Warm up Questions:

- **Question**: Which of the following color sampling methods offers 0% compression?
  a) 4:4:4
  b) 4:2:2
  c) 4:2:0
  d) 4:1:1
- **Question**: How many scan lines are there on an analog TV from the 1970s?
- **Question:** What does 720p mean?

Slide 1 of 44

Computer Science 1033 – Week 11

VIDEO II

Your goal is to count how many times the ball is passed by those wearing white shirts

"You know that little indestructible black box on the airplane? Why don't they use that material to make the entire airplane?." → Anonymous

---

Overview of Today's Topics

- Announcements
- Compression Strategies
- Data Rate
- Codecs
- File Formats
- Terminology
- Downloading Video
- Streaming
- YouTube
- Review

Slide 3 of 44

Announcements

- Final Exam: Sunday, December 17 at 10am
  - Link: https://studentservices.uwo.ca/secure/exams/FallWinter.cfm
  - Laura's Section : Althouse Gym or Thames Hall Gym
    - Bring:
      - Pencil (soft) and eraser
      - Student card
    - Do NOT bring: calculator, ipod, hat, etc..
    - Exam is checked for cheating…so don't ☺
    - 150 questions – about 80% from lectures, 15-20% from labs, 110 multiple choice, 40 true/false
    - I will give a review sheet next week.

COMPSCI								
Crse No.	Class Sect.	Day	Month	Date	Time	Bldg/Room	From	To
1033A	001	Sunday	December	17	10:00 AM	FEB GYM	ABDO	MING
1033A	001	Sunday	December	17	10:00	TH GYM	MODA	ZHEN
1033A	002	Sunday	December	17	10:00 AM		ABDE	LEE

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Web Assignment

- Marks will be a lot lower ☹ because
  - Forgot Titles (*La Moda Cheveux– Hair Stylists* NOT *stylist.html* or *stylists*)
  - Forgot images folder or called it Images
  - Called file Index.html instead of index.html
  - Called folder Webassign instead of webassign
  - Called index.html something like home.html
  - Called aboutus.html something like About Us.html
  - Forgot to check links ☹
  - Forgot to check images ☹
  - Forgot bullets ☹
  - Didn't make the references working links! Slide 5 of 44

Make sure you get a copy of all your work!

- Your websites will only be posted for the next month (till about June 1, 2017) so copy of everything you want onto a stick. YOU WILL NOT BE ABLE TO GET IT BACK AFTER JUNE 1, 2017

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1

Hints for Major Assignment

- **Remember:**
  - Rules for Titles
  - Headers
  - File names, spaces, lowercase
  - Images
    - Alt, Hover/tooltips on home page
    - Size within page
    - On each page
  - Banner
  - No Scrolling horizontal/vertically to see buttons
  - Consistency
  - Buttons → look, ease of use
  - links that go OFF your site open in a new window/tab
  - Back to top
  - References page layout
  - Text colours, contrast
  - Broken links
    - Check from a different computer!
  - Underlining
  - Colours
    - Link Colours
  - Paragraphs
  - Padding
  - Followed the instructions (make the anchor links, etc..)
  - Have an *images* subfolder
  - **Have an *originals* subfolder**
    - **NEED LINK TO animation .psd and banner .psd**

Slide 7 of 44

Old final assignments

- Some nice ones:
  - Student 8
  - Student 9
  - Student 10
  - Student 23

Slide 8 of 44

For Major Assignment life will be much easier if you set up a site in build your folders first (major, then major/images, then major/originals)

- Then move your images into images folder
- Move your banner .psd and your animation .psd into originals folder
- Doesn't matter where you put your .gif or .mp4 as long as it is BELOW major (not on your desktop, etc…)

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Major Assignment

- How to make a link on your references to your animation .psd file and your banner .psd file:
  - Make a folder inside of major called originals, so you should have this:
  - Move your banner.psd and your animation.fla into the originals folder, so you should now have this:
  - In Dreamweaver, on your references page, type the text like: My Banner and My Animation like this:
  - Make link to each of those files, like this:
  - What will happen when you click on the link:

Slide 10 of 44

Help with doing setting up originals in the major

- Animation should relate to your theme, this one is awesome! (or it could be your name)
- Video should relate to your theme:
  - Can just be images that transition with some captions
  - Keep it under 1 minute
  - Fade out the sound
- TRY TO GET IT DONE BY FRIDAY OF THIS WEEK (make your life (and weekend) easier!)
- **Something else cool**

