

# INTRODUCTION TO MEDIA INFORMATICS

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# FIRST OF ALL: TODAY'S PLAN

- Whoami?
- Whoareyou?
- Today's schedule:
  - 14:00-15:30 part I
  - 16:00-17:30 part II
- Tomorrow
  - 14:00-15:30
- Rest of the week: self-directed readings.

MOTIVATION: A YOUTUBE VIDEO



# MOTIVATION: A YOUTUBE VIDEO

- FallOut Nuka Break, Wayside Creations
- [http://youtu.be/\\_iq8swQ7kpg](http://youtu.be/_iq8swQ7kpg)



# VIDEO PRODUCTION: STORYBOARD



Man is happy to see pretty flower. Man bends over to touch flower.



Flower snaps up at Man. Man flinches back and is very surprised.



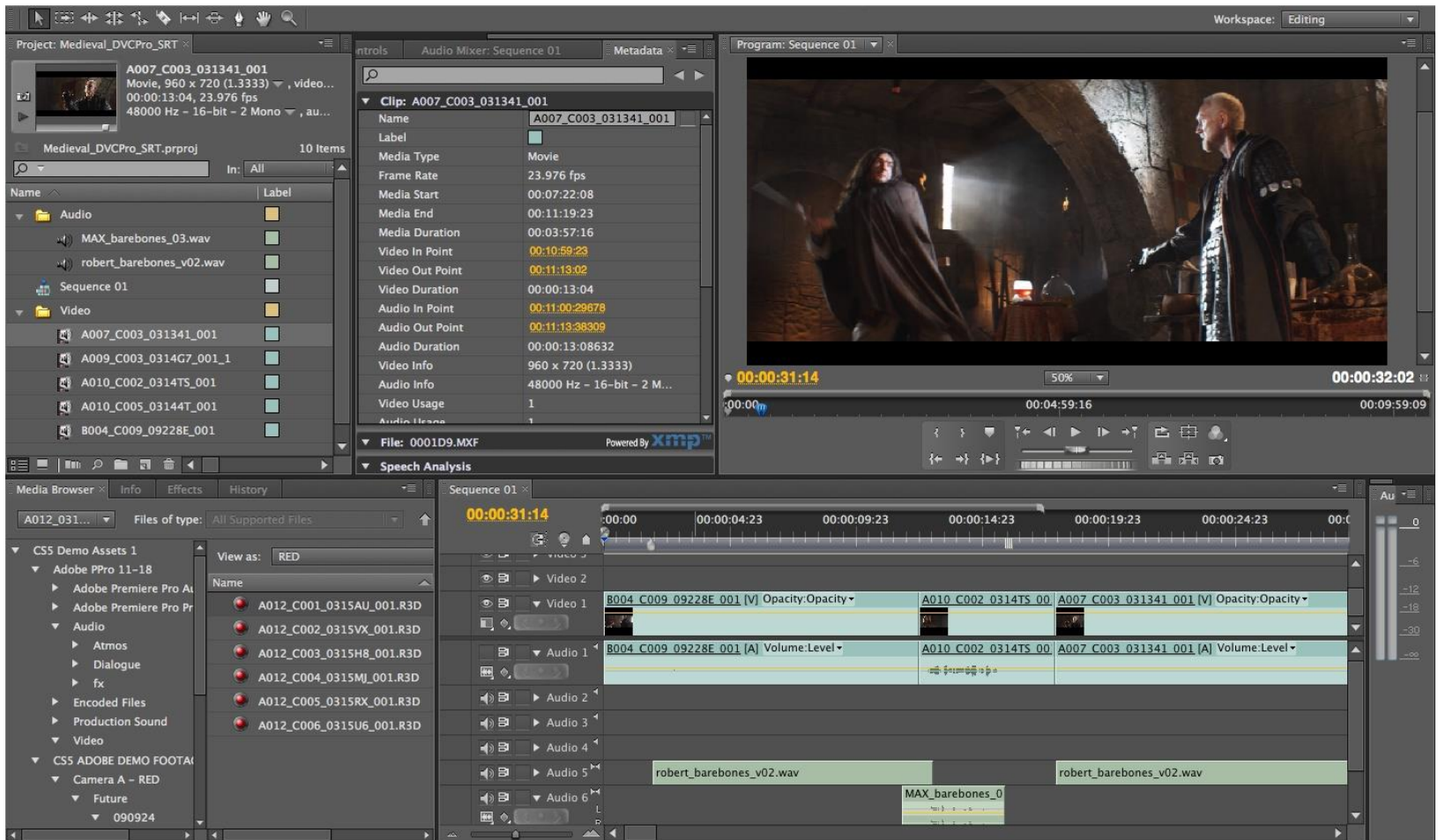
Flower goes back to original pose. Man is upset with the flower for scaring him. He gives the flower an angry glare.

# VIDEO PRODUCTION: RECORDING

- Behind the Scenes, Wayside Creations
- <http://youtu.be/dSjPaSWENw8?t=6m35s>



# VIDEO PRODUCTION: CUT, SFX & EDITING



# VIDEO PRODUCTION: CUT, SFX & EDITING



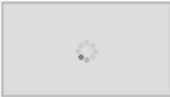


# VIDEO PRODUCTION: PUBLISHING


Uploaded 0 of 1 videos

Video Manager

+ Add more videos




## Supercooles Video mit einer Katze und einer Maus

Uploading your video. 2 minutes remaining. Your video will be live at: 

29%

+ Add to ▾

✕ Cancel




For better results, adjust your Quicktime settings to prepare videos for internet streaming. For more information, visit our [Help Center](#).

✕

Basic info

Advanced settings



### Title

Supercooles Video mit einer Katze und einer Maus

### Description

Katze spielt mit einer Maus.

### Tags ?

maus ✕ katze ✕ |

+Massachusetts Institute Of Technology (College/University)

### Video thumbnails ?

Thumbnail selections will appear when the video has finished processing.

### Privacy settings ?

Unlisted ▾

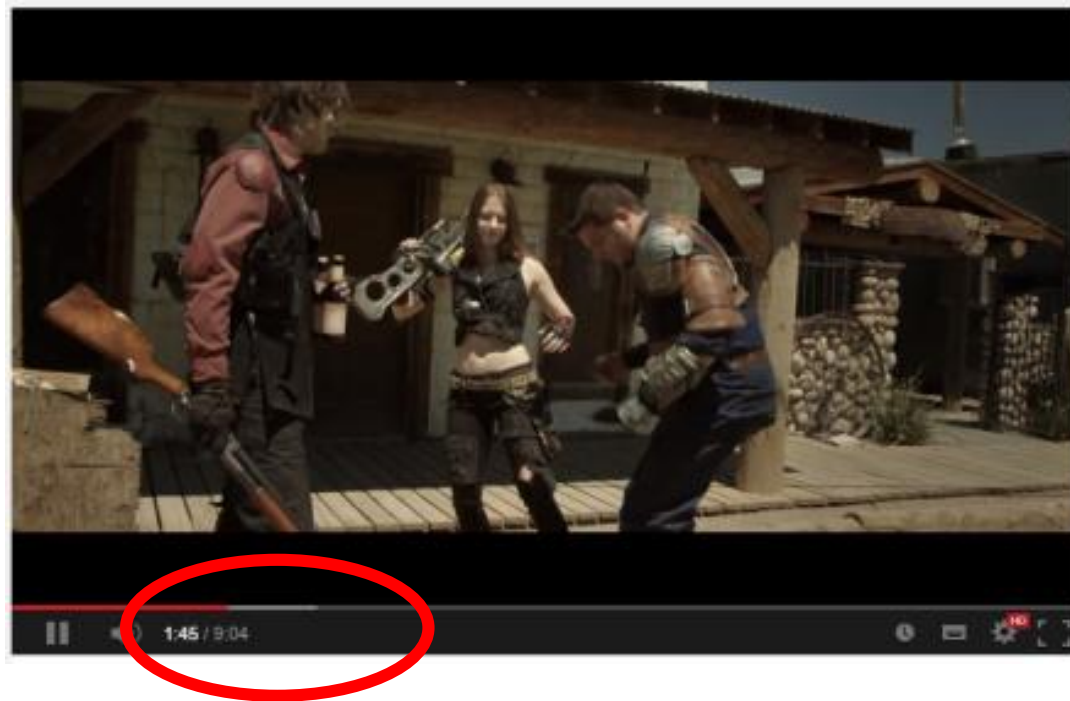
Anyone with the link can view

### Category

Entertainment ▾

# VIDEO CONSUMPTION: VIEWING

- Web server, video server
- Client browser, client video player



# TECHNO VIKING

- Viral video ...
- <http://www.heise.de/newsticker/meldung/Dokumentarfilm-Die-Story-des-Techno-Viking-2849367.html>

