

AI gets creative:

Use of machine learning in video enhancement

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BBC | Research & Development



Application scenario: content management platform



1. Content Creation, Archives



3. Production Team Smart Select



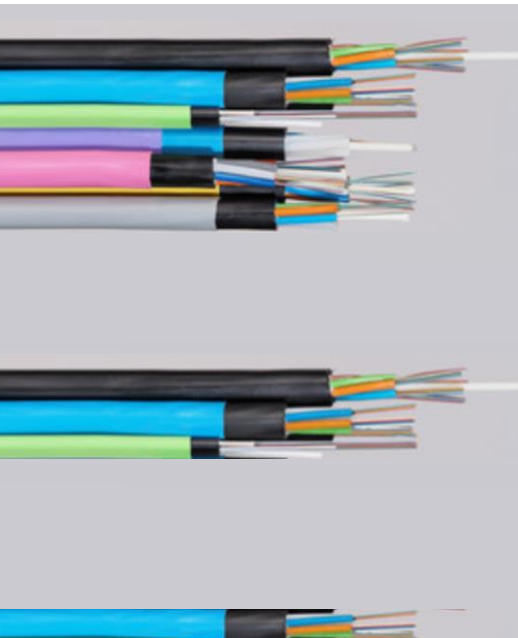
2. Auto AI Checks and Enhancements



4. Distribution

Video coding

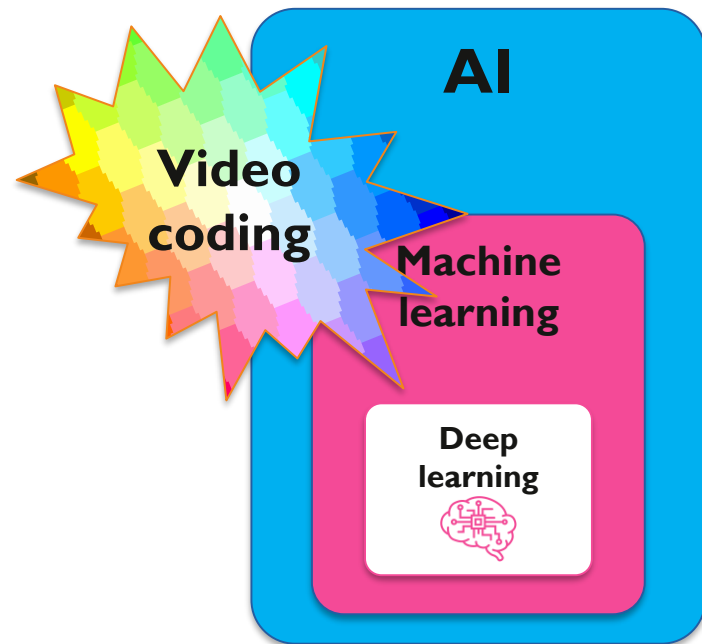
Video coding: an application of AI



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?

