



# Course Overview

**Multimedia Techniques & Applications**

**Yu-Ting Wu**

# Course Information

- **Meeting time:** 09:10 - 12:00, Monday
- **Classroom:** 資B1F-04
- **Instructor:** 吳昱霆 ([Yu-Ting Wu](#))
- **Teaching assistants:** 劉勇佑、賴彥富
- **Course webpage:**
  - <https://kevicosner.github.io/courses/MMTA2023/>
- **Grading:**
  - Assignments: 30%
  - Midterm: 30%
  - Final Project: 40% (teamwork)

# HW Late Policy HW

- One day 90%
- Two days 80%
- Three days 70%
- Four days 60%
- Five days+ 50%
- E.g., assume the deadline for the HW is 04/01 23:59 and you submit your HW on 04/02, you will get a 10% penalty
- You should **NOT** share your homework with any **living creatures** (**if caught, you will get zero**)

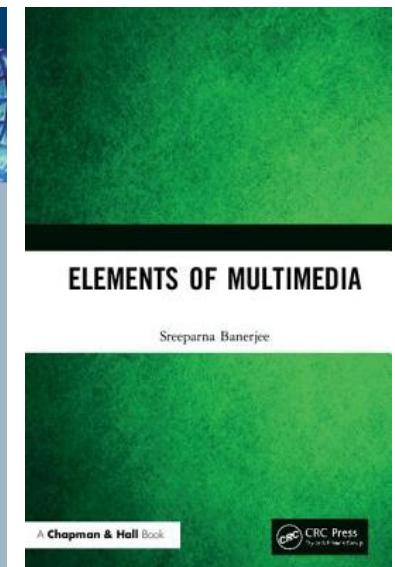
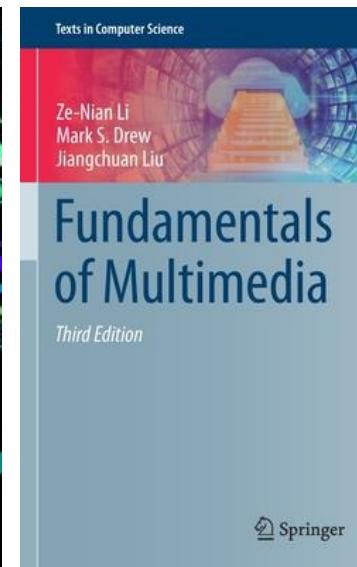
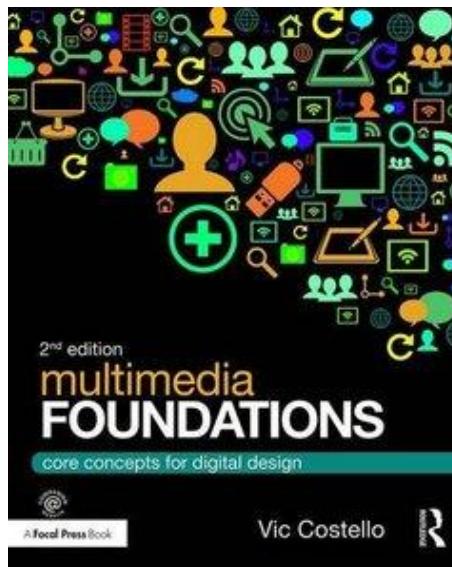
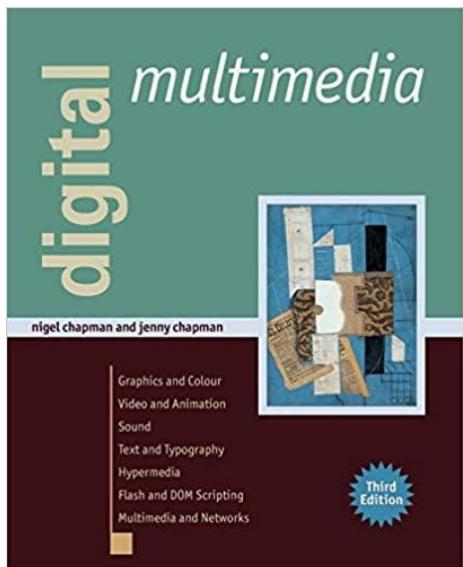
# Class Rules

- You are welcome to ask questions
  - Raise your hands anytime in class
  - Send an email to me anytime out of class (please be polite!)
- DO **NOT CHAT** in the class



# References

- No specific textbook for this course
  - I will prepare the slides
  - If you still want some textbooks, here are some options



# Copyright Statement

- We will use lots of materials from feature movies, games, capture or display devices, **the copyrights belong to the producers and developers of the original content or devices**
  - Please do **NOT** share the slides out of the class
- Some of the materials are borrowed from the course, “Digital Visual Effects”, by **Prof. Yung-Yu Chuang**, National Taiwan University (NTU)

# **What is Multimedia ?**

# **Multi --- Media**

# **What is Media ?**

# Media

- The plural of medium
  - Communication channels for delivering information



newspaper



magazine



outdoor advertising



radio



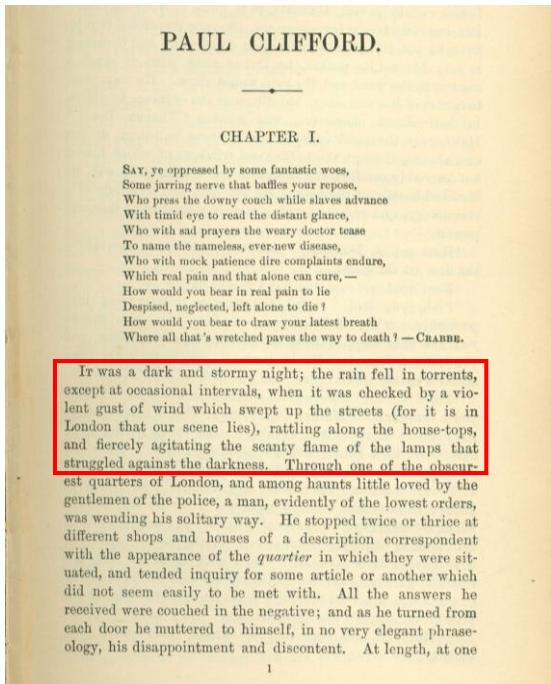
TV programs



internet

# Media (cont.)

- Example: *it was a dark and stormy night*



1

novel



comic



video

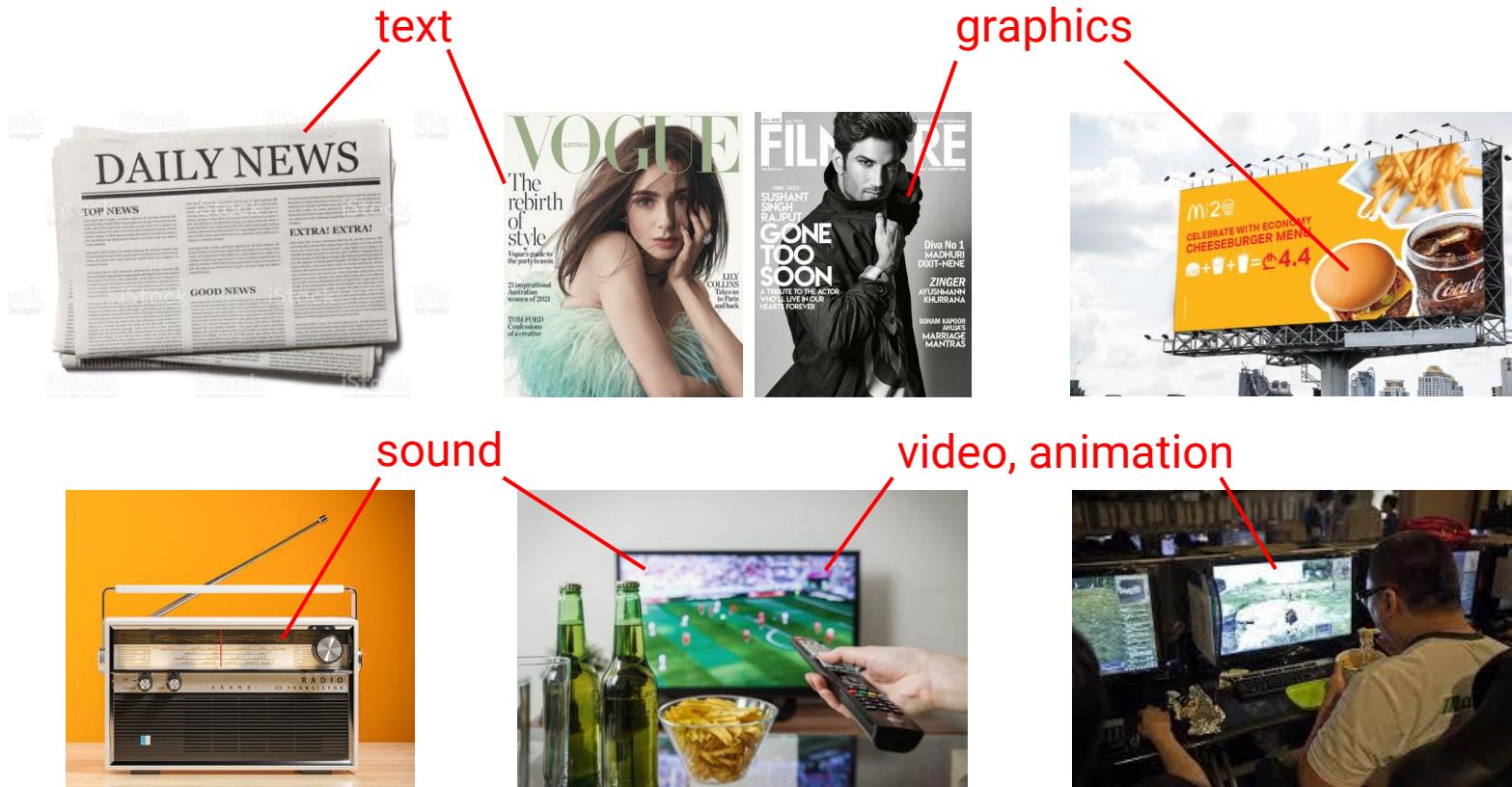


radio



drama

# Basic Components of Media



- We will introduce some of these components in the following courses

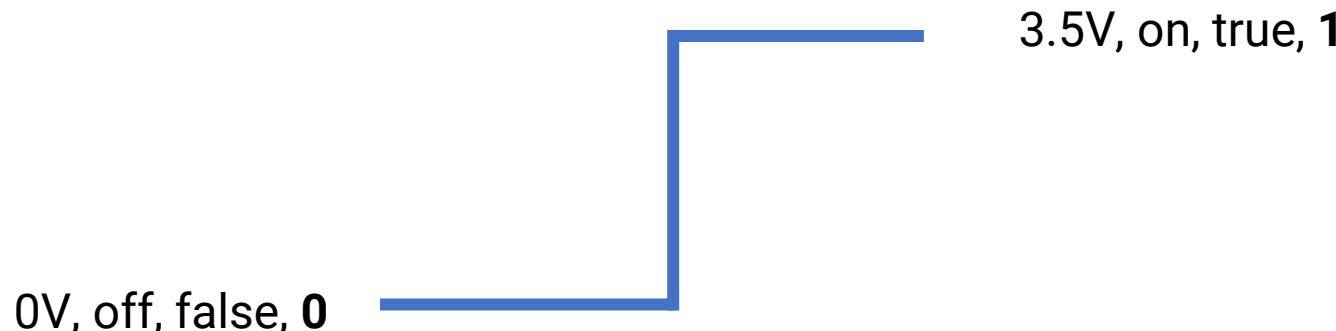
# Digital Media

- In this course, we focus on ***digital media***, which can be represented ***digitally***
  - Structured as collections of bits
  - Manipulated by programs
  - Stored on disks and other storage devices
  - Transmitted over networks



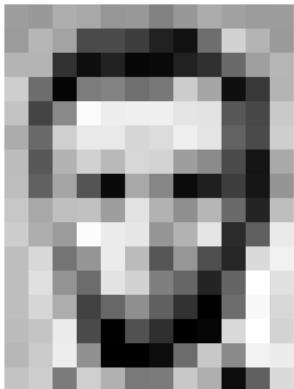
# Recap: Digital Representation

- Computers are built out of devices that can only be in one of two states (well-defined voltages)
- We usually say these devices store and operate in **bits**



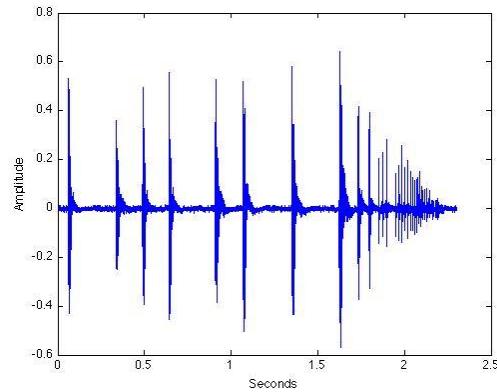
# Recap: Digital Representation (cont.)