Slide 11 of 44

Editing of Video

- Before Digital Video:
  - Had to copy from one tape to another tape
  - Had to load up tapes on a machine to copy
  - Loss of quality after each copy made
- Now:
  - Can easily move clips around
  - No loss of quality
  - Slight compression occurs in the camcorder when the video is captured
    - **Question**: Does anyone remember the name of the most common form of compression in the camcorder

Slide 12 of 44

Things to think about before exporting video:

- Where will I be putting my video?
  - On the web (bandwidth is an issue)
  - On CD-Rom (playback speed is an issue)
  - DVD video (must be in mpeg2 format)
- Who is my audience?
  - Will they be on different platforms
  - How old will their computer be, how old will their CD or DVD player be?
- Will I still need to edit it later on? Should I compress it at all?

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Why Compress? An Example

- Assume we have video that is:
  - 1440 X 1080 pixels → 1,555,200 pixels per frame
  - 24-bit colour
  - 30 fps
  - 1 second long
  - Audio is stereo so 2 channels
  - Audio is 48,000Hz and 16 bit = 48,000*1sec*16bits/sample*2=1,536,000bits
- **Video**
  - 1,555,200 X 24 bits per pixel (for color) = 37,324,800 bits per frame
  - 37,324,800 * 30 frames per second * 1 second= 1,119,744,000 bits/8 = 139,968,000 bytes =**133MB**
- **Audio**
  - 1,536,000bits/8 → **188 KB**
- **Total**
  - **133MB + 188KB =~ 133MB → LOTS OF STORAGE FOR JUST 1 SECOND**
  - **THUS a DVD could hold 35 seconds of uncompressed video… Not a very long movie ☹**

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Data Rate or Bit Rate

- Amount of video processed per second
- Average data rate=file size/length in seconds of video
- Our example → 133MB per second
- Consider a 48X Speed CD Rom
  - Average playback (data rate) rate is 7MB/s
  - Our video would be VERY CHOPPY
- Consider a video that is 100MB and 10 Seconds long:
  - **Question**: what would it's data rate be?
  - it would be choppy on our CD Player
- Consider a video that is 100MB and 33 second long, it would play back at 3MB per second and be fine on our CD Player
- NOTE: problems occur not just because of file size but also because of data rate!

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Compression

- **Question**: What things do you think we should think about optimizing to decrease video file size?
  - One thing to think about: what we did to an image to make it smaller
  - Another idea: think about what you could do with the frames on CNN Piers Morgan vs. a tennis match

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General Compression Strategies

- **Lower the frame size of the video**
  - If it was 640 by 480, change it to 320 by 240, less pixels!
- **Lower the frame rate of the video**
  - Changing the frame rate by ½ (say 20 fps to 10fps) will generally ½ the file size
  - **Question**: What type of video would you NOT want to do this on?
- **Pick a codec that does higher compression**
  - **Question**: What is a codec?

Slide 17 of 44

Codec

- A **codec** is a piece of code that **co**mpresses video or audio as it is created (exported from the editing software) and then when displaying it to the user **dec**ompresses the video or audio (also stands for **co**der/**dec**oder)
- There are LOTS of codecs. You have to use the same one to decompress that was used to compress a video.
- Most common codecs are:
  - H.264
  - DivX
- Can sometimes get a piece of video on your machine and then not be able to play it, this is because you are missing the appropriate codec! (just watch till 2:30)

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Codec Continued

- For example …if you take your friends camera and plug it into your computer and the jpgs will display but the videos won't play then likely: **You are missing the codec!**
- Codecs sometimes depend on the file format.
- What are the file formats available for video?