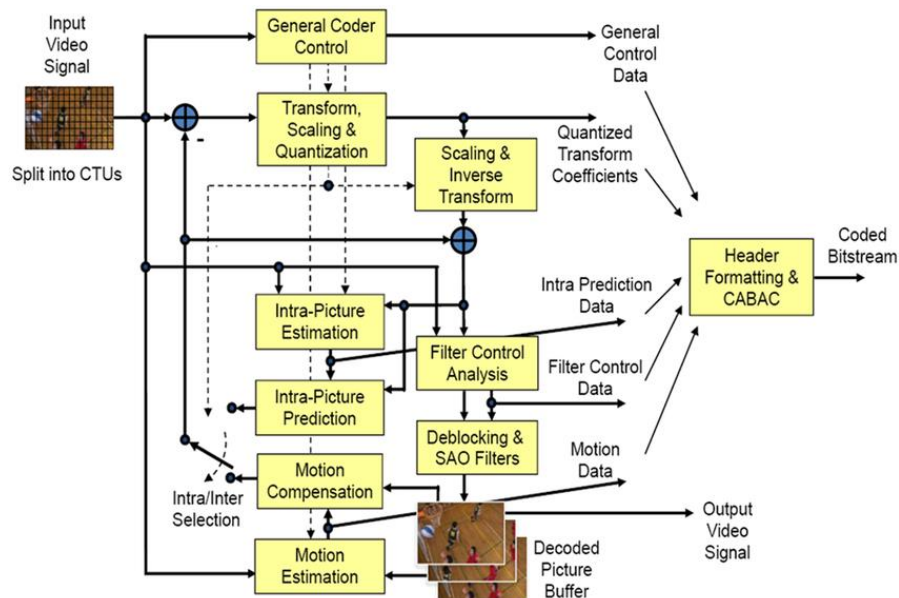


Video compression standards – building blocks

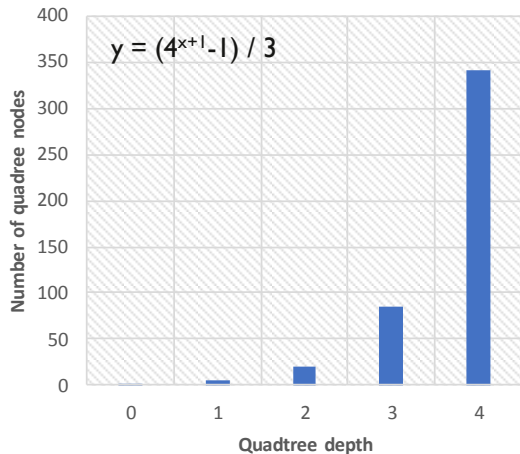
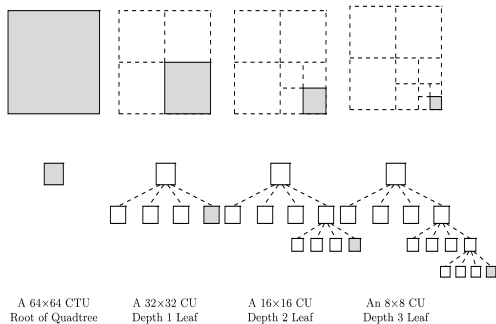
Video coding algorithms

- Signal processing
- Perception science
- Statistics
- Machine learning

+ brute force



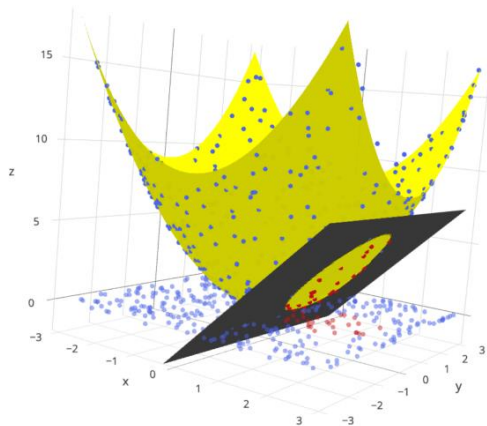
Applications of machine learning in video coding: reducing costs (or not)



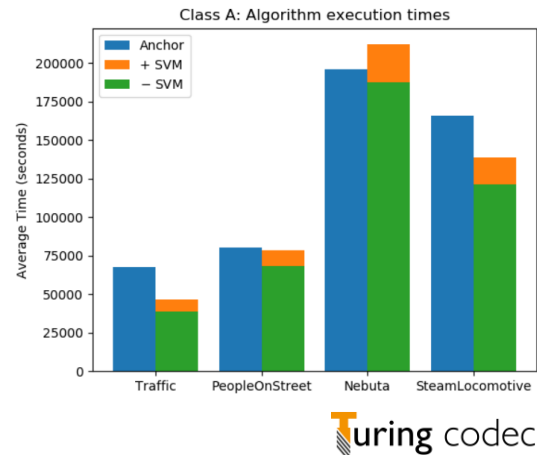
- **Brute force**
 - Check various split options, and pick the one that compresses given block the best
- **Required**
 - Reduce complexity of video encoder by reducing the number of split options that are checked
- **Hypothesis**
 - Reduction can be done using knowledge from the context



