





1.0

# Game Engines

\$ >

\$ >

\$ > Il videogioco è la declinazione  
\$ > moderna del gioco.

\$ >

\$ >

\$ > Il gioco viene fruito

\$ > attraverso uno SCHERMO. ■

## Il concetto di gioco

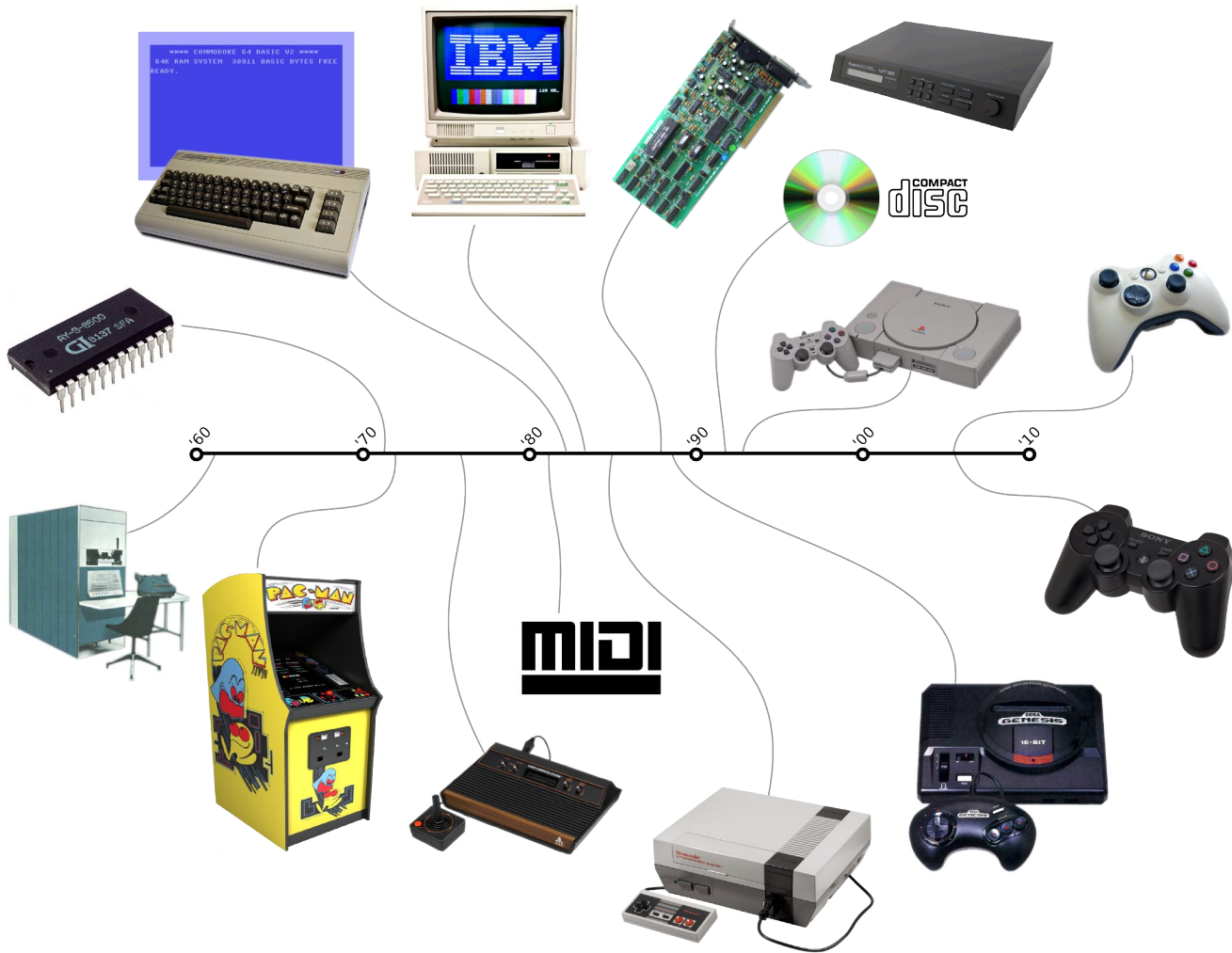
**Narrazione** guidata da **scelte** che uno o più **giocatori** compiono in conformità a un insieme di **regole** che limitano il campo d'azione

- Intrattenimento (non solo)
- Interattività

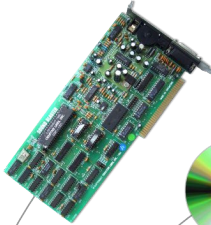
Nel videogioco in particolare

- Multimedialità





www.COMMODORE 64 BASIC V2 www  
6.4K RAM SYSTEM 32000 BASIC BYTES FREE  
READY.



COMPACT  
disc



'60

'70

'80

'90

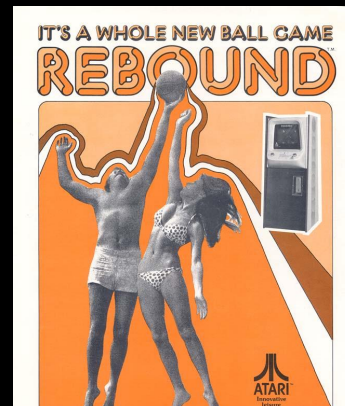
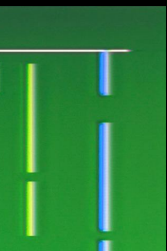
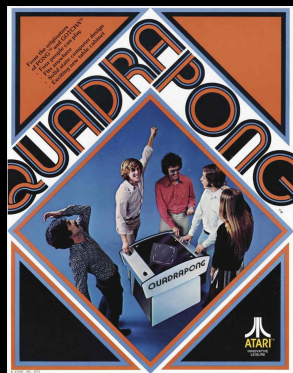
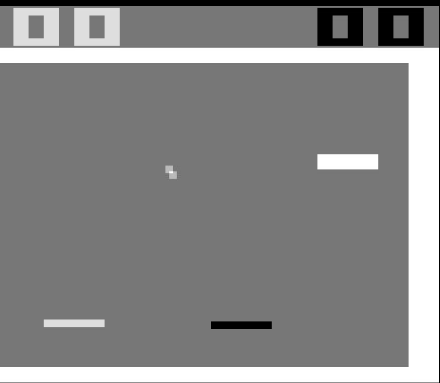
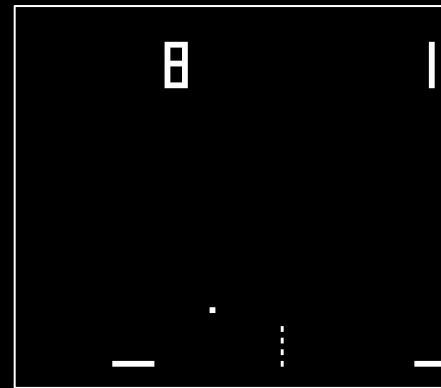
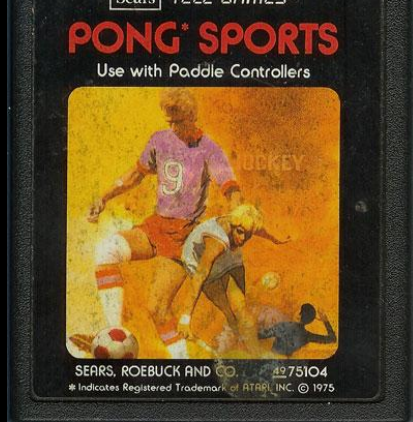
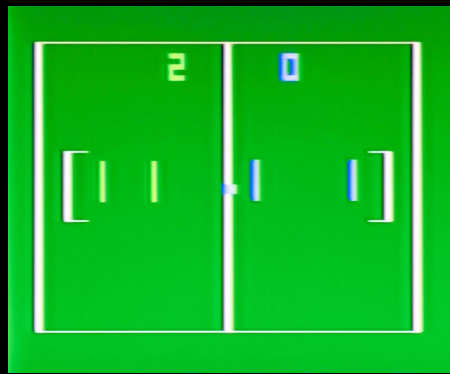
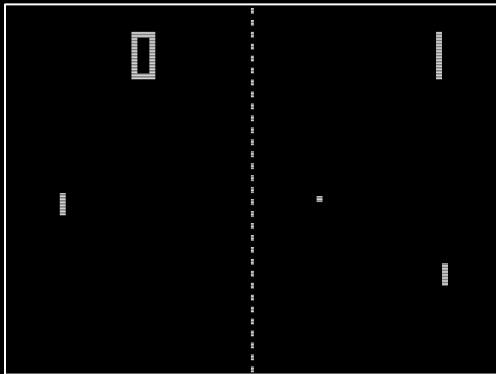
'00

'10



MIDI









SOMEWHERE NEARBY IS COLOSSAL  
CAVE, WHERE OTHERS HAVE FOUND  
FORTUNES IN TREASURE AND GOLD,  
THOUGH IT IS RUMORED THAT SOME  
WHO ENTER ARE NEVER SEEN AGAIN.  
LOAD GAME? NO  
BEFORE A SMALL BRICK BUILDING  
SURROUNDED BY FOREST. A STREAM  
FLOWS OUT OF THE BUILDING AND  
DOWN A GULLY  
OBVIOUS EXITS: N, S, E, W, D  
? █

Another working day begins for  
Lanson Rose, private investigator.  
I got three clients waiting outside  
my office, and beyond that, a town  
full of creeps, clowns, mobsters  
and, if you know where to look, the  
occasional honest citizen. When  
trouble is your business, you're  
rarely short of work in New Losago.

