



COMP7503 Multimedia Technologies

Introduction

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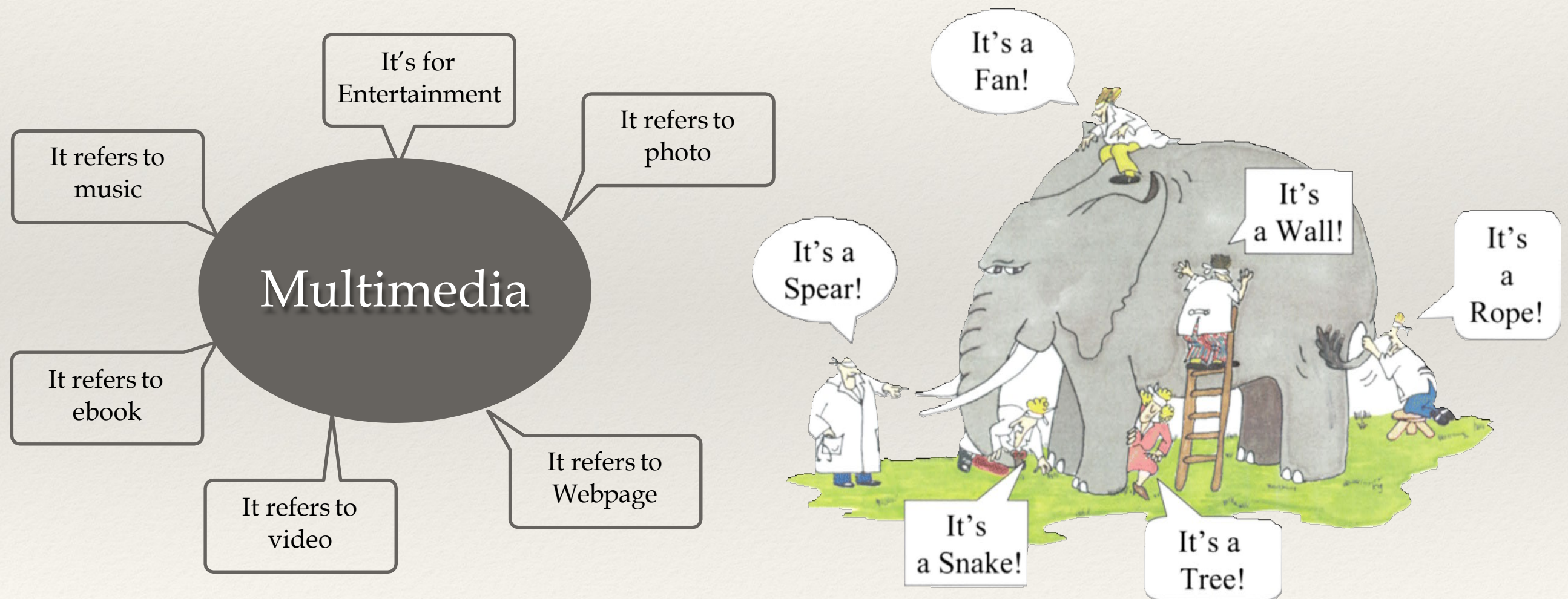


THE UNIVERSITY OF HONG KONG

D E P A R T M E N T O F
COMPUTER SCIENCE

What is Multimedia?

- ❖ Everybody thinks they know about the word “multimedia”, but most of them think of multimedia from narrow perspectives



Is audio alone enough?



Video adopted from <https://www.youtube.com/watch?v=FeTOf49mUyA>



Is text information alone enough?

- ❖ Under which scenario a person would say the following
 - ❖ “Just lie down, shut up, and open wide”



Why Multimedia?

- ❖ How do humans receive information?

- ❖ Five senses

- ❖ Sight
 - ❖ Hearing
 - ❖ Taste
 - ❖ Smell
 - ❖ Touch



- ❖ Each sense provides only partial information
- ❖ Multimedia refers to the combined use of several media that stimulate one or more of these five senses to deliver relevant information to users



Why Multimedia? (Cont'd)

- ❖ Audio and Visual Information dominates human activities
 - ❖ Humans are equipped with powerful visual and audio analysis capability
 - ❖ Taste, smell, and touch cannot be easily acquired and reproduced by existing multimedia computing technologies



Then, What is computing?

- ❖ Computing is any goal-oriented activity requiring, benefiting from or creating computing machinery.

(<https://en.wikipedia.org/wiki/Computing>)

- ❖ Multimedia computing means utilise signals from multifarious sensors and present to users only the relevant information in the appropriate sensory modality (media)

- ❖ The goal of multimedia computing
 - ❖ Information sharing on experiences
 - ❖ Knowledge extracting from experiences



