AI gets creative:

Use of machine learning in video enhancement

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Application scenario: content management platform

1. Content Creation, Archives

2. Auto AI Checks and Enhancements

3. Production Team Smart Select

4. Distribution
Video coding
Video coding: an application of AI

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 coding
Machine learning
Deep learning
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

\[ y = \frac{4^{x+1} - 1}{3} \]
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
Applications of machine learning in video coding: Decision Trees

• Decision trees – “glass box” approach
  - Determine optimised split decision structure

  Jieon Kim et al., “Fast Inter-prediction Based on Decision Trees for AV1 Encoding,” in Proc. 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

Histograms of Coding Unit Features

[Video not available in this version of the slides]
Deep learning
Deep learning

- Artificial neural networks
  - Algorithms inspired by the human brain
  - Learn from large amounts of data
  - Groups of neurons – layers (deep)
  - Learning by adapting the neurons and connections between neurons based on training data

- Why now
  - Increase in data
  - Computing power
## Visual data

- 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

### 2D Convolution Example

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An example of AI’s perception of media using convolutions

[Video not available in this version of the slides]
Examples of deep learning application in traditional video compression

Estimation of quality and bit-rate

- Intra prediction
- Colour prediction
- Inter prediction

• Maria Santamaria et al., “Estimation of Rate Control Parameters for Video Coding Using CNN,” in Proc. IEEE VCIP 2018
Video coding and ML: conclusions

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

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

[Video not available in this version of the slides]
AI gets creative
Video enhancement: super-resolution

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

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

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

AI

Video coding

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Machine learning

Deep learning
Thank you for your attention!