Applications of machine learning in video coding: Support Vector Machines

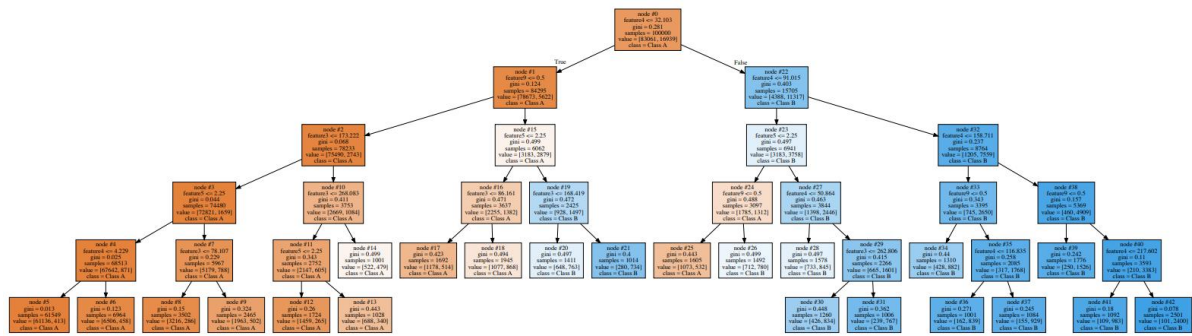
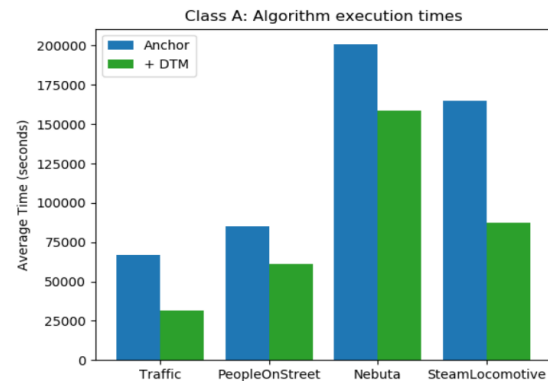
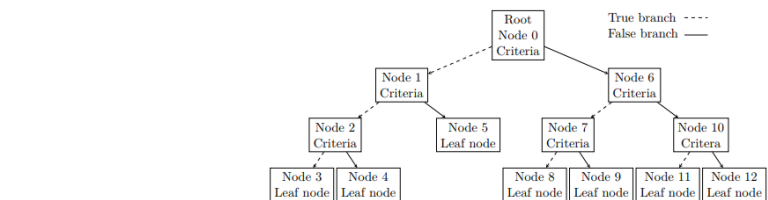


- Knowledge from the context filtered using SVM
- Reduced number of split options that are checked
- Reduced core encoder time ✓
- But...SVMs are costly
- Reduced overall cost ✗