- Using the representation of 0/1, we can interpret the group of bits (bytes or words) into a number to base 2
  - E.g., 01100001 → 97
- We can then express data using bits, bytes, or words



157	150	174	168	150	152	129	151	177	161	155	156
155	182	163	74	75	62	33	17	110	210	180	154
180	180	50	14	34	6	10	33	48	106	159	181
206	109	6	124	131	111	120	204	166	15	56	180
194	68	197	251	237	239	239	228	227	87	71	201
172	105	207	233	233	214	220	239	228	98	74	206
188	88	179	209	185	215	211	158	139	75	20	169
189	97	165	84	10	168	134	11	31	62	22	148
199	164	191	193	154	227	178	143	182	105	36	190
205	174	155	252	236	231	149	178	228	43	95	234
190	216	116	149	236	187	85	150	79	38	218	241
190	224	147	108	227	210	127	102	36	101	255	224
190	214	173	66	103	143	96	50	2	109	249	215
187	196	236	75	1	81	47	0	6	217	255	211
183	202	237	145	9	0	12	108	200	138	243	236
195	206	123	207	177	121	123	200	175	13	96	218

157	153	174	168	150	162	129	151	172	161	155	156
155	182	163	74	75	62	33	17	110	210	180	154
180	180	50	14	34	6	10	33	48	106	159	181
206	109	5	124	131	111	120	204	166	15	56	180
194	68	197	251	237	239	239	228	227	87	71	201
172	105	207	233	233	214	220	239	228	98	74	206
188	88	179	209	185	215	211	158	139	75	20	169
189	97	165	84	10	168	134	11	31	62	22	148
199	168	191	193	154	227	178	143	182	106	36	190
205	174	155	252	236	231	149	178	228	43	95	234
190	216	116	149	236	187	85	150	79	38	218	241
190	224	147	108	227	210	127	102	36	101	255	224
190	214	173	66	103	143	96	50	2	109	249	215
187	196	236	75	1	81	47	0	6	217	255	211
183	202	237	145	9	0	12	108	200	138	243	236
195	206	123	207	177	121	123	200	175	13	96	218



- We can also build electronic devices to perform the basic arithmetic operations
  - Addition, subtraction, multiplication, division, ... etc.

# Recap: Digital Representation (cont.)

- We can also build mapping, e.g.,
  - ASCII code
  - Instruction set

Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char
0	0	[NULL]	32	20	[SPACE]	64	40	@	96	60	`
1	1	[START OF HEADING]	33	21	!	65	41	A	97	61	a
2	2	[START OF TEXT]	34	22	"	66	42	B	98	62	b
3	3	[END OF TEXT]	35	23	#	67	43	C	99	63	c
4	4	[END OF TRANSMISSION]	36	24	\$	68	44	D	100	64	d
5	5	[ENQUIRY]	37	25	%	69	45	E	101	65	e
6	6	[ACKNOWLEDGE]	38	26	&	70	46	F	102	66	f
7	7	[BELL]	39	27	'	71	47	G	103	67	g
8	8	[BACKSPACE]	40	28	(	72	48	H	104	68	h
9	9	[HORIZONTAL TAB]	41	29	)	73	49	I	105	69	i
10	A	[LINE FEED]	42	2A	*	74	4A	J	106	6A	j
11	B	[VERTICAL TAB]	43	2B	+	75	4B	K	107	6B	k
12	C	[FORM FEED]	44	2C	,	76	4C	L	108	6C	l
13	D	[CARRIAGE RETURN]	45	2D	-	77	4D	M	109	6D	m
14	E	[SHIFT OUT]	46	2E	.	78	4E	N	110	6E	n
15	F	[SHIFT IN]	47	2F	/	79	4F	O	111	6F	o
16	10	[DATA LINK ESCAPE]	48	30	0	80	50	P	112	70	p
17	11	[DEVICE CONTROL 1]	49	31	1	81	51	Q	113	71	q
18	12	[DEVICE CONTROL 2]	50	32	2	82	52	R	114	72	r
19	13	[DEVICE CONTROL 3]	51	33	3	83	53	S	115	73	s
20	14	[DEVICE CONTROL 4]	52	34	4	84	54	T	116	74	t
21	15	[NEGATIVE ACKNOWLEDGE]	53	35	5	85	55	U	117	75	u
22	16	[SYNCHRONOUS IDLE]	54	36	6	86	56	V	118	76	v
23	17	[ENG OF TRANS. BLOCK]	55	37	7	87	57	W	119	77	w
24	18	[CANCEL]	56	38	8	88	58	X	120	78	x
25	19	[END OF MEDIUM]	57	39	9	89	59	Y	121	79	y
26	1A	[SUBSTITUTE]	58	3A	:	90	5A	Z	122	7A	z
27	1B	[ESCAPE]	59	3B	;	91	5B	{	123	7B	{
28	1C	[FILE SEPARATOR]	60	3C	<	92	5C	\	124	7C	
29	1D	[GROUP SEPARATOR]	61	3D	=	93	5D	^	125	7D	}
30	1E	[RECORD SEPARATOR]	62	3E	>	94	5E	_	126	7E	~
31	1F	[UNIT SEPARATOR]	63	3F	?	95	5F	[DEL]	127	7F	

		Target <tar>			
		4R or Mx		12R	
INC	\$0	--	C	Z	N
DEC	\$1	--	C	Z	N
ADDC	\$2	O	C	Z	N
SUBB	\$3	O	C	Z	N
ROLC	\$4	--	C <sup>1</sup>	Z	N
RORC	\$5	--	C <sup>2</sup>	Z	N
AND	\$6	--	--	Z	N
OR	\$7	--	--	Z	N
XOR	\$8	--	--	Z	N
CMP	\$9	--	C <sup>4</sup>	Z <sup>3</sup>	--
PUSH	\$A	--	--	--	--
POP	\$B	--	--	Z <sup>5</sup>	N <sup>5</sup>
JMP	\$C	--	--	--	--
JSR	\$D	--	--	--	--
NOP	\$E	--	--	--	--
MOV	\$F	--	--	Z <sup>6</sup>	N <sup>6</sup>
		--	--	Z <sup>7</sup>	N <sup>7</sup>

- **Program:** sequences of instructions can be stored in memory and execute

# Recap: Digitalization

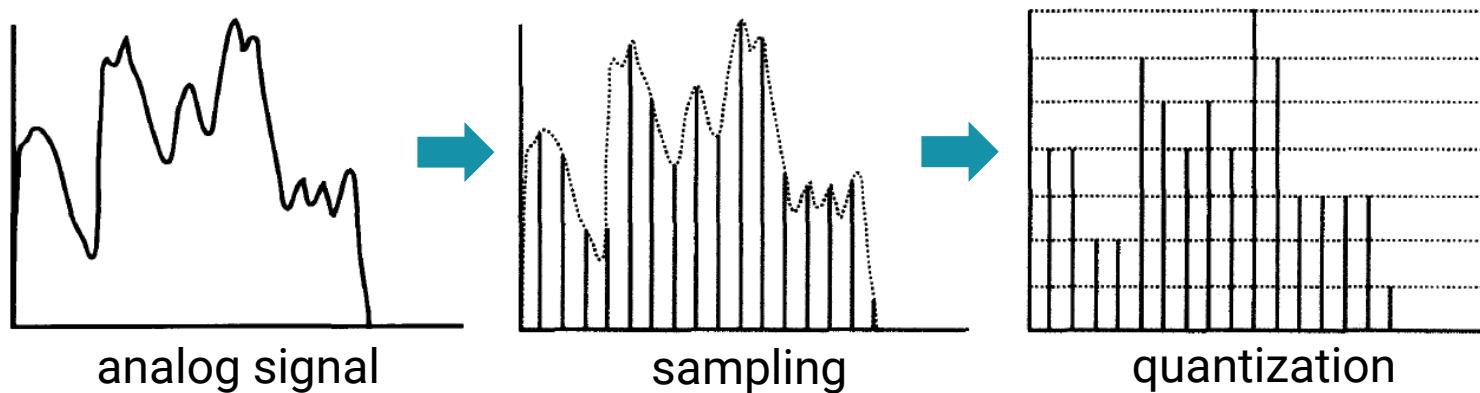
- However, not all data are generated digitally



- **Digitalization** is the process that transforms the sensor inputs that makeup **images, texts, moving pictures (animations or videos)**, and **sounds** into **patterns of binary digits** inside a computer

# Recap: Digitalization (cont.)

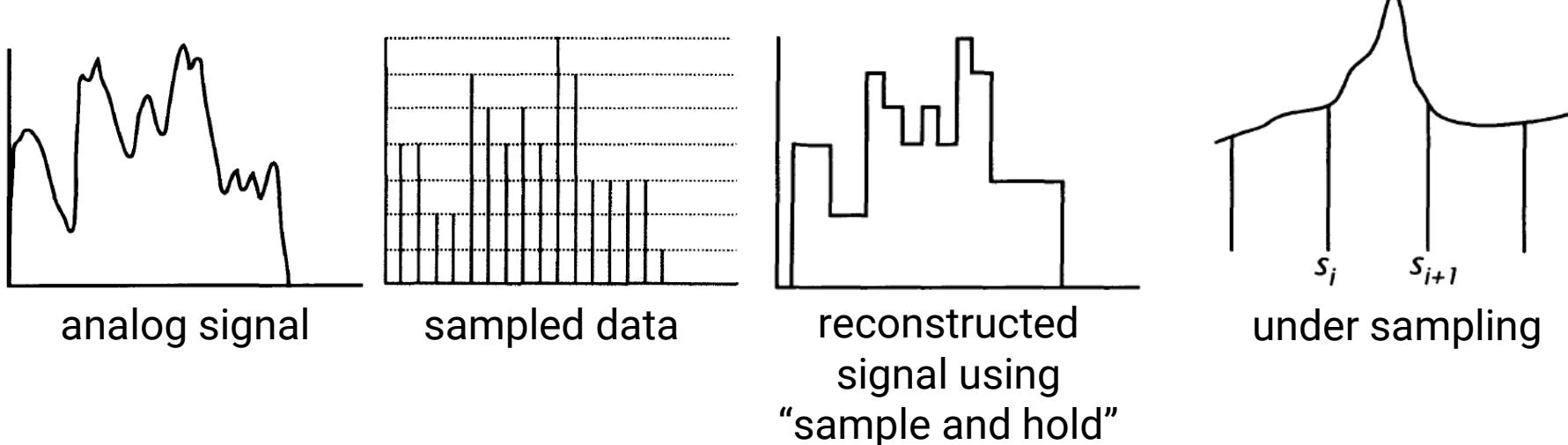
- **Process for digitalization**
  - **Sampling:** measure the signal's value at discrete intervals
  - **Quantization:** restrict the value to a fixed set of levels



- **Pros:** **fixed memory footprint** and **better noise tolerance**
- **Cons:** some information will **inevitably lose** during the digitalization process

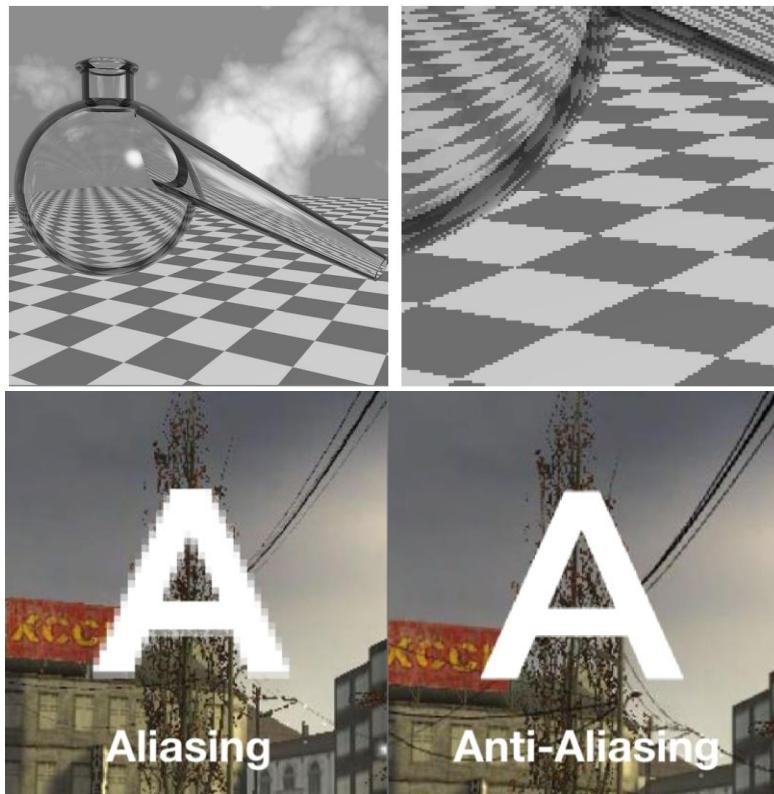
# Recap: Digitalization (cont.)