Communications in Human Society

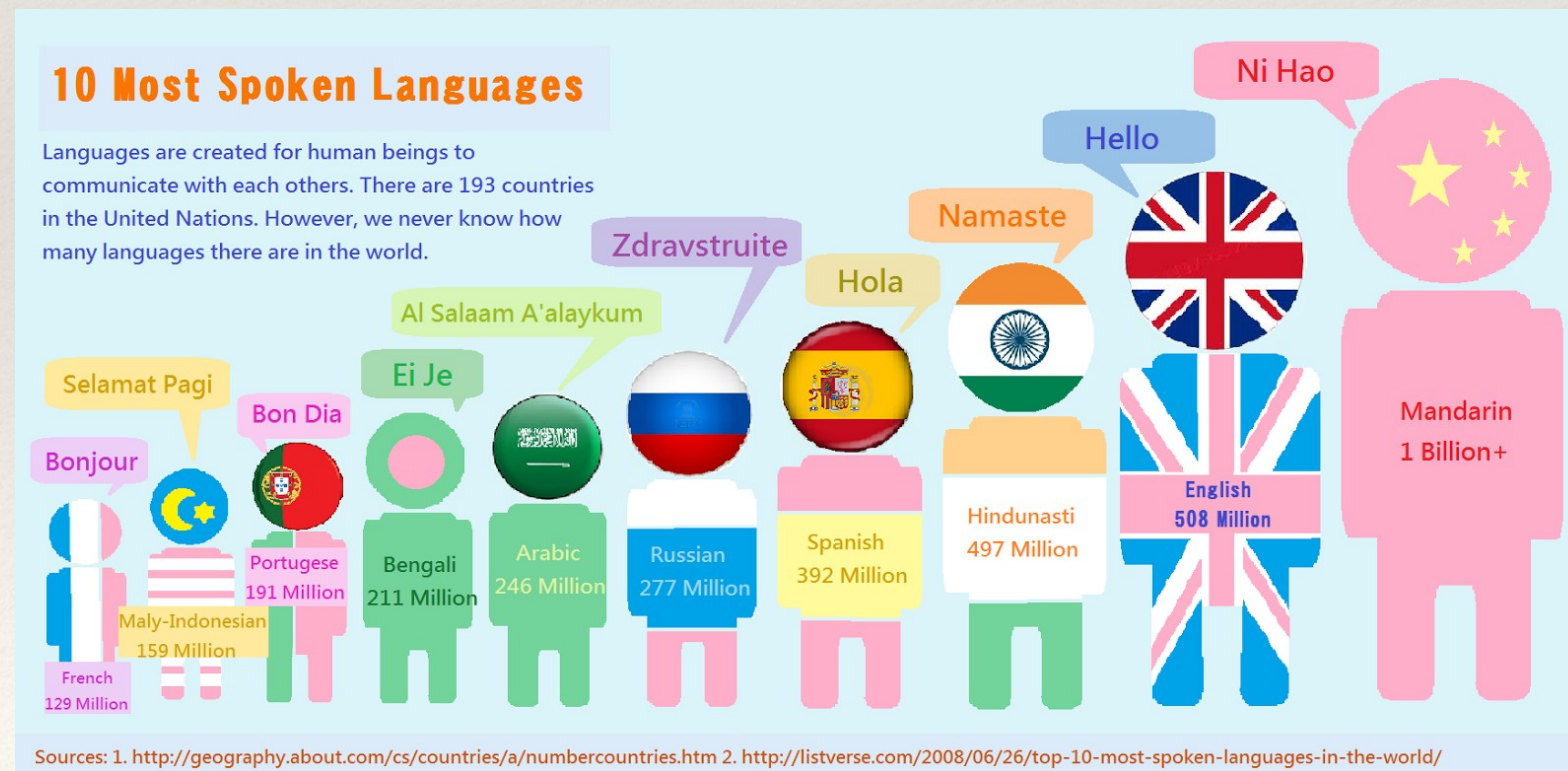
- ❖ The Communication is key for us to
 - ❖ Share experiences
 - ❖ Create, maintain, sustain, and propagate knowledge
- ❖ Communication across **space**
 - ❖ Allows people to exchange information independent of their current locations
 - ❖ Examples? What are the technologies required to support this?
- ❖ Communication across **time**
 - ❖ Allows people to experience an event over and over again without having to be there at the exact moment
 - ❖ Examples? What are the technologies required to support this?
- ❖ Communication to as many people as possible (**addressee**)
 - ❖ Examples? What are the technologies required to support this?



Human Communication Means (1)

❖ Spoken Languages

- ❖ Consisted of analog sounds uttered with the speech-producing infrastructure in the throat
- ❖ Able to convey complex facts
- ❖ Any invariance across time, space, and addressee?



Human Communication Means (2)

❖ Written Languages

- ❖ Evolved from drawings and paintings
- ❖ Enables sharing of experiences and knowledge
- ❖ Initial bulky preservation techniques (e.g. stone tablets) evolved into more practical storage devices and writing methods
 - ❖ e.g. Paper and ink
- ❖ Any invariance across time, space, and addressee?

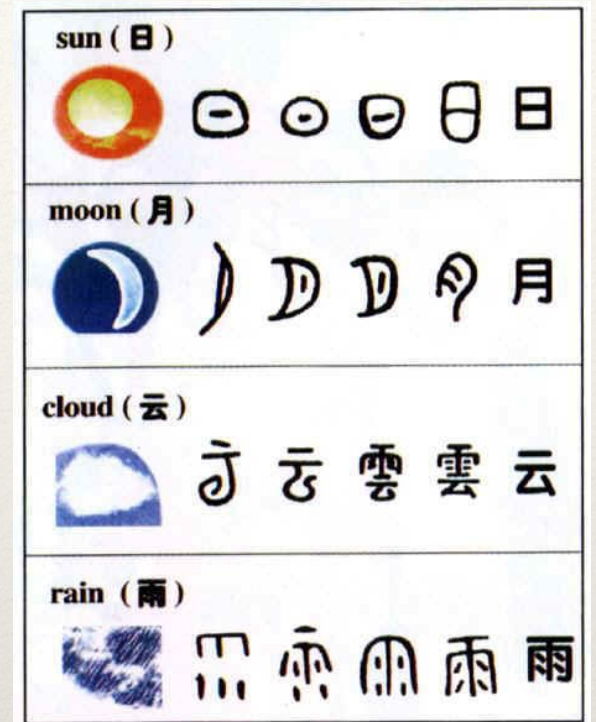


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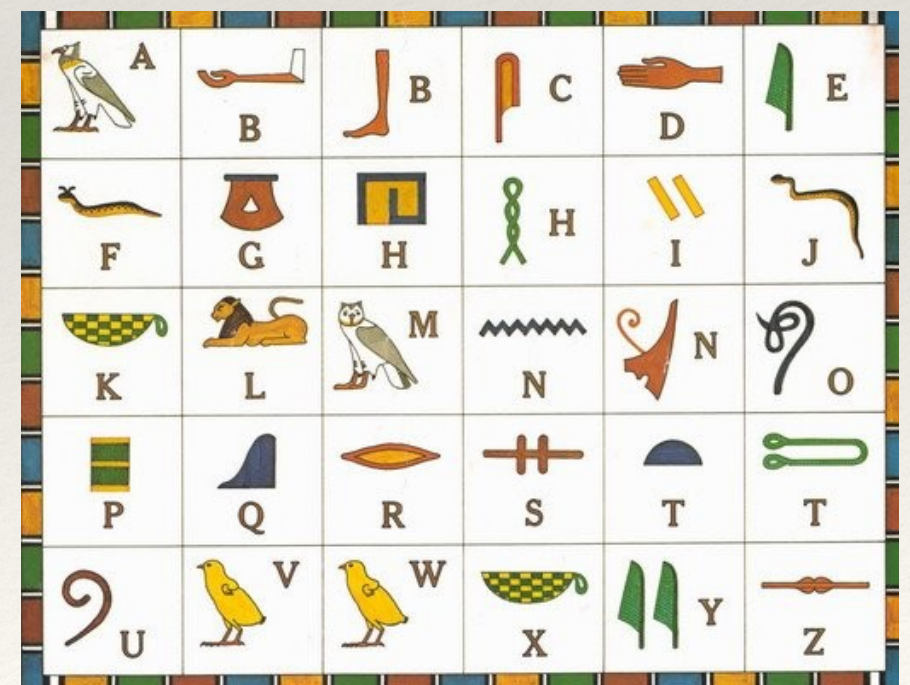


Image adopted from <http://ahmed-maher.blogspot.hk>



Human Communication Means (3)

❖ Printing Press

- ❖ Invented by Johannes Gutenberg around year 1440
- ❖ Enabled mass communication by making creation, storage, and distribution of documents more manageable
- ❖ Makes information and knowledge sharing earlier
- ❖ Any invariance across time, space, and addressee?

