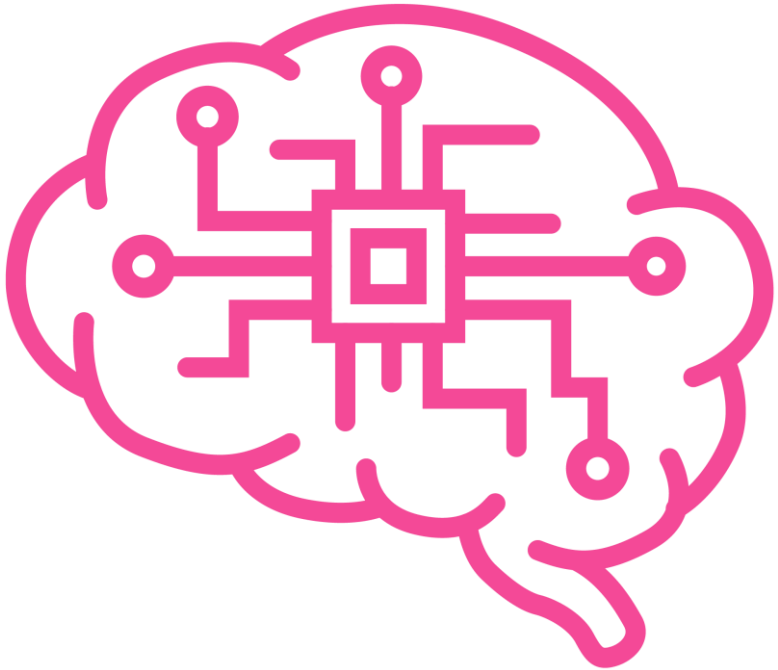


AI Gets Creative

Marta Mrak, Lead Engineer, BBC R&D

AI4TV @ ACM MM 2019 21 Oct 2019

BBC | Research & Development

Introduction to BBC R&D

BBC | Research & Development

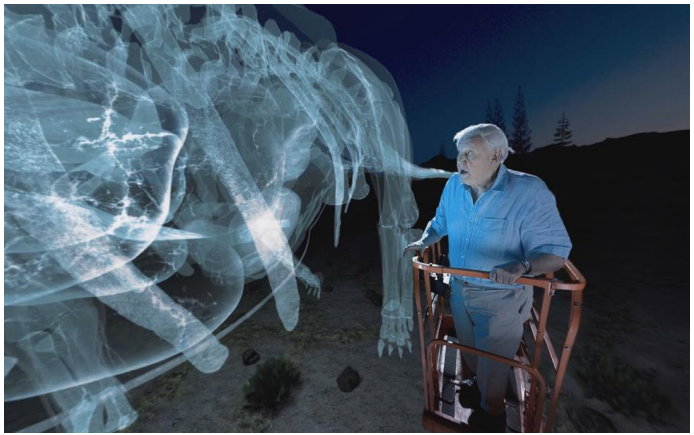
The BBC

- UK public service broadcaster
- Oldest national broadcasting organisation (since 1922)
- Largest broadcaster in the world by number of employees

- Its content is also consumed all around the world
- It operates one of the most popular websites in Europe

