

CMPE 80A: Universal Access: Disability, Technology, and Society



Contact:

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Website:

<http://www.soe.ucsc.edu/classes/CMPE080a>

<http://moodle.soe.ucsc.edu>



What is this course about

- ▶ Overview of human-centered technology
 - and of its potential for increasing the quality of life and independence of individuals with disabilities.
- ▶ Physical, psychological, and psychosocial aspects of disability
- ▶ Diversity and integration, legislation, accessibility.
- ▶ Universal design



Course Logistics

- ▶ Class meetings
 - M/W/F 3:30-4:40 PM, Humanities 206
 - Lectures, movies, demonstrations
- ▶ Assessment
 - Homework: 20%
 - Group Project: 60%
 - Attendance: 20% (in pop-quizzes, I will drop the lowest grade, no reason for absence is accepted)



Group projects (60%)

- ▶ Team of 3-4 students
- ▶ 40% for report, 15% the poster and Q&A, 10% all of the supporting evidences = 65%
 - 5% buffer, but no late delivery for any reason
- ▶ Recruit 3 persons with special needs
- ▶ Interview, observe, teach (details at the course website)
- ▶ Document the process (pictures, movies, audio recording, transcripts)
- ▶ Deliverables due in week 9
 - Remember the grades are curved
- ▶ Group presentation in week 10
 - 3'x5' poster
 - Presentation & QA



Living With Cystic Fibrosis

- ▶ **System Chosen:** Nebulizer, a device that sends medication directly into the lungs, along with a vest that helps loosen her lungs through concentrated vibration.
- ▶ **Difficulties Encountered:** Jessica had difficulties remembering which medications to use at which times of the day, and assembling and cleaning the nebulizer.
- ▶ **Final Thoughts:** We learned that Jessica was incredibly motivated to be taught how to use a machine that would help her live life to the fullest. Overall we were impressed with Jessica's ability to master her Nebulizer in just over a months time.



Navigating Campus with Visual Impairment

- ▶ **GOAL:** Provide our blind participant with the ability and confidence to walk independently from the Oakes to McHenry Library.
- ▶ **PROJECT ENCOMPASSED:**
 - 1) Build a 3-D representation of the path
 - 2) Teach each stage independently
 - 3) Preliminary run-through of all the stages
 - 4) Intermediary run-through introducing floor mats as ground markers
 - 5) Final run-through (our participant navigated the paths on his own with the markers)

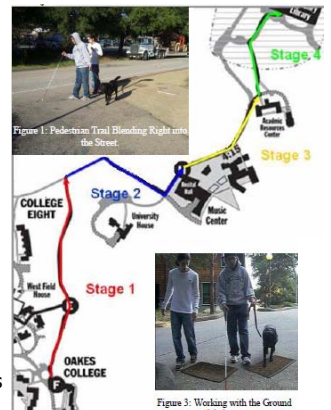
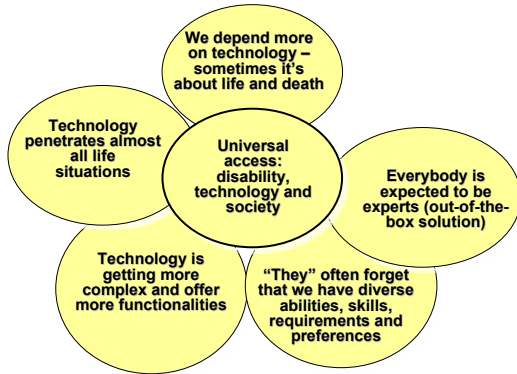


Figure 3: Working with the Ground Markers.



Why Universal Access?

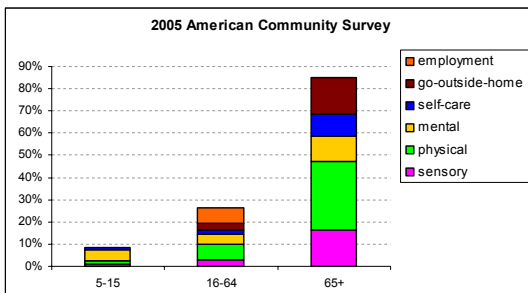


Ability Differences: We're all disabled once

- ▶ When?
 - Environment: in a foreign country, in a bouncing vehicle, in the dark
 - Non-optimal health: lack of sleep, drunk, fever
 - Injury: hit a finger with a hammer
 - At the two extremes of our lives
 - Changing role of technology: new products, unfamiliar interface
- ▶ Disability conditions:
 - Transient: Noisy room
 - Temporary: Broken arm
 - Permanent: For most, this one is labeled a disability