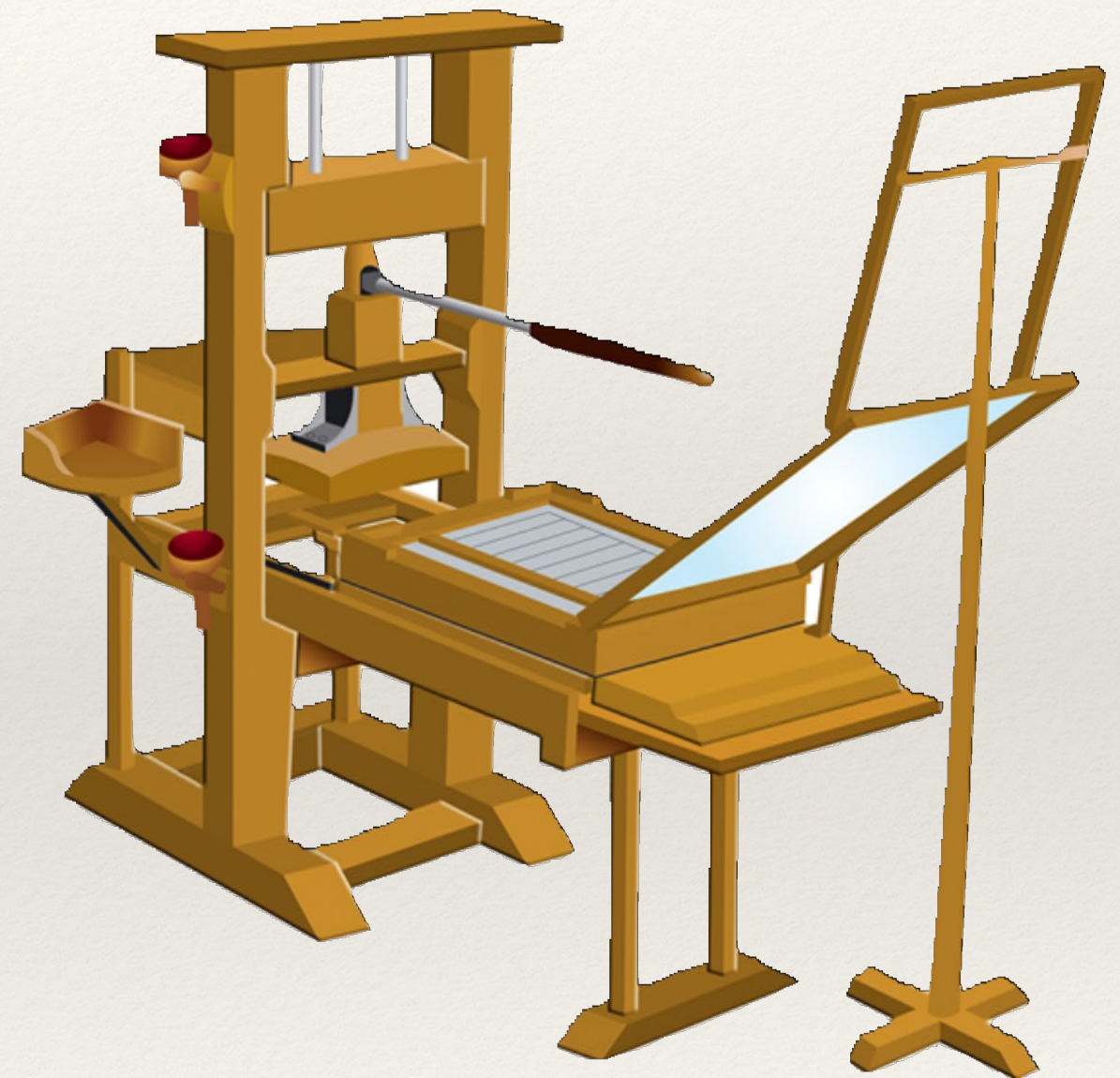


Image acquired from <http://www.howitworksdaily.com/see-inside-the-gutenberg-printing-press/>



Human Communication Means (4)

❖ Telegraph

- ❖ Allows instantaneous communication of symbolic information over long distances
- ❖ Any invariance across time, space, and addressee?

❖ Telephones

- ❖ Allows natural communication (talking) over long distance
- ❖ Any invariance across time, space, and addressee?