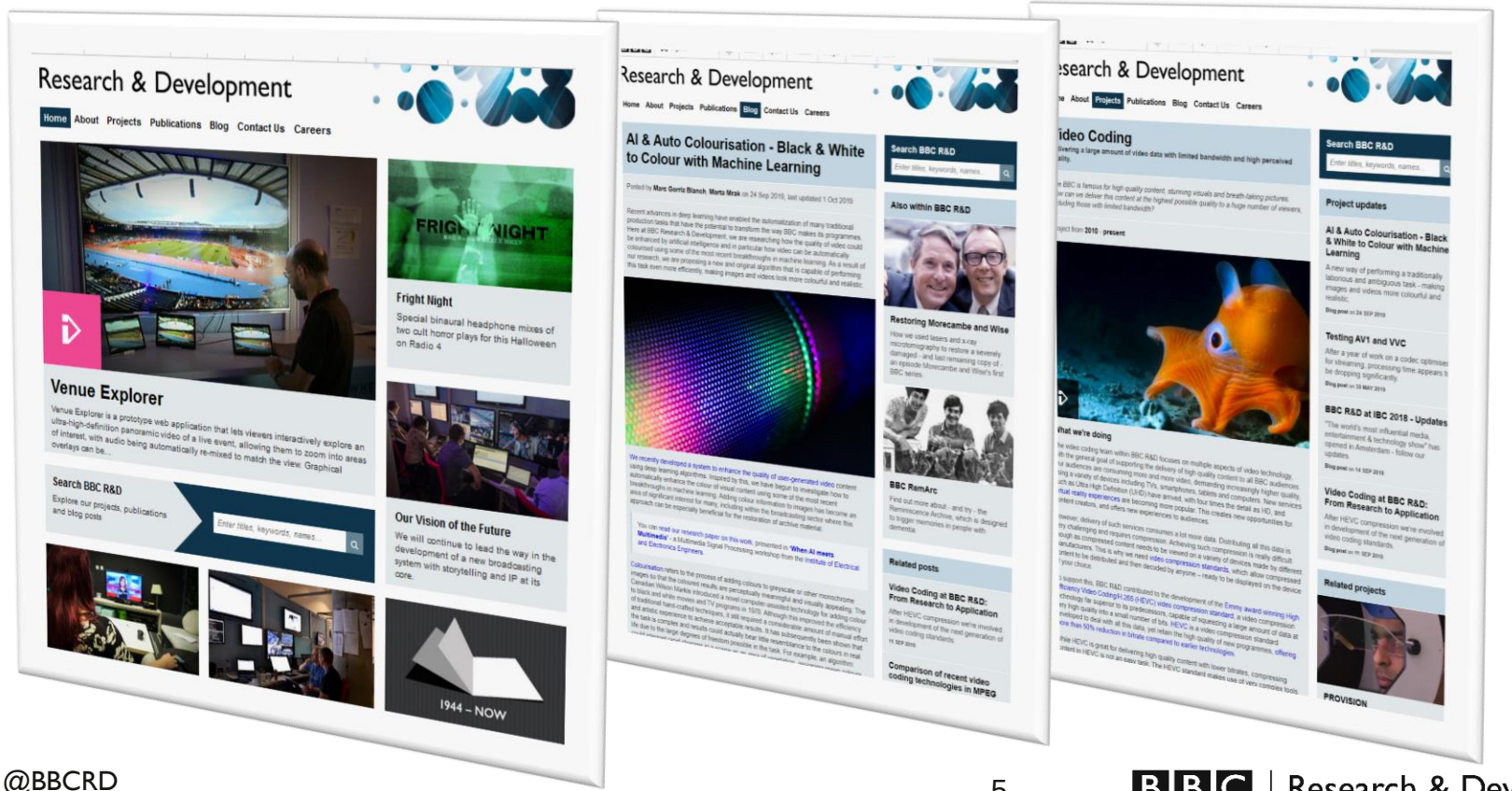
BBC R&D

- For over 60 years BBC R&D has played an integral part in shaping the future of broadcasting
  - Development of colour TV and High Definition to Freeview and Freesat
  - Fairest and highest quality broadcast innovations



- BBC R&D continues to provide the BBC with cutting edge innovations to help enhance their audience's experience
- At the moment includes around 200 engineers and scientist

www.bbc.co.uk/rd



AI4TV

- Focus on the visual content
- Examples from content creation to content distribution

1. Content Creation, Archives

2. Auto AI Checks and Enhancements

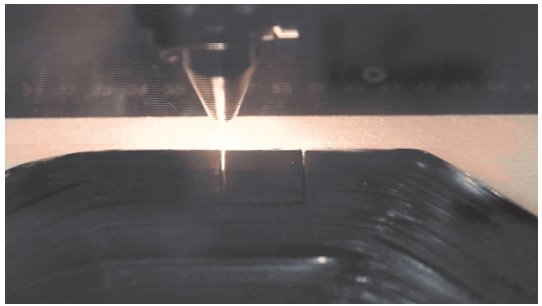
3. Production Team Smart Select

4. Distribution

Example of visual content: Historical videos

- Historical videos:
  - From videos in archives (> 1 million hours of playable material)
  - To the content currently broadcasted

https://www.bbc.co.uk/rd/blog/2017-12-morecambe-wise-video-film-archive-restoration



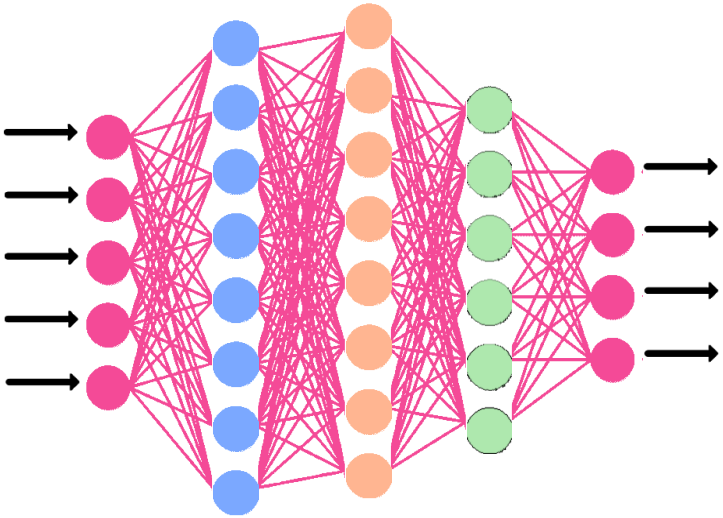
Example of visual content: user generated content

[Video not available in this version of the slides;
See https://twitter.com/BBCRD/status/976781283627098113]