- **Quality of digitalization**
  - How closely the original signal can be reconstructed
  - Depends on
    - Quality of the sampled data
    - Reconstruction algorithms

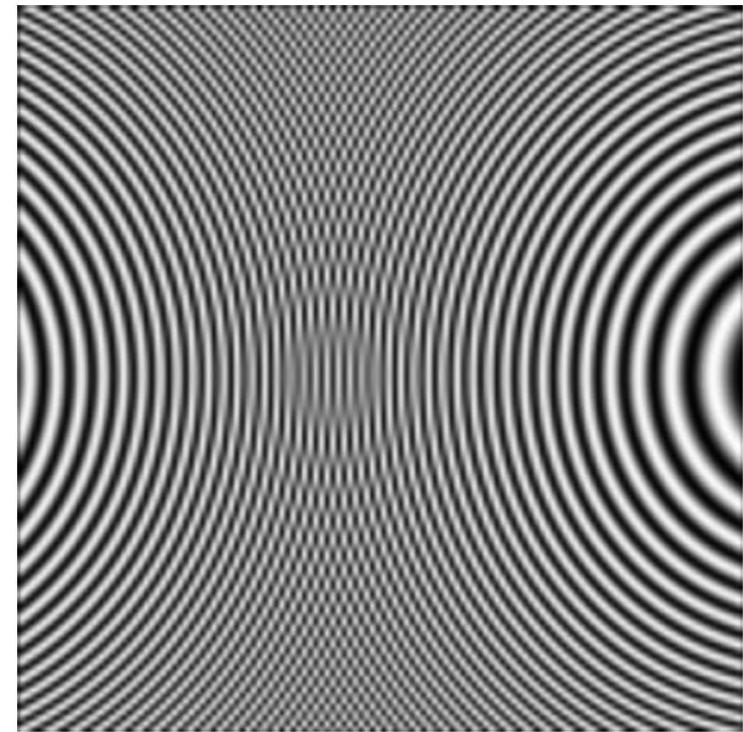


# Recap: Digitalization (cont.)

- Insufficient sampling causes aliasing
  - Spatial domain: image resolution



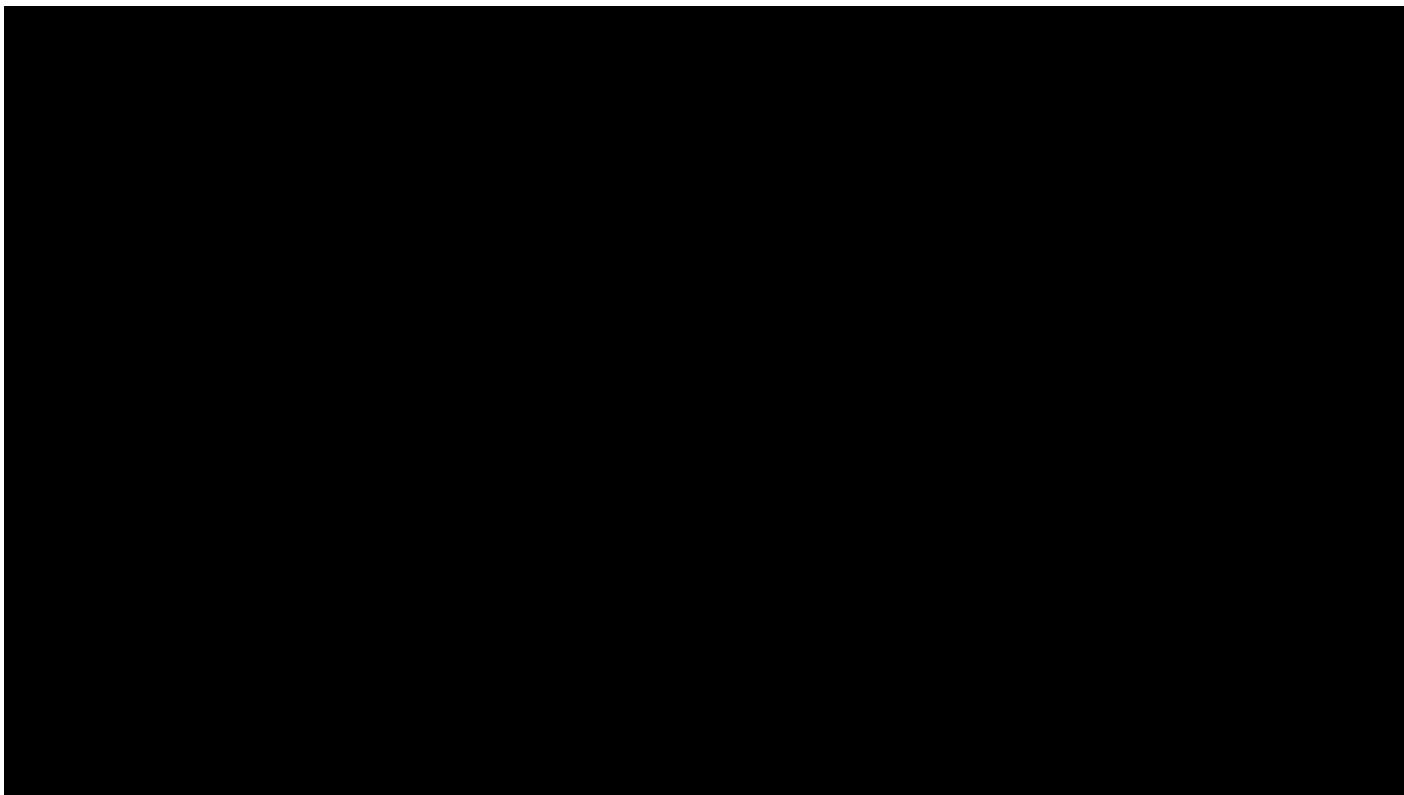
staircase pattern or jaggies



Moire pattern ( $x^2+y^2$ )

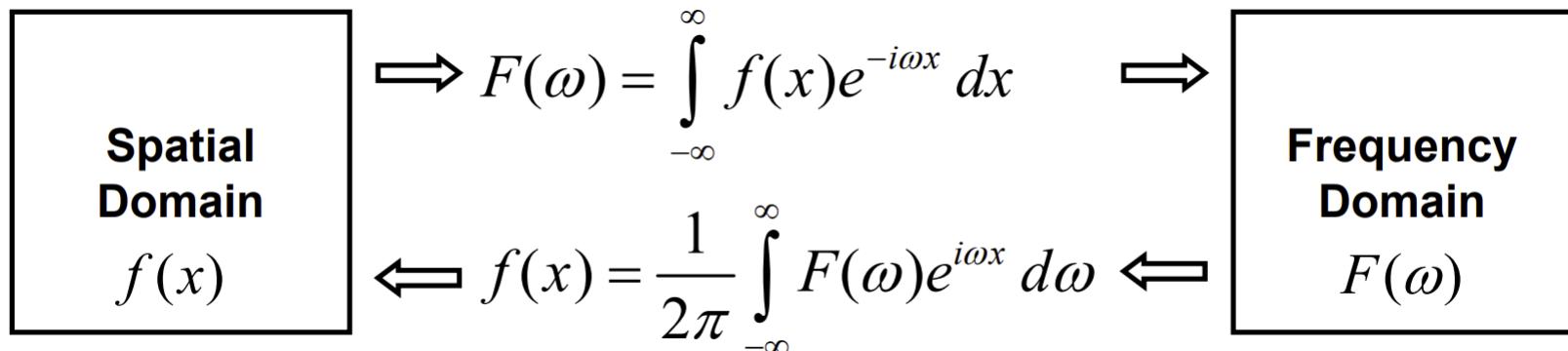
# Recap: Digitalization (cont.)

- Insufficient sampling causes aliasing
  - Temporal domain: Wagon wheel effect



# Recap: Frequency Domain

- How do we know how many samples are sufficient?
- Most functions can be decomposed into a weighted sum of shifted sinusoids
- The **Fourier transform** converts between the normal representation and frequency representation

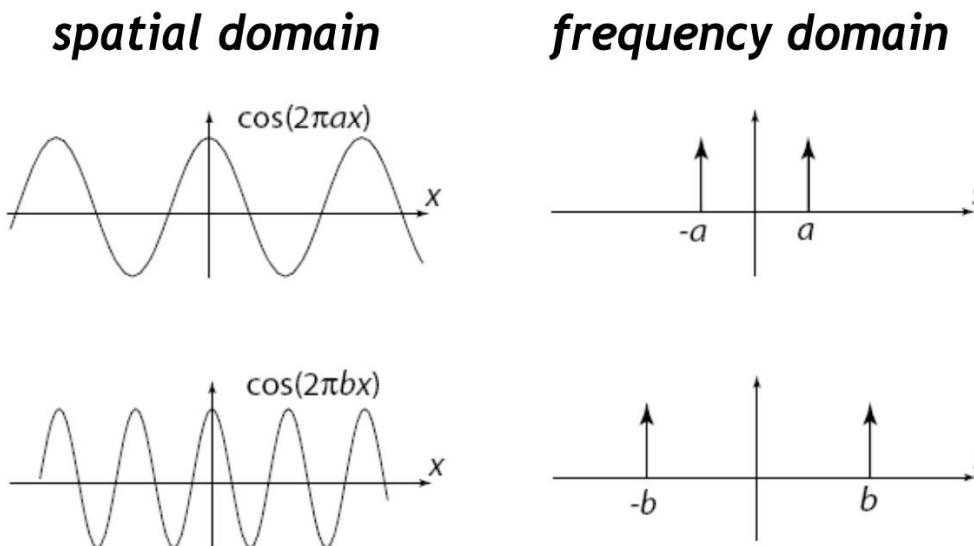


# Recap: Sampling Theorem

- **Claude Shannon [1949]**

“A signal can be reconstructed from its samples without loss of information **if the original signal has no frequencies above  $\frac{1}{2}$  the sampling frequency**”

- The frequency is called **Nyquist frequency**



# Digital Media

- In this course, we focus on ***digital media***, which can be represented ***digitally***
  - Structured as collections of bits
  - Manipulated by programs
  - Stored on disks and other storage devices
  - Transmitted over networks



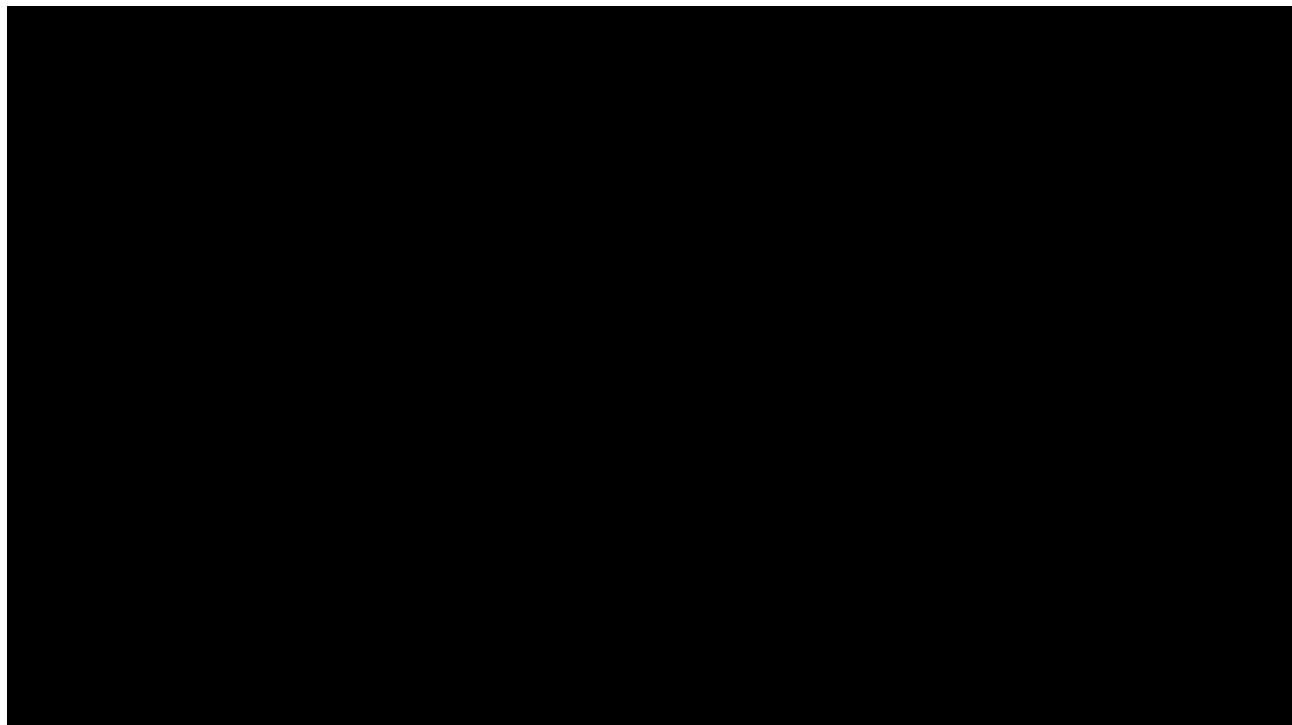
# Combination of Different Media

- The shared digital representation means that **different media can be combined**
- The integration of media is natural
  - We perceive the world through all the senses at once