DETECTIVELAND, by Robin Johnson

For instructions, touch:

instructions

I'm in my office.

> out

Ok

I'm in a dimly lit office  
building.

> talk to dame

"Step into my office, Miss..."

"Mrs Macdonald," she says

save game

restore game

restart game

undo

options

credits

hints

Talking to: Mrs  
Macdonald  
Ask about:

husband

home

another woman

money

end conversation



I'm in my office.

Exits: out

I can also see:

- Mrs Macdonald talk

- door reading "EVITCETED ETAVIRP"

- filing cabinet open

- bookcase

- book titled "1001 Detectiving

Tips" (on bookcase) take

wait

I'm carrying: money (\$10.00)



"I'm outta here. Try not to sell out the store while I'm gone."





2 damage  
Thief attacks! Hit!  
16 damage  
>Y

Hits: 46  
Food: 64  
Exp.: 1229  
Coin: 87

#### Character Record, Kane Tensen

	Human, Neutral Evil Fighter (7) Blackguard (1)
Strength	19 4
Dexterity	13 1
Constitution	17 3
Intelligence	8 -1
Wisdom	8 -1
Charisma	10 0
AC 26	Experience: 29421
HP 95/89	Next Level: 36000
Main Weapon: Desert's Fury	
Attack bonus: +14/+9	
+14/+9 vs. Undead	
Damage: 1-8 + 4 (Critical 20 / x2)	
+108 Fire Damage vs. Undead	
+1 Bludgeoning Damage	
+2 Bludgeoning Damage vs. Undead	



Equipped item swapped out.  
Armor/Shield Applies: Skill Armor Check Penalty: -10 Arcane Spell Failure: 50%  
Armor/Shield Applies: Skill Armor Check Penalty: -10 Arcane Spell Failure: 95%  
Equipped item swapped out.

Talk:



GAMESPOT

LAP INFO    LAP 0 OF 10    LEAD LAP  
LAST 0:00.00    0.00 MPH  
RACE    -0:00.0    POS 33





LEVEL	SCORE	LIVES		HEALTH	AMMO	
2	33900	3		94%	99	



## Quando si utilizzano i game engines?

Fase di produzione/sviluppo

Semplificazione del lavoro in team

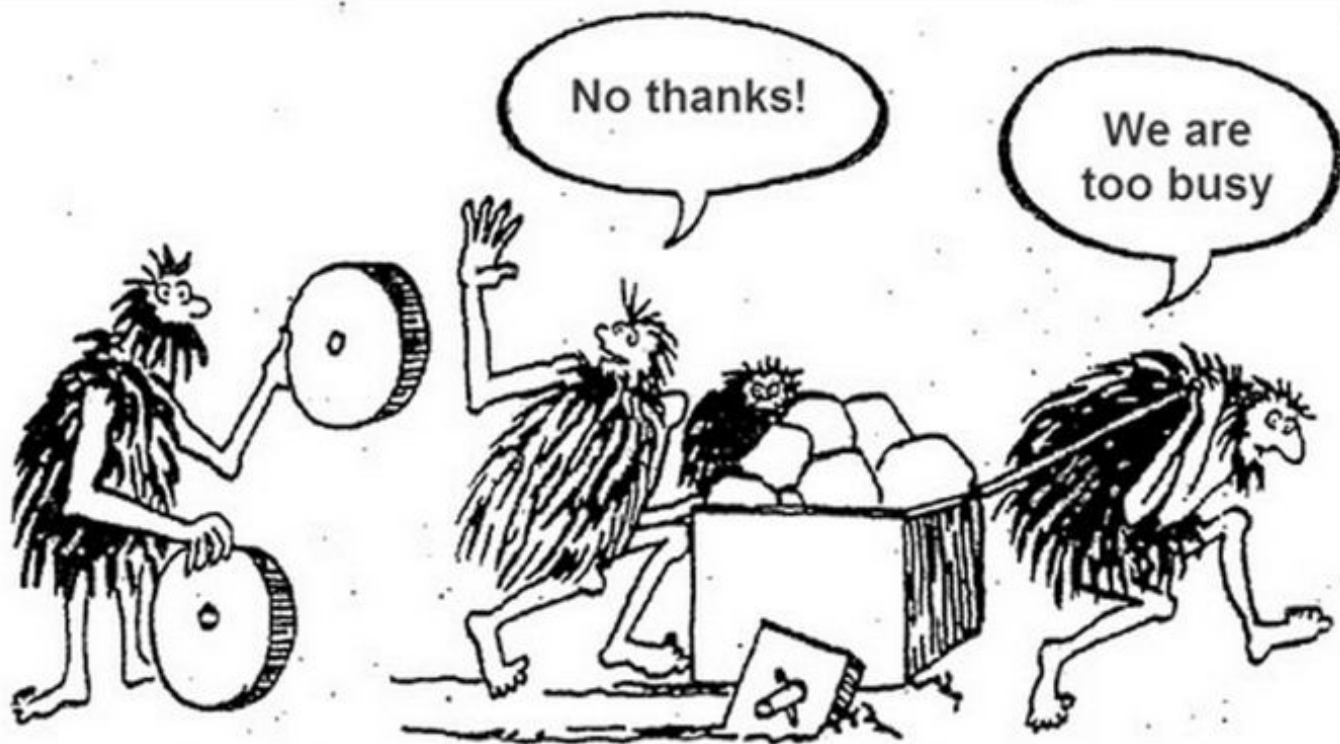
Astrazione da tecnicismi eccessivi

Lavoro ottimizzato per i programmatori

## Perchè si utilizzano?

mettiamoci nei panni di....







## Evoluzione storica del motore di gioco

Da strumenti software a tool grafici di sviluppo.



SCUMM engine (1987)



AGI a SCI di Sierra On-line (1984)

# INFOCOM™

Z-machine di Infocom (1979)

## Game engine di moderna concezione?

Unreal (Epic Games)

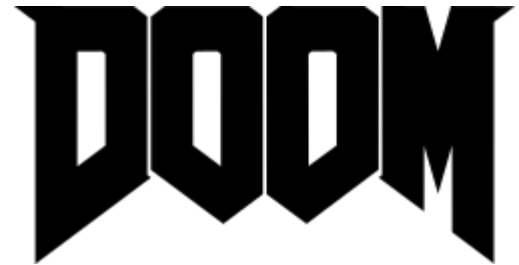
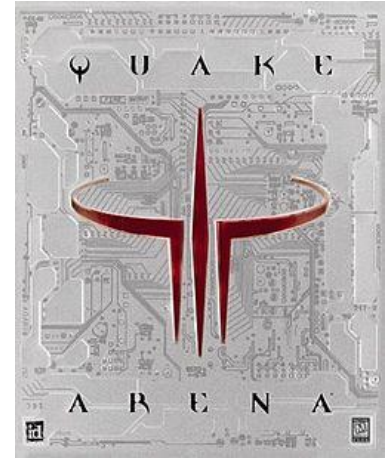
Doom / Quake (id Software)