Deep learning
for visual content enrichment

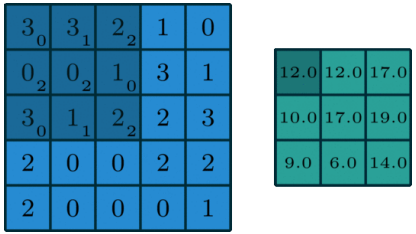
BBC | Research & Development

Deep learning and visual data

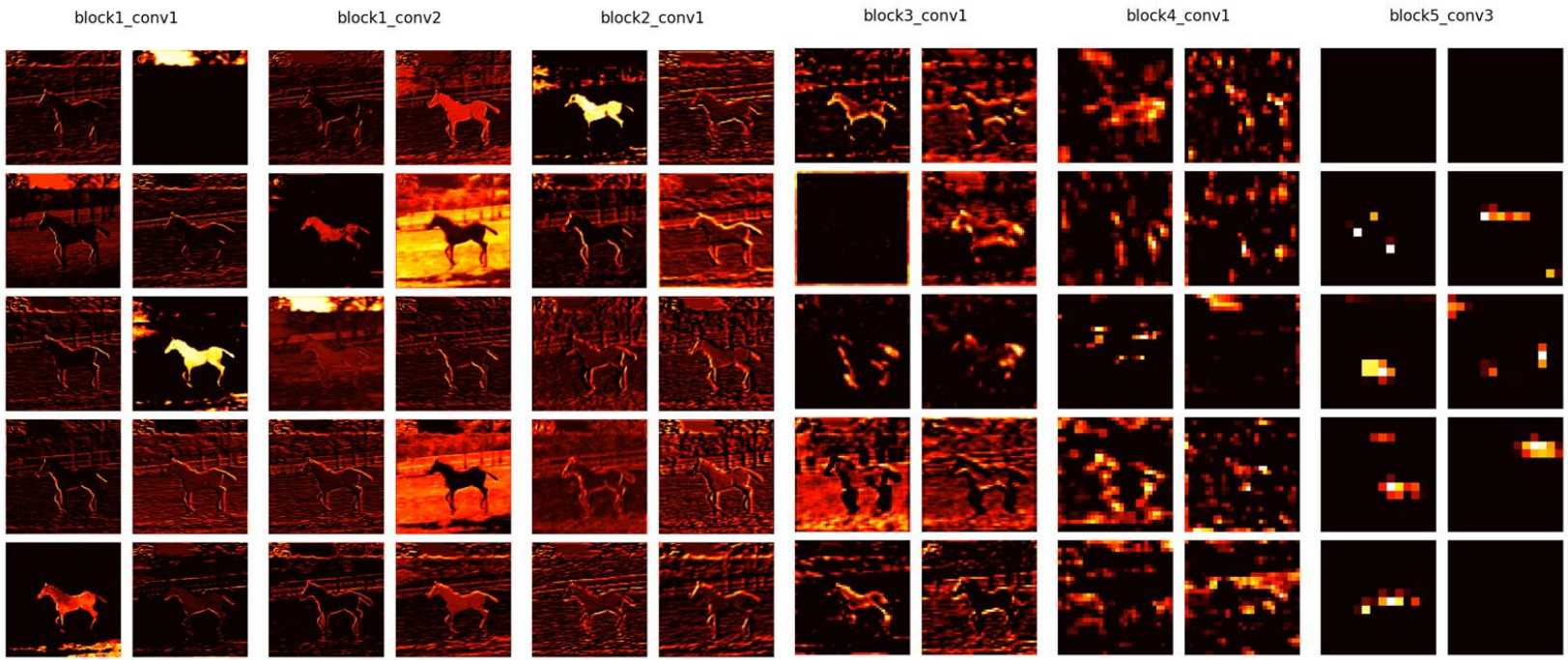


- Artificial neural networks
  - Learning by adapting the neurons and connections between neurons based on training data
- Why now
  - Increase in data
  - Computing power

- 50% of our neural tissue is related to vision
- Algorithms developed for visual data are very complex
  - But can help us with other data challenges
- Useful tool: 2D convolutions



An example of AI's perception of media using convolutions



[Video not available in this version of the slides]

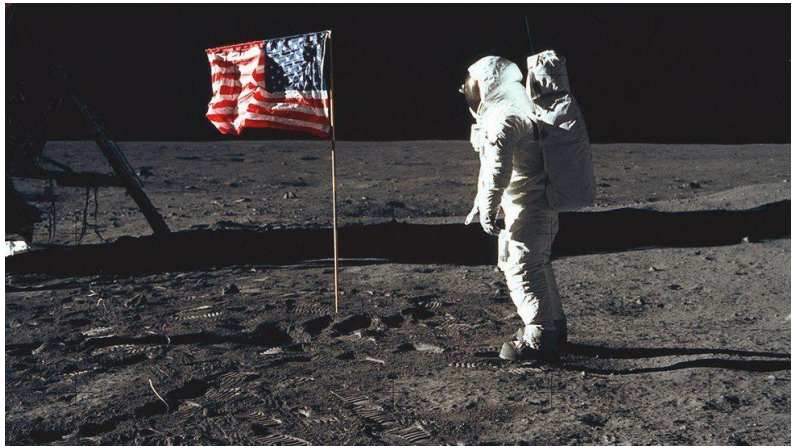
Enhancement of visual content

- Semantic enrichment

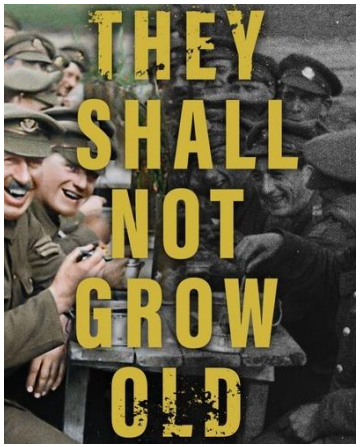
- Improve the appearance of images or videos:
  - Colour adjustment ✓
  - Sharpening
  - Inpainting
  - Deblurring
  - Denoising
  - Superresolution ✓
  - Perceptual enhancement
  - Artifact removal
  - Style transfer

Automatic image colourisation

- Introduced as a novel computer-assisted technology in 1970 for footages of the moon from the Apollo program missions



- Modern restoration techniques were used recently to colourise original footages of the World War I conflict, provided by BBC Archives and the Imperial War Museum



Colourisation methods

Semi-automatic

✔ Computer-assisted technology **improves the efficiency of traditional hand-crafted techniques**.

