal memory
  - Analyse data in the context of surrounding data points
  - Hidden layers and output dependent on previous states of the layers
- Video analysis





CNN-RNN

- Task: **identifying damaging behaviour from video**



Available data

Current data-set

- Pigs pre-weaning
- 25 pens
- ~1h labelled video / pen
- 60 frames/sec

➢ ~ 5 mil. frames

Done so far…

Data extraction/ editing

a) Sub-sample of images (N= 4029) extracted from video
   - Dimensions: 1920x1810, RGB

b) Labelled after occurrence of tail-biting (Y/N)

c) Augmented (flip-flop, N= 16116)

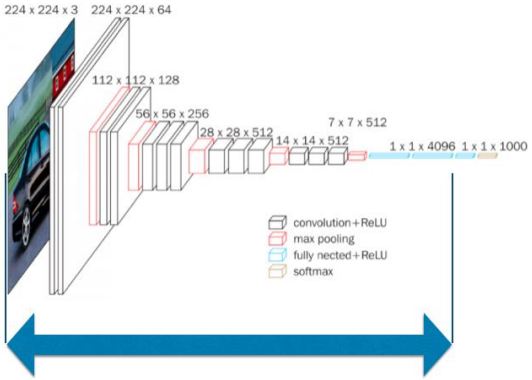
d) Resized to dim 224x224

Done so far…

Modelling building

a) Adapting pre-trained model (transfer learning)
   - Image features extracted using VGG-16 (Simonyan & Zisserman)
   - Classification
   - Input size: [*224, 224, 3]*
   - Model adapted: extracted at layer “Relu6”

https://medium.com/@salmariazi

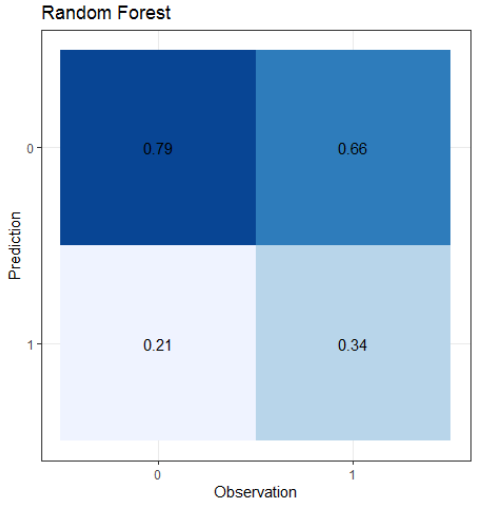


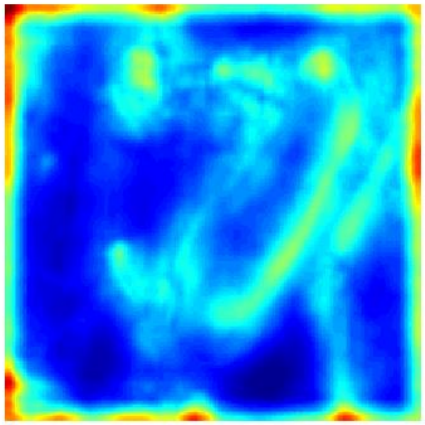
b) Image data input to pre-trained (adapted) Vgg16

c) Performance evaluation of (adapted) Vgg16
   - Feature output input into Random Forest
   - Train/test set

Results so far…

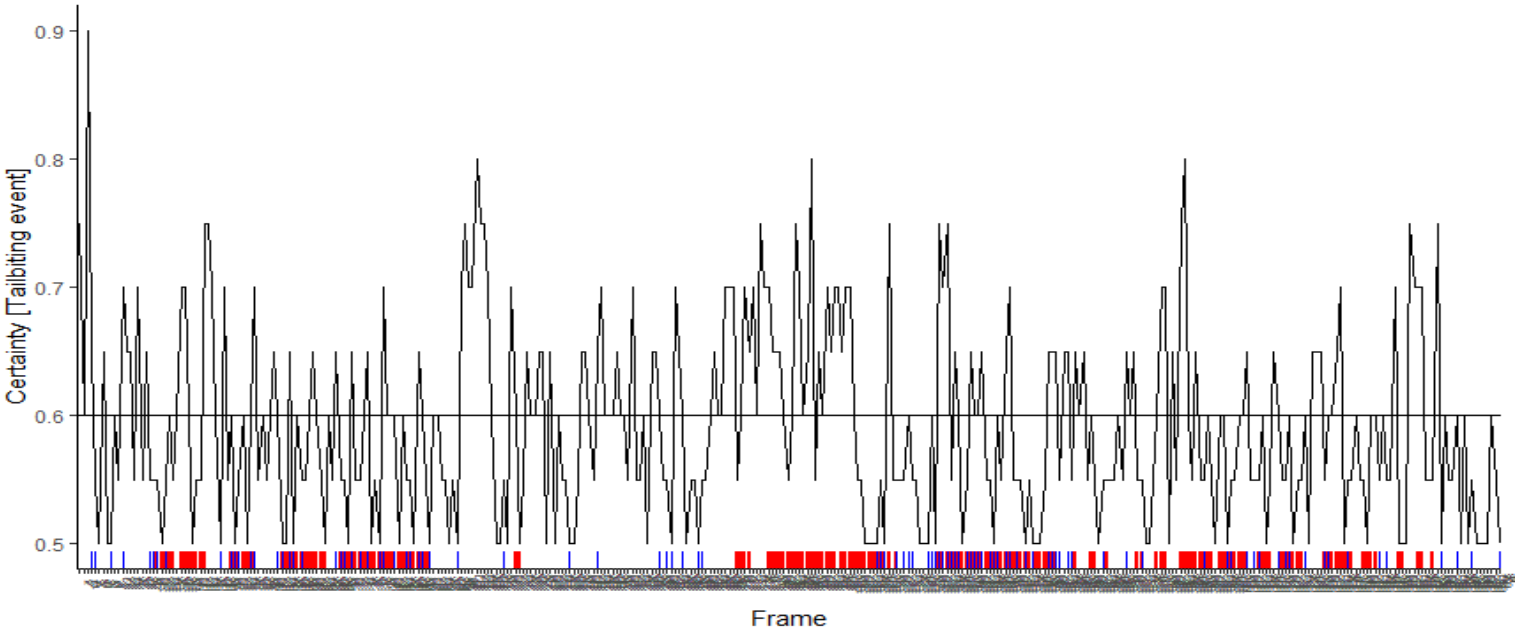
- Evaluating performance of CNN using test data and Random Forest
  - Low performance (mean accuracy: 0.57, 95% CI:0.53-0.61)





Results so far…

- Model certainty per frame plotted over time
  - Red: real tail-biting events
  - Blue: predicted tail-biting events



Challenges…for now

a) Hardware limitations
   - Low sample size
   - Slow model conversion, slow data extraction
   - ➢ Model converting but with low accuracy
   - ➢ Model crashing

b) Behaviour labelling
   - Occurrence of tail biting as binary variable
   - ➢ Pre-stages to one behaviour? (approach, interest,..)
   - ➢ Other behaviours

Thank you for listening!

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