Doom Engine - 1995

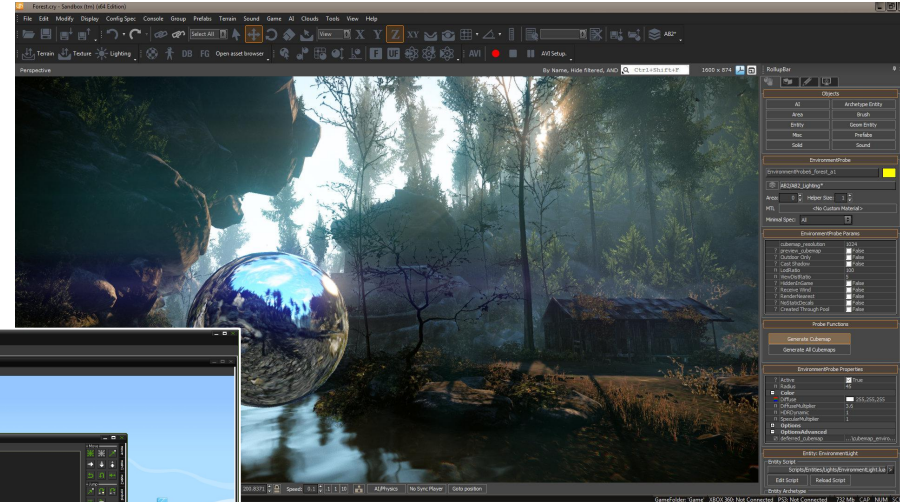
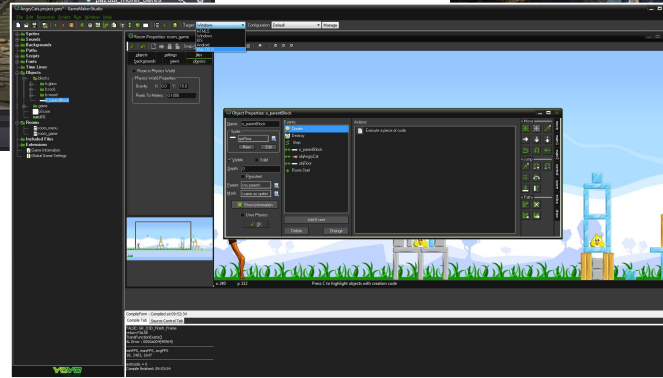
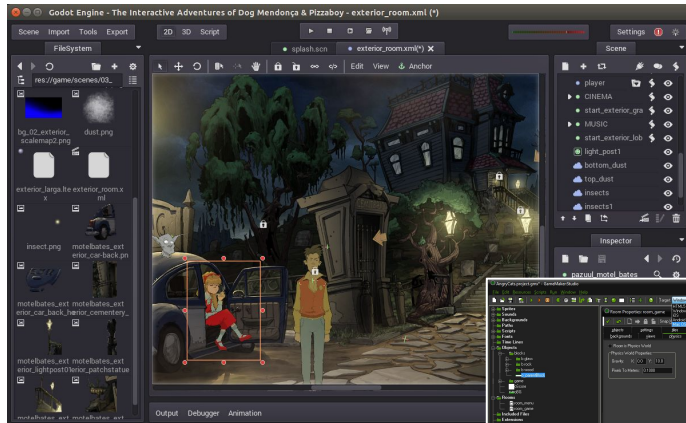
Unreal engine - 1998

idTech3 - 1999

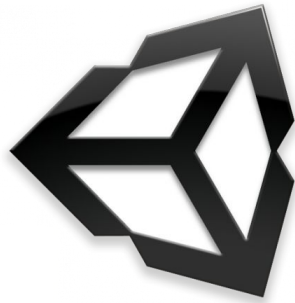
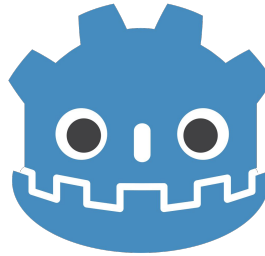


# In cosa differiscono dai precedenti?

IDE (Integrated Development Environment): interfaccia grafica di sviluppo



# Un game engine per ogni tipo di gioco



## Middleware

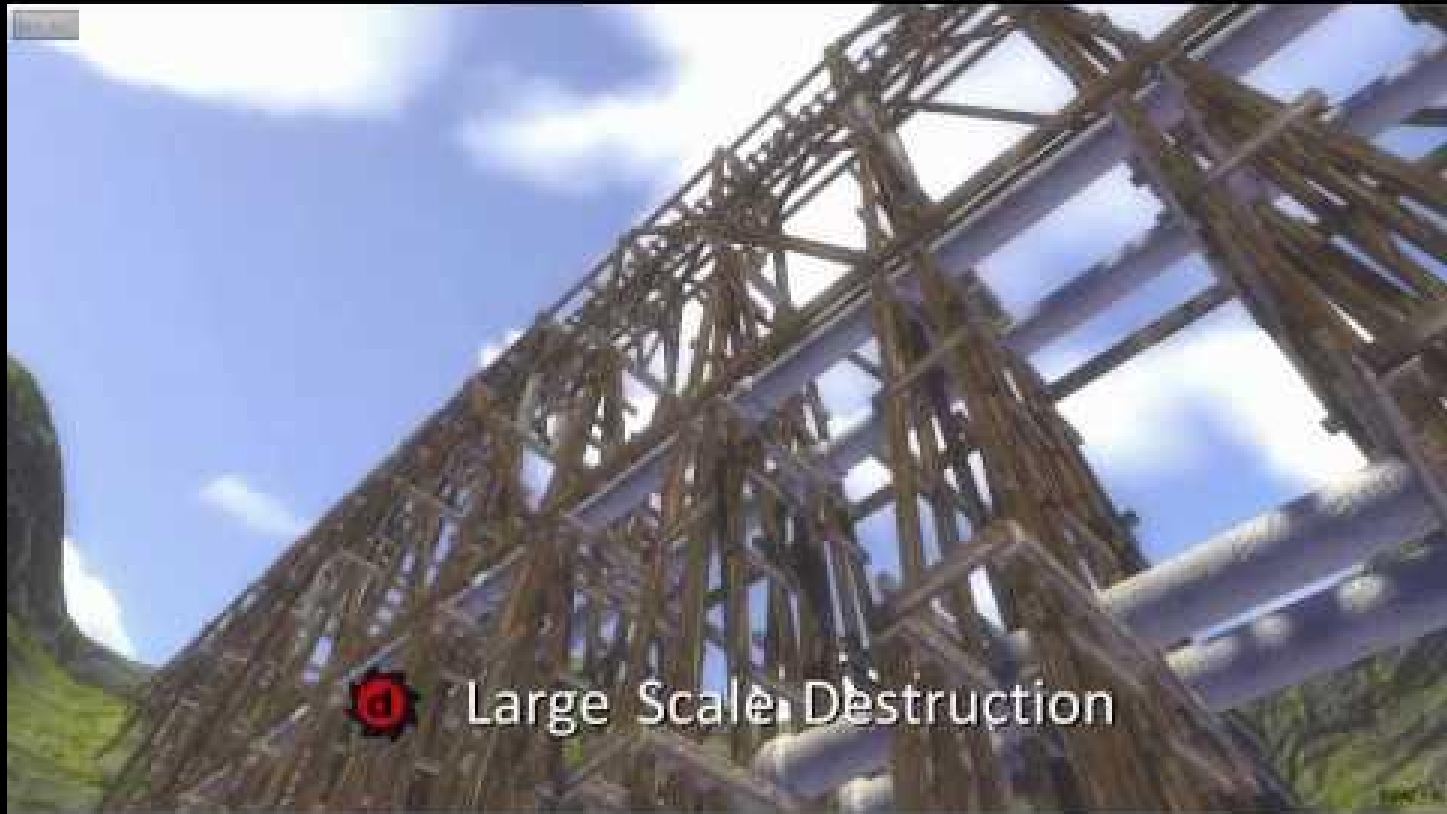
**fmod**.studio

Box2D 

**havoK**® 

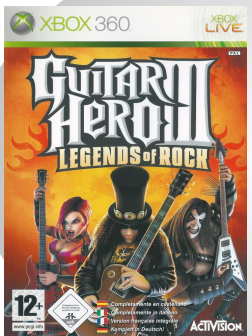
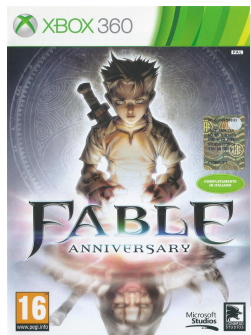
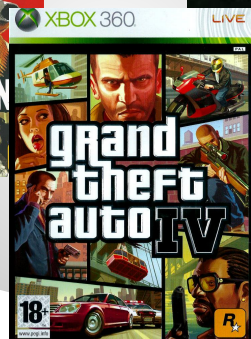
**euphoria**  
unique game moments 