# MEMES

RickRoll'd

<https://www.youtube.com/watch?v=E8EBWyRXPdw>

# WRECKING BALL – CHAT ROULETTE

[https://www.youtube.com/watch?v=W6DmHGYy\\_xk](https://www.youtube.com/watch?v=W6DmHGYy_xk)

# MEDIA INFORMATICS – A DEFINITION

- Informatik (de) == Computer Science (en)
- Computer Science and Media: Digital Media
- Digital Media is produced, consumed, shared, and edited by people
  - It's not about data bases
  - It's about people



# MEDIA – A DEFINITION

- Storage
- Transmission Channels
- Systems & Services

# MEDIA – STORAGE

- Physical Media
  - analog: audio tapes, records, paper, ...
  - digital: compact disc, DVD, hard drives
- Digital Formats
  - eBooks, HTML, ...
  - MPEG-4, AAC, MP3 ...





# MEDIA – TRANSMISSION CHANNEL

- Distribution of Information
- Analog
  - Radio Channels, Newspaper
- Digital
  - DVB-T, Internet



# MEDIA – SYSTEMS AND SERVICES

- “In the Media”



# MEDIA INFORMATICS - CHALLENGES

- Transform traditional to digital media
- Authoring and Production
- New Media and Interaction

# CHALLENGES – TRANSFORM TO DIGITAL

- Digital Rights Management
  - How to borrow, annotate or preserve an eBook or an audio tape, ie. with iPad, Kindle, ...
- Physical artifacts
  - Nothing to touch & possess, ie. games downloads
- Distribution
  - Costs and access, ie. mobile, distribution networks
- Business models
  - Added value, profit, user content, ...



# CHALLENGES – AUTHORIZING AND PRODUCTION

- Complex authoring tools
  - eg. motion capture, performance capture
  - <http://youtu.be/ikrM5DrWj10> (D. Cage, Beyond)
- Automated methods
  - eg. multi camera, bullet time
  - <http://youtu.be/rQmHFb4rd6U> (Multicam system)

# CHALLENGES – INTERACTION

- Mobile devices & screens
  - Additional sensors, etc.
  - <http://youtu.be/UOdOD3B8sg8> (B. Kaufmann)
- New devices
  - eg. Oculus Rift, stereoscopic cams ...



# MEDIA – INTERDISCIPLINARY APPROACHES

- Cognitive Science
  - human factors and impact of media on people
- Social Science
  - impact and role of media on society
- Economic Science
  - economic aspects of media
- Computer Science
  - technical possibilities and limitations

# HUMAN PERCEPTION VS. REALITY



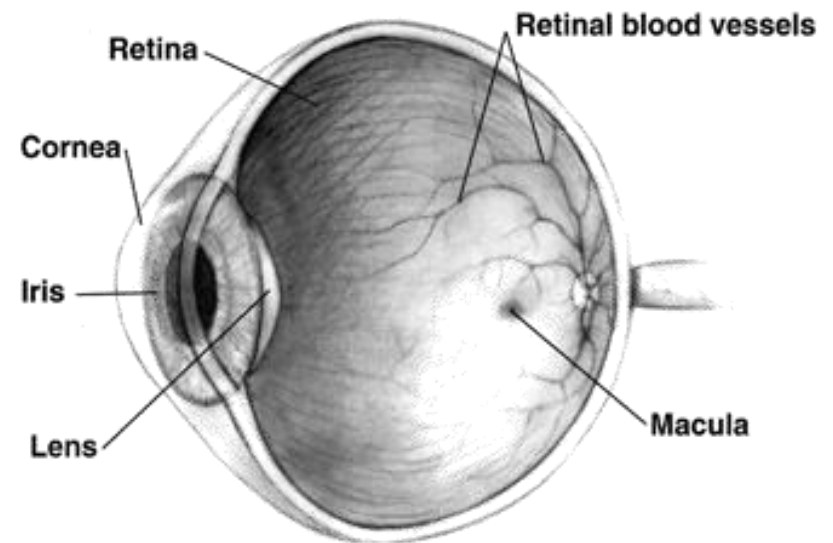


# HUMAN PERCEPTION

- How do people process information?
- Traditional senses
  - Sight, Hearing, Touch
  - Smell, Taste
- Other senses
  - Balance, acceleration, temperature, time, pain
  - Kinesthetic sense (Proprioception)

# THE SENSE OF SIGHT – HUMAN VISION

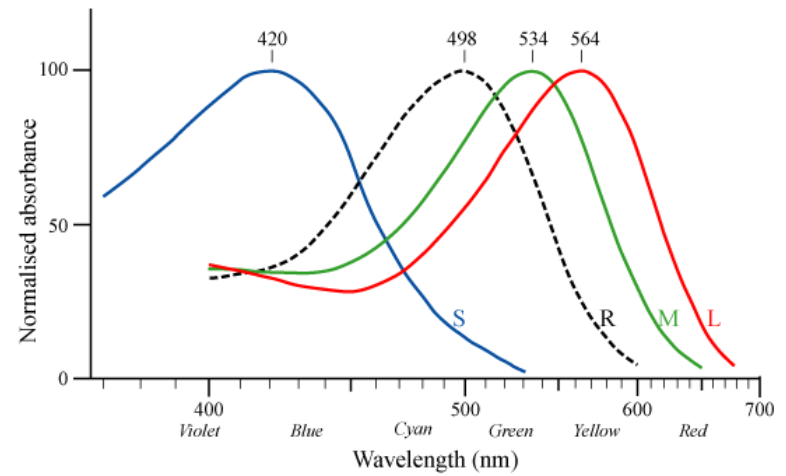
- The eye as instrument of perception
- Sensory capabilities
  - Cones (bright light): 6-7 Mio.
  - Rods (dim-light): 75-150 Mio.
  - Brain 'corrects' vision
    - e.g. blind spot



# THE HUMAN EYE – CONES AND RODS

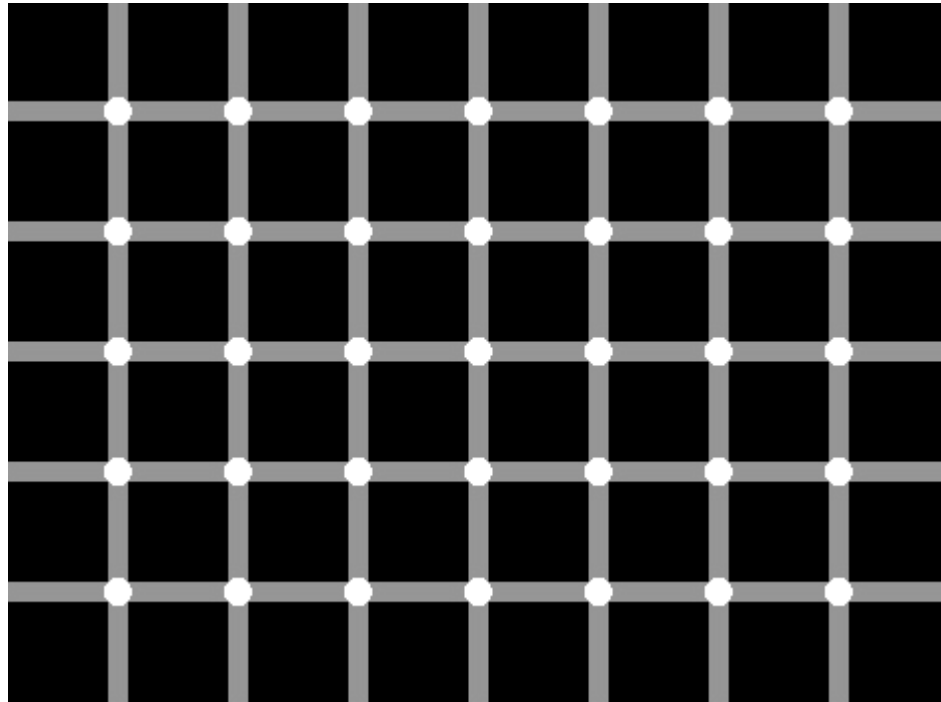
S-, M- and L-cones: Blue, green and red

- Responsiveness of cone types
- Number of cones / types
- etc.