Applications of machine learning in video coding: Decision Trees

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

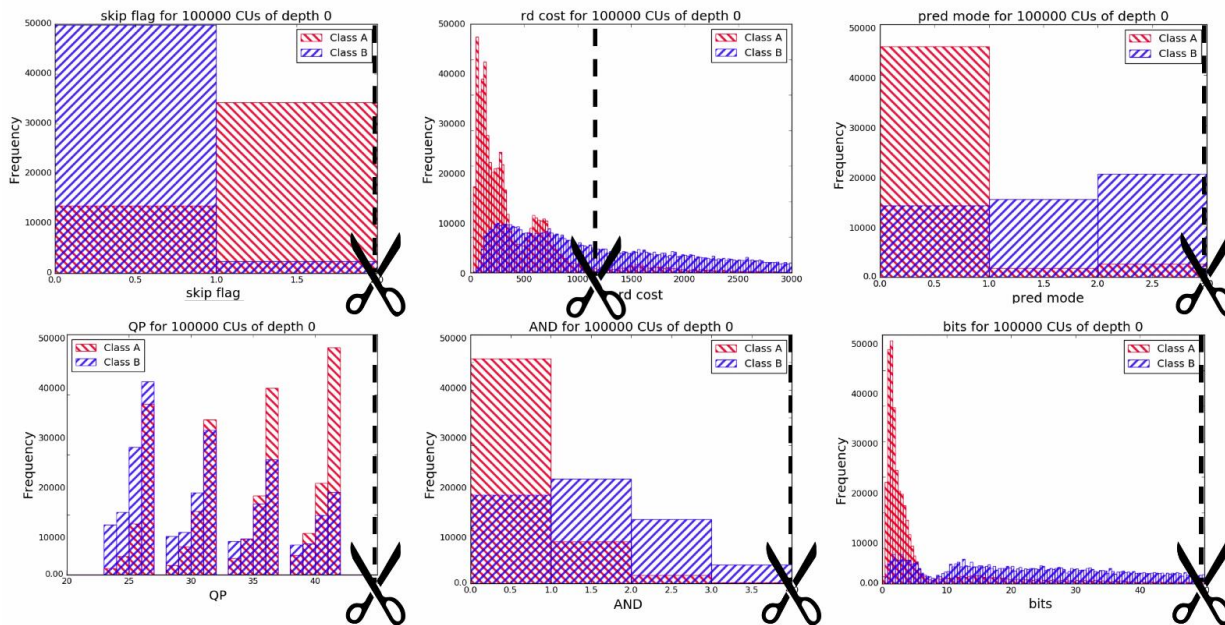


- Applied in HEVC and AV1 encoders
 - On average approx. 40% processing time saving, for less than 1% BD-rate loss

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

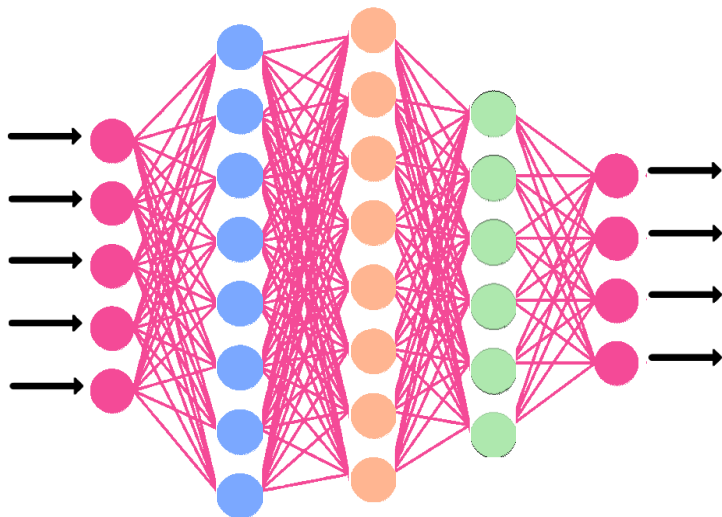
Growing of Decision Trees

Histograms of Coding Unit Features



[Video not available in this version of the slides]