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Video File Formats

File Type	Also known as:	Originally created by	More Info	Platforms
.mov	QuickTime movie	Apple	•Also for audio •Supports MIDI •Streaming with QuickTime Streaming Server •Can watch video as it is downloaded •Codecs→ Animation, Sorenson Video, H.264, PlanarRGB, Cinepak	Apple QuickTime player available for Mac and Windows
.avi	Audio Video Interleave	Intel	•Codecs→ Microsoft RLE, Intel Indeo Video, Cinepak	Mostly Windows but Apple QuickTime player can play avi files
.rm	Real Video	Real Systems	•High compression •Pick compression based on connection speed •Can stream with Real Server •Need for speed often compromises quality	Cross platform Need Real Player
.wmv	Windows Media	Microsoft	•Good compression	Used with Windows Media Player
.mpg .mpeg .mp4 (container)	MPEG	Motion Picture Experts Group	•mpeg-1→ VCD, •mpeg-2→ DVD **MUST USE THIS!** •mpeg-4→ often use hand held devices (heavily compressed) and good for HDTV	Cross Platform
.flv	Flash Video, f4v	Adobe	•Progressive download from webserver •Can be streamed with Adobe Flash Media Server •Codecs→ Sorenson Spark, On2 VP6 (can have transparent video), H.264	Cross Platform Need Flash Player to play a SWF file that holds the flv file

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Compression Strategies Continued

- **Pick a codec that does higher compression**
  - QuickTime and AVI use different codecs so you can pick one that gives better compression.
- **Lower the picture quality of the video**
  - Sorenson codec lets you set a limit on the data rate
  - H.264 is currently the most widely used
  - Some let you set the quality:

f 44
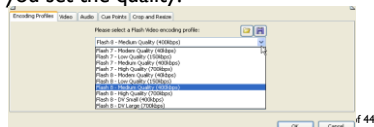
Compression Strategies Continued

- **Lower the color depth**
  - Not popular because video looks best at 24bit color (unless it is a cartoon)
  - Some compressors won't compress color
- **Play with the audio**
  - Unfortunately the audio is usually not the problem so compressing it more won't usually help much!

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Compression Concepts

- **Temporal Compression vs. Spatial Compression**:
  - **Spatial**
    - Compress each frame individually
    - Uses the same techniques as JPG compression
    - Codecs that do spatial compression are: Animation, PlanarRGB
  - **Temporal**
    - Just save info on selected frames (called keyframes)
    - All other frames just save the differences from the previous keyframe
    - Good when the difference between current frame and keyframe is small
    - Codecs using temporal compression are: Sorenson Video, H.264
  - **Question**: What kinds of video would not do well with temporal compression?

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Compression Concepts

- **Lossy vs. Lossless** Compression
  - Depends on the codec
  - **Lossless**
    - looks for large blocks of pixels that are the same to do RLE (run length encoding)
    - QuickTime Animation and PlanarRGB are lossless
  - **Lossy**
    - Lowers video quality but get better file size and better data rate.
- How this relates to bit rate (just watch first 2 minutes and 40 seconds)

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Sample Video

- Laura's Kid → OH BOY, home movies ☹
- http://www.csd.uwo.ca/~lreid/kids/baby/
  ◦ mpg → 11M
  ◦ wmv →771K (0.7M)
  ◦ wmv → 363K (0.3M)
  ◦ flv → 6.6 M
- http://www.csd.uwo.ca/~lreid/cs033/flvtest.html

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Before HTML5, to insert video, the code looked like this ☹:

```
<object classid="clsid:D27CDB6E-AE6D-11cf-96B8-444553540000" width="475" height="269" id="FLVPlayer">
  <param name="movie" value="FLVPlayer_Progressive.swf" />
  <param name="quality" value="high" /> <param name="wmode" value="opaque" />
  <param name="scale" value="noscale" /> <param name="salign" value="lt" />
  <param name="FlashVars"
value="&amp;MM_ComponentVersion=1&amp;skinName=Clear_Skin_1&amp;streamName=pictures_1&amp;autoPlay=false&amp;autoRewind=false" />
  <param name="swfversion" value="8,0,0,0" />
<!-- This param tag prompts users with Flash Player 6.0 r65 and higher to download the latest version of Flash Player.
Delete it if you don't want users to see the prompt. -->
  <param name="expressinstall" value="Scripts/expressInstall.swf" /> <!-- Next object tag is for non-IE browsers. So hide it
from IE using IECC. --> <!--[if !IE]>-->
  <object type="application/x-shockwave-flash" data="FLVPlayer_Progressive.swf" width="475" height="269">
<!--<![endif]--> <param name="quality" value="high" /> <param name="wmode" value="opaque" />
  <param name="scale" value="noscale" /> <param name="salign" value="lt" />
  <param name="FlashVars"
value="&amp;MM_ComponentVersion=1&amp;skinName=Clear_Skin_1&amp;streamName=pictures_1&amp;autoPlay=false&amp;autoRewind=false" />
  <param name="swfversion" value="8,0,0,0" /> <param name="expressinstall" value="Scripts/expressInstall.swf" />
<!-- The browser displays the following alternative content for users with Flash Player 6.0 and older. --> <div>
<h4>Content on this page requires a newer version of Adobe Flash Player.</h4> <p><a
href="http://www.adobe.com/go/getflashplayer">
<img src="http://www.adobe.com/images/shared/download_buttons/get_flash_player.gif" alt="Get Adobe Flash player"
/></a>
</p> </div> <!--[if !IE]--> </object> <!--<![endif]--> </object>
```