# THE HUMAN EYE ...

- Count the black dots on the image:



# THE HUMAN EYE ...

- Rabbit or duck?



# THE HUMAN EYE ...

- Anamorphic illusions



See e.g. <http://users.skynet.be/J.Beever/pave.htm>

# THE HUMAN EYE ...

- Anamorphic illusions



See e.g. <http://users.skynet.be/J.Beever/pave.htm>

# HUMAN PERCEPTION – THE EYE

- Cones and rods are not evenly distributed
- Focusing is done by small muscles
- Color blindness affects 8% of the male, 1% of the female population
- 285M people are visually impaired worldwide (WHO, June 2012)

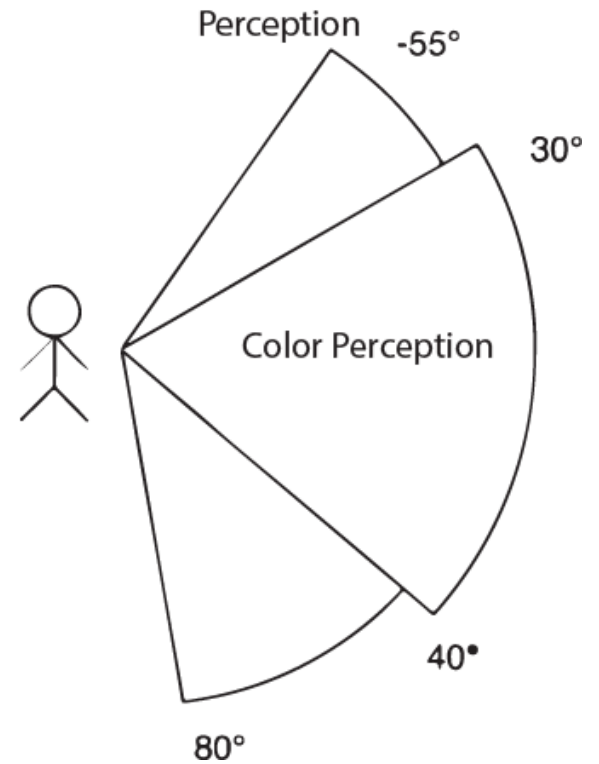
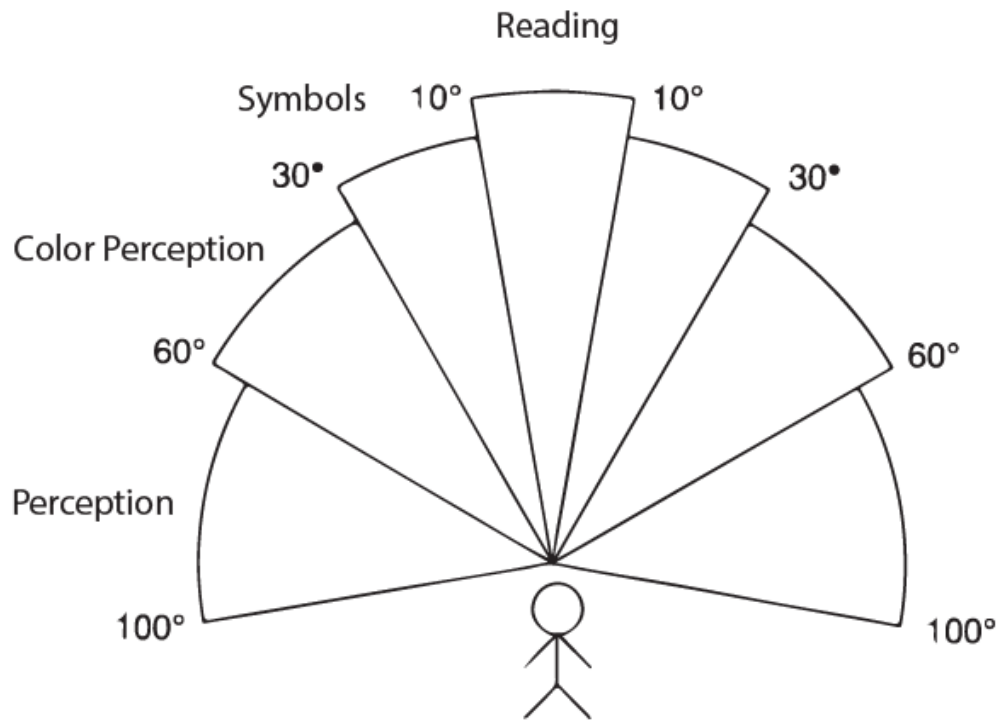


# 3D VISION

- Monocular cues
  - Relative & familiar size,
  - Motion Parallax, Occlusion
  - Depth from optical expansion, ...
- Binocular cues
  - Stereoscopy, ...



# THE HUMAN EYE – SPATIAL PROPERTIES



# THE HUMAN EYE – TEMPORAL PROPERTIES

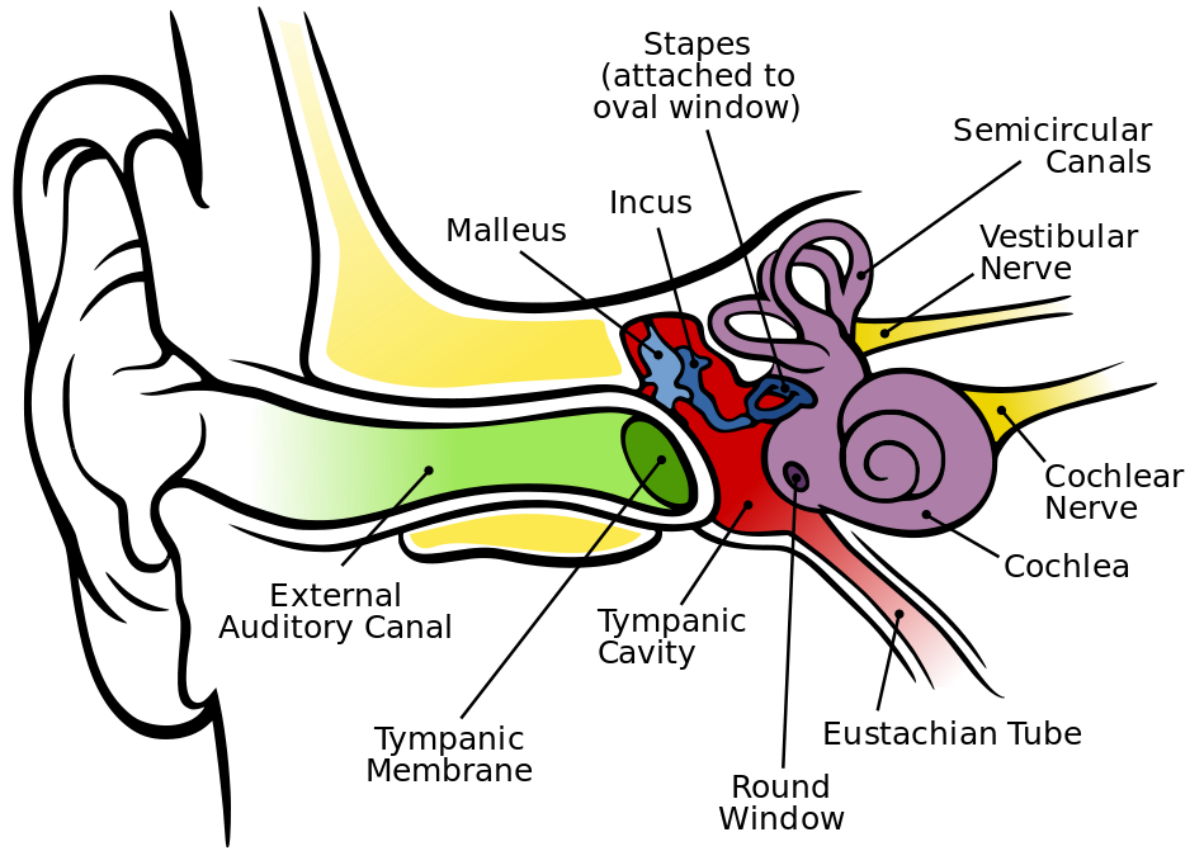
- Visual information is perceived in 15-50ms
- Subsequent images are perceived as motion
  - ie. motion pictures, videos
- 3-5 images / second imply movement
- 20-25 images and more imply smooth movement