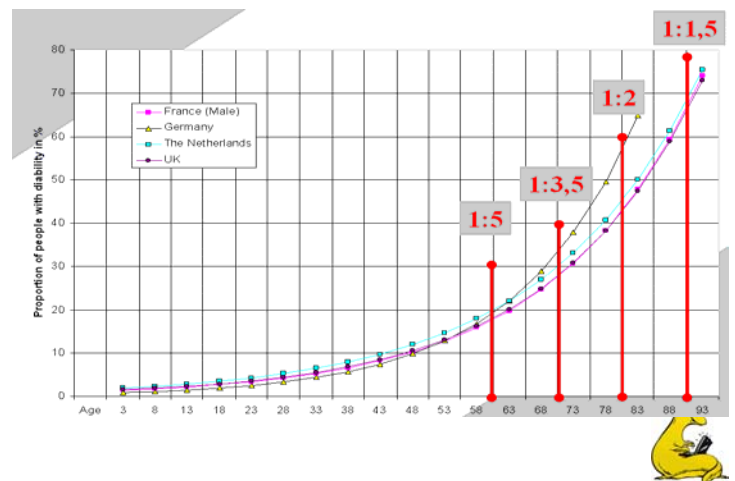
American with Disabilities



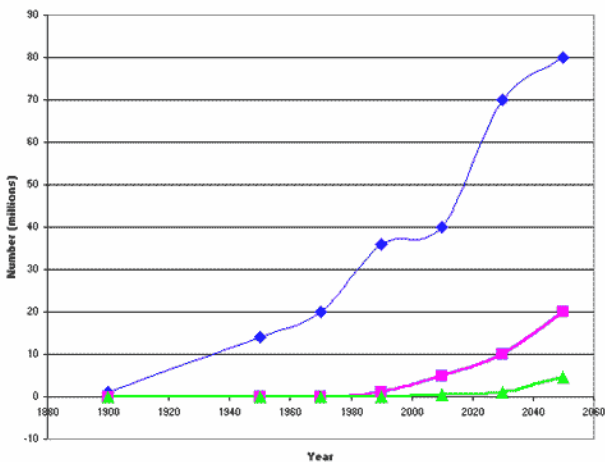
Ages	5-15	16-64	65+
sensory	1.2%	2.8%	16.4%
physical	1.2%	7.2%	30.8%
mental	5.2%	4.5%	11.5%
self-care	0.9%	2.0%	9.7%
go-outside-home	0.0%	3.0%	16.6%
employment	0.0%	6.8%	0.0%



How special are special needs?



How special are special needs?



Models of disabilities

- ▶ Medical Model
 - Problem entirely with individual, not society
 - Ideally: transform person with disability (pathological) into "normal"
 - Stress on cure, hospitalization, rehabilitation
 - Results in *eugenics* (the study of hereditary "improvements" of the human race by controlled selective breeding)
 - Peter Singer, Princeton University: *When the death of a disabled infant will lead to the birth of another infant with better prospects of a happy life, the total amount of happiness will be greater if the disabled infant is killed.*
 - Read R. Olkin's "[The Human Rights of Children with Disability](#)"



Models of disabilities

► Environmental Model

- Environment (*social* or *physical*) may cause, define, or exaggerate disability
- Physical** environment: historic town with uneven ground and no wheelchair access
- Social** environment: Prejudice, discrimination, stigma → *The chief handicap of the blind is not blindness, but the attitude of seeing people towards them*, H. Keller
- Cultural** environment → [Foot binding in Manchurian China](#) → Not being able to walk was a sign of distinction
- Economical** barrier → no money to remedy disability



Models of disabilities

► Functional Model

- Disability defined by the **functions** that an individual can perform, typically work-related
- Example: A person using a wheelchair is not a disabled when the functional activity is computer programming
- Shift of U.S. economy from farming, mining and manufacturing to service and Information Processing has changed functional criteria for disability
- Cognitive disability has become more limiting than physical disability
- Older workers (or those coming back to work after war) have become "disabled"