# Combination of Different Media (cont.)

- The first commercial movie with sound:
  - AL JOLSON “The Jazz Singer” in 1927

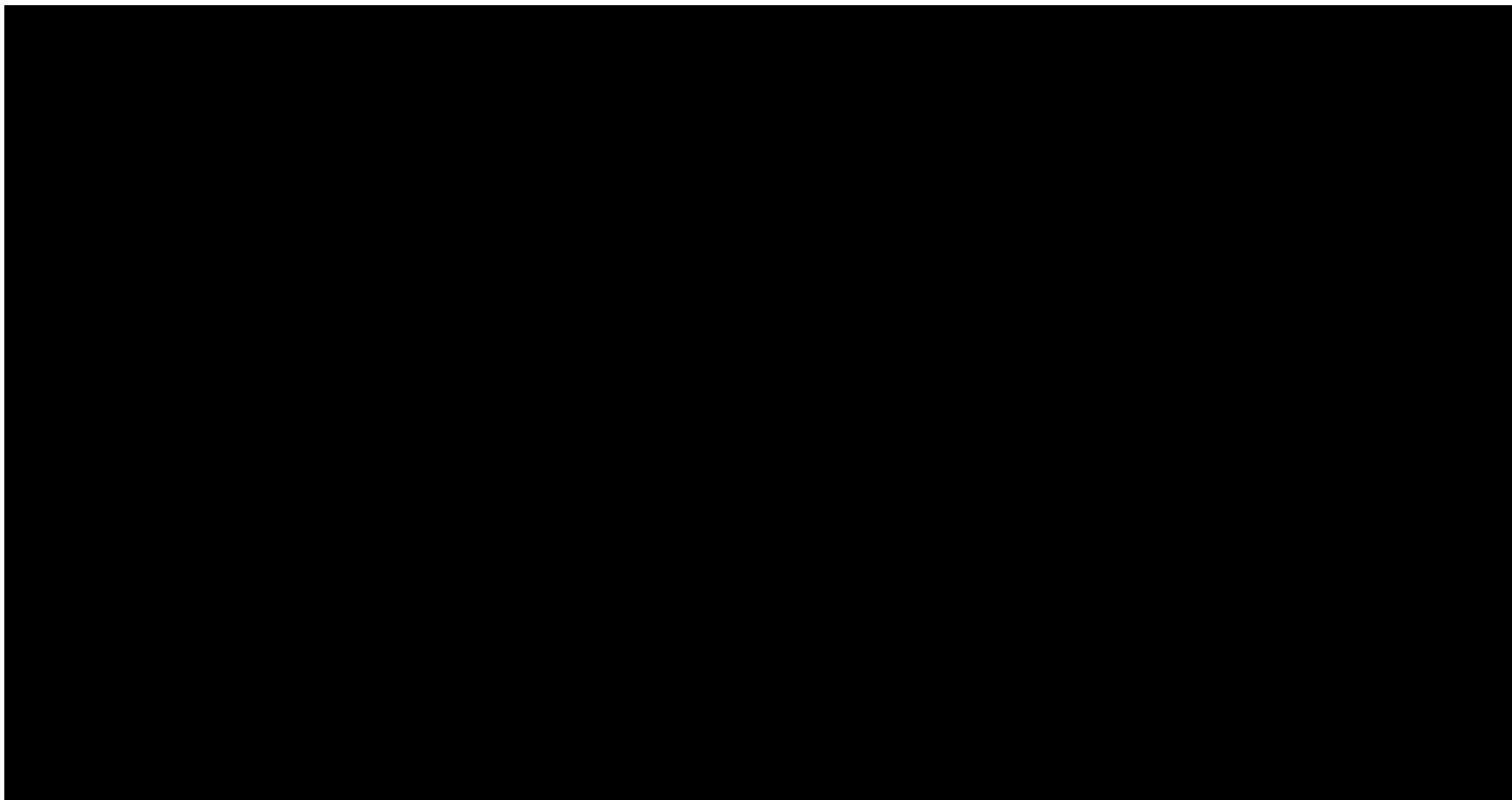


# Multimedia

- **Multimedia** is considered slightly different from multiple media or combined media
  - Multiple media or combined media require users to **switch** between modalities
  - True multimedia requires us to combine modalities **at the same time**
    - **Can bring in new content, such as the pop music videos**
    - Usually provide some interactivity
- In this course, we also focus on ***digital multimedia***, which can represent text, sound, and pictures using ***bits***
  - Control the order of each media component
  - Response to input from a user, thus being **interactive!**

# Multimedia (cont.)

- Music video: Ed Sheeran – Shivers



# Multimedia (cont.)

- Music video: ONE OK ROCK – Last Dance



# Multimedia Applications

- Entertainment
- Education
- Instruction
- Training
- Presentation
- Promotion
- Visualization
- Forensic

# Multimedia for Entertainment

- Entertainment



games

movies



music  
videos

# Multimedia for Entertainment (cont.)

- The production can make extremely different experiences
- Avengers (1978)



# Multimedia for Entertainment (cont.)

- The production can make extremely different experiences
- Avengers: Infinite Wars (2018)

# Multimedia for Entertainment (cont.)

- The production can make extremely different experiences
- Myst (1993)



# Multimedia for Entertainment (cont.)

- The production can make extremely different experiences
- Myst (2021)



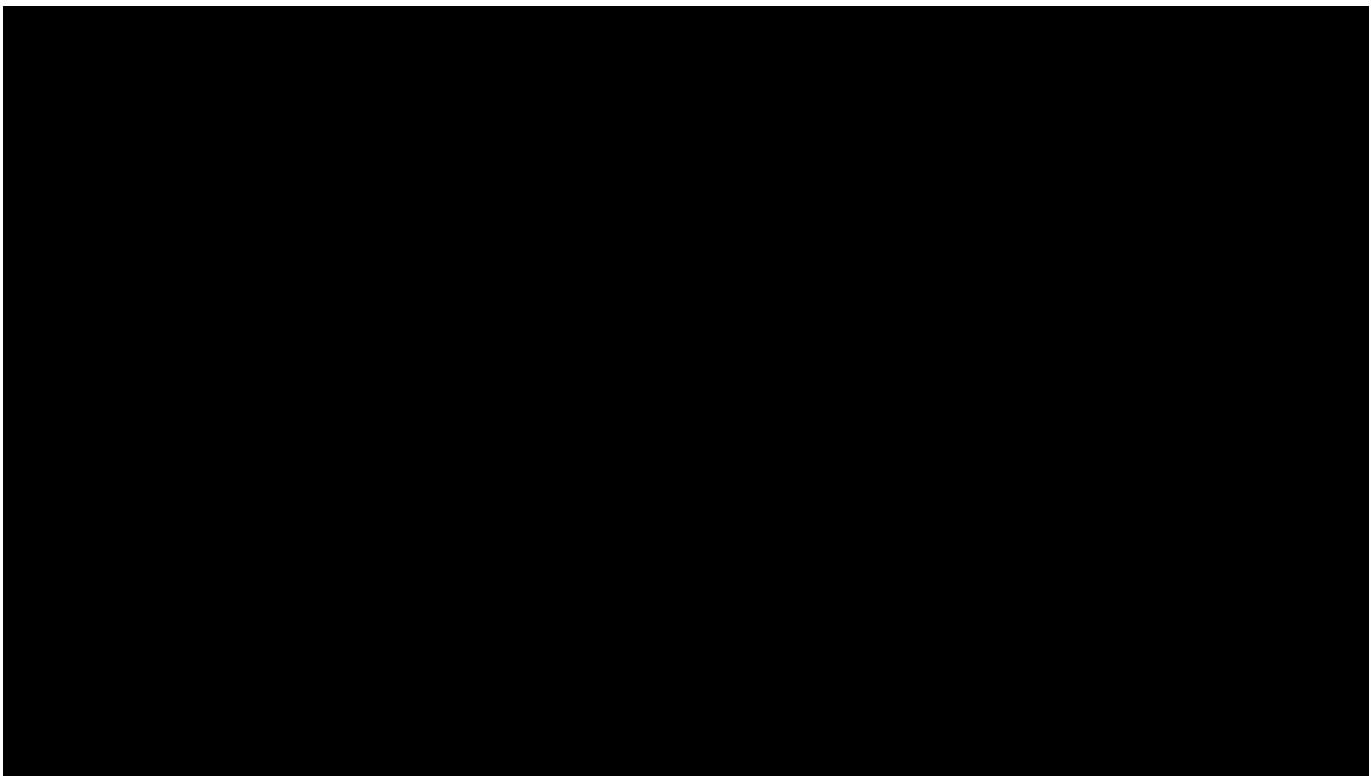
# Multimedia for Entertainment (cont.)

- The production can make extremely different experiences
- Final Fantasy VII (1997)



# Multimedia for Entertainment (cont.)

- The production can make extremely different experiences
- Final Fantasy VII Remake (2020)



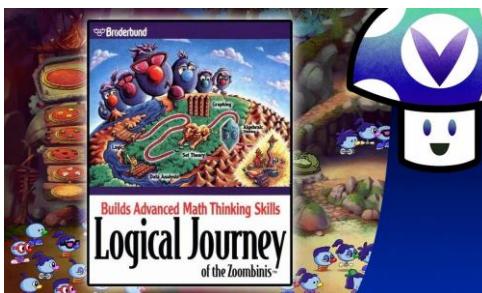
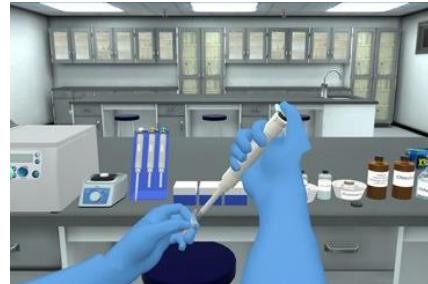
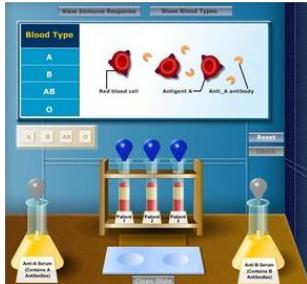
# Multimedia for Education

- Education



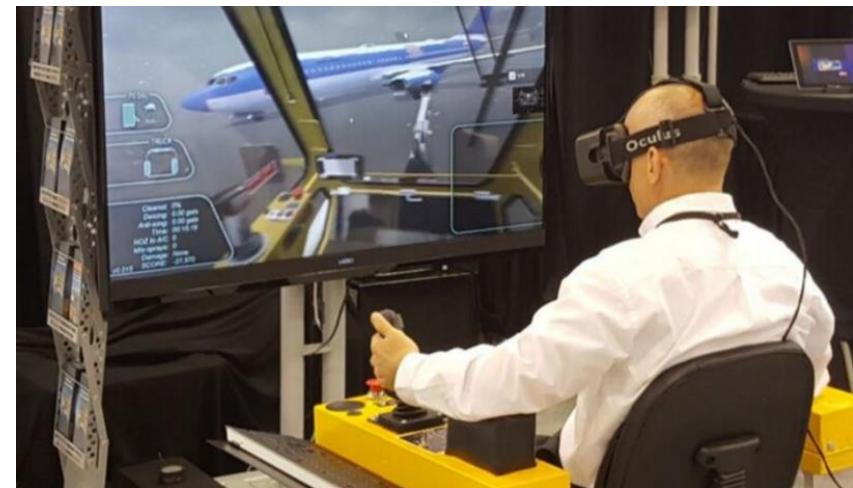
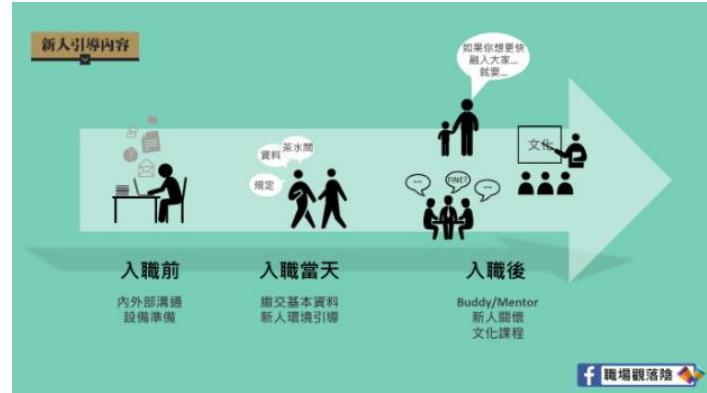
film clips and  
original recordings