# THE HUMAN EYE – TEMPORAL PROPERTIES

- Demo: Videos with 6, 12, 20, 24 frames.
  - The Simpsons Movie Trailer



# THE SENSE OF HEARING

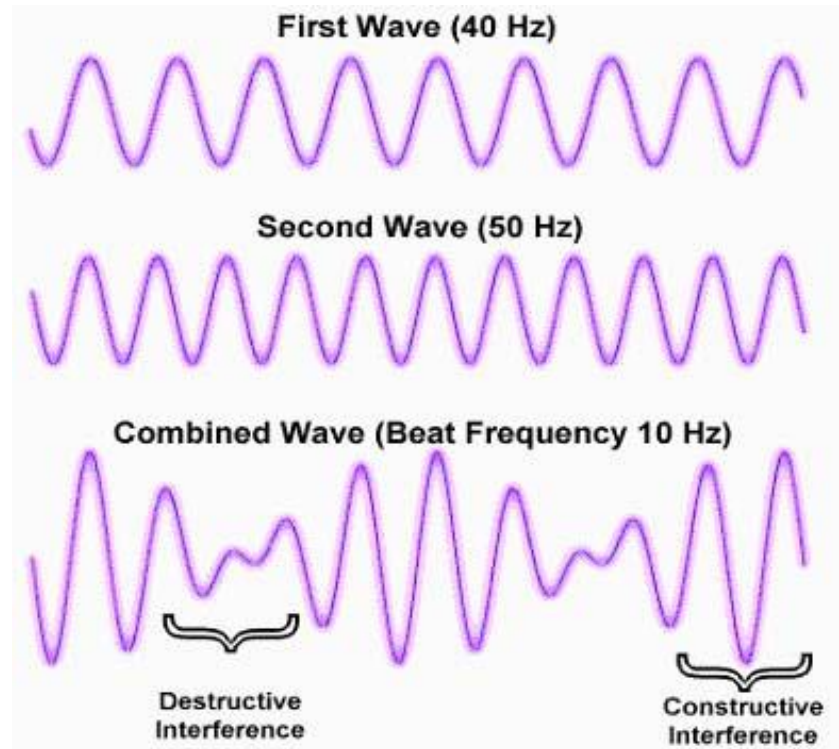


# WHAT IS SOUND?



# WHAT IS SOUND?

- Multiple sounds at the same time?



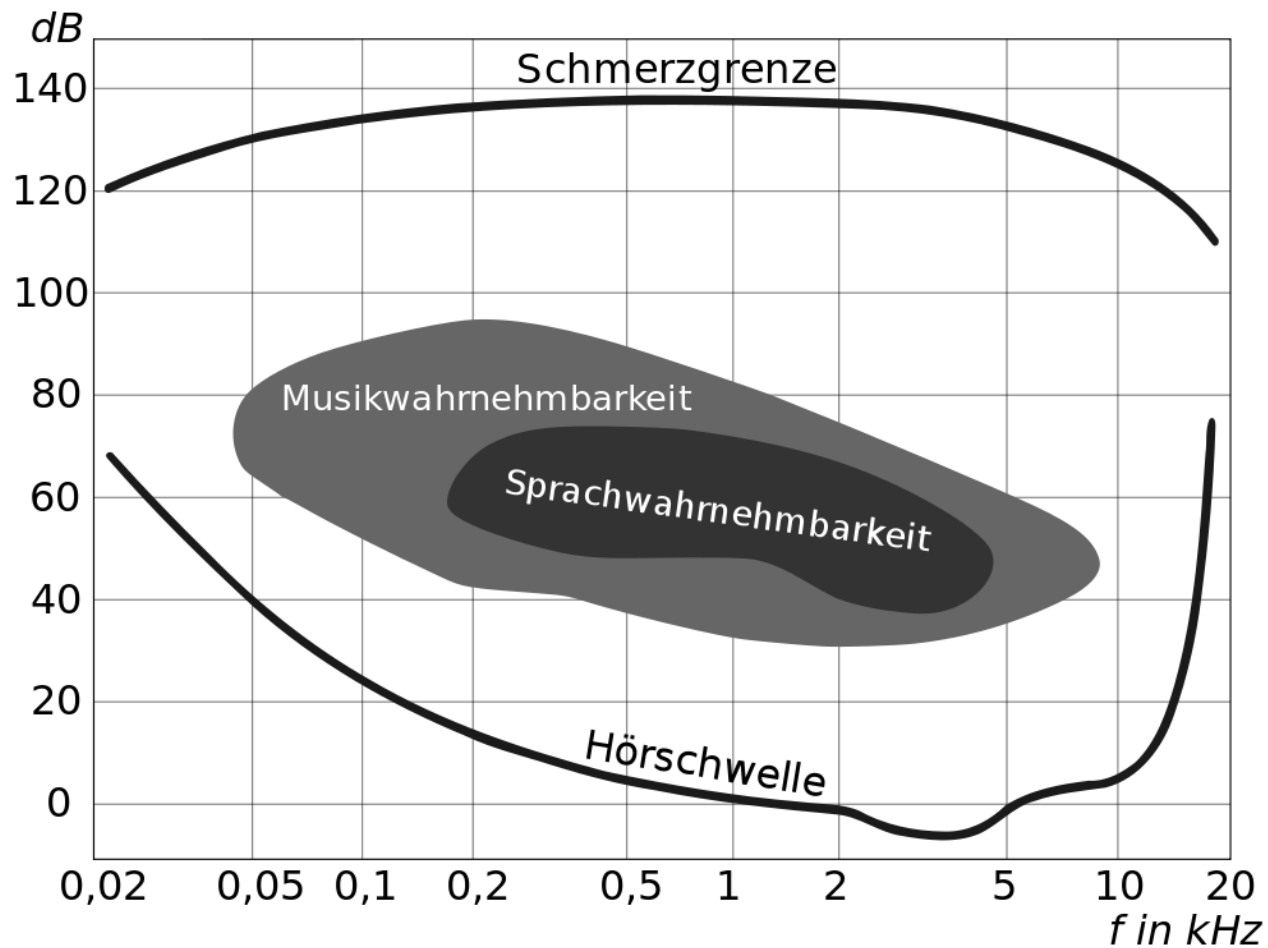
# WHAT IS SOUND?