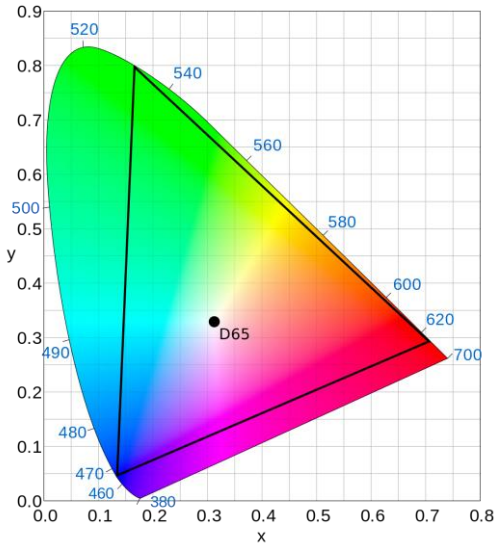
✕ Requires a considerable amount of **manual effort** and **artistic experience** to achieve acceptable results.

Automatic

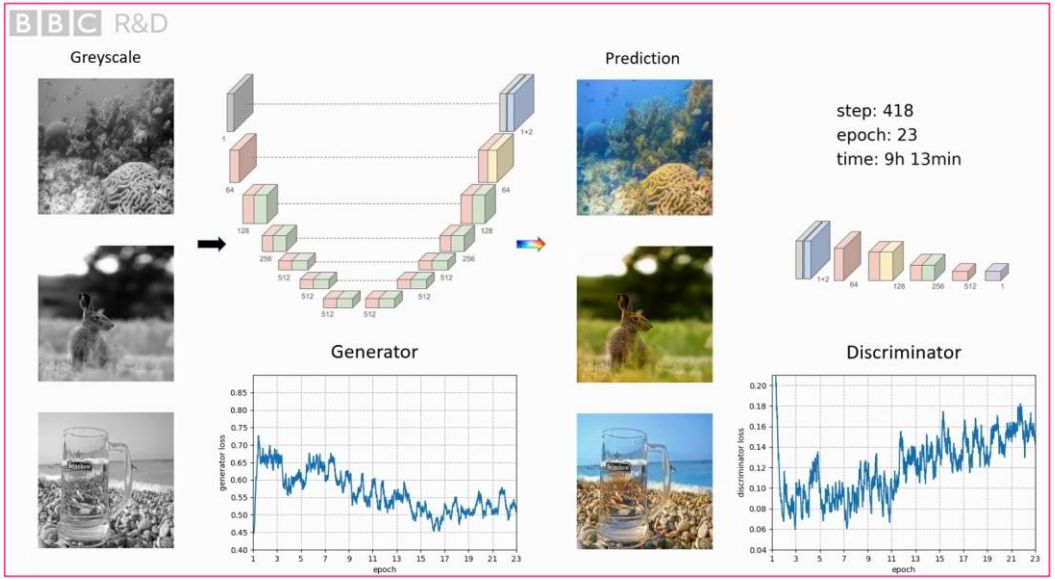
✔ End-to-end techniques without involving manual effort.

✕ **Loss of precision** due to **inherent ambiguity** and **large degrees of freedom** possible in the task.

✕ Likely production of **desaturated results** due to **lack of generalisation in large databases of natural images**.



Automatic colourisation



[Video not available in this version of the slides; see https://www.bbc.co.uk/rd/blog/2019-09-artificial-intelligence-colourisation-video]

Find out more

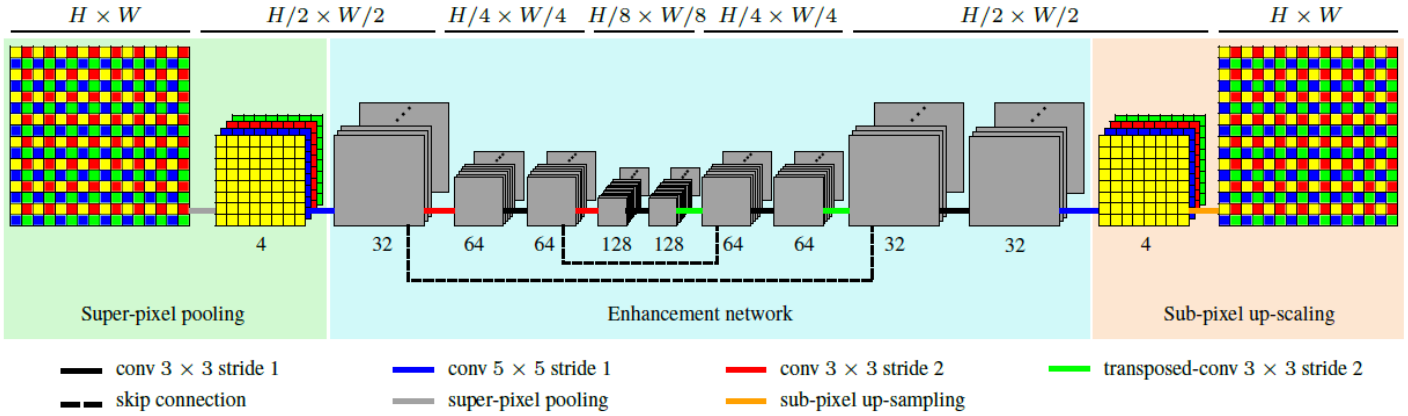
@BBCRD

- Marc Gorriz Blanch et al., "End-to-End Conditional GAN-based Architectures for Image Colourisation," IEEE MMSP 2019