Overcoming barriers to access

► Two main approaches:

- Universal/inclusive design
- Assistive technology

► Universal design (<http://www.universaldesign.org/>)

- goes beyond the design of interactive systems and applies to all design endeavours.
- grounded in a certain philosophical approach to design encapsulated by an international design community
- if a design works well for people with disabilities, it works better for everyone

► Inclusive design is more pragmatic → doesn't claim to cover the whole population



Assistive Technology

- Technology designed to be utilised in device or service to increase, maintain, or improve functional capabilities of individuals with disabilities
- Provide user with alternative technology to operate the system
 - allowing them to operate the system through an alternative interface (e.g. input device).
 - allowing them to modify some parts of the system.

Accessible technology	Assistive technology
Convenient (doesn't require people to own additional device)	Necessary for people with multiple disabilities
Removes the stigma of special aids	Sometimes more commercially/practically viable



Principles of Universal Design

- Equitable Use:** The design does not disadvantage or stigmatize any group of users.
- Flexibility in Use:** The design accommodates a wide range of individual preferences and abilities.



Principles of Universal Design

- Simple, Intuitive Use:** Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
- Perceptible Information:** The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.



Principles of Universal Design

5. Tolerance for Error: The design minimizes hazards and the adverse consequences of accidental or unintended actions.
6. Low Physical Effort: The design can be used efficiently and comfortably, and with a minimum of fatigue.

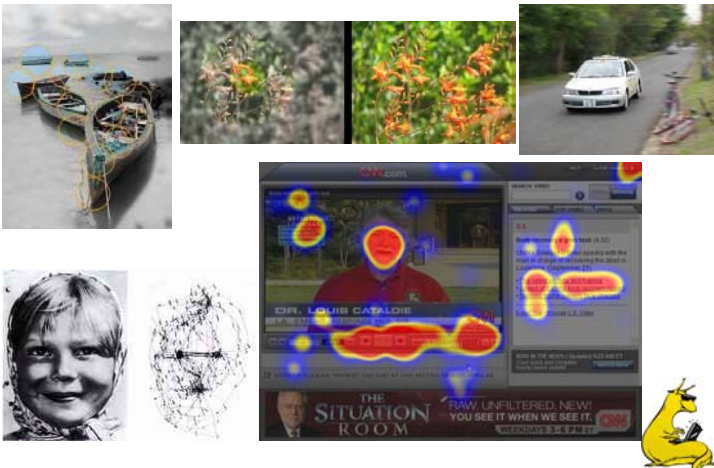


Principles of Universal Design

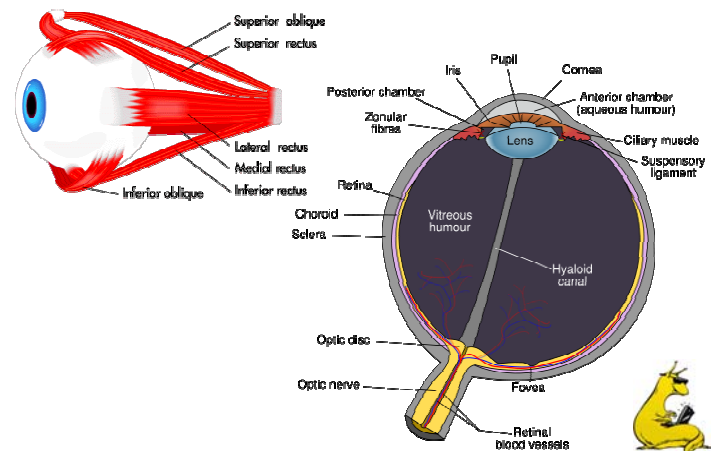
7. Size and Space for Approach & Use: Appropriate size and space is provided for approach, reach, manipulation, and use, regardless of the user's body size, posture, or mobility.