- Analog Synth Demo

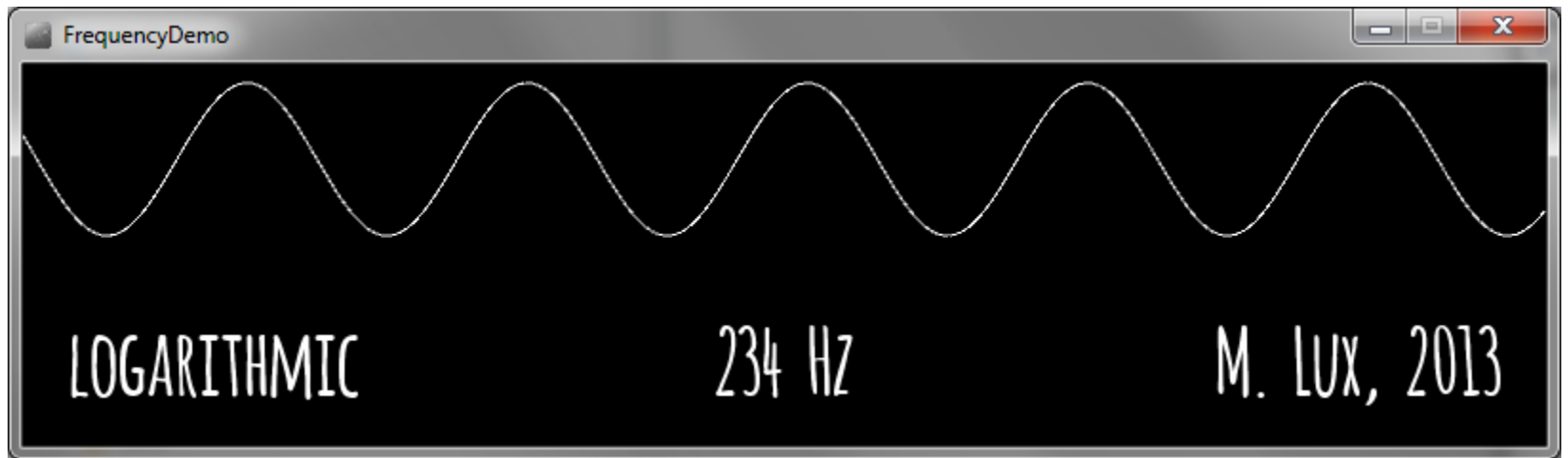




# THE SENSE OF HEARING



# THE SENSE OF HEARING



# THE SENSE OF HEARING

- Human ear is very sensitive to temporal changes (2-3ms)
- Spatial resolution is worse than with the eye
- Exponential frequency change is perceived linear
- Brain also “adds” information to everything heard

# DIGITIZING INFORMATION

- Converting analog signals to digital ones
- Analog-to-digital converter

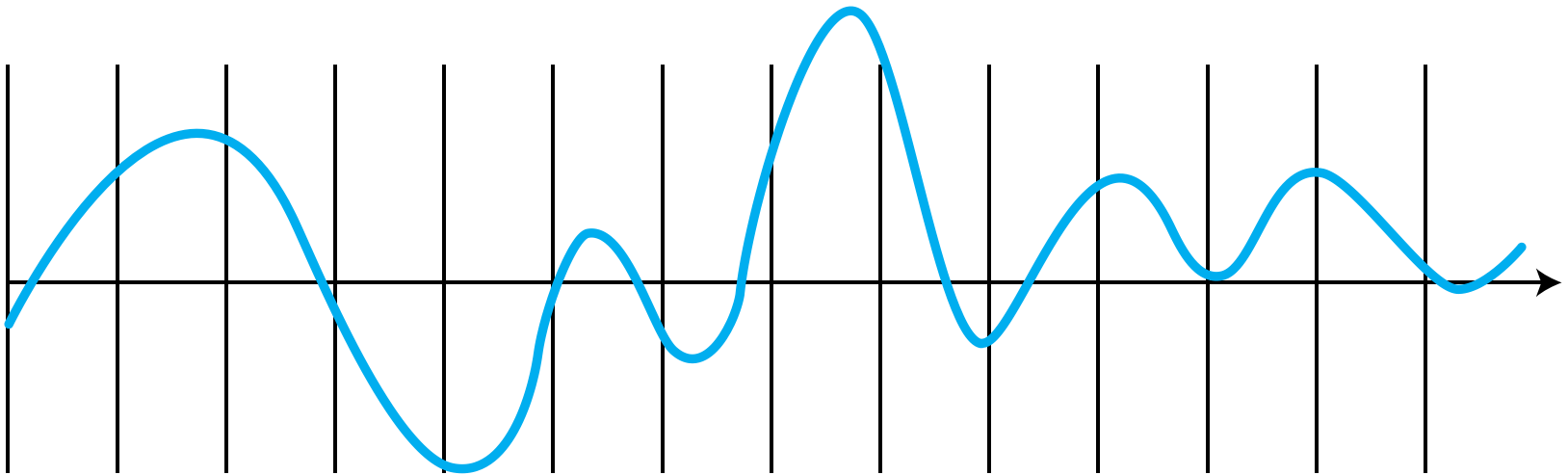


# WHAT IS AN ANALOG SIGNAL?

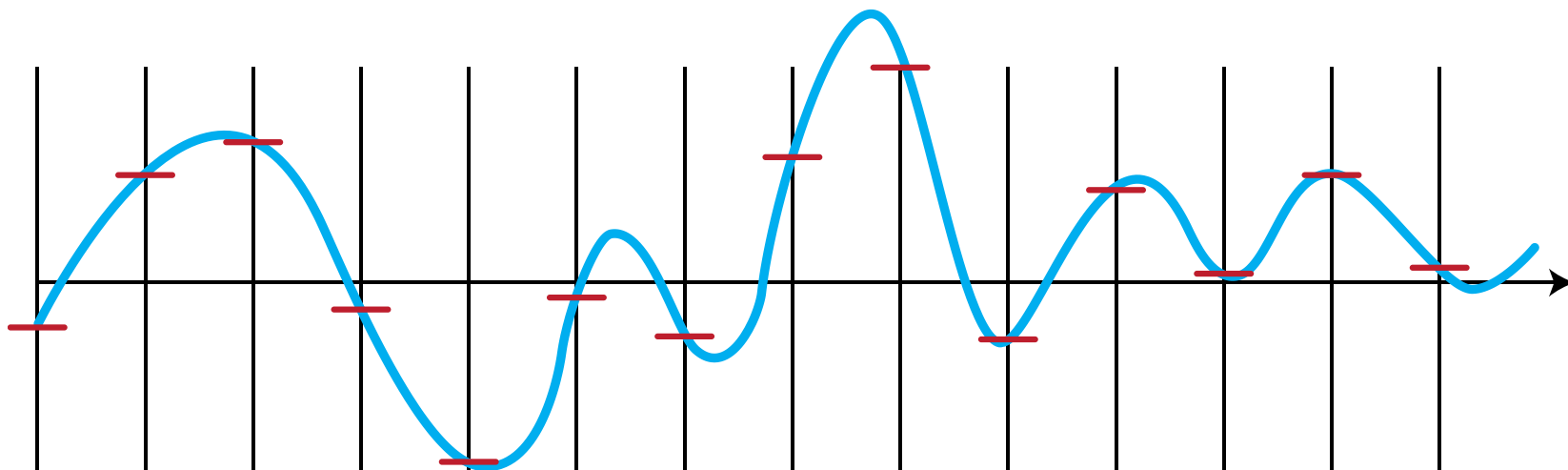
- Continuous signal
- Varying a physical feature
  - e.g. more light, less light
  - voltage, pressure, current, ...

# WHAT IS A DIGITAL SIGNAL?

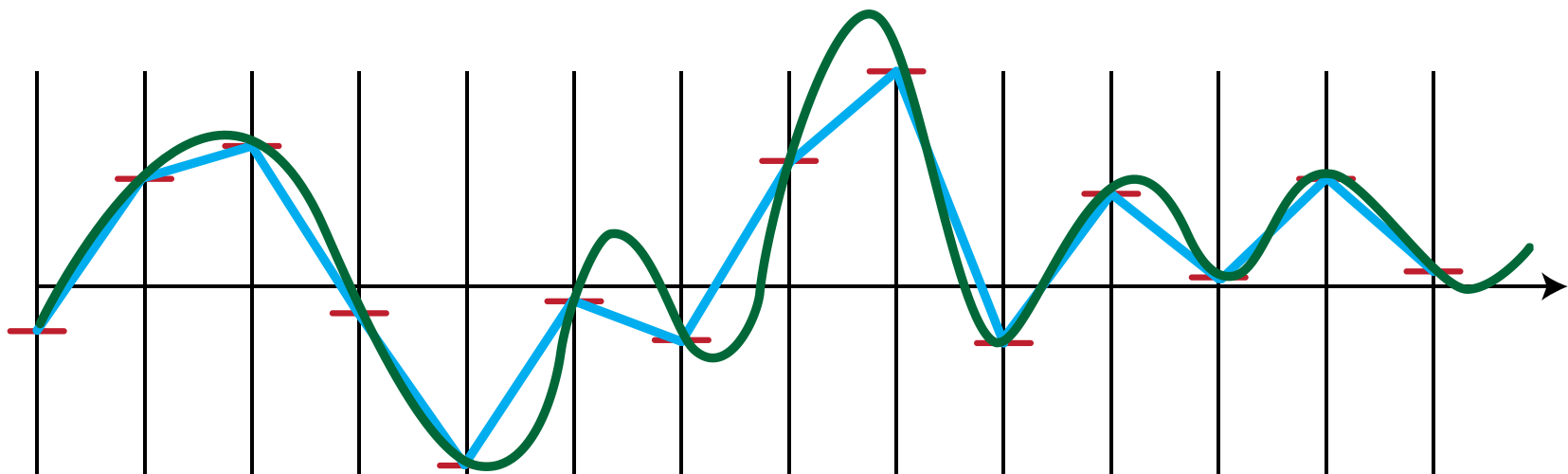
- Has a limited and discrete range for variables
- Is typically an approximation of a analog signal
- Allows for processing in a digital computer.