Video enhancement: super-resolution

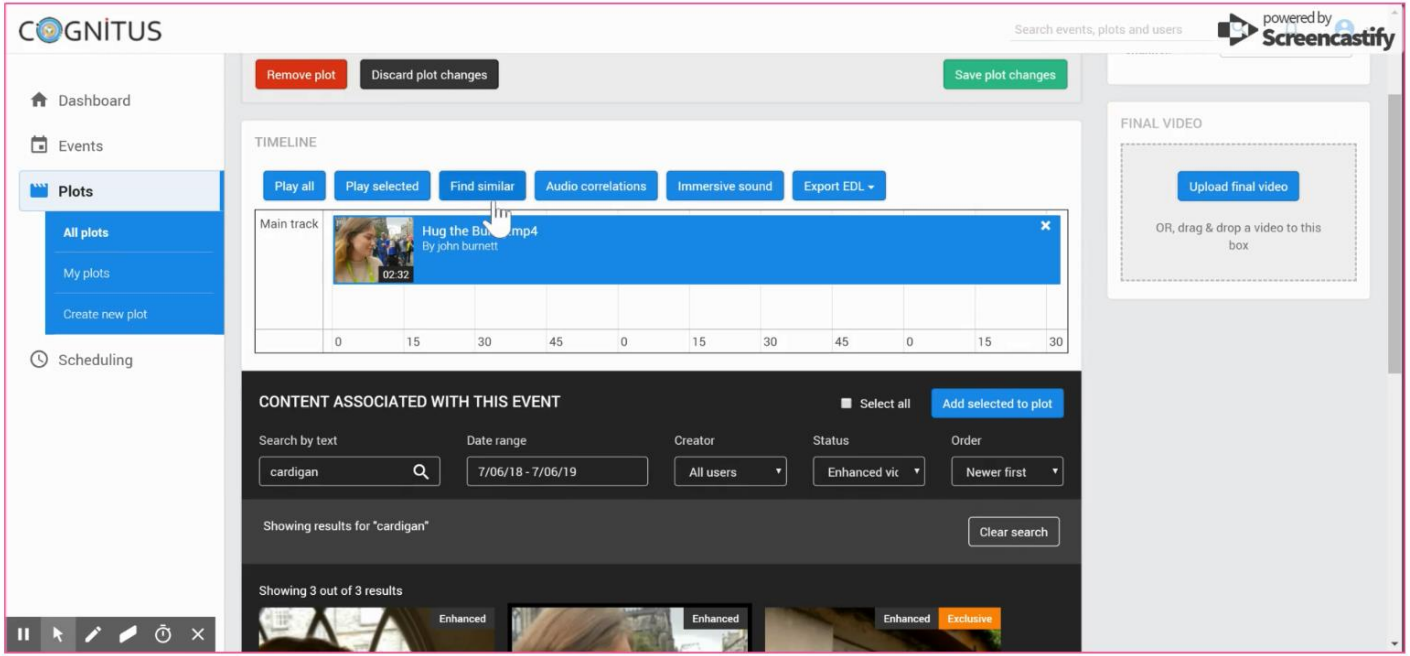
[Video not available in this version of the slides; see https://www.bbc.co.uk/rd/projects/cognitus]

Video enhancement: super-resolution



F. Toutounchi, and E. Izquierdo, "Enhancing Digital Zoom in Mobile Phone Cameras by Low Complexity Super-Resolution", IEEE ICME Workshops 2018 (ICMEW)

Semantic enrichment



[Video not available in this version of the slides; see https://www.bbc.co.uk/rd/projects/cognitus]

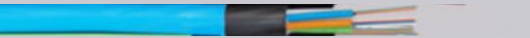
Video coding and AI

BBC | Research & Development

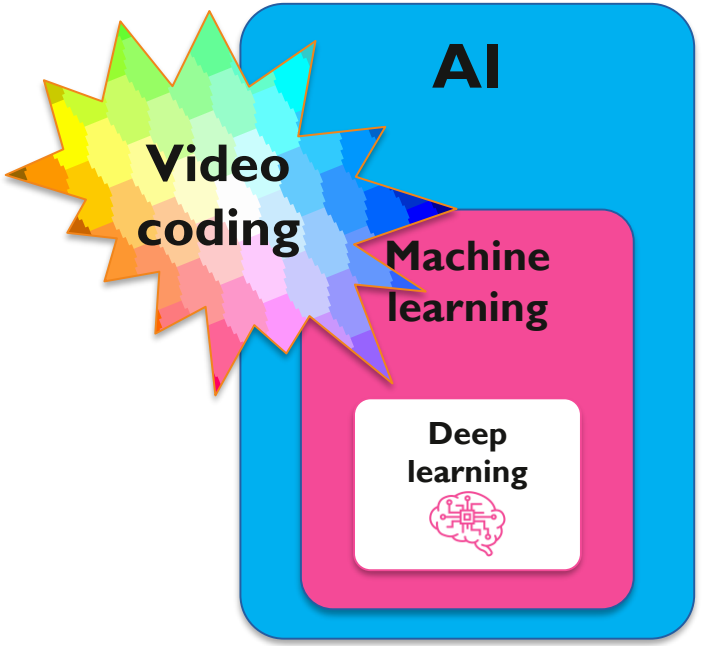
Video coding

H.264/AVC
> 15 years old
Video streaming enabler

H.265/HEVC
> 5 years old
UHD / HDR streaming enabler



VVC (/H.266?)
Under development
Killer app?