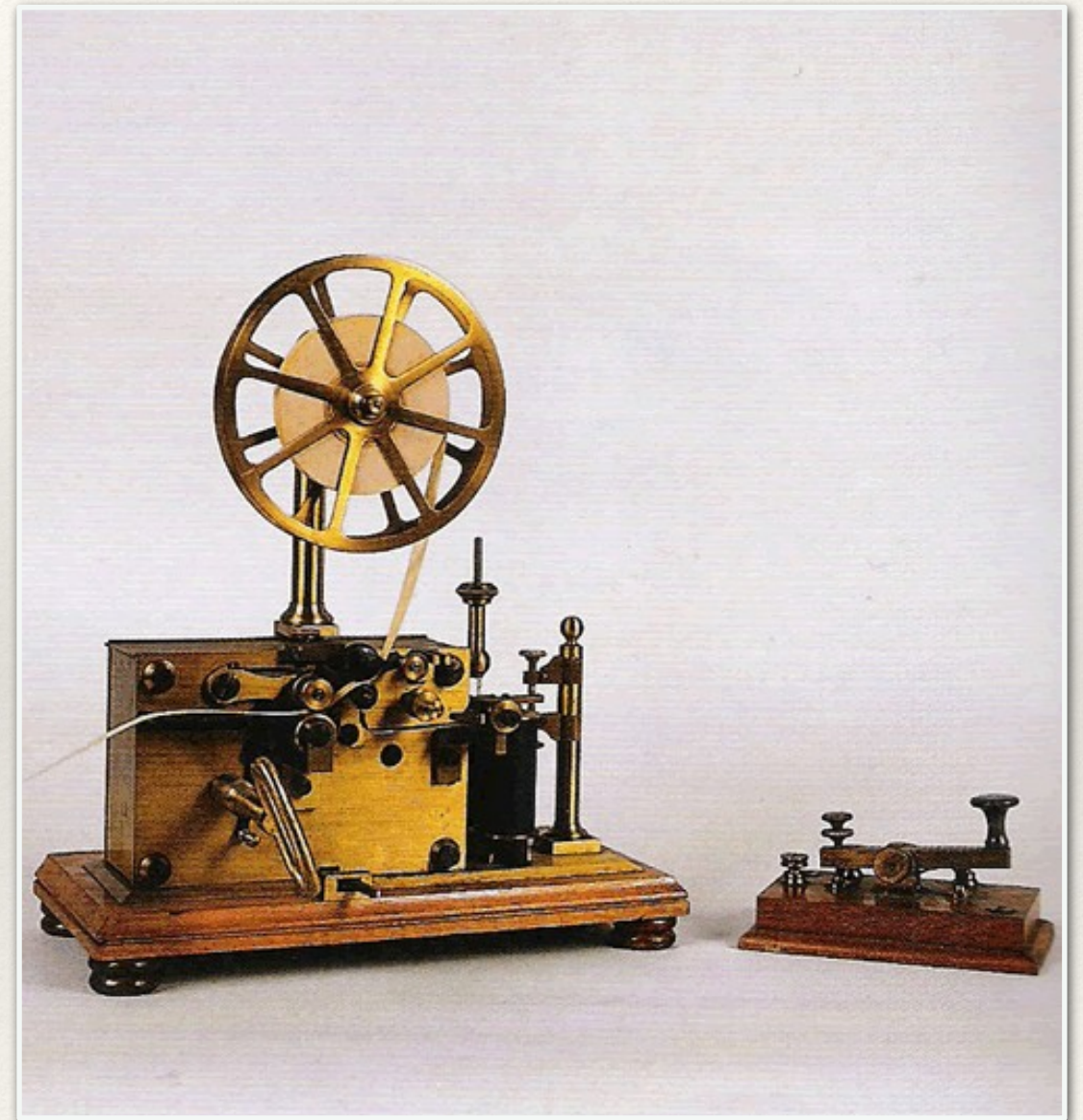


Image acquired from <http://imgbuddy.com>



Human Communication Means (5)

❖ Radio

- ❖ Allows distribution of sound wirelessly
- ❖ First form of instantaneous mass communication
- ❖ Any invariance across time, space, and addressee?



Image acquired from <http://radiomunansi.info/about-us/>

❖ Movies and Television

- ❖ Combine our senses of sight and hearing for more natural communication
- ❖ Effective way to key into our emotions
- ❖ Any invariance across time, space, and addressee?



Image acquired from https://fbcpolson.files.wordpress.com/2014/08/television_1.jpg



Human Communication Means (6)

❖ Storage Technologies

❖ Storage Media

- ❖ Magnetic Tape
- ❖ Digital Storage

❖ Allows storage, preservation and distribution of sound, video, etc.

❖ Any invariance across time, space, and addressee?

❖ Distribution Technologies

❖ Sending physical copy

❖ Copy by wire

❖ Internet distribution

❖ Any invariance across time, space, and addressee?



Images acquired from
<http://www.bbc.co.uk/schools/gcsebitesize/ict/hardware/1datastoragerev6.shtml>



Image acquired from
http://www.dealersolutions.com.au/car_inventory_distribution?content=overview



Communications-related Inventions

Inventions	Resulting Applicatoin	Invariance
Spoken Languages	Natural communication	None
Written Languages	Symbolic record of language	Time
Paper	Portability	Time, space
Print	Mass distribution	Time, space, addressee
Telegraph	Remote narrow communication	Space
Telephone	Remote analog communication	Space
Radio	Broadcasting of sound	Space, addressee
Television	Broadcasting of sight and sound	Space, addressee
Movies	Recording of sight and sound	Time, space, addressee
Recording media	Recording	Time, space, addressee
Digital media	Machine enhancement and processing	Time, space, addressee
Internet	Personalized reception	Time, space, (addressee)



The role of Computer in Multimedia during 1960s-era

- ❖ During 1960s, computer is bulky
 - ❖ e.g. IBM1620
 - ❖ No ALU, arithmetics processing is done based on lookup tables
 - ❖ Hardware
 - ❖ CPU a.k.a. *CADET*
 - ❖ *Can't Add, Doesn't Even Try*
 - ❖ RAM: 60kbytes
 - ❖ I/O: Paper Tape reader and writer, or Punch Cards
 - ❖ Software
 - ❖ Symbolic Programming System (assembly language)
 - ❖ Fortran



A 1960s-era Computer at NASA

Image adopted from
Figure 2.1 in the textbook



The role of Computer in Multimedia

Before 1990s

- ❖ Before 1990s, computing power, storage, bandwidth, and processing algorithms were not capable to deal with audio and video
 - ❖ Using multimedia in computer was under R&D phase
 - ❖ Hardware
 - ❖ CPU < Intel 80286, < 6MHz
 - ❖ RAM < 640KB
 - ❖ Graphics Modes: 320x200 / 640x200, 16 colors
 - ❖ Storage: Floppy Drive, Harddisk <= 20MB
 - ❖ Software
 - ❖ OS: MS-DOS
 - ❖ Mostly text-based applications



PC XT 286

Image adopted from

<http://www.old-computers.com/museum/computer.asp?st=1&c=260>



The role of Computer in Multimedia

Early 1990s

- ❖ Early 1990s, high end PC's are equipped with multimedia capabilities, like IBM PS/2
 - ❖ Hardware
 - ❖ CPU Intel 80386/80486, 50-60 MHz
 - ❖ RAM $\leq 64\text{MB}$
 - ❖ Graphics Modes: 640x480, 1024x768, 256/64k colors
 - ❖ Storage: Floppy Drive, Harddisk $\leq 400\text{MB}$
 - ❖ May be equipped with dedicated Sound Card (e.g. Soundblaster)
 - ❖ Software
 - ❖ OS: MS-DOS
 - ❖ GUI crafted by Application
 - ❖ 3D Gaming Possible



IBM PS/2



3D Games Wolfenstein on
386/486 PC



The role of Computer in Multimedia

Mid 1990s

- ❖ Around mid 1990s, more high end PC's evolved, like Acer Presario 4122
 - ❖ Hardware
 - ❖ CPU Intel Pentium 150MHz
 - ❖ RAM up to 128MB
 - ❖ Graphics Modes: up to 1280x1024
 - ❖ Storage: Floppy Drive, 2.5GB harddrive, 8x CD-ROM
 - ❖ Integrated 16-bit Stereo Sound
 - ❖ Software
 - ❖ OS: Windows 95
 - ❖ Audio Player, Video Player
 - ❖ CorelDraw 5
 - ❖ Various kinds of games



Compaq Presario 4122

Image adopted from <http://www.computinghistory.org.uk/details/5043/Compaq-Presario-4122/>



The role of Computer in Multimedia by the end of 90s

- ❖ PC manufactures no longer labeled their units “Multimedia Computer”, because nearly every computer comes with multimedia capability
 - ❖ but R&D in multimedia continues
- ❖ R&D in Speech, Audio, Image and Video was fuelled mostly by telephony, broadcast and entertainment applications
 - ❖ Speech processing, compression, and recognition
 - ❖ Audio processing and compression
 - ❖ Image processing and compression
 - ❖ Video processing and compression