**Wwise**® 



Large Scale Destruction

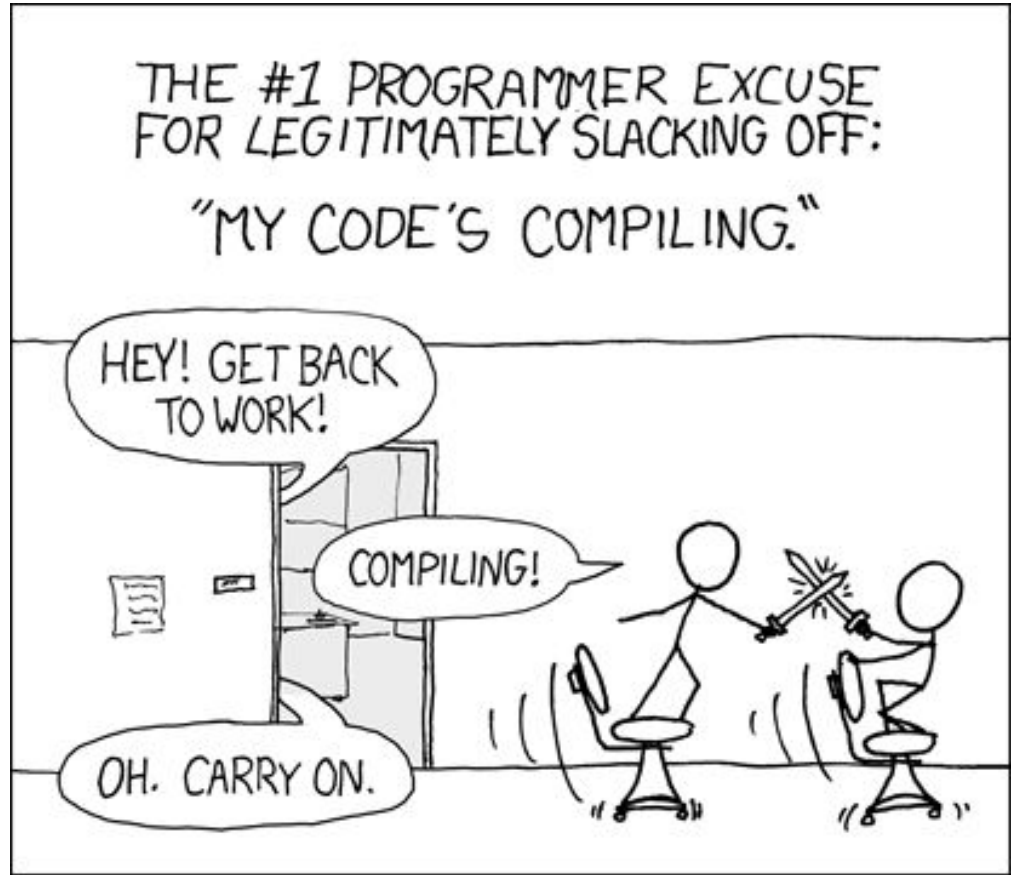






Tuttavia...

...i game engines sono uno strumento che velocizza e semplifica la fase di sviluppo, ma non si sostituiscono alla programmazione



## Perché programmare?

1. linguaggio comune
2. nuova alfabetizzazione
3. tools creativi



# Panoramica sulla programmazione

# COMPUTER PROGRAMMING



**What my Family  
Thinks I Do**



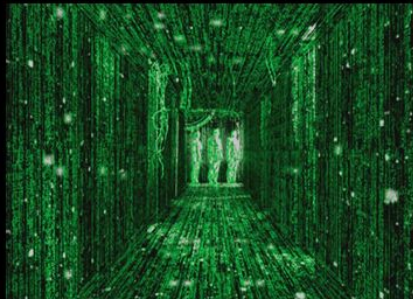
**What my Friends  
Think I Do**



**What Society  
Thinks I Do**



**What Hard Sciences  
Majors Think I Do**



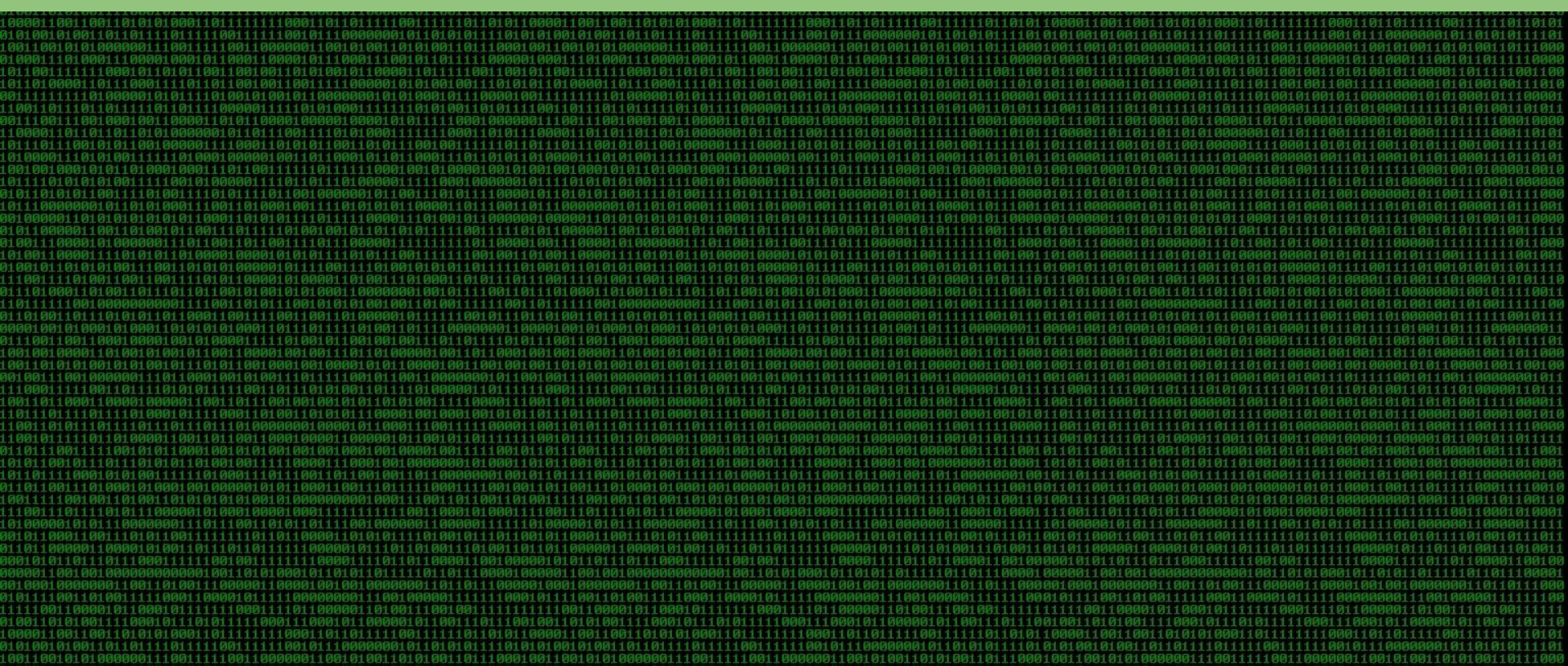
**What I Think I Do**



**What I Actually Do**



# file binario



# codice assembly

```

*-----*
*
*  P L A Y B A C K
*
*  Playback all sounds listed in sound table
*
*-----*
PLAYBACK
  lda soundon
  beq :rts ;sound switched off?

  ldx soundtable
  beq :rts ;sound table empty?

:loop lda soundtable,x

  stx savex

  jsr makesound ;make sound #A
;(may destroy registers)
  ldx savex

  dex
  bne :loop

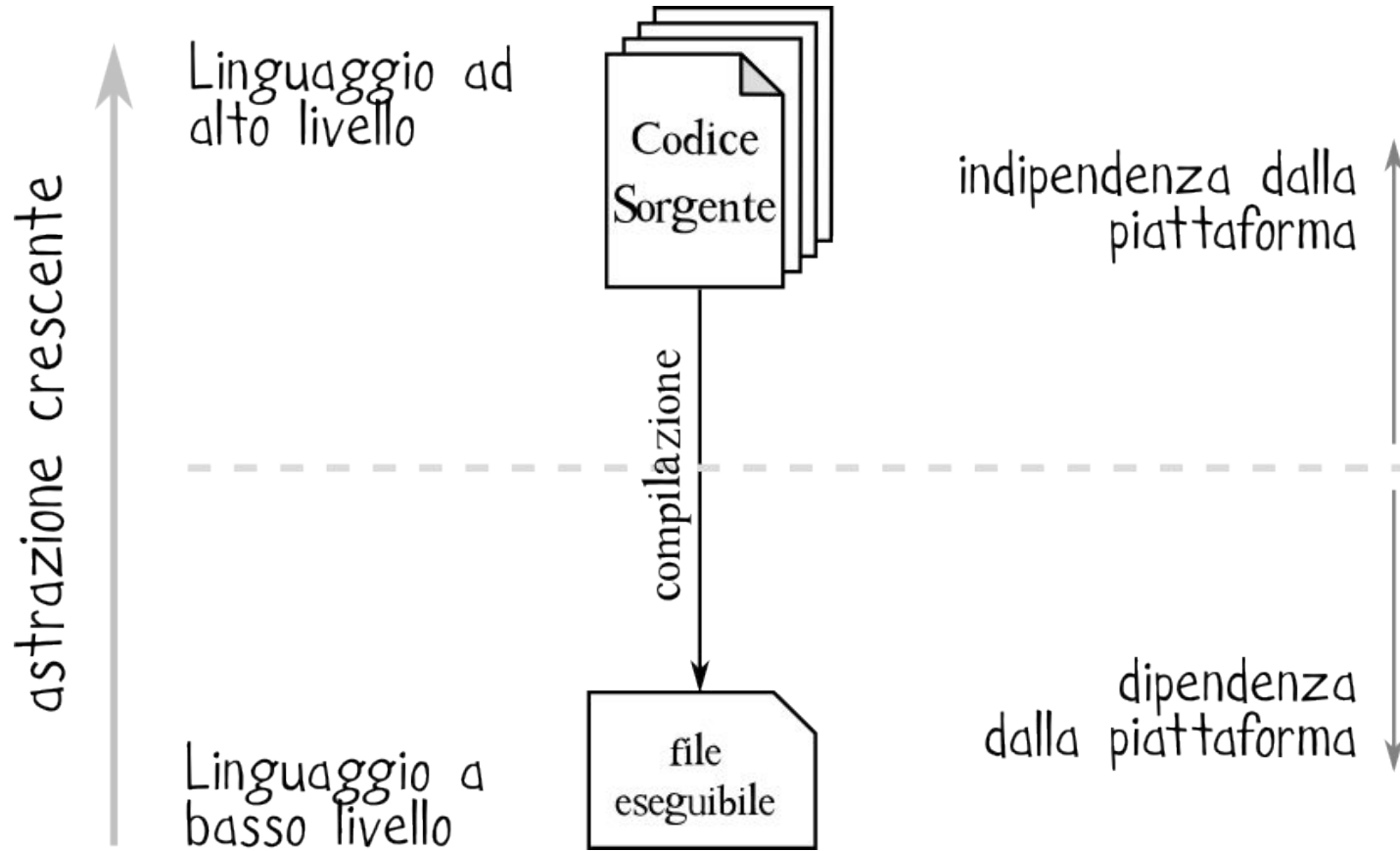
:rts rts