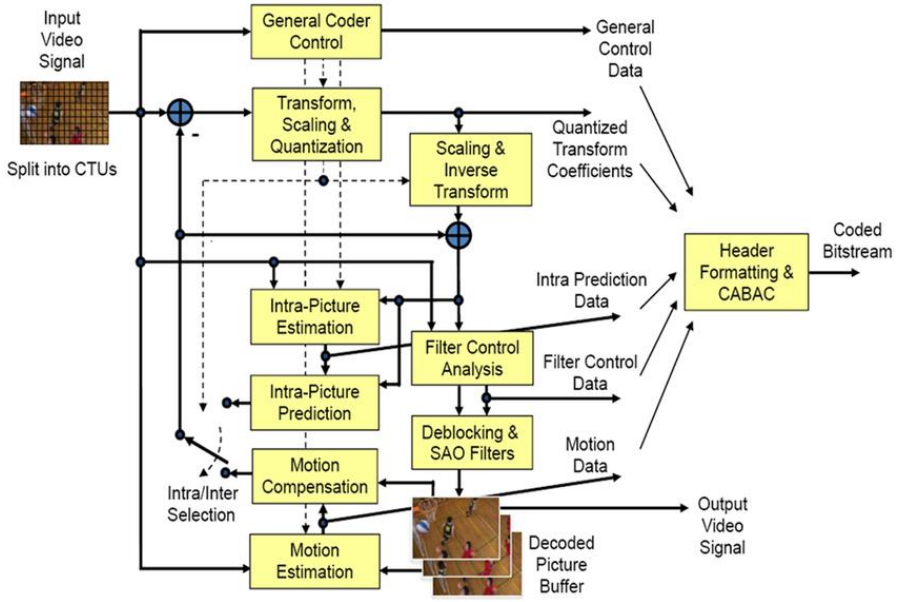


Video compression standards – building blocks

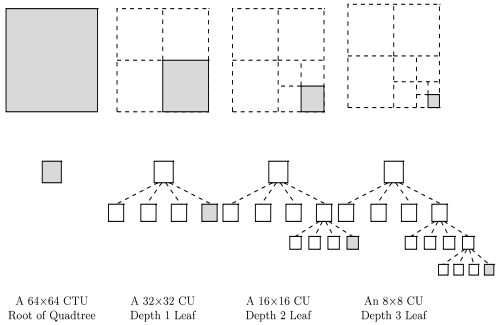
Video coding algorithms

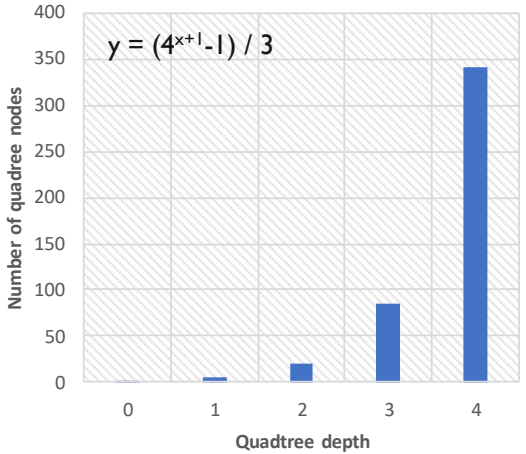
- Signal processing
- Perception science
- Statistics
- Machine learning

+ brute force



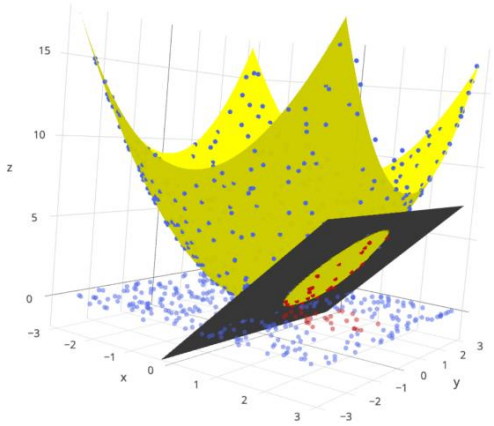
Applications of machine learning in video coding: reducing costs (or not)



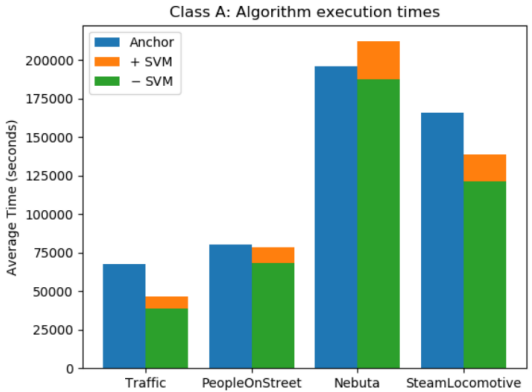


- Brute force
  - Check various split options, and pick the one that compresses given block the best
- Required
  - Reduce complexity of video encoder by reducing the number of split options that are checked
- Hypothesis
  - Reduction can be done using knowledge from the context