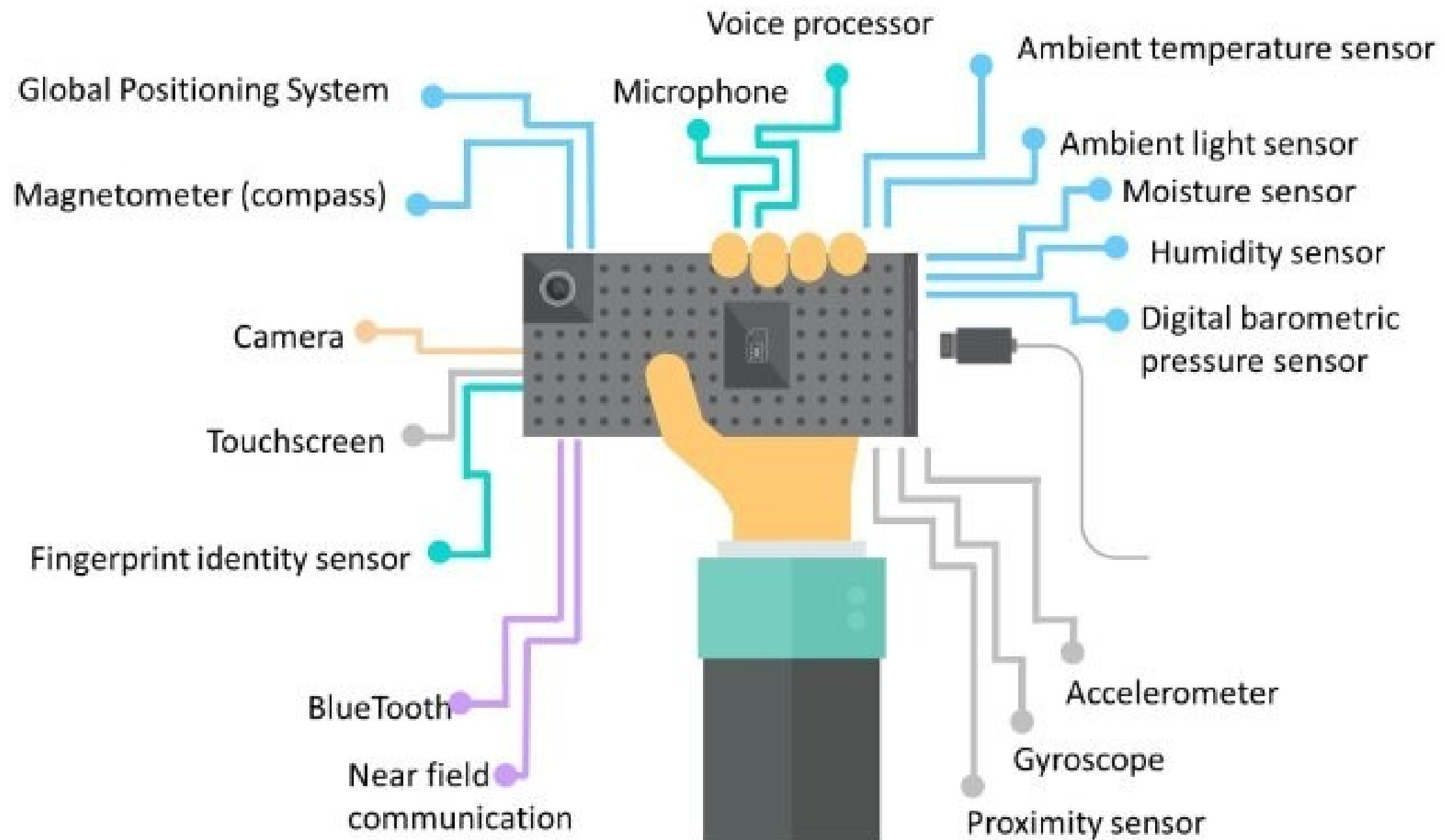


The role of Computer in Multimedia in 21 century

- ❖ Progress in processing, storage, networking, and software technology has changed computing beyond anyone's expectations
 - ❖ Even our mobile devices are several orders of magnitude more powerful and sophisticated than computers in late 80s
 - ❖ PCs and laptops are now being replaced by personal devices like tablets and mobile phones
- ❖ Mobile devices can use audio and visual mechanisms equally effectively as traditional alphanumeric computing
 - ❖ They are equipped with more diverse sensing mechanisms than humans have
 - ❖ e.g. GPS receivers to sense geo-location
 - ❖ These are truly multimedia computing and communication devices



Different Sensors on Mobile Devices



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Applications drove Computer Technologies Development

Applications	Technologies Developed	Device(s) Name
Numerical Computations	Arithmetic Processing Unit (ALU)	Computer
Business Data Processing Applications	Alphanumeric Processing, Database, Centralised Server Technologies	Workstation, Server
Word Processing, Spreadsheets, Mail, WWW	Internet Connectivity, More power CPU	Personal Computer, Laptop
Social Network, Photography, Instant Chat and Media Sharing	3G, 4G communications; Audio and Video Media Processing, Geo-Location Technologies.	Mobile Phones, Tablets
Future Applications ???	Future Technologies ???	???



Properties of Emerging Computing and Communication Applications

- ❖ Spatiotemporal and live data streams are norm rather than the exception
- ❖ A holistic picture of an event or situation is more important than silos of isolated data
- ❖ Users want insights and information that are independent of the medium and data source
- ❖ Only relevant information counts
- ❖ Exploration (browsing) is the predominant mode of interaction
 - ❖ Instead of relational database querying is the primary interaction in previous generation application



Properties of Emerging Computing and Communication Applications (Cont'd)

- ❖ Emerging applications are pushing
 - ❖ *Computing to use primarily data from multiple sources*
 - ❖ *Computing focus more on information, experiences, and understanding than on the medium or data source*
- ❖ Two aspects to pay attention
 - ❖ *The evolving nature of information*
 - ❖ *Expected results from computing*



E-com Operations Related Information

- ❖ Question 1: *How many orders are operated by Amazon between Hong Kong and Tai wan?*
- ❖ Question 2: *Which parts of the world are seeing rapid growth in Amazon sales record?*
- ❖ Question 3: *What is the hottest item now?*
- ❖ What is/are the differences of these questions in terms of
 - ❖ *The evolving nature of information*
 - ❖ *Expected results from computing*