virtual experiments  
or surgery



teaching  
materials

# Multimedia for Instruction and Training



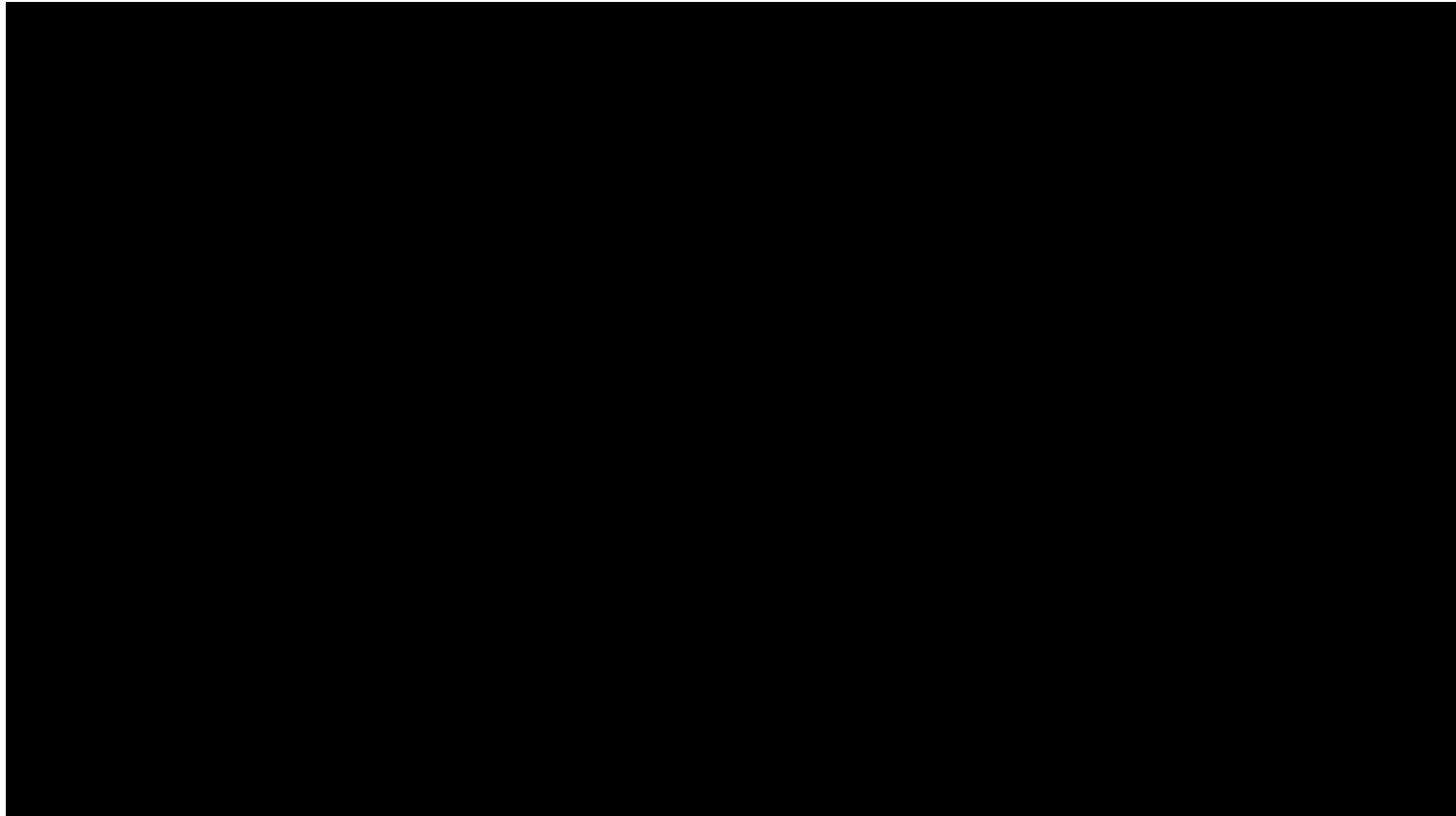
# Multimedia for Promotion and Presentation



A screenshot of a 3D model marketplace website. At the top, there are navigation links: EXPLORE, BUY 3D MODELS, FOR BUSINESS, and a search bar. Below that is a profile for Alina Zhdanova from Novosibirsk, Russia, listing 186 followers and 1 following. There are tabs for SUMMARY (selected), 17 MODELS, STORE, COLLECTIONS, and 2 LIKES. Under POPULAR 3D MODELS, there are six thumbnails: "Handpainted House" (4k views, 9 likes, 258 rating), "GEISHA - Feu..." (4.2k views, 5 likes, 193 rating), "Zeiss Ikon Co..." (8.7k views, 6 likes, 167 rating), "Hand-Painted..." (1.5k views, 5 likes, 113 rating), "Rabbit's Kitchen" (1.5k views, 4 likes, 84 rating), and "Girl" (1.5k views, 3 likes, 62 rating). Each thumbnail includes a gear icon and a price symbol (\$).

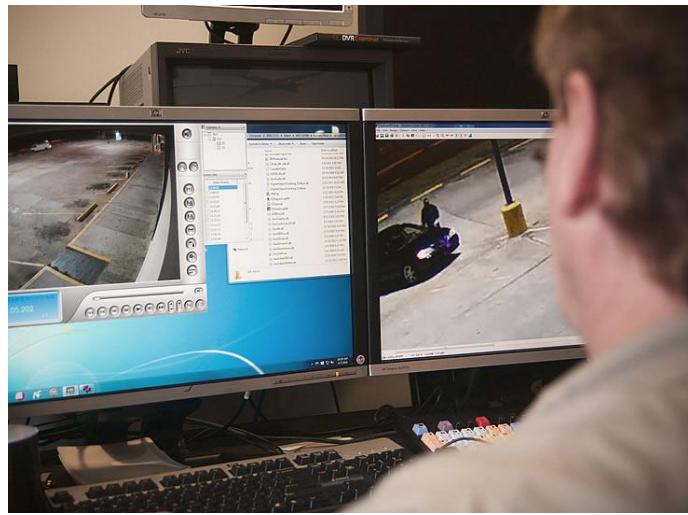
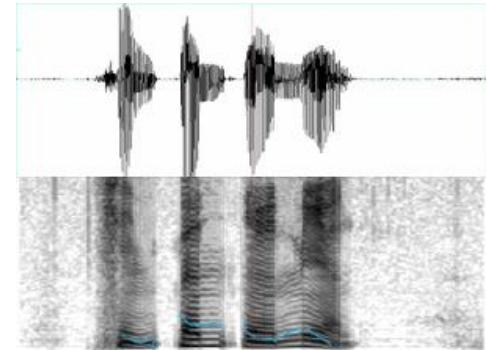
# Multimedia for Visualization

- Most favored anime characters (2007–2019)



from [https://www.youtube.com/watch?v=\\_CvtsaFgpfA](https://www.youtube.com/watch?v=_CvtsaFgpfA)

# Multimedia for Forensic



# Multimedia Delivery

- Get the material from its producer to its consumers
- **Offline** delivery: removable storage media
  - Still widely used in areas with low bandwidth to the internet



8-inch floppy disk  
150 KB  
(since 1969)



5.25-inch floppy disk  
1.2 MB  
(since 1976)



3.5-inch floppy disk  
2.88 MB  
(since 1984)



CD-ROM  
650 MB  
(since 1982)



VCD  
800 MB  
(since 1993)



DVD  
4.7 ~ 17 GB  
(since 1995)



BD  
25 ~ 128 GB  
(since 2006)

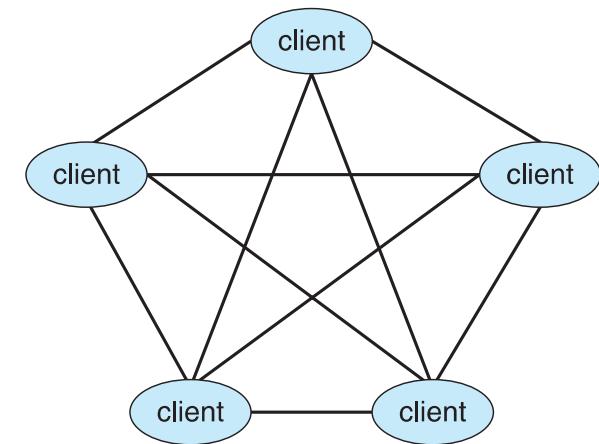
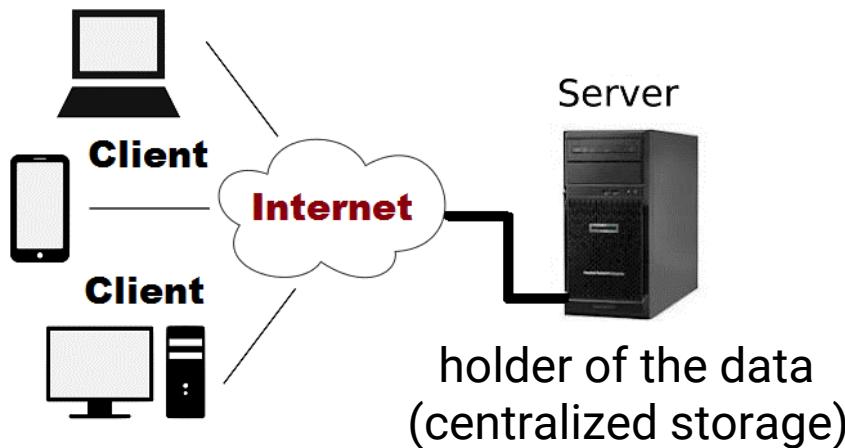
# Multimedia Delivery (cont.)

- Get the material from its producer to its consumers
- **Offline** delivery: removable storage media
  - The success of CD-ROM (and the following VCD, DVD) brings the surge in interest in multimedia



# Multimedia Delivery (cont.)

- Get the material from its producer to its consumers
- **Online delivery:** network
  - Client–Server (most common)
  - Peer-to-Peer (P2P)



- Online delivery offers opportunities that are not available offline, such as video conferencing and broadcasting

# Multimedia Delivery (cont.)

- Get the material from its producer to its consumers
- **Hybrid** (of offline & online) delivery
  - Physical removable medium (main content) with online update / or downloadable content (DLC)



# Multimedia Production

- The making of multimedia requires authoring systems
  - Preparation of individual media elements
  - Integration into a finished production