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Inserting Video into your webpage using…HTML5

- Currently HTML5 supports 3 video formats:
  ◦ MP4
  ◦ WebM
  ◦ Ogg
- Have to worry about what browser your viewer is going to use:

Browser	MP4	WebM	Ogg
Internet Explorer	YES	NO	NO
Chrome	YES	YES	YES
Firefox	YES	YES	YES
Safari	YES	NO	NO
Opera	YES (from Opera 25)	YES	YES

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HTML5 Video Formats

- Apple is trying to get away from Flash so it won't support .flv,
- HTML5 does NOT support .flv
- HTML5 Standards group wanted:
  ◦ Good compression, good image quality
  ◦ Royalty free
  ◦ Should handle hardware issues as well as software issues
- Works on handheld devices too ☺

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HTML5 supports →ogg, webm and mp4

- Originally only wanted to use codec: Theora or Vorbis (.ogg containers) because they were open source but Apple wasn't sure if they were open source
- WebM another file format, royalty free, open source, backed by Google
  ◦ YouTube uses WebM
- Apple and Microsoft only support the codec: H.264 which creates .mp4 files
  ◦ Used in blu-ray discs, vimeo, YouTube and iTunes
  ◦ H.264 is lossy but can do lossless

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How to add video in HTML5

- Make sure you encode your video as a mp4, ogg or WebM file using Adobe Encoder
- Put your video somewhere inside the folder containing your website (perhaps a subfolder). E.g. if you folder is assign3, maybe put video in *assign3/myvideo* folder:
- Make sure the first line of your webpage is:
  ◦ <!DOCTYPE html> (this indicates it is html5)

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HTML5 <video> tag

- Edit the html code in the assign3 folder (e.g. the index.html file) and put the following <video> tag where you want the video as follows:

```
<video width="320" height="240">
  <source src="myvideo/dog.mp4" type="video/mp4">
</video>
```

- Might need this →

```
<video width="320" height="240">
  <source src="myvideo/dog.mp4" type="video/mp4">
  <source src="myvideo/dog.ogg" type="video/ogg">
  <source src="myvideo/dog.webm" type="video/webm">
  Your browser does not support the video tag.
</video>
```

- QUESTION: What do you think each of these parameters do?

```
<video width="320" height="240" controls autoplay loop muted poster="doggy.jpg">
  <source src="myvideo/dog.mp4" type="video/mp4">
```

- QUESTION: What do you think this does:

```
<source src="myvideo/dog.mp4#t=10,22" type="video/mp4">
```

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Other Terms You Need To Know

- ***Container File Format***
  - A file format that stores both the data (the frames) AND how to play the data(which codec to use)
  - Some common containers are:
    - **avi** → sometimes has uncompressed video, just depends, no streaming
    - **flv** (doesn't allow subtitle)
    - **.ogg** (free open source container format)
    - **mp4**
      - **Question**: Why, in our multicultural world, might this container format be useful?
- Newer container formats support subtitles, chapters, etc…
- **Question**: Why can your computer sometimes play one .avi file but then not play another .avi file?

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Something else cool you can do with HTML5 and container file formats:

- Pick a subtitle (need to have the video set up specially but it is possible):

```
<video controls style="width:640px;height:360px;" poster="poster.png">
  <source src="devstories.webm" type='video/webm;codecs="vp8, vorbis"' />
  <source src="devstories.mp4" type='video/mp4;codecs="avc1.42E01E, mp4a.40.2"' />
  <track src="devstories-en.vtt" label="English subtitles" kind="subtitles" srclang="en" default></track>
</video>
```

http://www.html5rocks.com/en/tutorials/video/basics/

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How do you insert a YouTube video into your webpage?