Experiential Environments

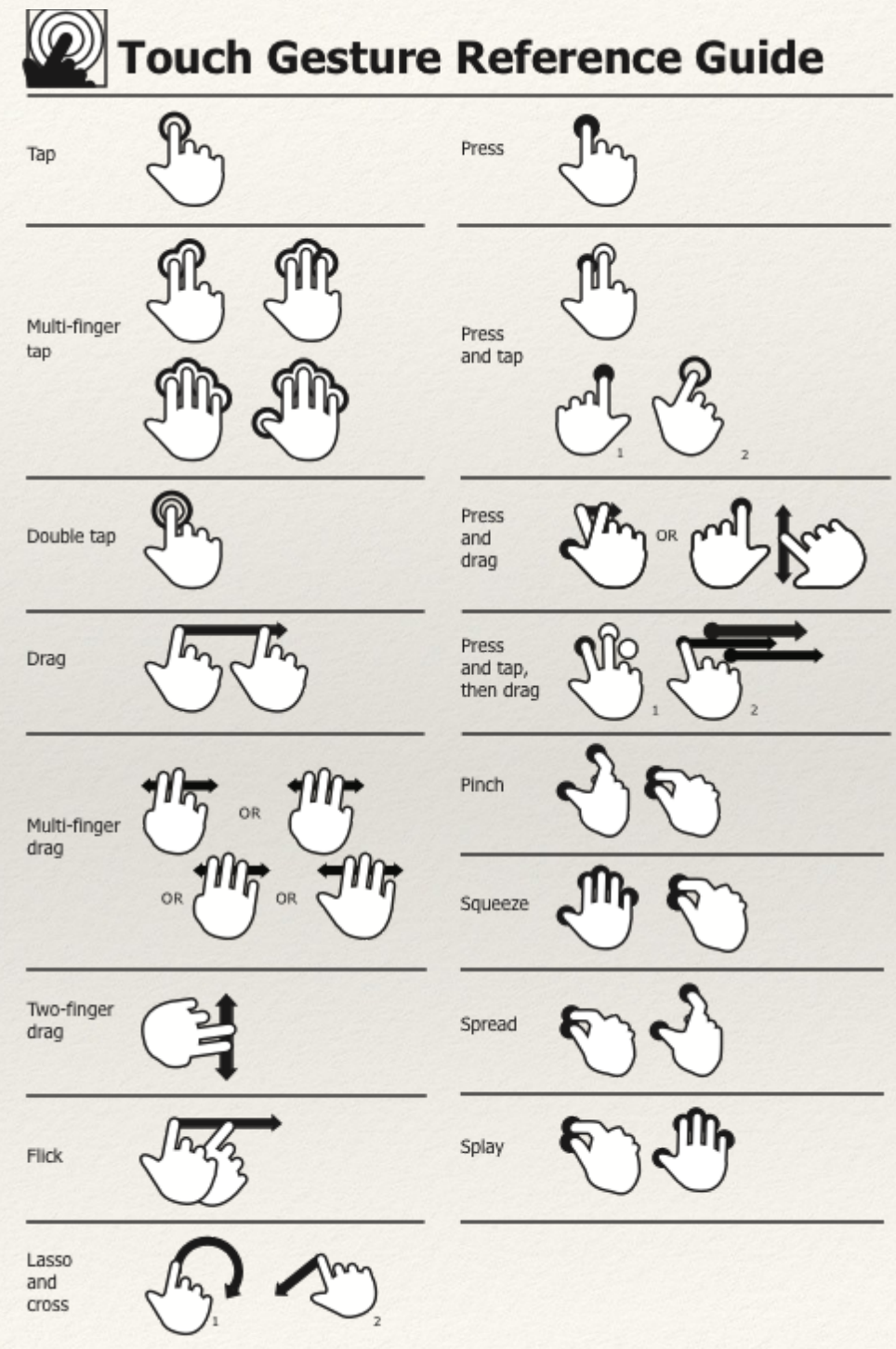
- ❖ Current information environments often work against the human-machine synergy
 - ❖ Humans are good at *conceptual and perceptual analysis*
 - ❖ Computers are exactly the opposite, they are efficient at *mathematical and logical analysis*
- ❖ Experiential environment is an environment where users directly use their senses to observe data and information of interest related to an event
 - ❖ Natural interaction with the data based on the users' particular set of interests in the *context* of that event



Properties of Experiential Environments (1)

❖ *Direct and Intuitive*

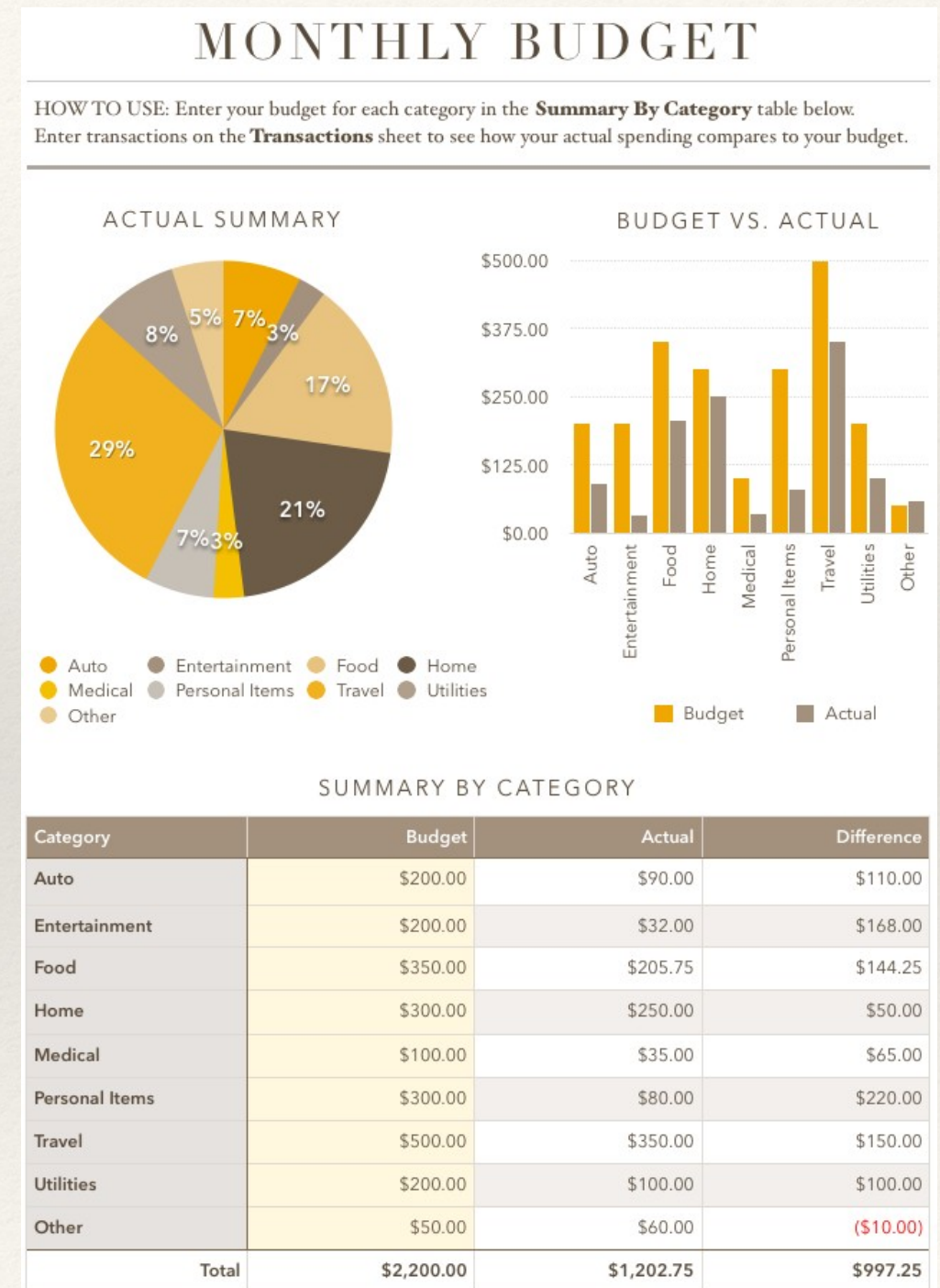
- ❖ Provides a holistic picture of an event without using unfamiliar metaphors and commands.
- ❖ Example(s)
 - ❖ Swiping a photo toward the left brings a new photo
 - ❖ Pushing on an icon representing an application launches an application
 - ❖ Game systems like Microsoft Kinect
- ❖ In experiential environments, users easily and rapidly interpret the data presented and then interact with the dataset to get a modified dataset