Adobe Photoshop



Adobe Premiere



Blender



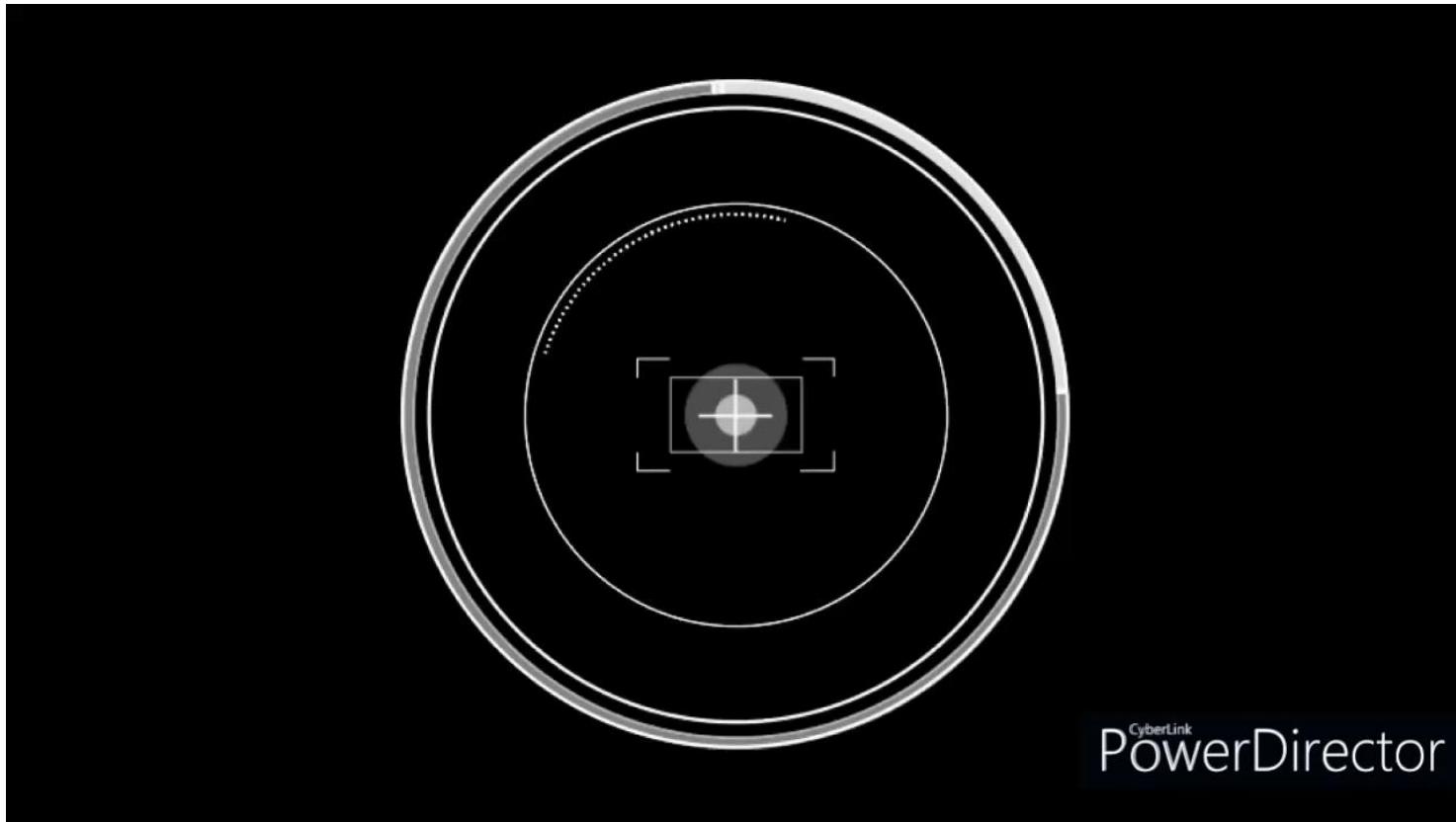
Unity / Unreal Engine

We will cover several authoring systems  
in this course

# **Topics We Plan to Cover**

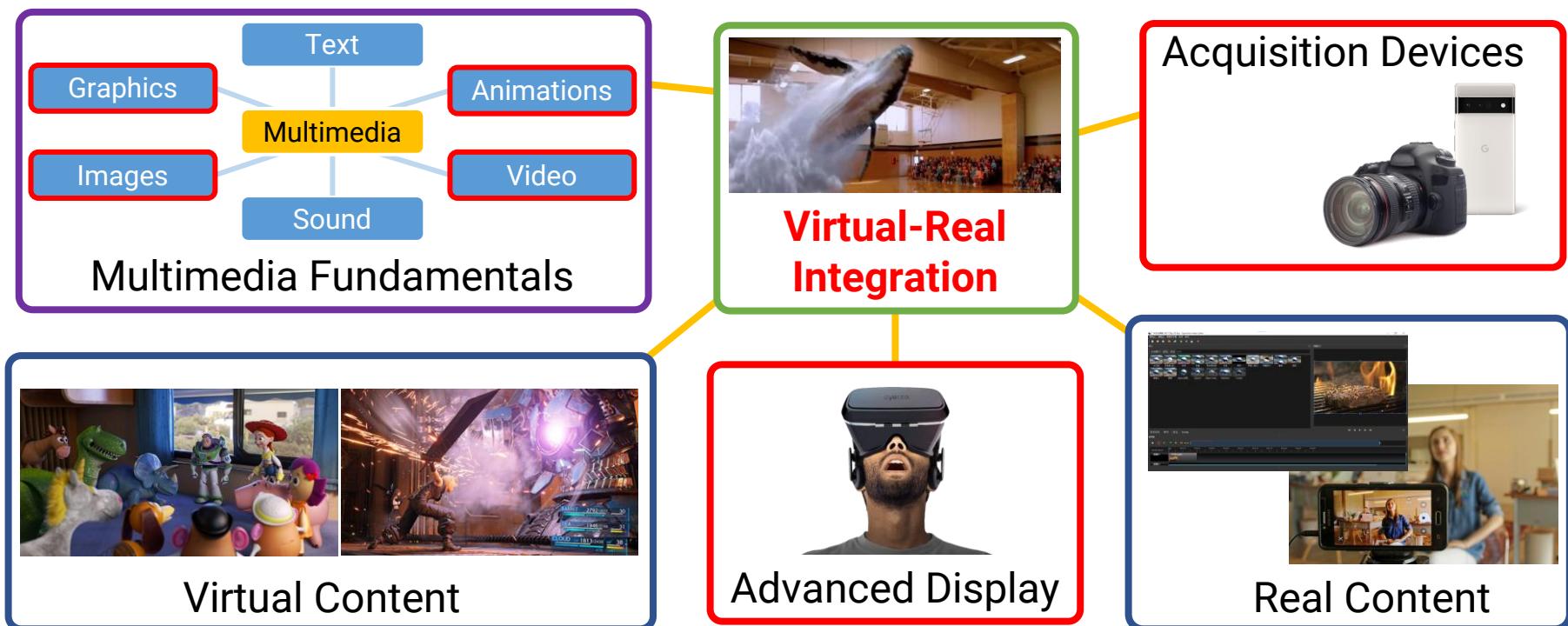
# Our Goals (Final Project)

- One short film made from some VFX techniques
- The most-voted work 2022 (蔡哲倫 余忻璋 周冠霖 同學)

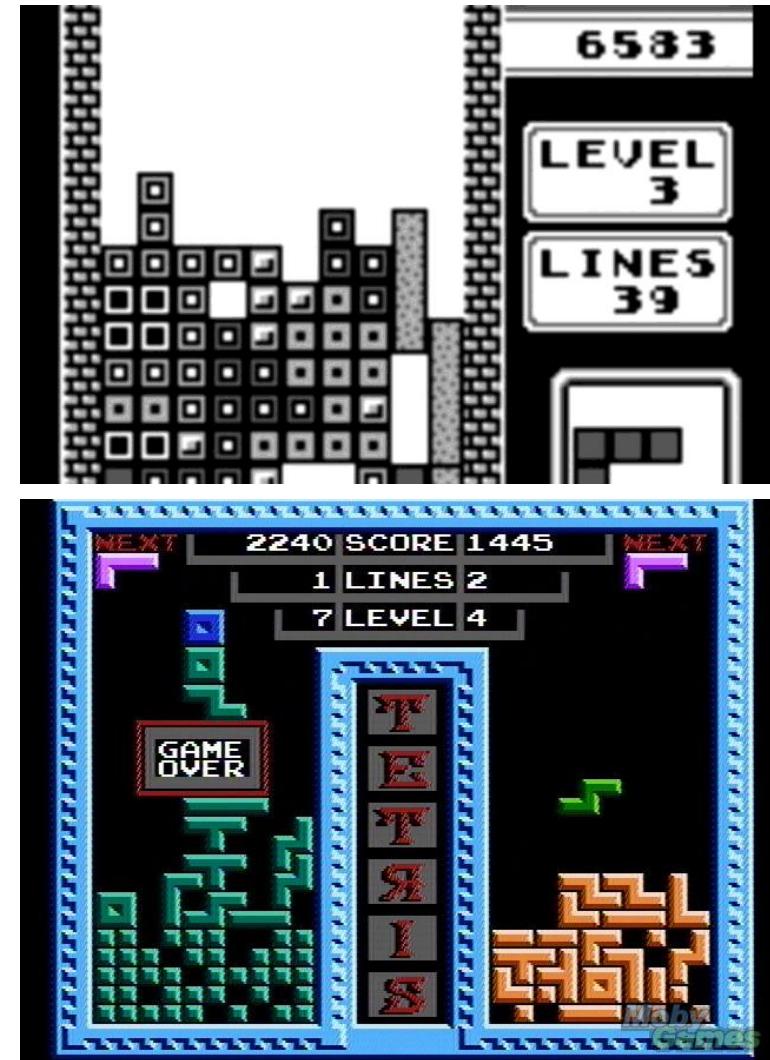
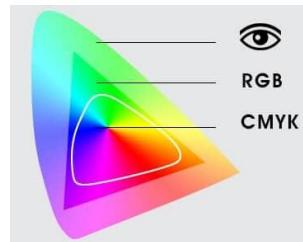
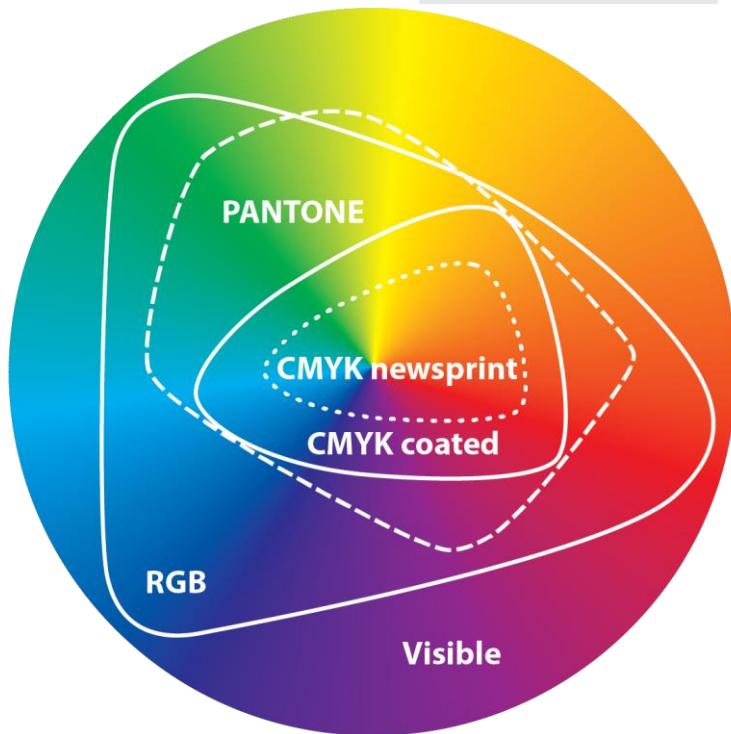


# Topics Map

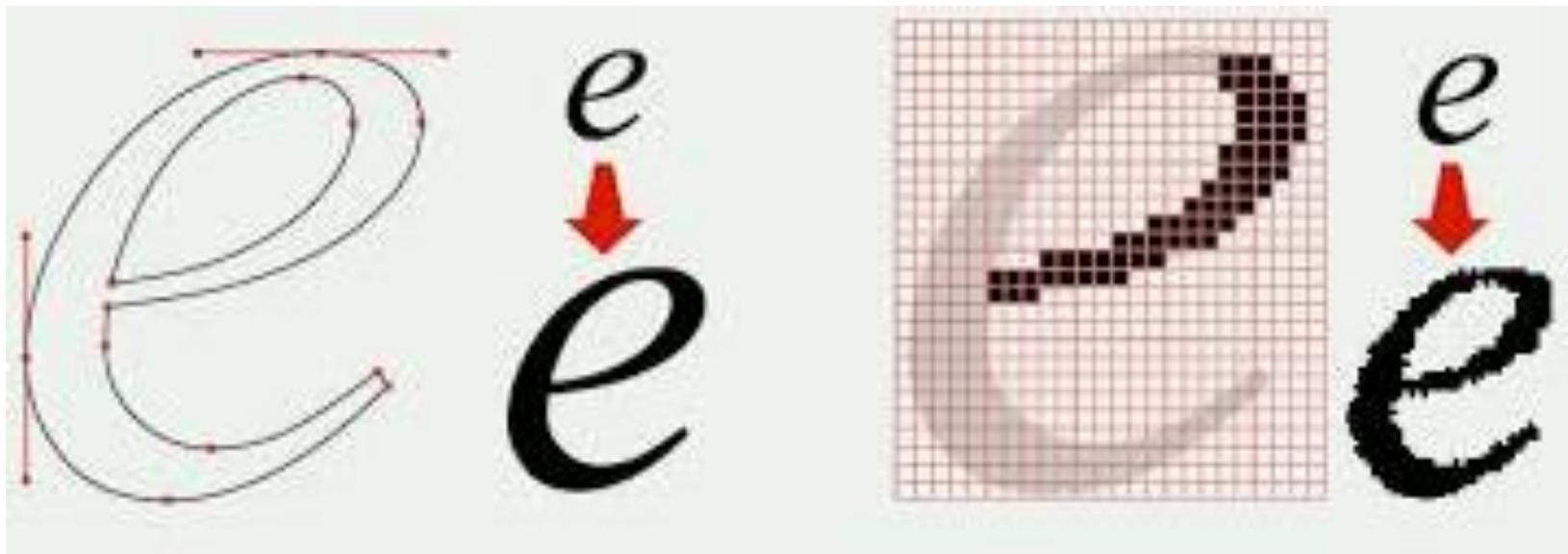
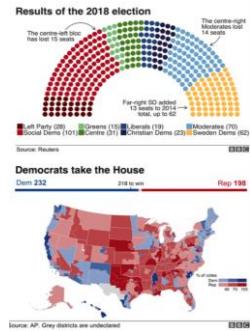
- We will introduce how to manipulate **real-world content** as well as synthesize **virtual content**



# Color



# Graphics (Images)



vector graphics

bitmapped graphics

# Camera



Note we are **NOT** teaching

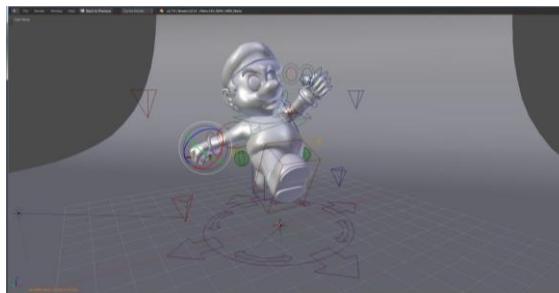


# 3D Computer Graphics

Modeling

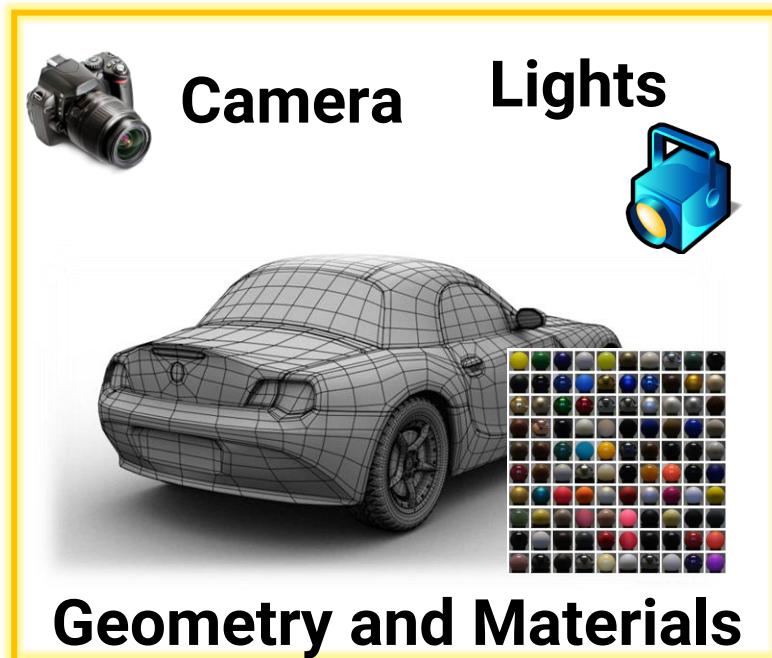
Animation

Rendering



# 3D Computer Graphics (cont.)

- Create the virtual 3D world description
- Synthesize a 2D image from the virtual 3D world