```



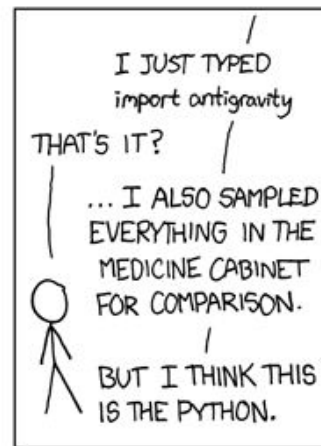
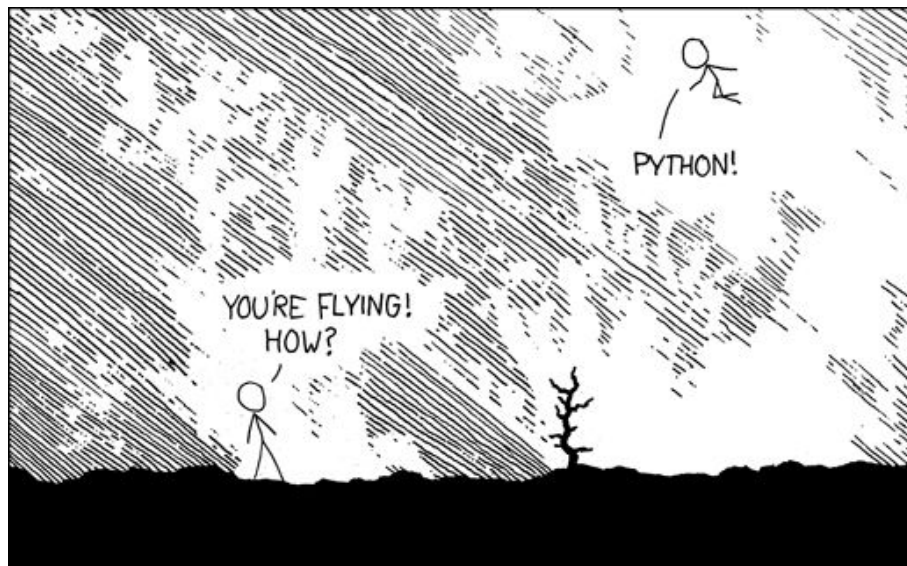
# file in linguaggio C

```
1 #include "stdio.h"
2
3
4 int main() {
5
6     FILE *pToFile = fopen("text.txt", "r");
7
8     int line = 0;
9
10    char input[512];
11
12    while( fgets( input, 512, pToFile ) {
13        line++;
14        printf("Line:%d -> %s",line,|
15    }
16
17    return 0;
18
19 }
20
```

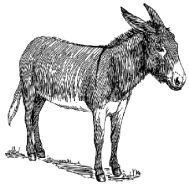




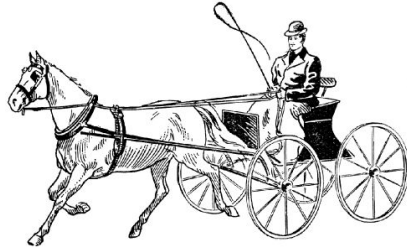
Linguaggio  
di scripting



Binary



Assembly



Compiled languages



Scripting

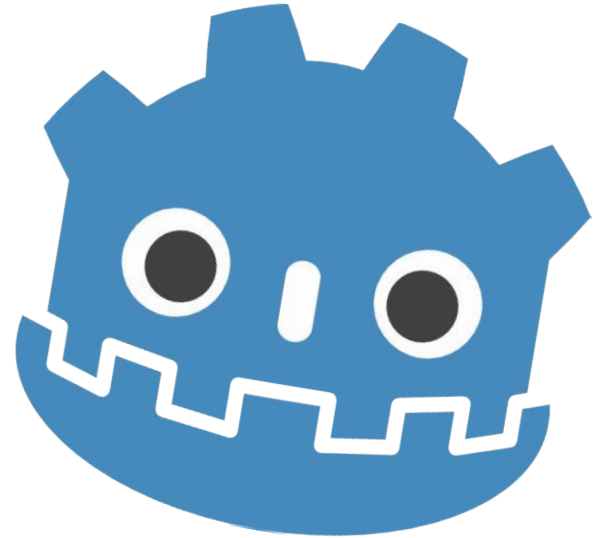


## Game Engine: cosa c'è dentro?

- rendering engine (3D/2D)
- physics engine
- interprete del linguaggio di scripting
- AI engine
- animation tools
- sound engine
- memory management
- threading (physics engine e AI engine)
- supporto video (codec)
- GUI/UI
- particle systems



# Godot





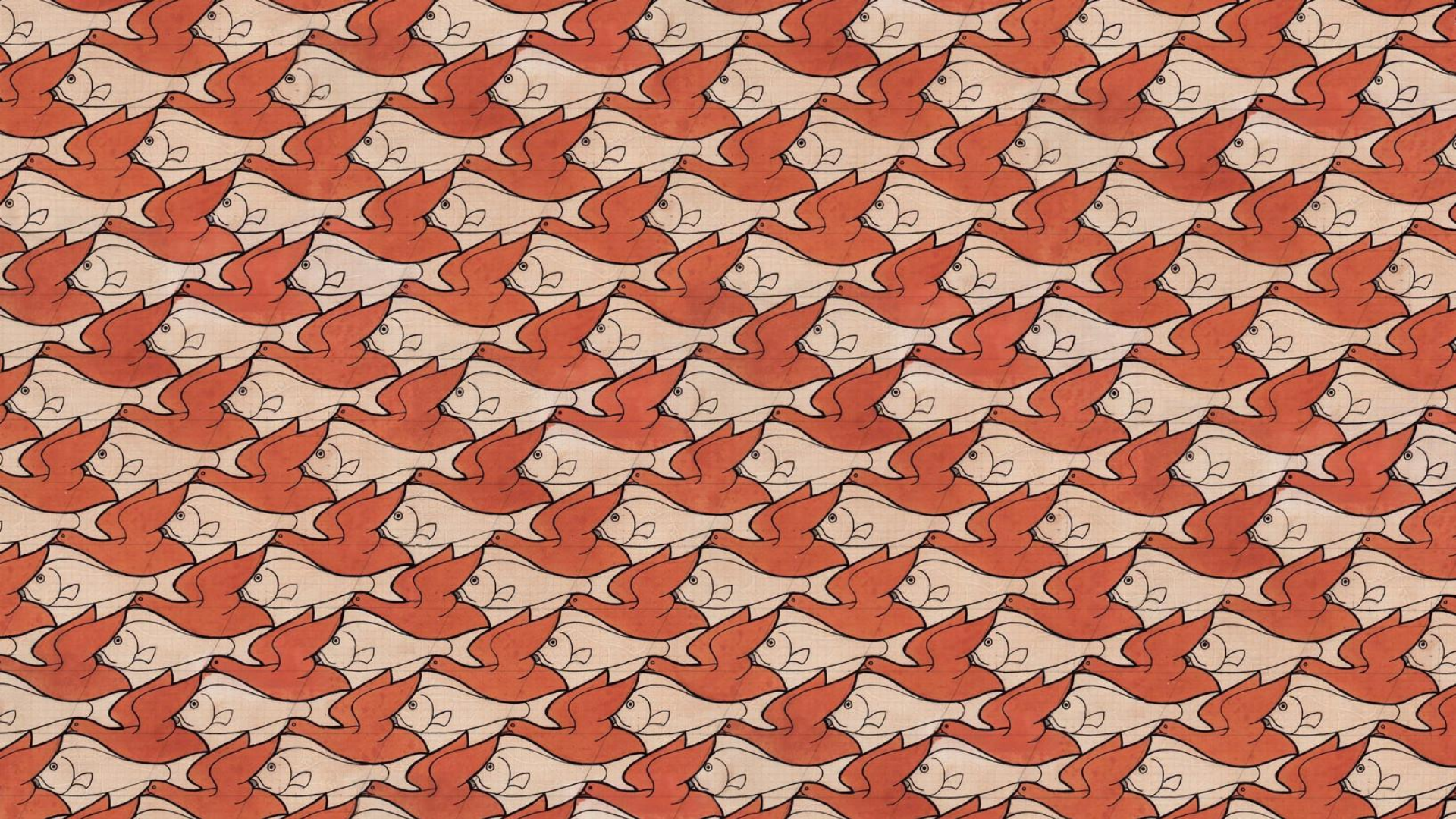
Global Illumination with Real-Time Lighting