Properties of Experiential Environments (2)

❖ *Provide the same query and presentation spaces*

- ❖ Query and presentation spaces are the same (WYSIWYG)
- ❖ Example(s)
 - ❖ Spreadsheet
 - ❖ Query: Change of certain data that is displayed in the context of other data items
 - ❖ Presentation: Results in a new sheet showing new relationships



Properties of Experiential Environments (3)

- ❖ *Consider both the User State and Context*
 - ❖ People operate best when they are in known contexts
 - ❖ Good experiential environment should promote perceptual analysis and exploration
 - ❖ Example(s)
 - ❖ Video Games effectively use audio, video and tactile media to create compelling interactive environments



Why Multimedia Computing?

- ❖ We need a good experiential systems to improve human-machine synergy for current information environments
- ❖ Experiential Systems are technically implemented as Multimedia Systems
 - ❖ Integrate, Process and Output data from different sensory modalities

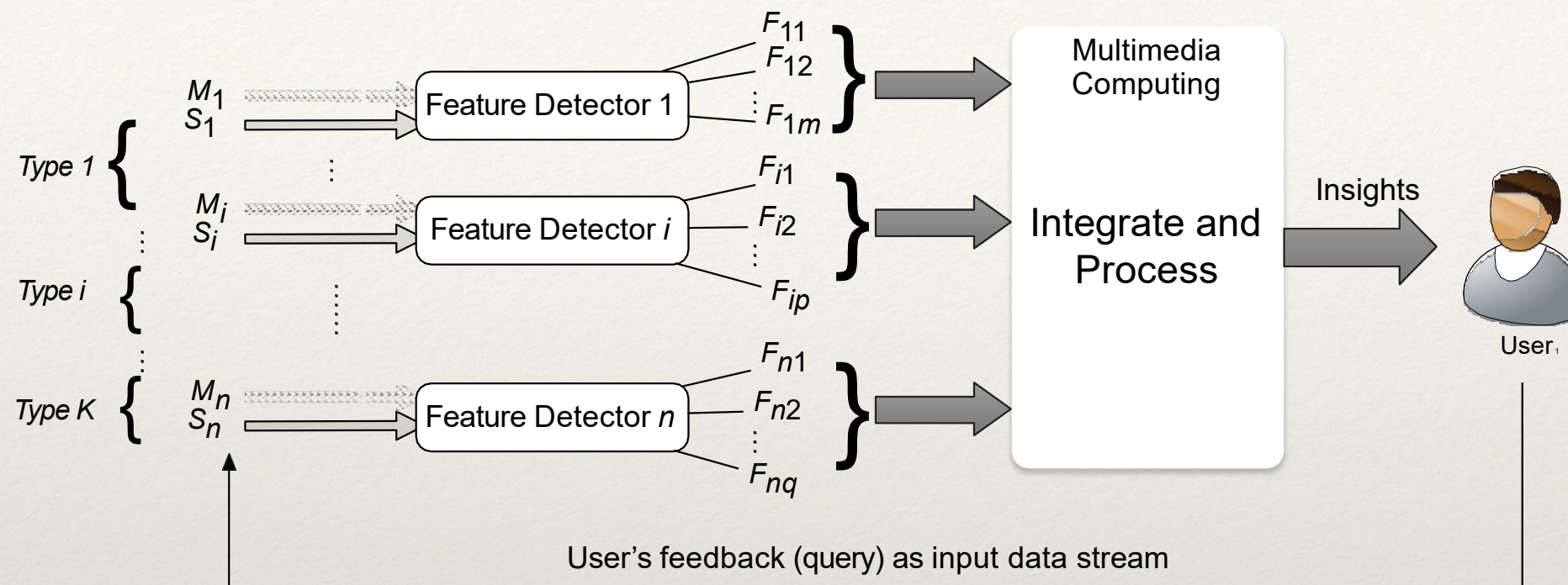


Formal Definition of Multimedia Computing

- ❖ Consider a system equipped with multiple sensors working in a physical environment
 - ❖ Assume that S_1, \dots, S_n are synchronised data streams from sensors
 - ❖ These data streams have K types of data in the form of
 - ❖ Image sequence, Audio stream, Motion detector, etc.
 - ❖ Let M_1, \dots, M_n be the metadata for each stream
 - ❖ Annotations, Parameters, etc.
 - ❖ Let F_{ij} be the j -th feature stream from S_i



Formal Definition of Multimedia Computing (Cont'd)



- ❖ Multimedia differs from monomedia fields like computer vision or audio processing in the way that
 - ❖ Multimedia is closely related to how humans experience the world
 - ❖ Partial information from multiple media sources is correlated and combined to get complete information about the environment
 - ❖ Multimedia computing and communication is fundamentally about combining information from multiple sources in the context of the problem being solved