# DIGITIZATION

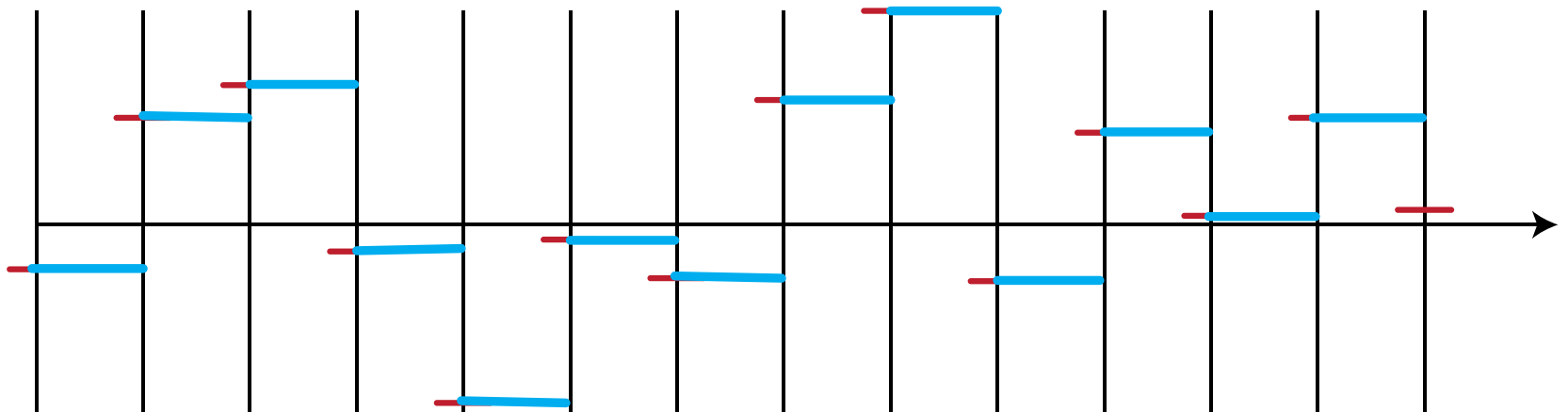


# DIGITIZATION



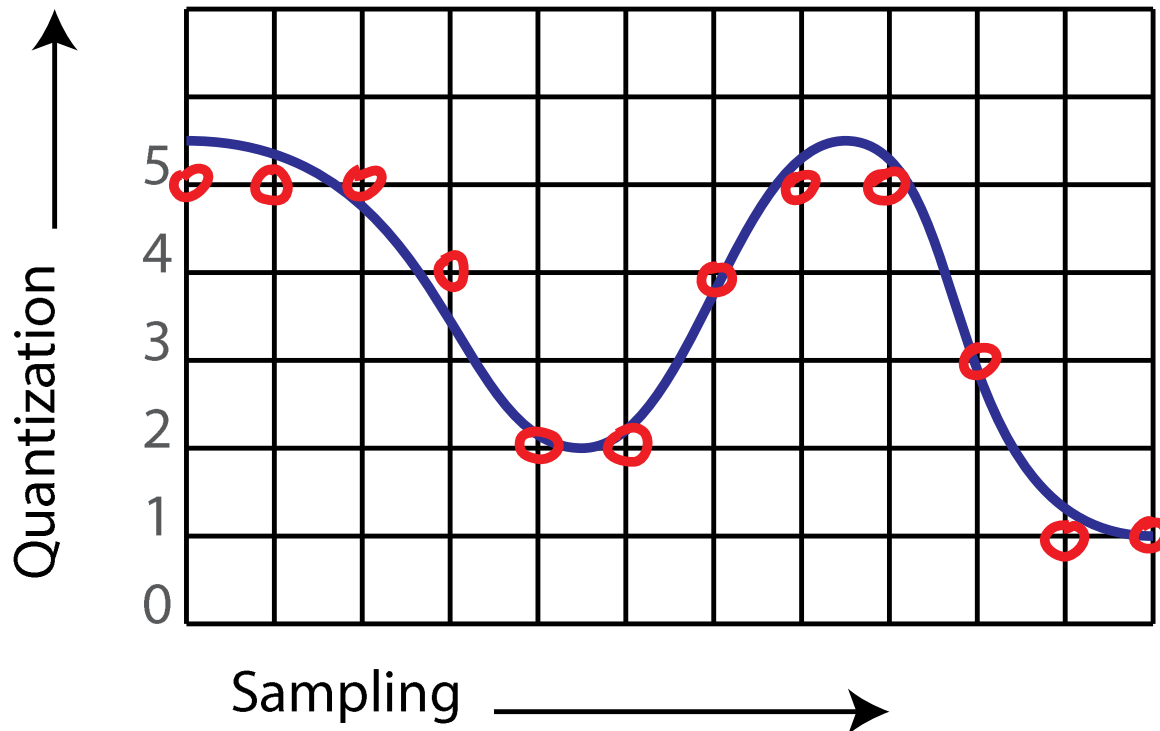


# DIGITIZATION



# QUANTIZATION & SAMPLING

- Digital signal: 5, 5, 5, 4, 2, 2, 4, 5, ...
- Binary: 101101101100010010100101...



# SAMPLING THEORY

- Nyquist-Shannon sampling theorem
  - Harry Nyquist and Claude Shannon (1949)

If a function  $x(t)$  contains no frequencies higher than  $B$  hertz, it is completely determined by giving its ordinates at a series of points spaced  $1/(2B)$  seconds apart.

# ADDITIONAL CONCEPTS

- Information Theory
- Entropy & Entropy Coding
- Digital Rights Management
- Licenses

# INFORMATION THEORY

- Quantification of information
- Limits for compression
- Reliable storing & communication

# INFORMATION THEORY

Which signal carries most information?

1. 010101010101010101010101
2. 000000000000000000000000
3. 01101001110101100111101010

# ENTROPY

- Key measure in information theory
- Measures the uncertainty “for the next value”
  - Cp. How “chaotic” is your data?
- 00000000000000000000000000000000
  - It’s certain that the next value will be 0
  - Entropy is zero

# INFORMATION THEORY & ENTROPY

- The higher the entropy, the higher the quantified information
- The lower the entropy, the lower the quantified information
  - Information can be compressed
  - 00000000000000000000 -> 16x0



# ENTROPY

- Probability of occurrence of a symbol  $z_i$  is  $p_i$
- If there is 50% for letter “a”  $=: z_1$  to occur
  - $p_1 = 0.5$
- The entropy of a letter  $z_i$  is then

$$h_i = \log\left(\frac{1}{p_i}\right)$$

# ENTROPY

- Expected entropy  $H$  of a message
- Is based on each symbol of an alphabet  $A$

$$H = \sum_{i=1}^{|A|} (p_i \cdot h_i) = \sum_{i=1}^{|A|} (p_i \cdot \log_2(\frac{1}{p_i}))$$

# ENTROPY EXAMPLE

z	p	1/p	h	p*h
a	0,50	2	1	0,5
b	0,25	4	2	0,5
c	0,25	4	2	0,5
				H=1,5

$$H = \sum_{i=1}^{|A|} (p_i \cdot h_i) = \sum_{i=1}^{|A|} (p_i \cdot \log_2(\frac{1}{p_i}))$$

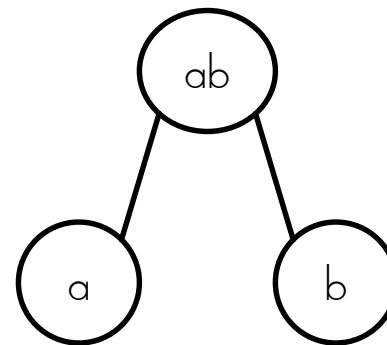
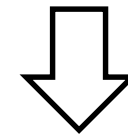
# HUFFMAN CODING

- Given an alphabet with probabilities for each symbols.
- We construct a code, that the entropy of a message is maximized.
- That is done with an algorithm ...