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

3_0	3_1	2_2	1	0
0_2	0_2	1_0	3	1
3_0	1_1	2_2	2	3
2	0	0	2	2
2	0	0	0	1

12.0	12.0	17.0
10.0	17.0	19.0
9.0	6.0	14.0

An example of AI's perception of media using convolutions



block1_conv1

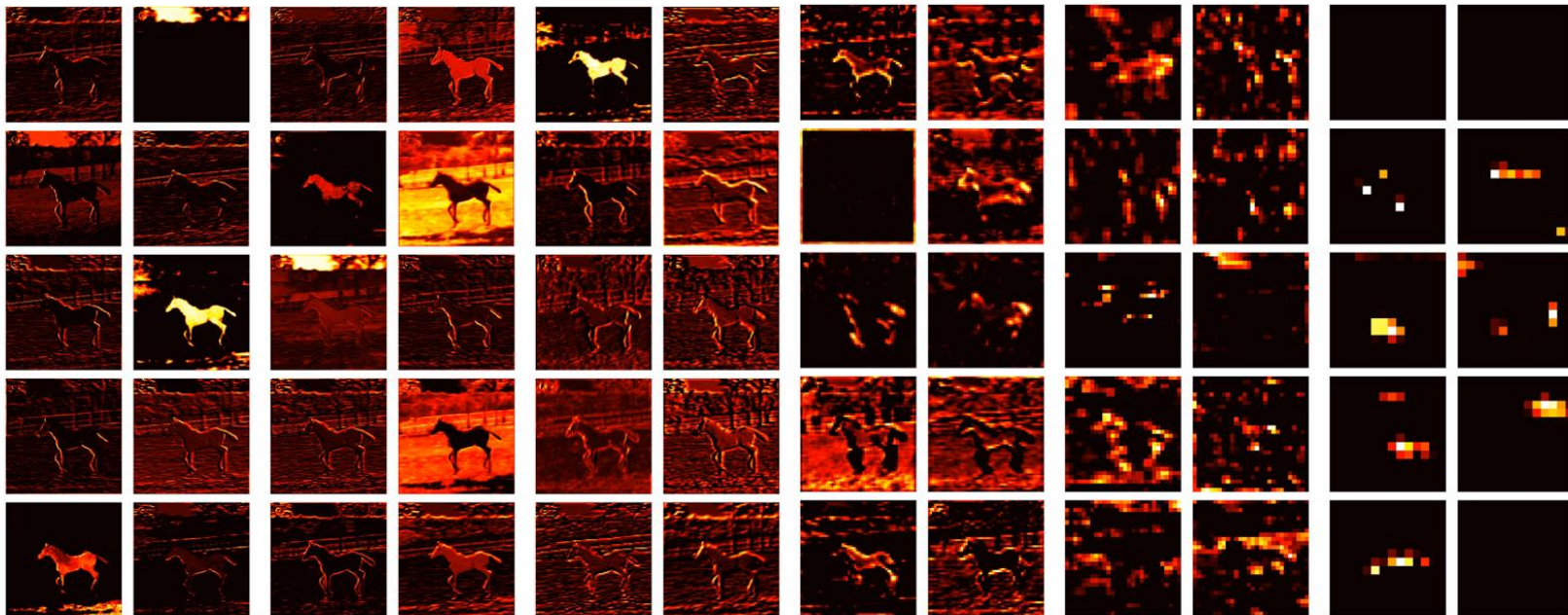
block1_conv2

block2_conv1

block3_conv1

block4_conv1

block5_conv3

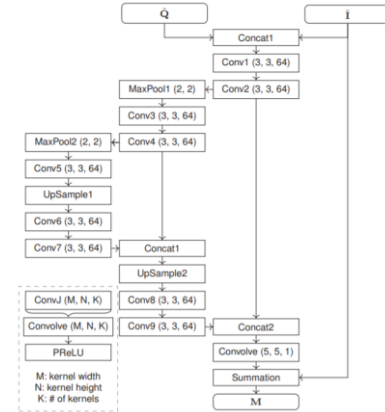
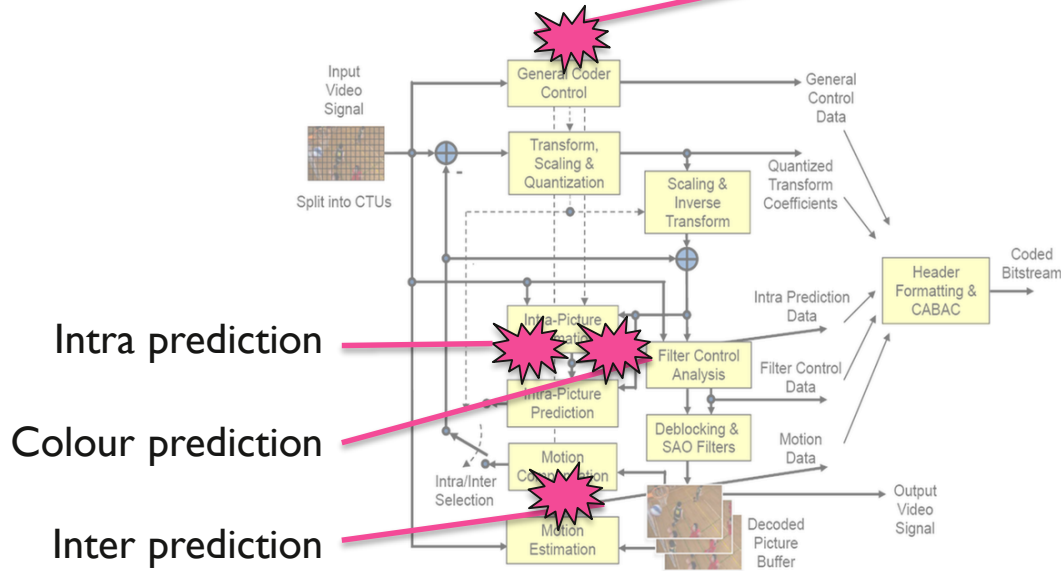