Applications of machine learning in video coding: Support Vector Machines



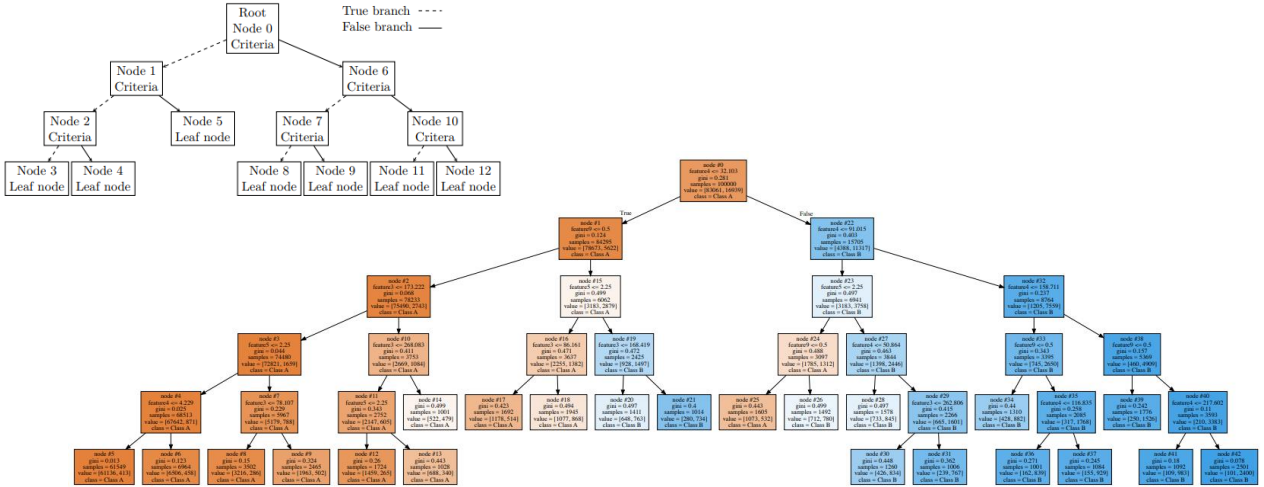
- Knowledge from the context filtered using SVM
- Reduced number of split options that are checked
- Reduced core encoder time
- But…SVMs are costly
- Reduced overall cost

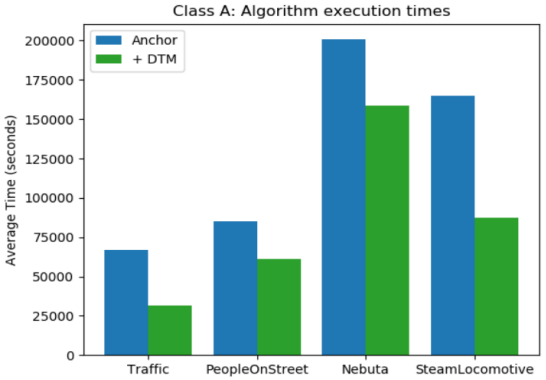


Turing codec

Applications of machine learning in video coding: Decision Trees

- Decision trees – "glass box" approach
  - Determine optimised split decision structure

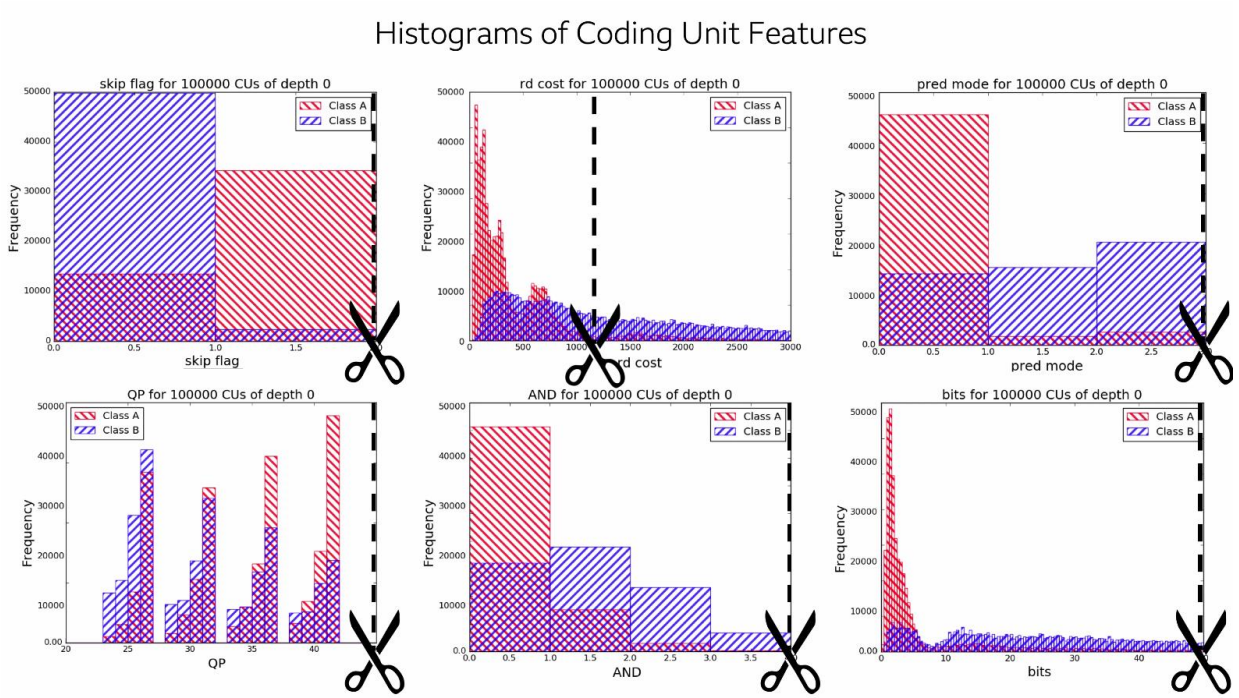




- Natasha Westland et al., "Decision Trees for Complexity Reduction in Video Compression," IEEE ICIP 2019
- Jieon Kim et al., "Fast Inter-prediction Based on Decision Trees for AV1 Encoding," IEEE ICASSP 2019

- Applied in HEVC and AV1 encoders
  - On average approx. 40% processing time saving, for less than 1% BD-rate loss