# HUFFMAN CODING

- Find the two symbols with the lowest probabilities.
- Combine those two in a tree with two leaves.
- Combine them in the table.
- If there is more than one symbol left, start over.

Symbol	p
a	0,10
b	0,15
c	0,30
d	0,16
e	0,29



Symbol	p
ab	0,25
c	0,30
d	0,16
e	0,29

# INTRODUCTION TO CRYPTOGRAPHY

- What is cryptography?
- What is cryptography used for?
- Basic principles & common methods

Readings: Menezes, Alfred J., Paul C. Van Oorschot, and Scott A. Vanstone. *Handbook of applied cryptography*. CRC press, 2010.  
<http://cacr.uwaterloo.ca/hac/>

# WHAT IS CRYPTOGRAPHY?

- Information as value
- Cryptography to secure this value
- For military, government & diplomatic services
  - ie. make sure “others” cannot access or manipulate information.

# WHAT IS THE USE OF CRYPTOGRAPHY? (1)

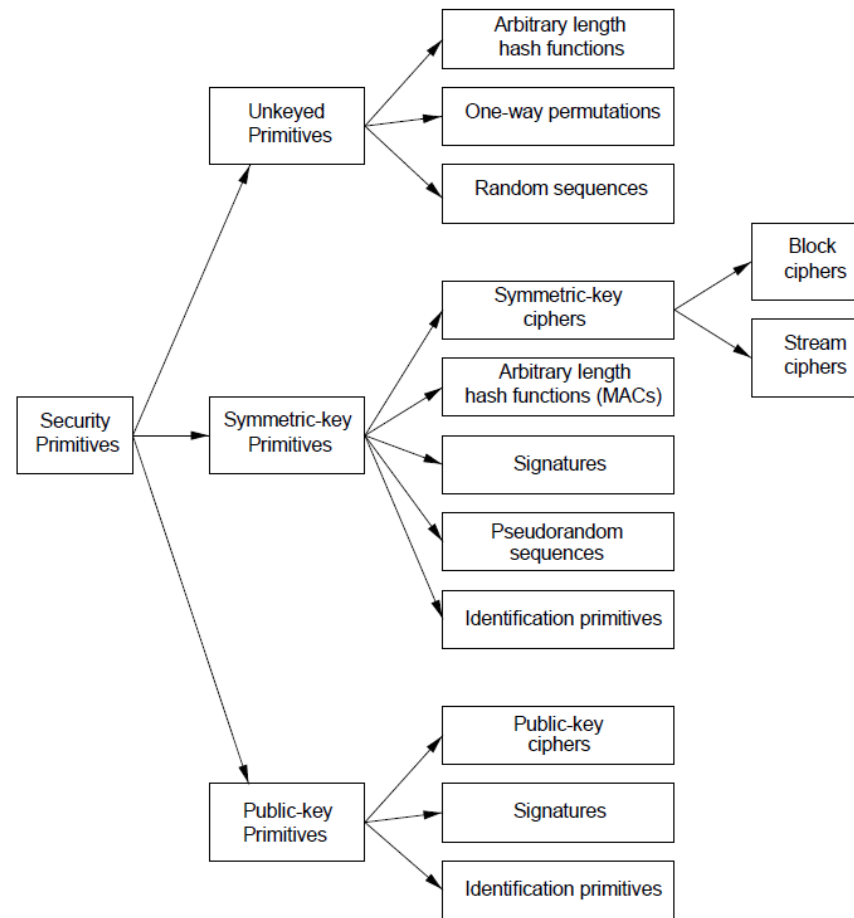
privacy or confidentiality	keeping information secret from all but those who are authorized to see it.
data integrity	ensuring information has not been altered by unauthorized or unknown means.
entity authentication or identification	corroboration of the identity of an entity (e.g., a person, a computer terminal, a credit card, etc.).
message authentication	corroborating the source of information; also known as data origin authentication.
signature	a means to bind information to an entity.
authorization	conveyance, to another entity, of official sanction to do or be something.
validation	a means to provide timeliness of authorization to use or manipulate information or resources.
access control	restricting access to resources to privileged entities.



# WHAT IS THE USE OF CRYPTOGRAPHY? (2)

certification	endorsement of information by a trusted entity.
timestamping	recording the time of creation or existence of information.
witnessing	verifying the creation or existence of information by an entity other than the creator.
receipt	acknowledgement that information has been received.
confirmation	acknowledgement that services have been provided.
ownership	a means to provide an entity with the legal right to use or transfer a resource to others.
anonymity	concealing the identity of an entity involved in some process.
non-repudiation	preventing the denial of previous commitments or actions.
revocation	retraction of certification or authorization.

# TAXONOMY OF CRYPTO-METHODS



from Menezes, Alfred J., Paul C. Van Oorschot, and Scott A. Vanstone. Handbook of applied cryptography. CRC press, 2010.

# TRAPDOOR ONE-WAY FUNCTIONS

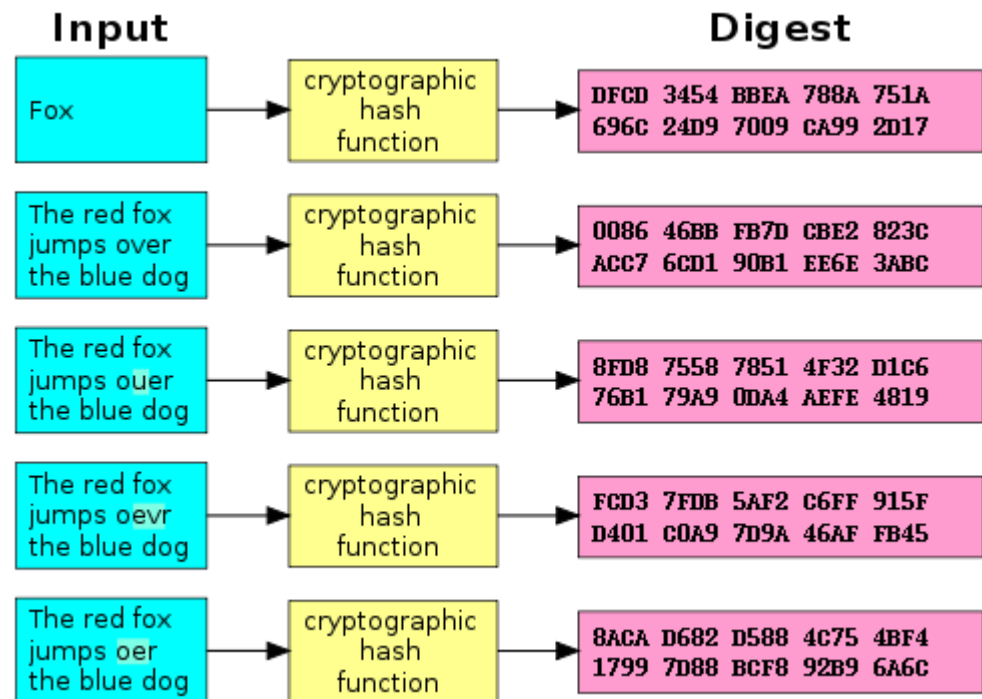
**Definition.** A function  $f$  from a set  $X$  to a set  $Y$  is called a one-way function if  $f(x)$  is "easy" to compute for all  $x$  in  $X$  but for "essentially all" elements  $y$  in  $Im(f)$  it is "computationally infeasible" to find any  $x$  in  $X$  such that  $f(x) = y$ .