## Perchè Godot?

- **open source**: posso modificarlo come voglio e c'è una community che amplia e consolida la piattaforma;
- **multiplatforma**: linux, Windows, Mac OS
- **2D e 3D**: parimenti sviluppato per entrambi i formati di gioco
- **leggero e veloce** non pesa sulla memoria del sistema operativo
- **GScript** è mutuato su Python (Godot3 ha porting per Python): è un linguaggio molto usato (dalla computer vision alla AI, al NLP)
- **visual programming** (dalla versione 3)



2.0





# La ripetizione è un bene

- audio rewards
- UI



# La ripetizione è un male

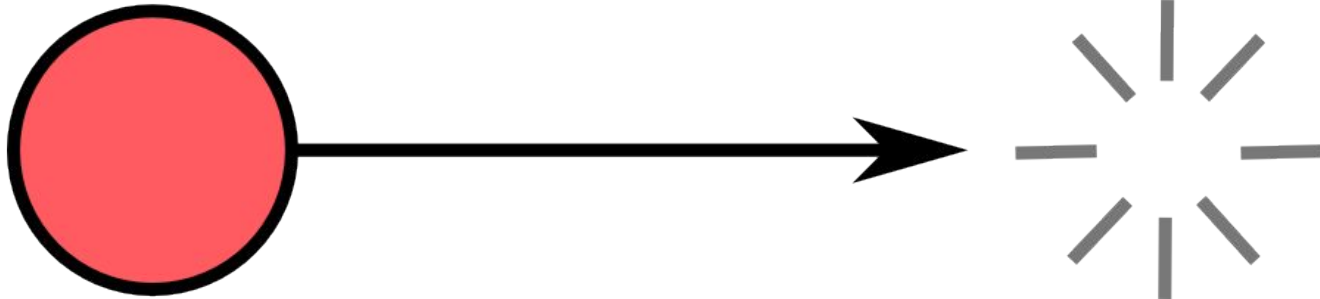
- dialoghi;
- fooley;
- fisica;
- suono senza corrispondenza visiva;



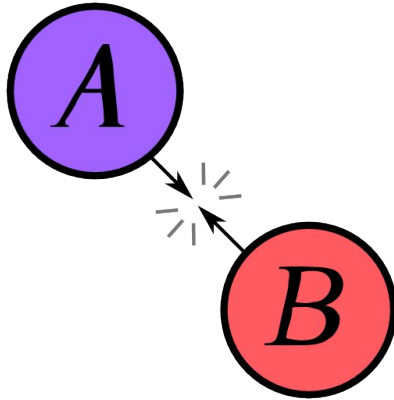
Che cos'è un evento?

*event*

*sound*



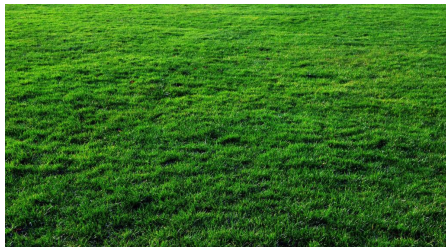
Crescita combinatoria:



$$\binom{n}{k} = \frac{n!}{k!(n-k)!}$$



$$\binom{13}{2} = 78$$



Swords										
	sfoderare	rinfoderare	brandire	super brandire	colpire	fendere	graffiare	parare	estrarre	collision
<b>base sword</b>										
short	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue
medium	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue
long	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue
<b>evil sword</b>										
short	green	green	green	green	green	green	green	green	green	green
medium	green	green	green	green	green	green	green	green	green	green
long	green	green	green	green	green	green	green	green	green	green
<b>good sword</b>										
short	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue
medium	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue
long	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue
<b>aurora sword</b>										
short	green	green	blue	blue	blue	blue	blue	blue	blue	blue
medium	green	green	blue	blue	blue	blue	green	blue	blue	green
long	green	blue	blue	blue	blue	blue	green	blue	blue	blue
<b>intricate sword</b>										
short	green	green	green	green	blue	blue	green	green	green	green
medium	green	green	green	green	blue	blue	green	green	green	green
long	green	green	green	green	blue	blue	green	green	green	green

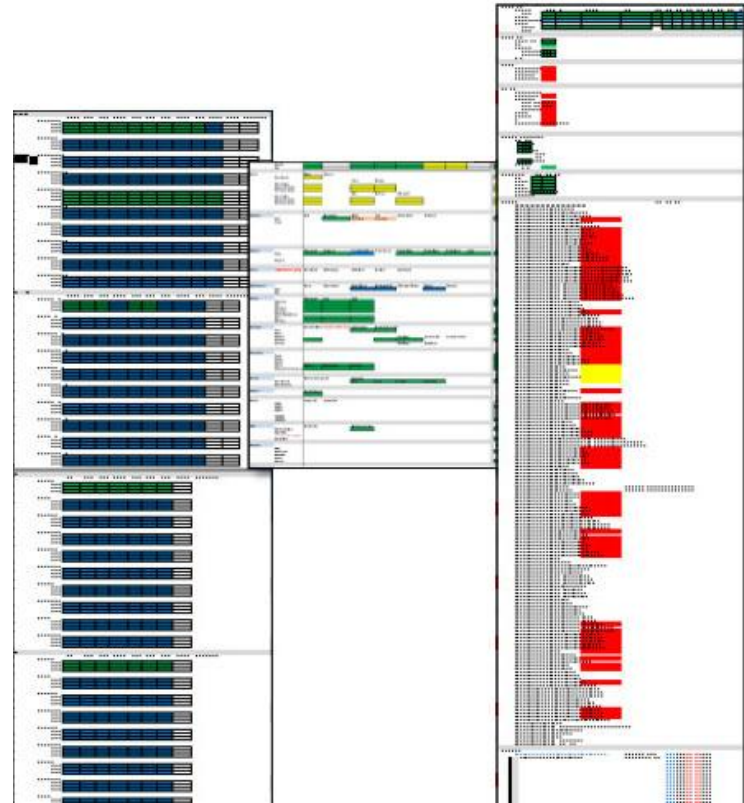
Swords										
	sfoderare	rinfoderare	brandire	super brandire	colpire	fendere	graffiare	parare	estrarre	collision
base sword	short	blue	blue	blue	blue	blue	blue	blue	blue	blue
	medium	blue	blue	blue	blue	blue	blue	blue	blue	blue
	long	blue	blue	blue	blue	blue	blue	blue	blue	blue
evil sword	short	green	green	green	green	green	green	green	green	green
	medium	green	green	green	green	green	green	green	green	green
	long	green	green	green	green	green	green	green	green	green
good sword	short	blue	blue	blue	blue	blue	blue	blue	blue	blue
	medium	blue	blue	blue	blue	blue	blue	blue	blue	blue
	long	blue	blue	blue	blue	blue	blue	blue	blue	blue
aurora sword	short	green	green	blue	blue	blue	blue	blue	blue	blue
	medium	green	green	blue	blue	blue	blue	blue	blue	blue
	long	green	blue	blue	blue	blue	green	blue	blue	blue
intricate sword	short	green	green	green	blue	blue	green	green	green	green
	medium	green	green	green	blue	blue	green	green	green	green
	long	green	green	green	blue	blue	green	green	green	green
Axes										
	sfoderare	rinfoderare	brandire	super brandire	colpire	fendere	graffiare	parare	estrarre	collision
base axe	short	blue	blue	blue	blue	blue	blue	blue	blue	blue
	medium	blue	blue	blue	blue	blue	blue	blue	blue	blue
	long	blue	blue	blue	blue	blue	blue	blue	blue	blue
evil axe	short	blue	blue	blue	blue	blue	blue	blue	blue	blue
	medium	blue	blue	blue	blue	blue	blue	blue	blue	blue
	long	blue	blue	blue	blue	blue	blue	blue	blue	blue
good axe	short	blue	blue	blue	blue	blue	blue	blue	blue	blue
	medium	blue	blue	blue	blue	blue	blue	blue	blue	blue
	long	blue	blue	blue	blue	blue	blue	blue	blue	blue
aurora axe	short	blue	blue	blue	blue	blue	blue	blue	blue	blue
	medium	blue	blue	blue	blue	blue	blue	blue	blue	blue
	long	blue	blue	blue	blue	blue	blue	blue	blue	blue
intricate axe	short	blue	blue	blue	blue	blue	blue	blue	blue	blue
	medium	blue	blue	blue	blue	blue	blue	blue	blue	blue
	long	blue	blue	blue	blue	blue	blue	blue	blue	blue



Swords										
	sfoderare	rinfoderare	brandire	super brandire	colpire	fendere	graffiare	parare	estrarre	collision
base sword	short									
	medium									
	long									
evil sword	short									
	medium									
	long									
good sword	short									
	medium									
	long									
aurora sword	short									
	medium									
	long									
intricate sword	short									
	medium									
	long									