Example of Multimedia Computing Application

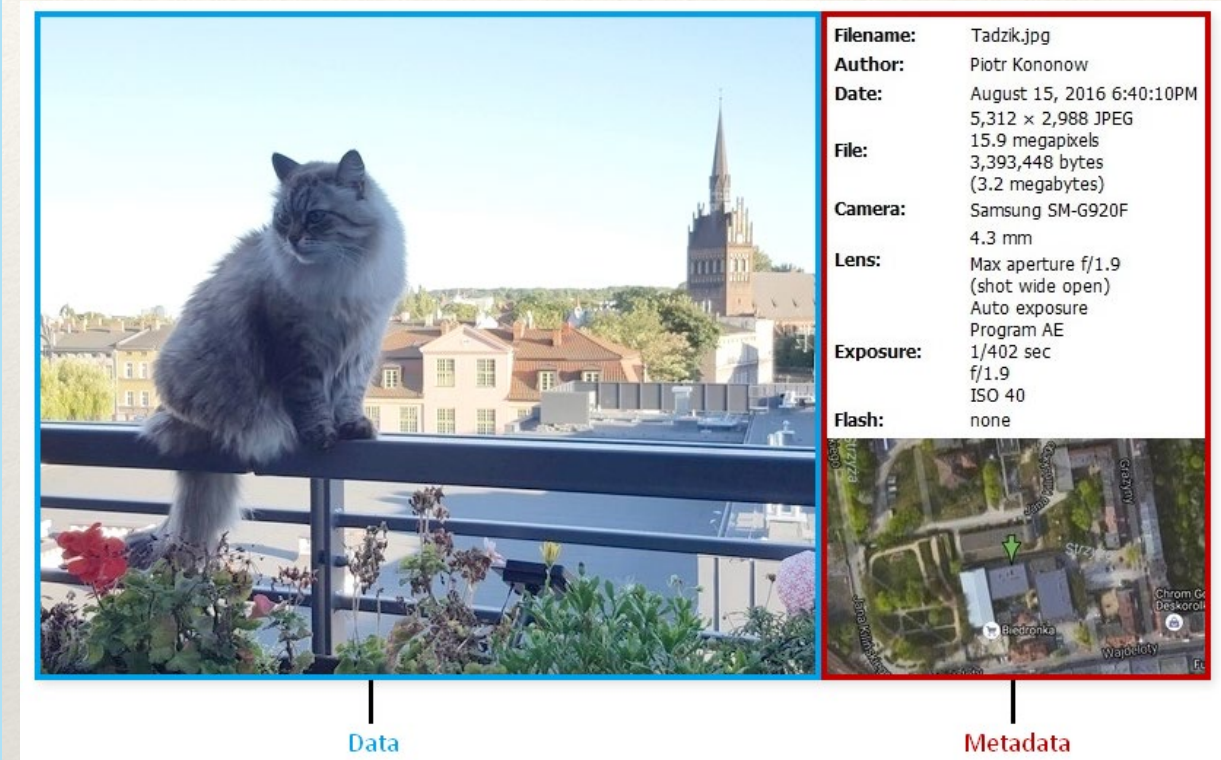
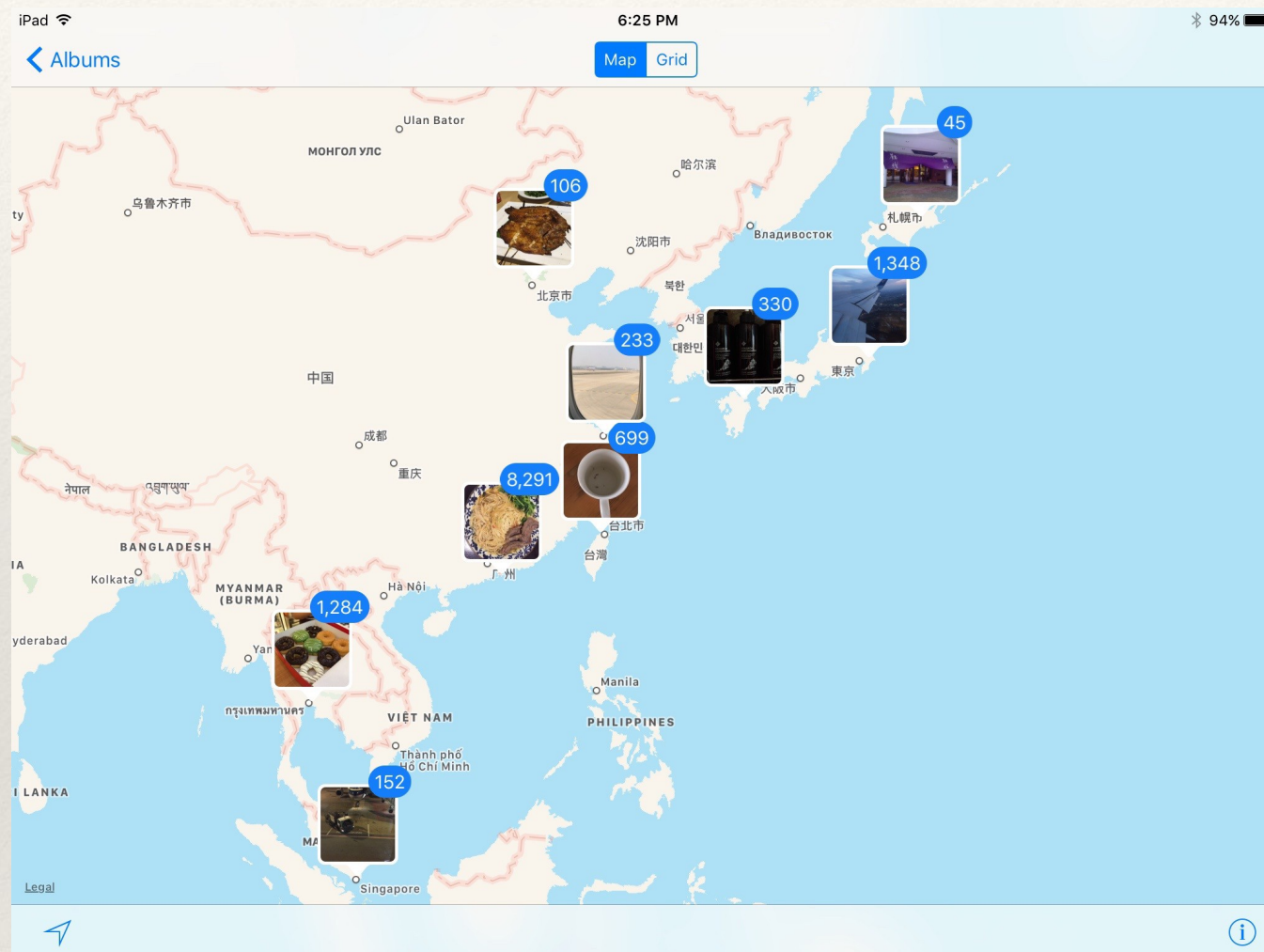


Image acquired from <https://dataedo.com/kb/data-glossary/what-is-metadata/>

Input: Metadata

Output: Insight (route of trip)