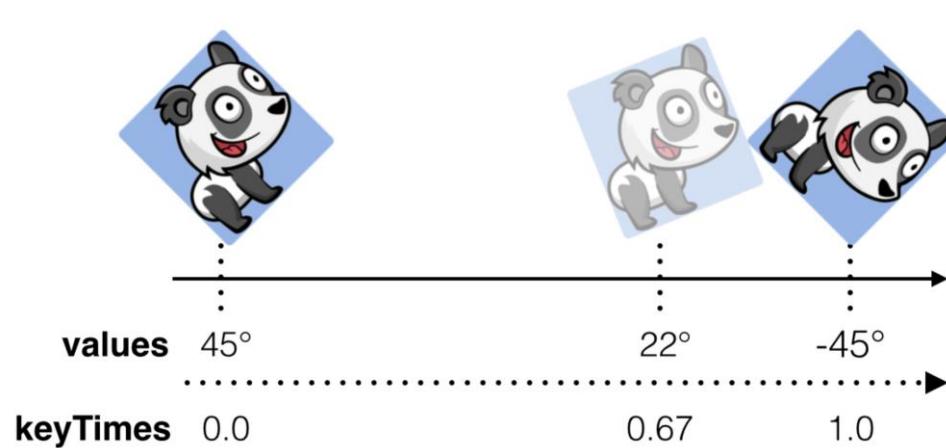
**Geometry and Materials**

3D description of a scene

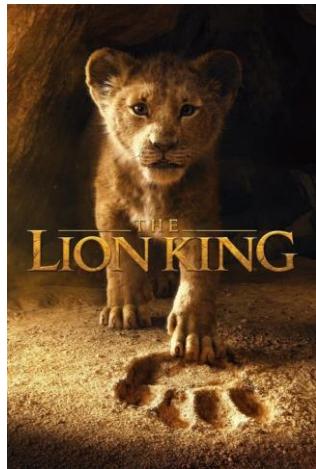
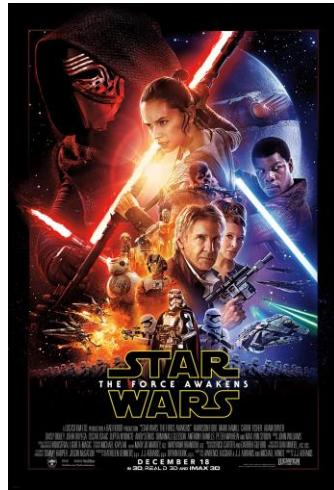


output: 2D synthetic image

# Video and Animation

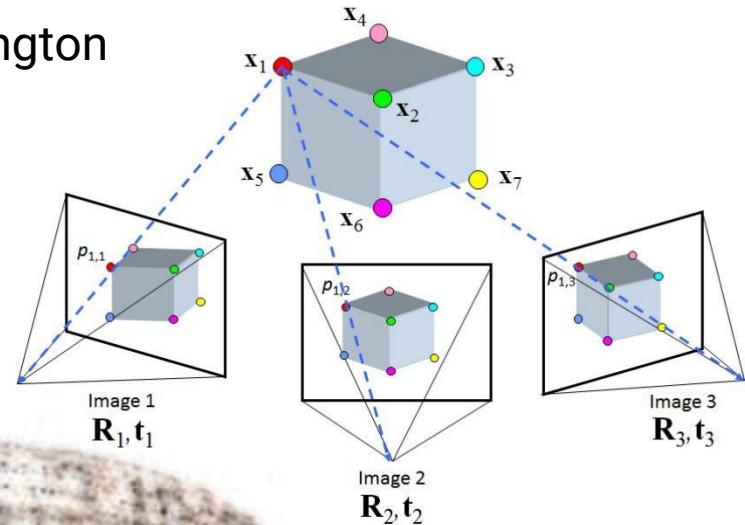
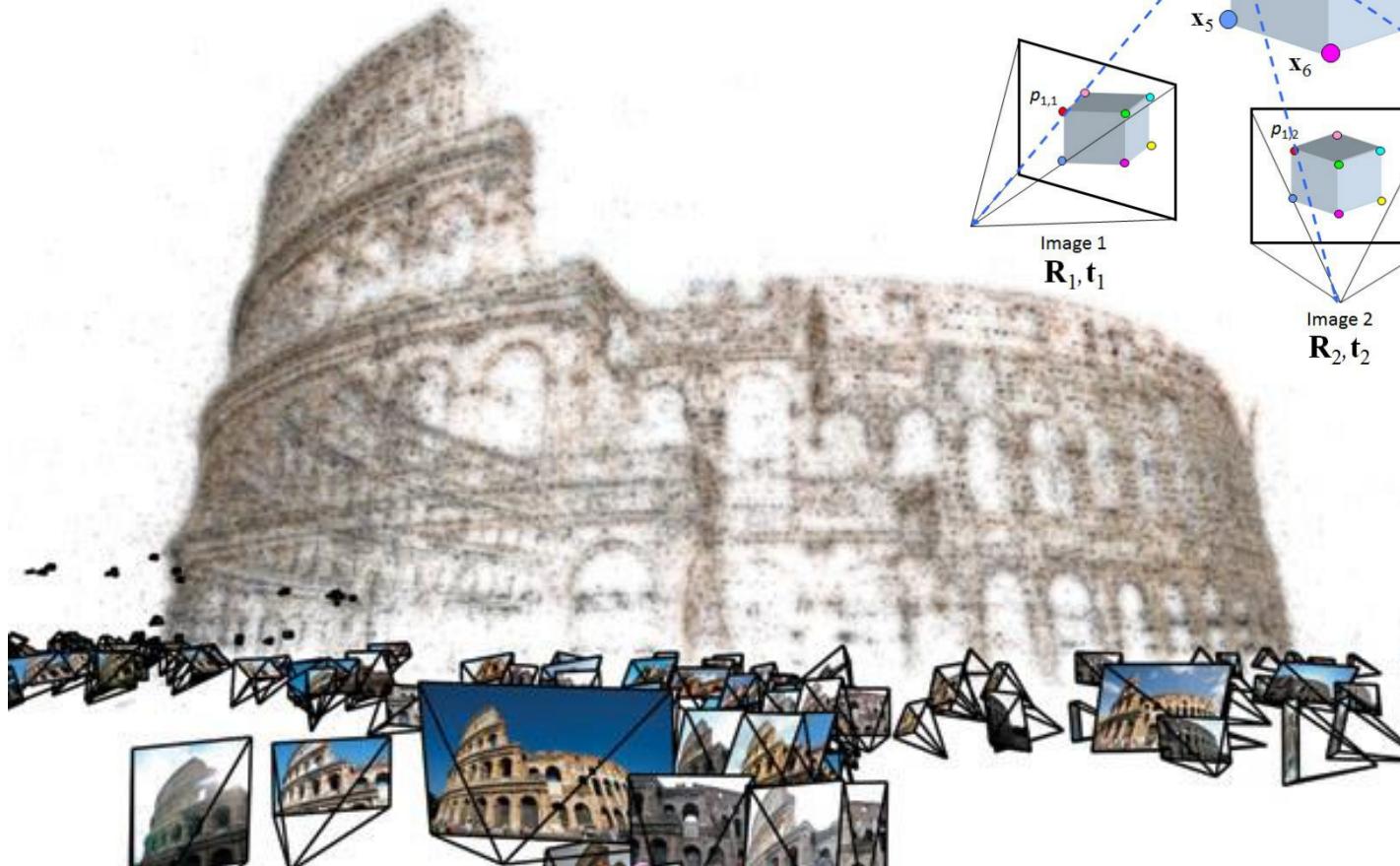


# VFX: Top Selling Movies



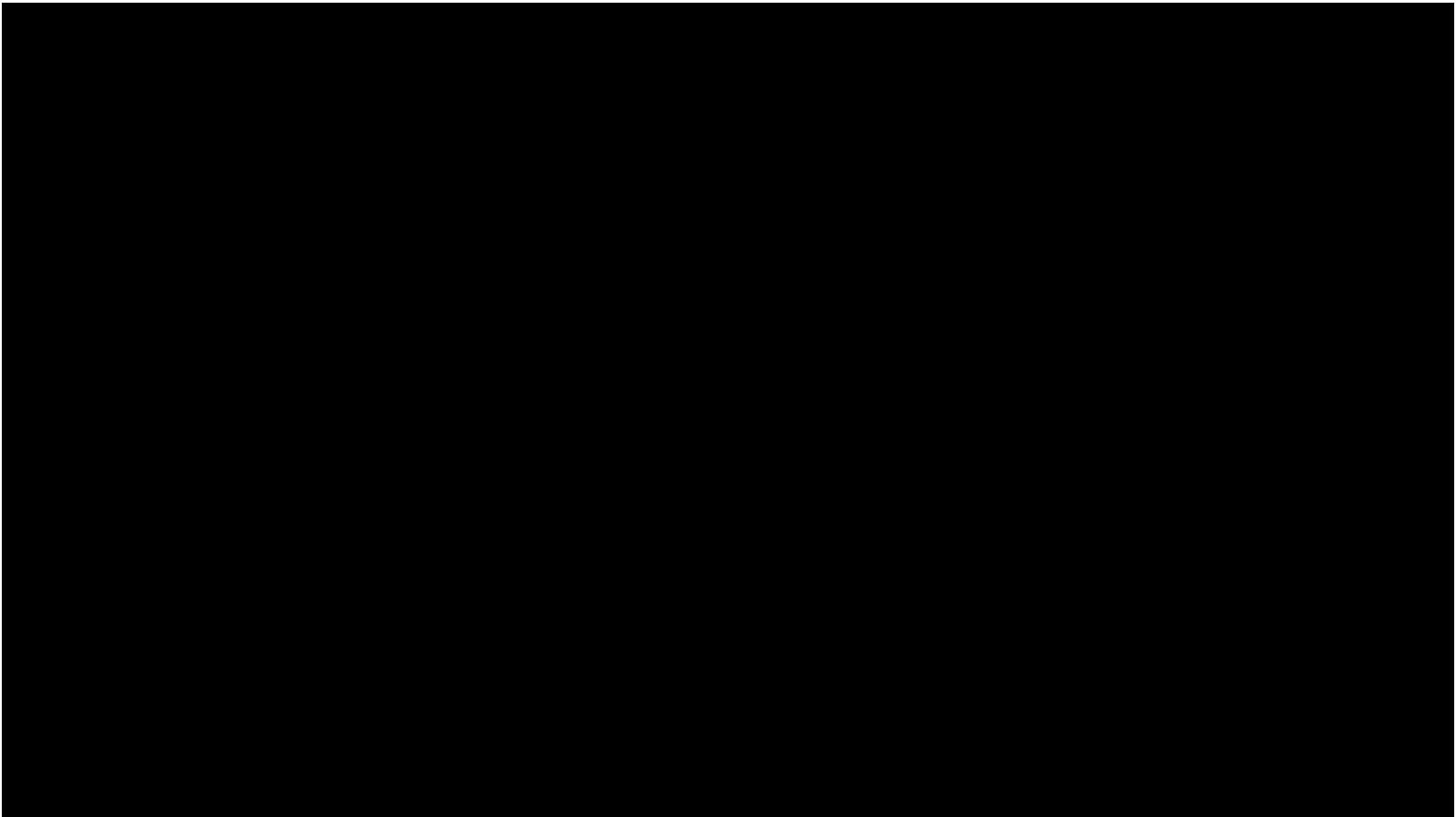
# VFX: Match Move

**Building Rome in a Day**, University of Washington  
From 2106 images to 819242 points



# VFX: Match Move (cont.)

- Jurassic Park (1993)



# Matting and Compositing (cont.)



# Matting and Compositing (cont.)



# Matting and Compositing (cont.)



要把身材高大的甘道夫和小矮人們拍攝在一起，我們是沒法在同一個片場的。和我一起拍攝的只有柱子上貼著的13張他們的照片，後面還有一個小燈，哪個角色說話了燈就亮起來。想像一下你在拍一場和13個人一起演的戲，但你卻只有獨自一人。這真的會把你的演技推到極限。我哭了，真的，我當時真的哭了。然後我還說出了聲：我認真演了一輩子不是為了跟這些照片對戲啊！

# More About VFX

- Alchemy of Souls (2022)