- Steps:
  - 1. View and then cut the url for the video you want to include on your page, eg:
    https://www.youtube.com/watch?v=uJpaQWWgaC8
  - 2. cut just the part after …watch?v= so in our case it would be: uJpaQWWgaC8
  - 3. go into the html code for the page where you want put your YouTube video and insert this:

```
<!DOCTYPE html>
<html>
<body>
<iframe width="480" height="390"
src="https://www.youtube.com/embed/uJpaQWWgaC8" frameborder="0">
</iframe>
…
```

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More Terms

- **Digital Media Player** → a piece of software that will play multimedia files (audio or video) but not necessarily in a browser.
- Most players will play a variety of file formats
- *Windows Media Player* (bundled with Windows 7). Some Features (e.g. supports streaming)
- **Question**: What is the Apple version of Windows Media Player for playing video files?
- **Question**: What is the Apple software developed for playing audio files?
- **Question**: Can anyone name another player?
- Good Review (start at minute 2)

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Break

- Laura's old Favourite YouTube video

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6

Bandwidth and Bit Rate and Streaming

- *Bandwidth* → how much data CAN be pushed can be pushed across a connection (the capacity) in a given amount of time
  - Similar to the pipe that comes into your house to bring water in. The wider the pipe the more water
  - For years, Ethernet has been one of the best connections methods (100 Gigabits in 2010)
  - **QUESTION: what does this image imply about bandwidth?**

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Table o' Bandwidth Requirements (Downstream)

Bandwidth (per user)	What it's fast enough for...
< 1 Mbps	Email Instant Messaging Frustrating Web Browsing MUDs (those old text adventure games, remember?)
1-2 Mbps	Web Browsing Audio Chat Streaming Audio (i.e. Pandora) Online Gaming Facebook
3-4 Mbps	Video Chat Streaming Video (YouTube, Netflix, etc.) High Quality Photos Peer to Peer File Sharing Obsessive Facebook Use
5-9 Mbps	Streaming HD Video Porn (see Streaming HD Video)
10-20 Mbps	Digital Software Distribution
20-50 Mbps	Downloading very large files Porn Addiction (see Downloading very large files)
50+ Mbps	Huge households Corporations Small Countries Impatient People

- http://www.ctrl-shift.net/today/advice/how-much-bandwidth-do-i-need Slide 38 of 44

Bit Rate
- Video are given a data rate or bit rate (bits per second) but images are not, why?
  - **Question: What are the 2 issues you have to content with when delivering a image vs. video over the internet? Assume:**
    - **video file size =10 Megabytes and about 1.5 minutes long (bit rate is about → .11 Mbytes)**
    - **image file size = 0.5 Megabytes**
    - **Connection A has a bandwidth of 100 Megabytes per second**
    - **Connection B has a bandwidth of 5 Megabytes per second**
    - **Connection C has a bandwidth of 0.1 Megabytes per second**
    - **NEED TO CONSIDER not only file size but bit rate!**

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Video on the Web
- 4 main ways to get video/audio (media) from a website onto your computer so you can view it:
  - **Download**
  - **Progressive Download**
  - **Streaming**
  - **Adaptive Streaming**
- Media is either streamed or not streamed.

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Download
- Used to be the ONLY option!
- When you visit a website containing video, the entire video must be downloaded to your computer before you can play it.
- For the web, usually stored on a HTTP protocol
- Data that is sent is **permanently** stored on the end machine.
- Disadvantages:
  - **Question**: What do you think is a disadvantage?
- Advantages:
  - **Question**: What do you think is an advantage?

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Progressive Download
- A click begins the download, but after some portion of the file has been downloaded, the video will start to play.
- The player (e.g. Windows Media Player) calculates the speed of the download and guesses when to start playing it.
- Data that is sent is **permanently** stored on the end machine.
- Disadvantages:
  - **Question**: What do you think is a disadvantage?
- Advantages:
  - **Question**: What do you think is an advantage?