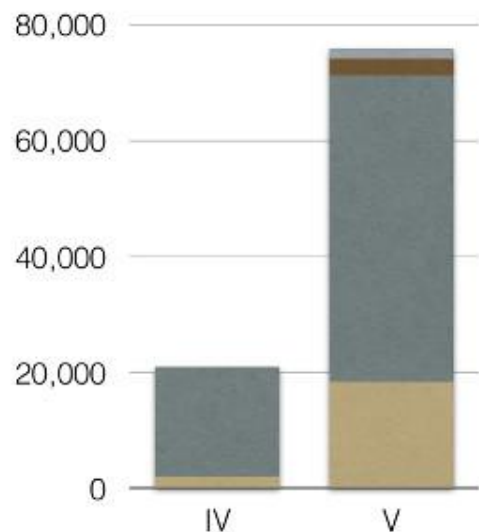
Axes										
	sfoderare	rinfoderare	brandire	super brandire	colpire	fendere	graffiare	parare	estrarre	collision
base axe	short									
	medium									
	long									
evil axe	short									
	medium									
	long									
good axe	short									
	medium									
	long									
aurora axe	short									
	medium									
	long									
intricate axe	short									
	medium									
	long									



# Asset Sizes

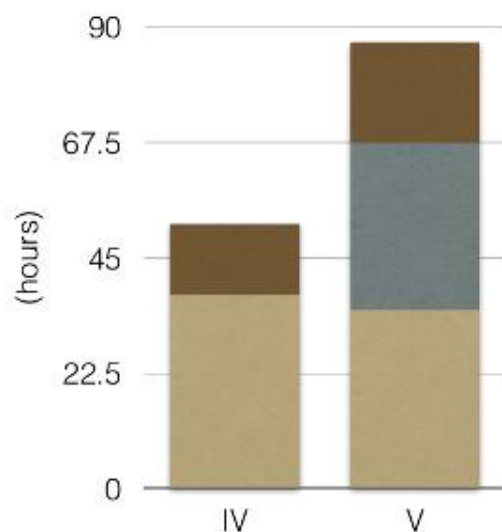
GameObjects    Sounds  
DynamicMixer    Synth

## Metadata



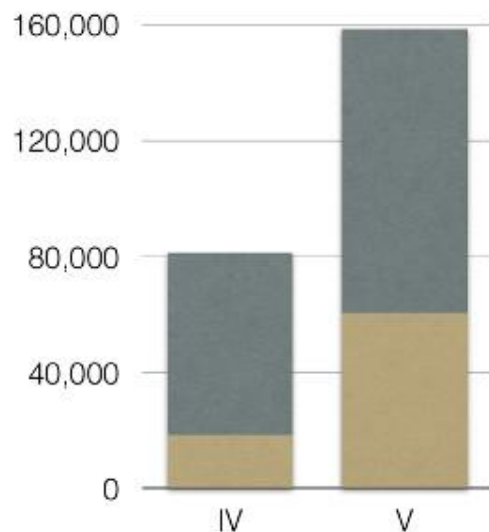
Radio    Score  
Cinematics

## Streaming Assets



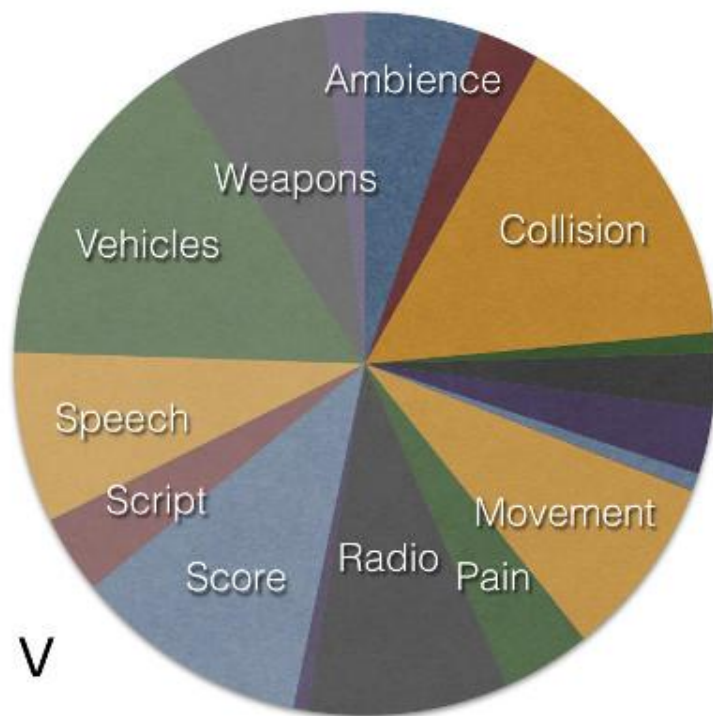
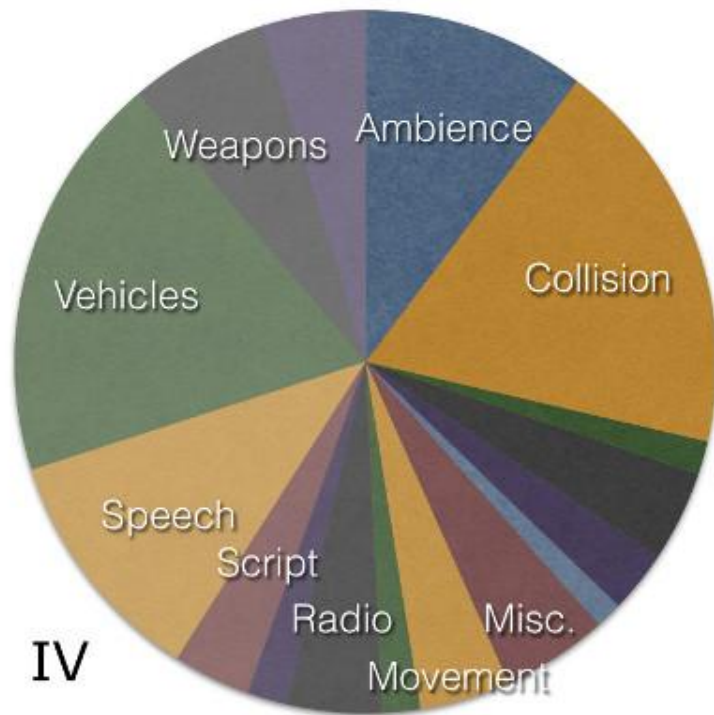
Scripted    Ambient

## Lines of Dialogue



# Wave Memory

- Ambience
- Animals
- Collision
- Doors
- Explosions
- Frontend
- Melee
- Misc.
- Movement
- Pain
- Radio
- Scanner
- Score
- Script
- Speech
- Vehicles
- Weapons
- Weather