Growing of Decision Trees



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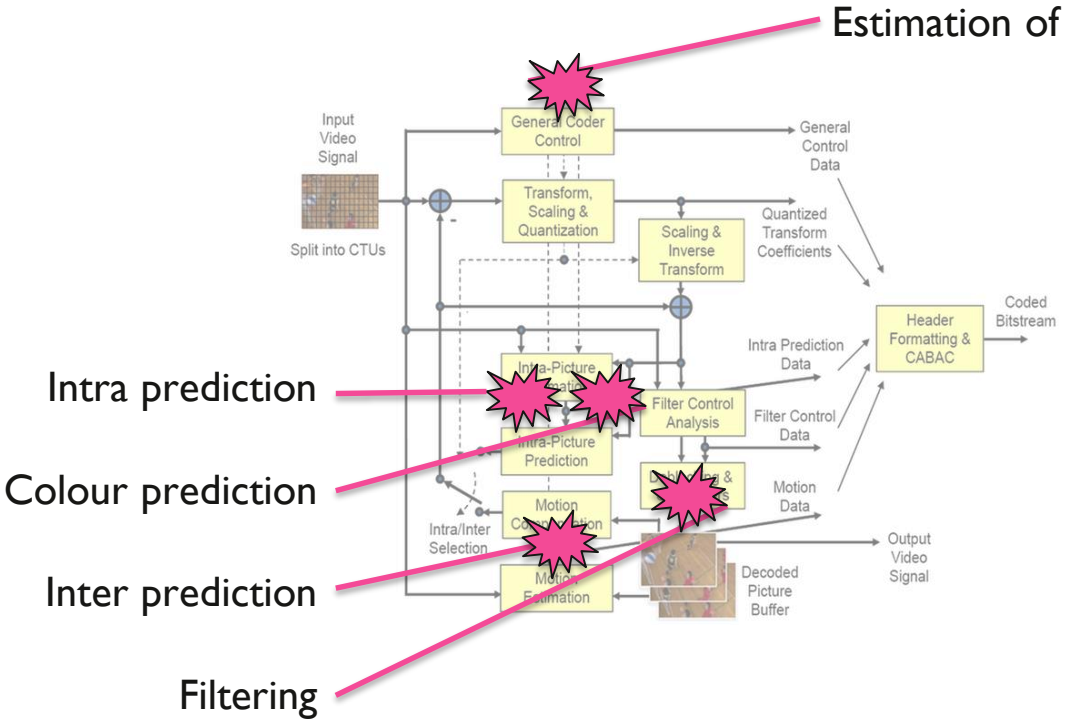
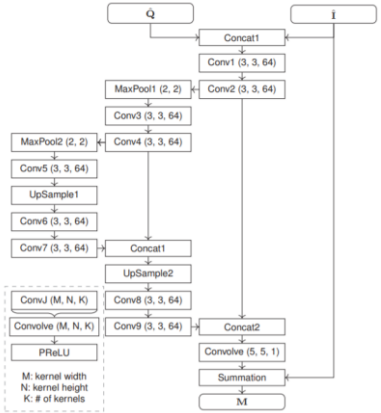
Examples of deep learning application in traditional video compression





- Maria Santamaria et al., "Estimation of Rate Control Parameters for Video Coding Using CNN," in Proc. IEEE VCIP 2018

Video coding and ML: conclusions

[Video not available in this version of the slides]

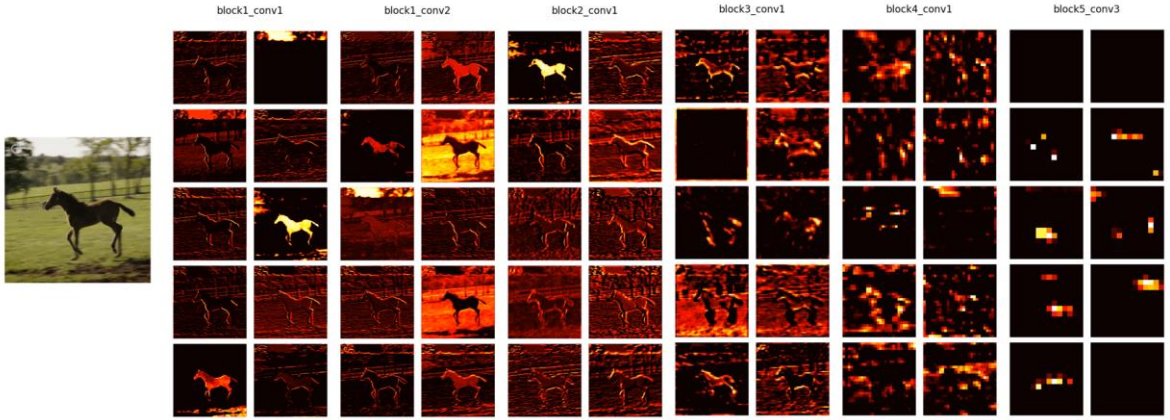
- For AI to be effective, algorithms have to be carefully designed

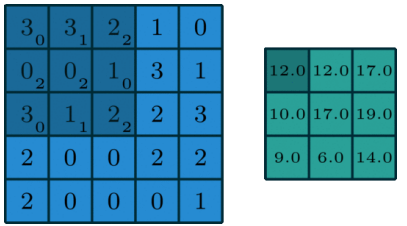
- Benefits:
  - Improved efficiency
  - Improved accuracy
  - Better decisions
  - Better predictions
  - Cost reduction
  - Quality improvement

Last but not the least

Beyond the power of data crunching

- The AI toolsets enable previously unachievable results
  - Embraced by the media sector
- However, there are also some negative consequences, e.g.:
  - Excessive use of computational power
  - Biases in AI systems
  - Manipulation, e.g. deepfakes
- Solutions
  - Deep technical understanding
  - Interpretability
  - Ethical use of data
  - Predictability





Thank you for your attention!

@martamrak