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Examples of deep learning application in traditional video compression

Estimation of quality and bit-rate



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

Video coding and ML: conclusions



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- For AI to be effective, algorithms have to be carefully designed
- Benefits:
 - Improved efficiency
 - Improved accuracy
 - Better decisions
 - Better predictions
 - Cost reduction
 - Quality improvement

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

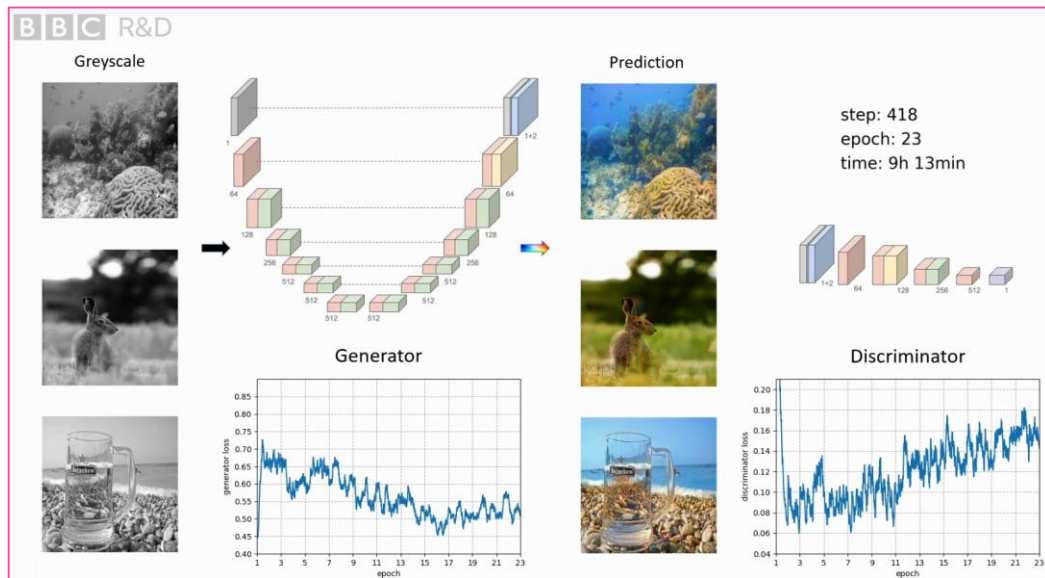


The screenshot displays the COGNITUS web application interface. At the top left, the logo 'COGNITUS' is visible. A search bar on the top right contains the text 'Search events, plots and users' and is powered by 'Screencastify'. The main interface is divided into several sections:

- Left Sidebar:** Contains navigation options: 'Dashboard', 'Events', 'Plots' (selected), 'All plots', 'My plots', 'Create new plot', and 'Scheduling'.
- Top Action Bar:** Includes buttons for 'Remove plot', 'Discard plot changes', and 'Save plot changes'.
- TIMELINE:** Features a horizontal timeline with markers at 0, 15, 30, and 45. A video plot titled 'Hug the Bull.mp4' by 'john burnett' is shown, starting at 07:32. Above the timeline are buttons for 'Play all', 'Play selected', 'Find similar', 'Audio correlations', 'Immersive sound', and 'Export EDL'.
- CONTENT ASSOCIATED WITH THIS EVENT:** A search results section with filters for 'Search by text' (cardigan), 'Date range' (7/06/18 - 7/06/19), 'Creator' (All users), 'Status' (Enhanced vic), and 'Order' (Newer first). It shows 'Showing results for "cardigan"' and 'Showing 3 out of 3 results'.
- FINAL VIDEO:** A section on the right with an 'Upload final video' button and the instruction 'OR, drag & drop a video to this box'.
- Bottom Bar:** Contains playback controls: play/pause, stop, previous, next, and close.

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

Video enhancement: colourisation



#jolt



[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

Machine learning

AI gets creative

Deep learning



Thank you
for your attention!