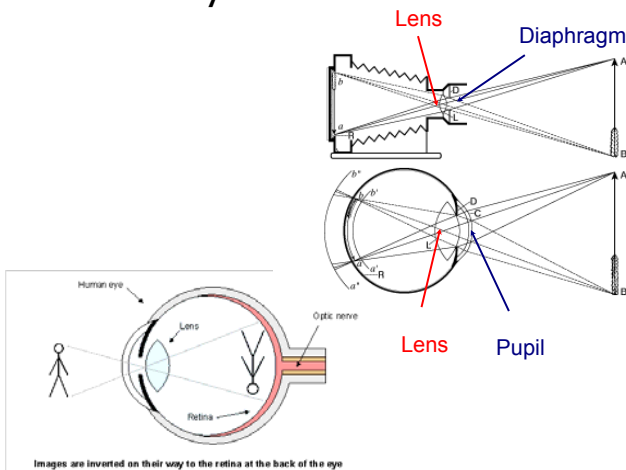
How we see the world



Eye Anatomy



The eye works like a camera!



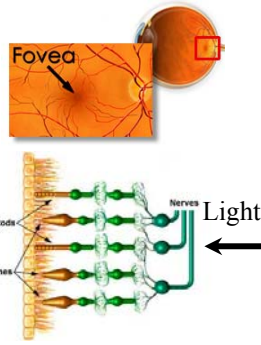
The Eye

- ▶ Non-retinal parts keep a focused, clear image of outside world anchored on the two retinas
 - 6 muscles (3 pairs working in opposition) per eye
 - If eyes not precisely aimed at same point, we see double
- ▶ Adjustment of focus is done by changing the shape of the rubbery, jelly-like lens
 - Performed by the *ciliary muscles*
 - At age beyond 45, lens becomes hard and we lose our ability to focus
- ▶ Diameter of the pupil controlled by two sets of muscles
 - Works like the diaphragm of a camera
- ▶ Self-cleaning of cornea by blinking lids and lubricating with tear glands



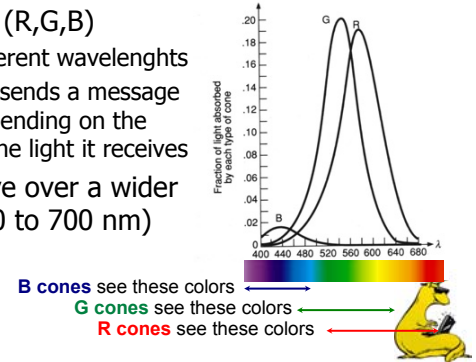
Retina

- ▶ Translates light into nerve signals
- ▶ Connects to the brain via the optic nerve
- ▶ At the back of the retina, *photoreceptors*
 - Rods: vision in dim light (not functional in bright light)
 - Cones: color, high resolution vision in bright light
- ▶ Fovea: small area with high density of cones (no rods)
 - Only 1% of the retina, but takes up 50% of the visual cortex in the brain
 - Outside fovea, cones are present but with lower density



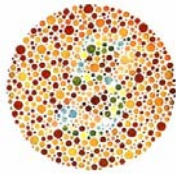
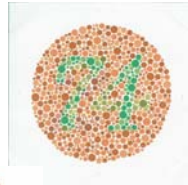
Color Vision

- ▶ The light spectrum is electromagnetic energy spread over different wavelengths λ
 - The wavelength λ of the light indicates the light color
- ▶ 3 types of cones (R,G,B)
 - Sensitive to different wavelengths
 - Each cone type sends a message to the brain depending on the wavelength of the light it receives
- ▶ Rods are sensitive over a wider light spectrum (380 to 700 nm)



Color Blindness

- ▶ 8-10% male and 0.5% female populations have some form of color deficiency
- ▶ Very rarely can only see B/W
- ▶ Protanope
 - 1% males, "red-weakness"
- ▶ Deuteranope
 - 5% males, "green-weakness"
- ▶ Tritanope
 - blue/yellow deficit
- ▶ Simulation:

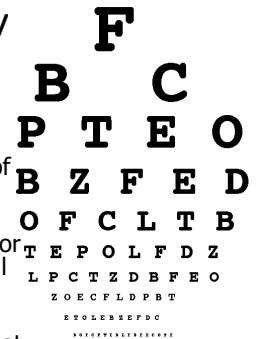


<http://www.vischeck.com/vischeck/vischeckURL.php>

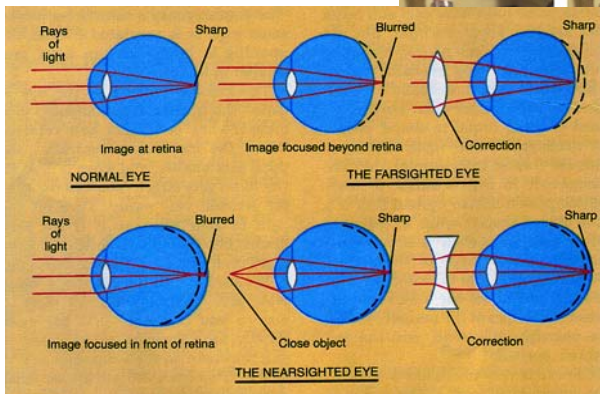


Visual Acuity

- ▶ Ability to resolve fine detail
- ▶ Snellen scale (e.g., 20/20)
 - A score of 20/x means that the person's performance matches that of a person with unimpaired vision at a distance of x
 - 20/40 : you need twice the font size or half the distance to read what normal people can read at 20'
 - Acuity is always measured in 20/x even when measurements are taken at closer distances → 8/16 vision is equivalent to 20/40
 - 20/200 at the better eye = legally blind
- ▶ <http://moviesfortheblind.com/>

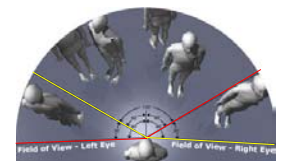
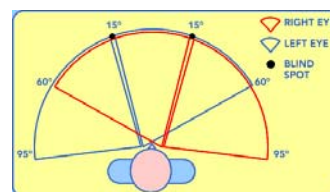


Near/Farsightedness



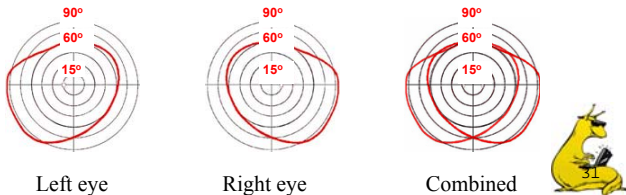
Visual Field

- ▶ Entire region of space off to all sides that is visible when the person is looking and facing straight ahead
 - Measured in degrees
 - Decrease with aging



Normal Visual Fields

- ▶ Extends from the point of fixation out to:
 - ~95° towards one's temple, ~60° towards one's nose, ~50° above, ~65° below
- ▶ Everything at 60° to the right/left is seen by both eyes
 - The farthest 35° are seen by only one eye
 - Overall: 190° of continuous visual field
- ▶ Vision field corresponding to fovea: 3° (twice the width of your thumbnail at arm's length)



Visual Field Defects

- ▶ **Peripheral visual field defects** (beyond 30°)
 - Only central vision remaining
 - Greatest impact on safe visually guided **travel** and **driving**
 - <20° visual field in the better eye defines **legal blindness**
- ▶ **Central visual field defects**
 - Only peripheral vision remaining
 - *Scotoma*: dense and localized blind spot
 - Makes **reading** difficult
 - ▶ Acuity outside the fovea is limited
 - ▶ Peripheral areas of retina cannot support rapid reading
 - Need to shift gaze slightly to one side or another (*eccentric viewing*)
- ▶ Simulation of visual field defects:
 - www.nei.nih.gov/health/examples/index.asp



Contrast Sensitivity

- ▶ *Contrast* = relative difference of brightness between foreground and background
 - Affected by color, brightness/luminance
- ▶ *Contrast sensitivity* = ability to detect various levels of contrast
 - High contrast sensitivity allows one to detect low levels of contrast
- ▶ Implications of low contrast sensitivity
 - Mobility problems with low light (especially tasks such as detecting curbs and ascending/descending stairs)
 - Reading problems with poor print quality or colored paper



Main Causes of Visual Impairment

- ▶ Macular degeneration
 - Affects the central visual field. Produces a scar that over time may involve a large area of the retina
 - Can occur to young or (more typically) old (> 50) persons
- ▶ Cataract
 - Opacity of the lens (normally due to aging)
 - Cataract surgery (lens substitution) is now a standard procedure
- ▶ Glaucoma
 - Progressive loss of optic nerve cells, producing loss of visual field
 - Progressive; early detection important