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Streaming

- In true streaming the file is never permanently saved to the user's hard drive, media begins to play as soon as it gets first packet.
- Disadvantages:
  - **Question**: What do you think is a disadvantage?
- Advantages:
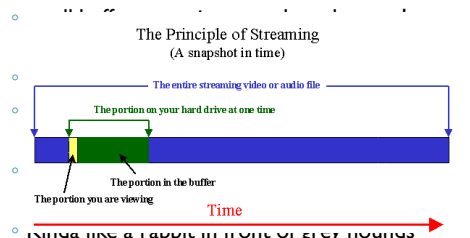 - **Question**: What do you think is an advantage?

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Streaming

- Media such as "streamed" (older radio, TV) or non-streamed (books, CDs, DVDs)
- Live streaming or True streaming→ content delivered LIVE over the internet
  - needs GREAT compression
  - encoder to digitalize content
  - not saved to the hard drive, make is much harder to copy!
- On Demand Streaming (progressive download)
  - Often saved to hard disk (easier to copy)

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Streaming

- When streaming video (like on youtube), the video must be delivered fast enough so there appears to be no delay
- Uses buffering:
  - will buffer certain amount and stay ahead

The Principle of Streaming
(A snapshot in time)

The entire streaming video or audio file

The portion on your hard drive at one time

The portion in the buffer

The portion you are viewing

Time

  - Kinda like a rabbit in front of grey hounds

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Streaming…

- Sometime requires special streaming server (RTSP)
- Video starts almost immediately
- If the data rate (bit rate) of the encoded video file is bigger than the bandwidth capacity of the viewer, the video will frequently STOP PLAYING ☹
- Unicast vs. Multicast
  - **Unicast** → each user gets his/her own stream of video, the server has to send out A LOT of data if several users are watching at once
  - **Multicast** → send the same stream to a bunch of users but then they lose the ability to pause, rewind, etc.

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Progressive Download…

- Starts to play as soon as buffer full enough
- Easier to copy because it is stored on the hard disk
- YouTube used to do *Progressive Download* (it would start downloading and start playing as soon as there was enough in the buffer)
- https://www.youtube.com/watch?v=Fal0IdL05JM&t=56
- YouTube is now (because of 4K content) starting to do *Adaptive Streaming*

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Adaptive Streaming

- Don't need a streaming server, can use http
- In adaptive streaming, the provider monitors your bandwidth, if the connection is not very busy (lots of bandwidth), high quality video is sent, if the connection is busy, low quality video is sent, this way it can "adapt" to the situation so the user never has to wait.

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Largest online video sites (as of 2014)

Largest online video sites

Site	Monthly global traffic (PB)	Monthly unique visitors	Monthly video v
Youtube	7,874.8	1,000,000,000	70,000,00
Netflix	6,102.9	48,000,000	
Bittorrent	3,861.5		
Apple iTunes video*	817.2	34,500,000	
Dailymotion	488.8	120,000,000	2,500,00
Amazon Prime Instant Video	315.9	20,000,000	
Hulu	289.3		

More info about streaming websites

Great Review of the Concepts

Chart from: http://techexpectations.org/tag/dailymotion/

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A Little More on YouTube

- YouTube accepts video in the following formats: .WMV, .AVI, .MOV, MPEG and .MP4 but then converted them to the mp4 format
- YouTube used to output everything in as either .flv or .f4v (Flash video) as every computer had Flash
- **QUESTION: Why is YouTube moving away from Flash (HINT: what devices won't play Flash video)?**

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YouTube

- Moving towards HTML5 and now converting video to .mp4 files (still Flash compatible)
- Quality
  - Standard (original) format 320X240 pixels, mono audio
  - March 2008 → up to 864X480 pixels and stereo sound
  - Nov 2008 → 1280X720pHD added, changed ratio from 4:3 to 16:9
  - Nov 2009 → 1080p HD support
    - http://upload.wikimedia.org/wikipedia/commons/c/c4/Youtubecompfull.png
  - NOW even does 4K

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Video in Multimedia Applications

Things to consider when using video in your site:
- **Source**
  - Quality is tied to colour, resolution, fps, compression format, frame size.
- **Appropriateness**
  - If the quality of the video is going to be bad (because of required compression), perhaps we should just use images or animations instead?
- **Playback Systems**
  - Will the user have the required playback software? (will they need to be directed to download a plugin?). **HTML5 does NOT need a plug in!!!**
- **User Controls**
  - Let the user have ability to pause/stop/loop/control volume

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Review

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