# TRAPDOOR ONE-WAY FUNCTIONS

- In other words: It's hard to reverse the function
  - Example: function  $y=2^x$  is easy to reverse
- Additional constraints
  - computationally inexpensive
  - few collisions
- Examples
  - document hashes
  - password hashes

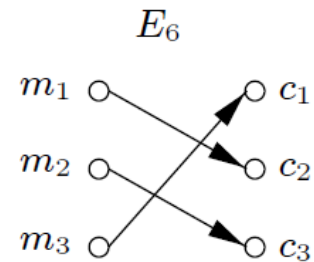
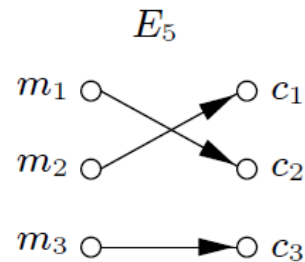
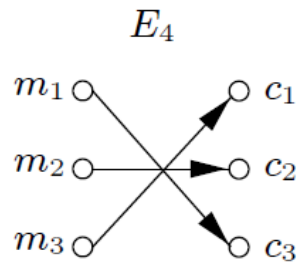
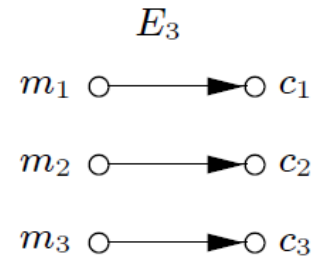
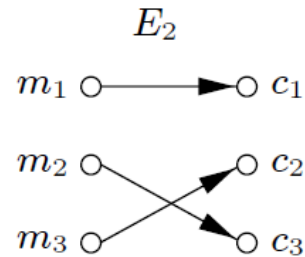
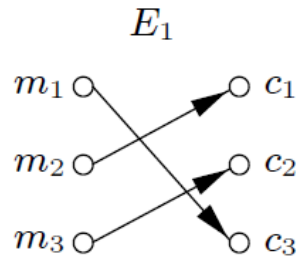
# TRAPDOOR ONE-WAY FUNCTIONS

- Common functions are
  - MD5, SHA-0, SHA-1, SHA-2, RIPEMD, ...



# PERMUTATIONS

- Change symbols based on a rule

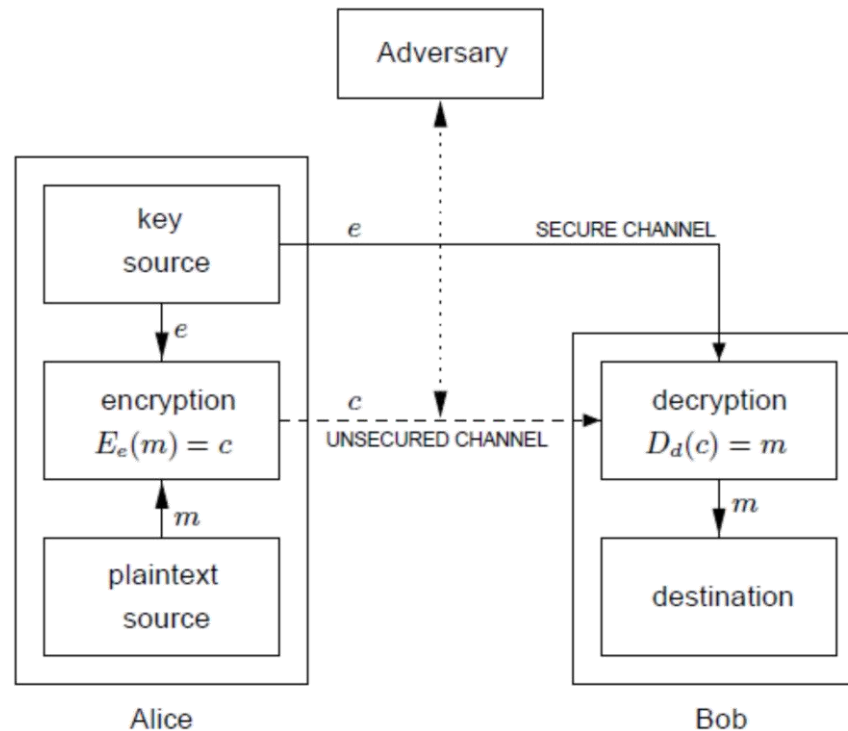


# PERMUTATIONS

- Historical Examples
  - Cesar Shift
  - Enigma: product of permutations
- Easy to break
  - Symbol probabilities lead to decryption table

# SYMMETRIC KEY

- A key is applied to a message to encrypt it
- The same key decrypts the message



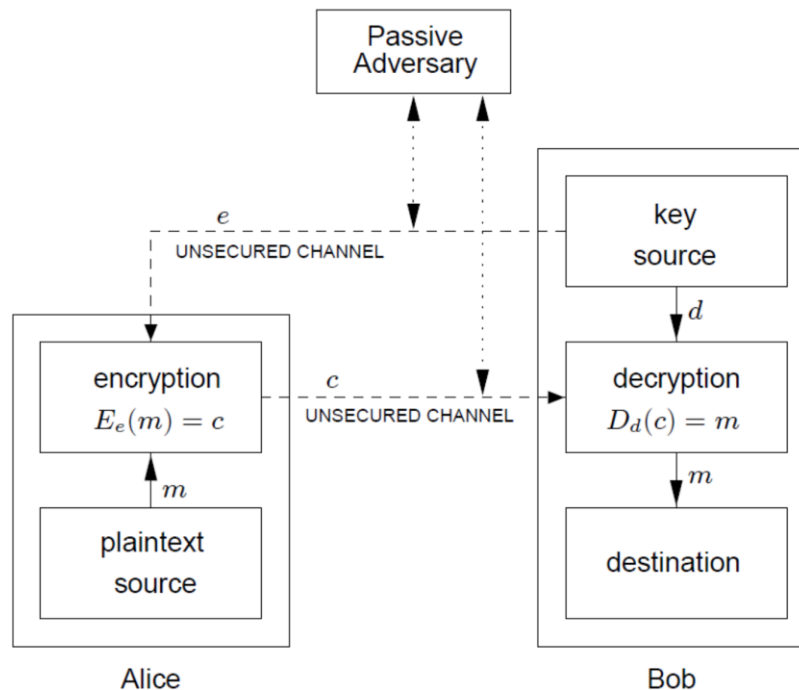


# SYMMETRIC KEY

- The larger the key, the better the encryption
  - If the key is as large as the message and only used once this method is theoretically unbreakable
- This method is used for HTTPS, SSH, etc.
  - For on-the-fly encryption
- Common methods are
  - DES, Triple-DES, AES, Blowfish

# PUBLIC KEY CRYPTOGRAPHY

- Two keys (a corresponding pair) are used
  - public key is known to anyone
  - private key is known only by one entity



# PUBLIC KEY CRYPTOGRAPHY

- Most prominent example: RSA (1977)
  - Ron Rivest, Adi Shamir and Leonard Adleman
- Implementations are available
  - Pretty Good Privacy (PGP)
  - Gnu Privacy Guard (GPG)
- Public keys are stored on key server
  - Users can search for keys of others
- Based on two large prime numbers

# DIGITAL RIGHTS MANAGEMENT

- Software & hardware framework that makes sure that content can only be consumed
  - in the right place
  - at the right time
  - by the right entity

# DIGITAL RIGHTS MANAGEMENT

## Examples

- Pay per view for a movie
- Download music for a specific ecosystem
- Disable storing of streams (audio, video)
- HDCP, Content Scramble System, etc.

Discuss turn in business models for digital music!

# EXERCISE: READINGS

1. Read <http://craphound.com/msftdrm.txt> (Cory Doctorow, 2004)
2. Watch L. Lessig - Laws that choke Creativity  
– [http://www.ted.com/talks/larry\\_lessig\\_says\\_the\\_law\\_is\\_strangling\\_creativity.html](http://www.ted.com/talks/larry_lessig_says_the_law_is_strangling_creativity.html)
3. Learn about Creative Commons Licenses  
– Read & watch <http://creativecommons.org/about>