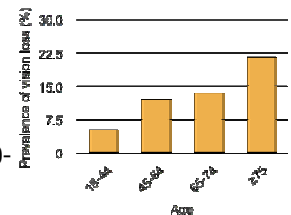
Main Causes of Visual Impairment

- ▶ Diabetic retinopathy
 - Damage to fovea and outer retina due to long-standing diabetes
 - Laser therapy may be effective to stop the damage process
- ▶ Retinitis pigmentosa
 - Group of inherited disorders of the retina
 - Begins with night blindness (due to malfunctioning of the rods), followed by tunnel vision
- ▶ Optic neuropathy
 - Damage of the optic nerve due to blockage of blood supply or toxins
- ▶ Brain damage
 - Due e.g. to trauma, stroke or tumor
- ▶ For more info: <http://www.nei.nih.gov/health/>



Statistics

- ▶ 21.2 million Americans with vision loss
 - From "having trouble seeing" even with glasses, to blindness
- ▶ 1.3 million Americans legally blind
 - Of which, 58,000 are children (0-21)
- ▶ About 250,000 totally blind or with only some light perception



Statistics



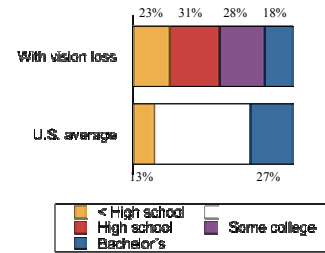
- ▶ Mobility with vision loss:
 - 110,000 use long canes to get around
 - 7,000 use guide dog
- ▶ Almost 10% of persons with "severe visual impairment" use a wheelchair
- ▶ ~30% of persons with blindness make no independent trips outside the home

- ▶ <http://video.guidedogs.com/soulmateshi.aspx>
- ▶ http://www.guidedogs.com/site/PageServer?pagename=help_volunteer



Statistics

- ▶ Educational attainment:



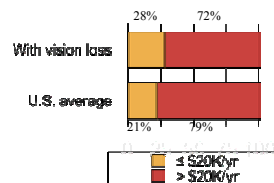
- 10% of legally blind children use Braille as their primary reading medium



Statistics

- ▶ Employment rate (working age):
 - 47.5% with sensory impairment (ACS)
 - 55.3% with "difficulty seeing words or letters" (U.S. Census Bureau)
 - 19% of legally blind (NHIS)
 - 18% of out-of-school youth who received special education (NLTS)

- ▶ Family income:



Basic Tools and Techniques

- ▶ Lenses and screen magnifiers for reading
- ▶ White cane for mobility
 - Sometimes used also by low vision individuals
 - Allows one to detect obstacles, identify materials (sound, texture)
 - Aural cues for mobility → e.g.: listening to traffic sounds to infer when to cross an intersection



Crossing a Street

- ▶ Orientation and alignment cues (US Dept. of Transp.)
 - Detect slight slopes under foot and/or a detectable change in surface texture
 - Listen to direction that cars are traveling to align to cross
 - Listen to when the cars start moving in the closest lane as indication of time to cross
 - Maintain awareness of buildings, sun, other pedestrians, smells, and sounds which provide information
 - Ask sighted people
 - [Smart crossing button](#)
 - [Japan's crossing](#)



Basic Accommodation Tools

- ▶ Braille print / Embossed paper
- ▶ Audible pedestrian signals at traffic intersections
 - Sound type depends on crossing orientation
- ▶ Detectable warning surfaces
 - E.g. bumps on curb ramps
- ▶ Auxiliary aids are regulated in public settings by the American with Disabilities Act (ADA)



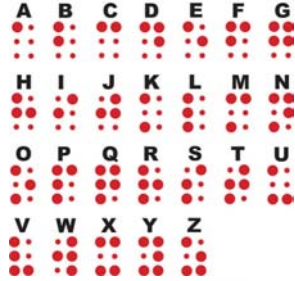
Braille

▶ Each Braille character or (cell) is made up of 6 dot positions

- Arranged in a vertical rectangle of 2 columns of 3 dots each

▶ Typing:

- Perkins Braille (manual)
- Embosser (used as a printer)



Movies to watch

- ▶ http://www.ted.com/talks/thulasiraj_ravilla_how_low_cost_eye_care_can_be_world_class.html
- ▶ <http://www.youtube.com/watch?v=gruMSgu5IBo>
- ▶ <http://www.youtube.com/watch?v=Ud5WXs-rEPc>
- ▶ http://www.youtube.com/watch?v=R_ck8S_3RLY