# Game Engines



# Game Production (?)



# Virtual Reality



# Mixed Reality



a promotional video by Magic Leap (2016)

# **Homework Assignments and Final Project**

# Homework #1: Poster Design

- Design a **poster** to promote your department using both **bitmapped** and **vector graphics**



姓名：吳信龍 系主任



姓名：莊東嶺 學院院長



姓名：張仁俊 特聘教授

學歷：國立交通大學 - 資訊工程博士

學歷：美國德州大學 - 電腦科學博士

專長：機器學習、演算法、計算理論

專長：行動計算、無線網路

專長：編碼技術、密碼技術



林翊婷 同學



**國立台北大學資訊工程學系  
學士班熱烈招生中**

網路及  
多媒體  
整合研究

科技整合人才

四大教學領域

國內外  
實務合作

設施「SG 數位網路建設」，  
「數位內容網路服務與應用」，  
「智慧車輛」，「智慧機器人」，  
「大數據分析」，「人工智慧」  
等研究項目。

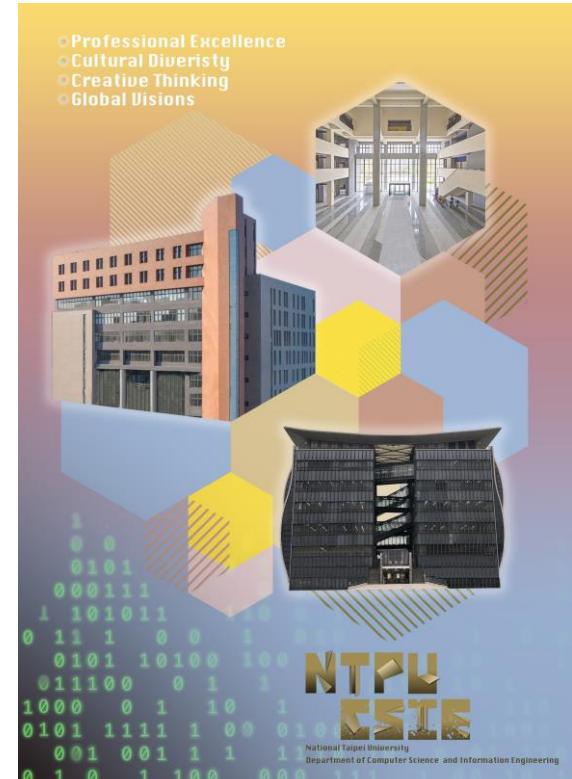
強調網絡護謹體與法商、人  
文社會科學之融合，以發展  
網路行銷等新創領域，並  
藉由各項課程之深耕教導與  
研究基礎，培育出跨域整合  
人才。

課程主要分為四大領域：資  
料處理、計算機系統、密碼  
學及統計。每項領域皆包含  
必修課程、選修課程或課程  
一般選修課程。

強調學術與國內外產官學界  
之即時與資源合作交流，並  
藉由一處轉育、推動卓質印獎  
研究團隊。

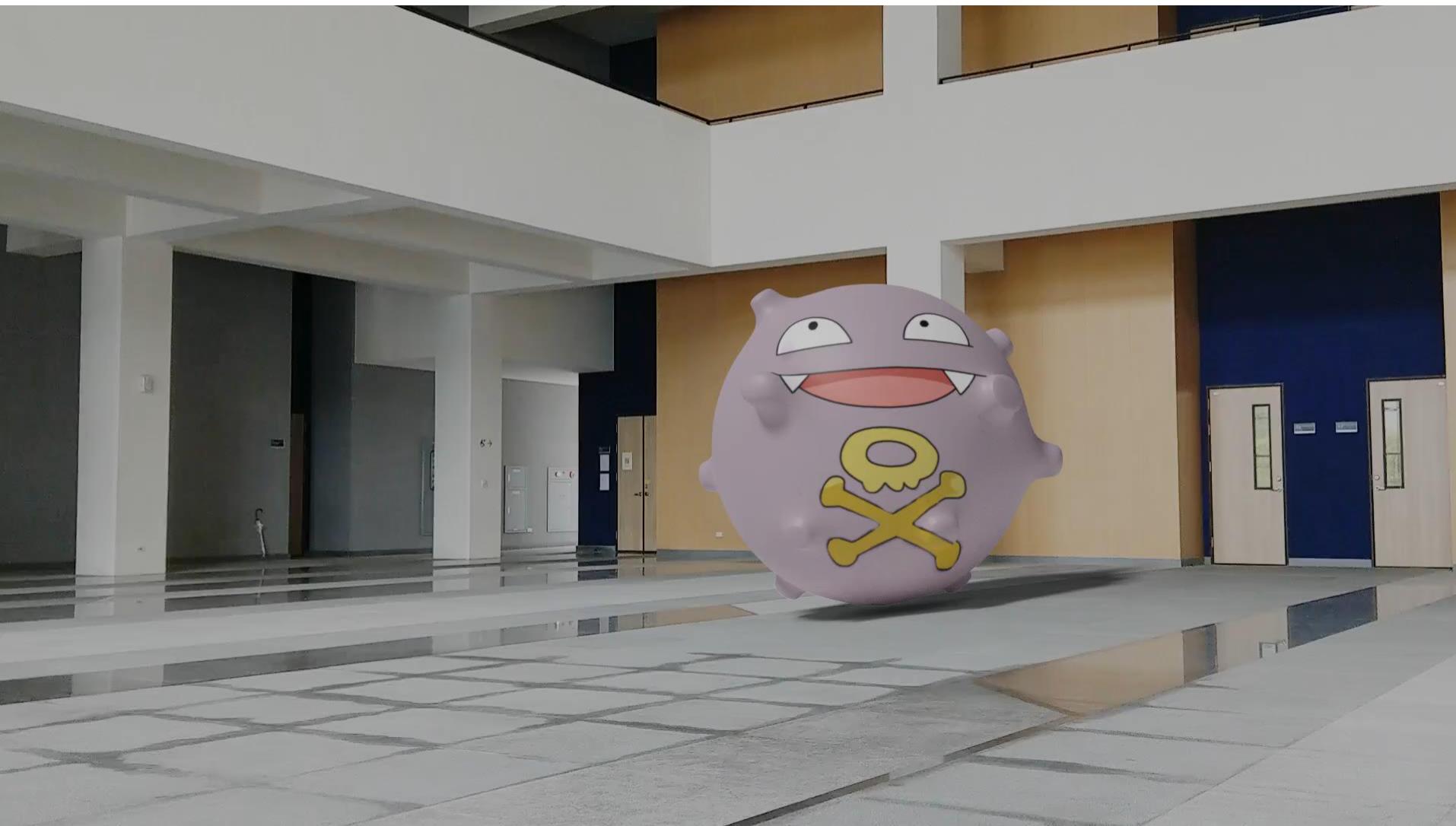
地址：(2327) 新北市三峽區大園路 151 號 遊戲搖籃園藝大樓 307  
電話：(02)86741111 分機：68888／傳真：(02)26744448

施巧軒 同學



陳麒升 同學

# Homework #2: Match Move



# Final Project

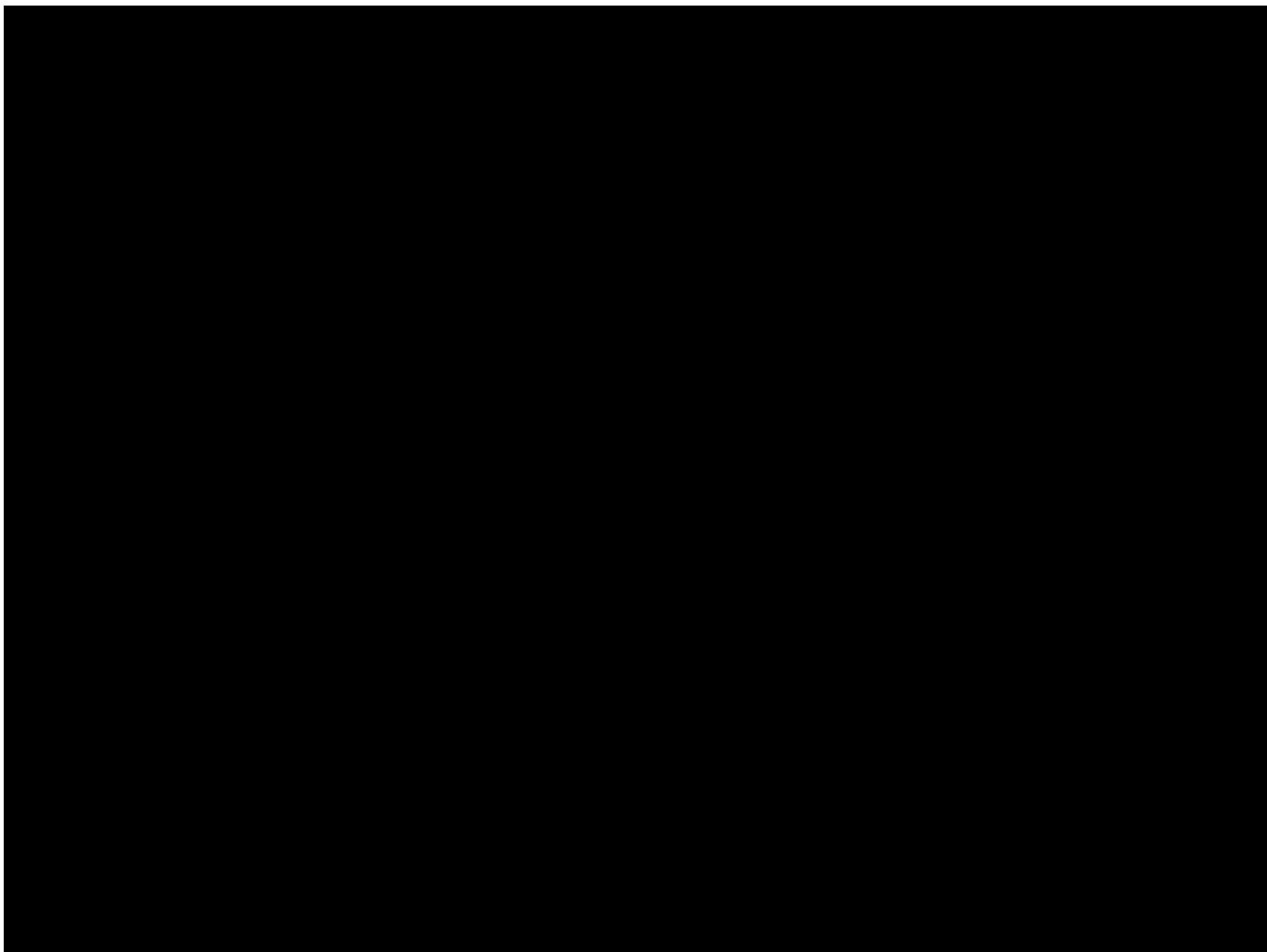
- **Group work (2–5 students)**
- A short film that contains some techniques taught in this course
  - Image editing
  - Video editing
  - 3D virtual objects manipulation
  - Animation
  - Match move
- We will have a demo at the end of this semester
- You can vote for the films for each other
  - <https://ppt.cc/fVqWWx>

# Examples: 405 the Movie

- Created solely by two visual effects artists in the year of 2000
- Took over three months of nights, weekends and any spare moments that they could find
- [https://en.wikipedia.org/wiki/405\\_\(film\)](https://en.wikipedia.org/wiki/405_(film))



# Examples: 405 the Movie



# Examples: 405 the Movie (cont.)

- Step 0: script and shooting plan

Shot#	Description	Full CG	CG	Length Frames
01	Title Animation	X	X	401
02	Freeway speeds beneath car			123
03	Speed Limit 65			120
04	LA Freeway from Overpass			238
05	Empty Freeway--Car enters frame	X	X	150
06	Pan From Freeway J looks at lack of traffic			237
07	Plane swings into landing position toward freeway	X	X	139
08	Hand on Gear shift			36
09	Plane lowers into view through rear window		X	84
10	Plane nears Car	X	X	65
11	J looks to side mirror--plane visible behind		X	84
12	Plane in sideview mirror		X	65
13	J looks from side view to rear view mirror -- plane behind		X	27
14	J eyes react in rear view mirror--remove traffic		X	33
15	Plane chases Car toward camera	X	X	77

# Examples: 405 the Movie (cont.)

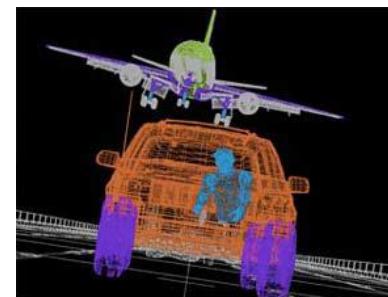
- **Step 1: Shooting**

- Two days with a Canon Optura DV camera with the progressive mode
- 70 minutes of raw footage



- **Step 2: building CG**

- Some shots are combined with VFX techniques



- **Step 3: compositing**



- **Step 4: fine touchup and music**

# Other Examples

- Produced by students in NTU VFX course



# Other Examples (cont.)

- Produced by students in NPTU MMTA course 2022
  - 楊喻丞 陳弘竣 郭語綿 同學

