Data-driven methods: Video Texture
Michel Gondry train video

http://www.youtube.com/watch?v=0S43lwBF0uM
Weather Forecasting for Dummies™

Let’s predict weather:

• Given today’s weather only, we want to know tomorrow’s
• Suppose weather can only be {Sunny, Cloudy, Raining}

The “Weather Channel” algorithm:

• Over a long period of time, record:
  – How often S followed by R
  – How often S followed by S
  – Etc.
• Compute percentages for each state:
  – P(R|S), P(S|S), etc.
• Predict the state with highest probability!
• It’s a Markov Chain
Markov Chain

What if we know today and yestarday’s weather?
[Shannon, ’48] proposed a way to generate English-looking text using N-grams:

- Assume a generalized Markov model
- Use a large text to compute prob. distributions of each letter given N-1 previous letters
- Starting from a seed repeatedly sample this Markov chain to generate new letters
- Also works for whole words

WE NEED TO EAT CAKE
Results (using \textit{alt.singles} corpus):

- “As I've commented before, really relating to someone involves standing next to impossible.”
- “One morning I shot an elephant in my arms and kissed him.”
- “I spent an interesting evening recently with a grain of salt”
Video Textures

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Still photos
Video clips

[Image of an American flag waving in the wind]
[Image of a flame burning at night]
[Image of two children swinging on a swing set]
[Image of a house decorated with colorful lights]
Video textures
Problem statement

video clip

→

video texture
Our approach

• How do we find good transitions?
Finding good transitions

- Compute $L_2$ distance $D_{i,j}$ between all frames

Similar frames make good transitions
Markov chain representation

Similar frames make good transitions
Transition costs

- Transition from i to j if successor of i is similar to j
- Cost function: $C_{i \rightarrow j} = D_{i+1, j}$
Transition probabilities

- Probability for transition $P_{i \rightarrow j}$ inversely related to cost:

  - $P_{i \rightarrow j} \sim \exp \left( - \frac{C_{i \rightarrow j}}{\sigma^2} \right)$

  ![high σ](image1.png) ![low σ](image2.png)
Preserving dynamics
Preserving dynamics
Preserving dynamics

- Cost for transition $i \rightarrow j$

$$C_{i \rightarrow j} = \sum_{k=-N}^{N-1} w_k D_{i+k+1, j+k}$$
Preserving dynamics – effect

- Cost for transition $i \rightarrow j$
  \[ C_{i \rightarrow j} = \sum_{k = -N}^{N-1} w_k D_{i+k+1, j+k} \]
Dead ends

• No good transition at the end of sequence
**Future cost**

- Propagate future transition costs backward
- Iteratively compute new cost

\[ F_{i \rightarrow j} = C_{i \rightarrow j} + \alpha \min_k F_{j \rightarrow k} \]
Future cost

- Propagate future transition costs backward
- Iteratively compute new cost

\[ F_{i \rightarrow j} = C_{i \rightarrow j} + \alpha \min_k F_{j \rightarrow k} \]
Future cost

- Propagate future transition costs backward
- Iteratively compute new cost

\[ F_{i\rightarrow j} = C_{i\rightarrow j} + \alpha \min_k F_{j\rightarrow k} \]
Future cost

• Propagate future transition costs backward
• Iteratively compute new cost

• $F_{i \rightarrow j} = C_{i \rightarrow j} + \alpha \min_k F_{j \rightarrow k}$
**Future cost**

- Propagate future transition costs backward
- Iteratively compute new cost
  
  \[ F_{i \rightarrow j} = C_{i \rightarrow j} + \alpha \min_k F_{j \rightarrow k} \]

- Q-learning
Final result
Finding good loops

- Alternative to random transitions
- Precompute set of loops up front
Video portrait

• c.f. Harry Potter
Region-based analysis

• Divide video up into regions

• Generate a video texture for each region
User-controlled video textures

slow  variable  fast

User selects target frame range
Video-based animation

• Like sprites computer games
• Extract sprites from real video
• Interactively control desired motion

©1985 Nintendo of America Inc.
Video sprite extraction

blue screen matting
and velocity estimation
Video sprite control

• Augmented transition cost:

$$C_{i\rightarrow j} = \alpha C_{i\rightarrow j} + \beta \text{ angle}$$

Animation

Similarity term

Control term

vector to mouse pointer

velocity vector
Video sprite control

- Need future cost computation
- Precompute future costs for a few angles.
- Switch between precomputed angles according to user input

[GIT-GVU-00-11]
Interactive fish
Summary / Discussion

• Some things are relatively easy
Discussion

• Some are hard
“Amateur” by Lasse Gjertsen

http://www.youtube.com/watch?v=JzqumbhfxRo

similar idea:
http://www.youtube.com/watch?v=MsBMG-p1HDM&feature=share&list=PLFFD733D0FF425290
Hyperlapse Videos

https://www.youtube.com/watch?v=Wt_Y04xn84M
“Do As I Do” (ICCV 2003)

Efros, Berg, Mori, Malik, “Recognizing Action at a Distance”, ICCV 2003