## Applicare variazioni real-time

Volume

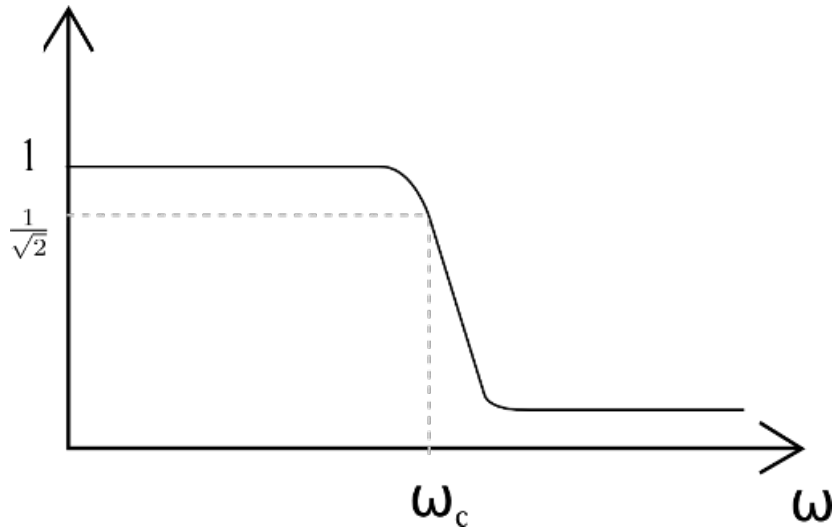


Pitch shifting



## Applicare variazioni real-time

### Filtering

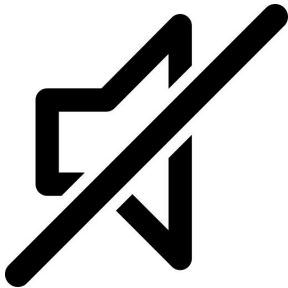


### Timing variations

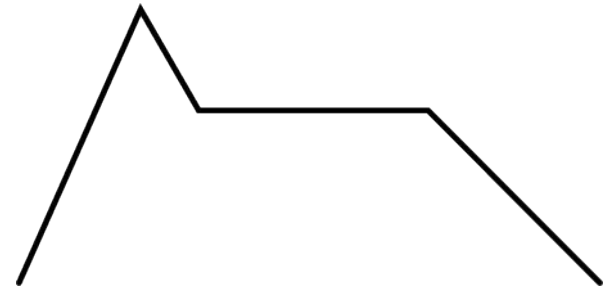


## Applicare variazioni real-time

Silence

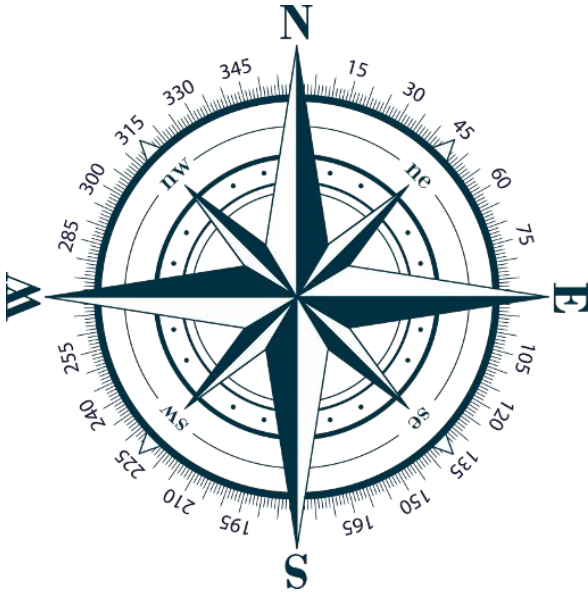


Envelope

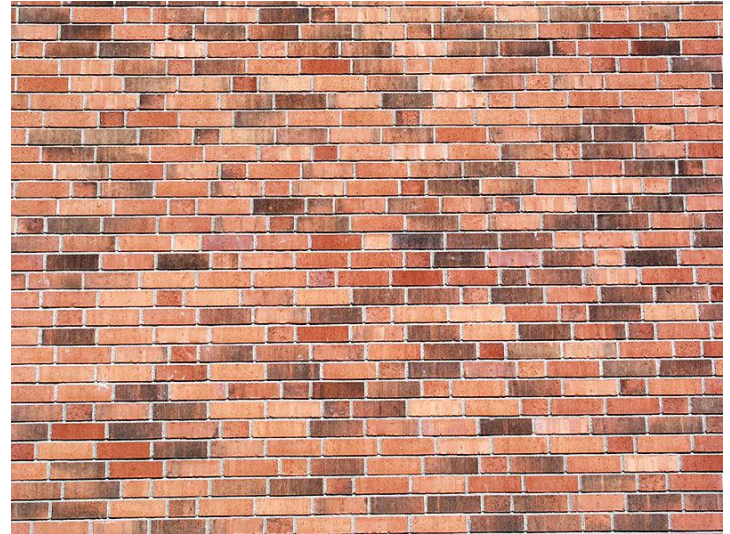


## Applicare variazioni real-time

### Positional variation



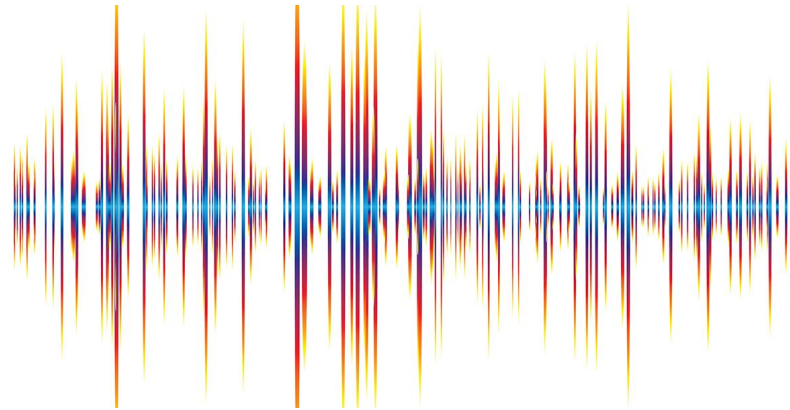
### Environmental variation



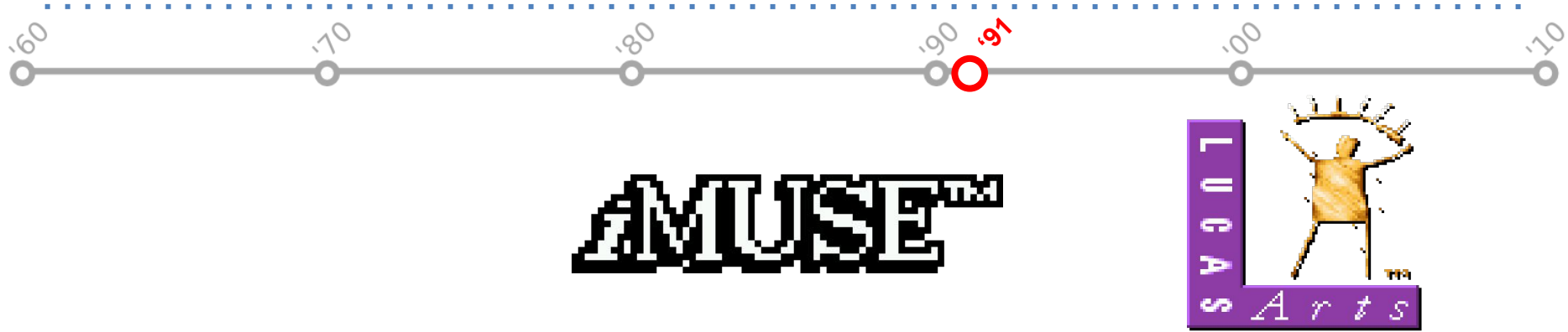
## Quando applicare queste modifiche:



- dialogs (ADR, masking, interazioni di gruppo);
- sndfx
- music







1991 Michael Land e Peter McConnell sviluppano iMuse, il sound engine di SCUMM, il game engine per le avventure grafiche P&C di LucasArts

Introduzione di componenti audio dinamici tramite invio di messaggi SysEx nei file MIDI.

## iMuse come funziona

2 tipi di messaggi SysEx: markers e hooks

### **markers (ID):**

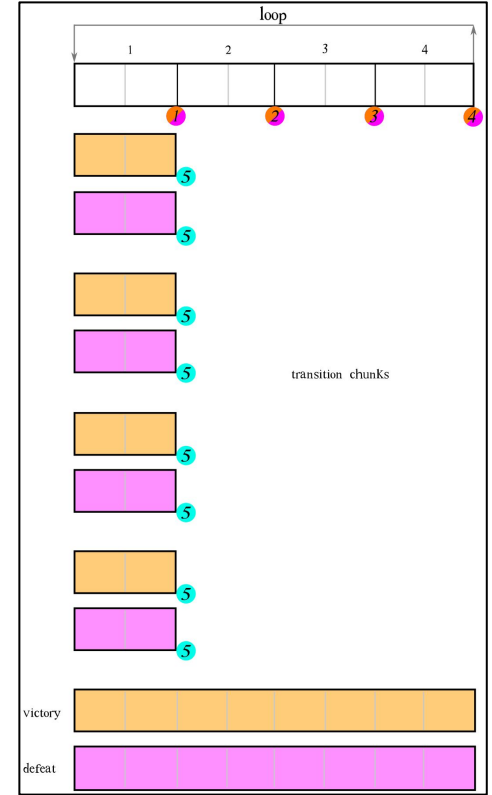
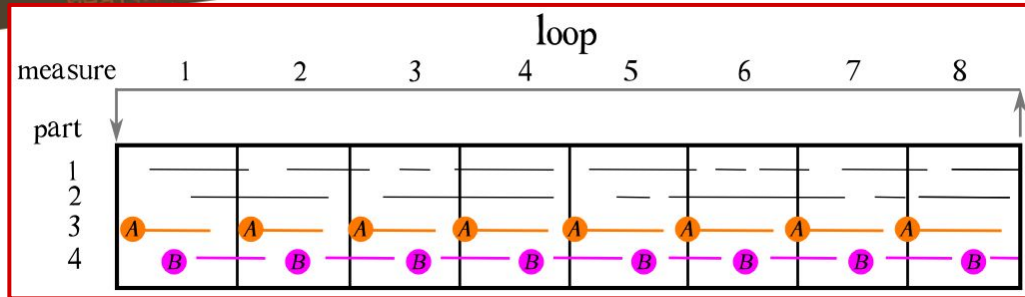
- posti nel file MIDI nel punto in cui deve essere eseguito un comando
  - il comando è inserito in una coda di comandi nella memoria del sistema
  - quando il lettore MIDI raggiunge il punto, il marker triggera l'esecuzione del comando legato all'ID del marker stesso
- esempio:* fade in/out, variazioni in volume, pause/resume

### **hooks (ID + comando)**

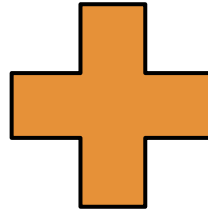
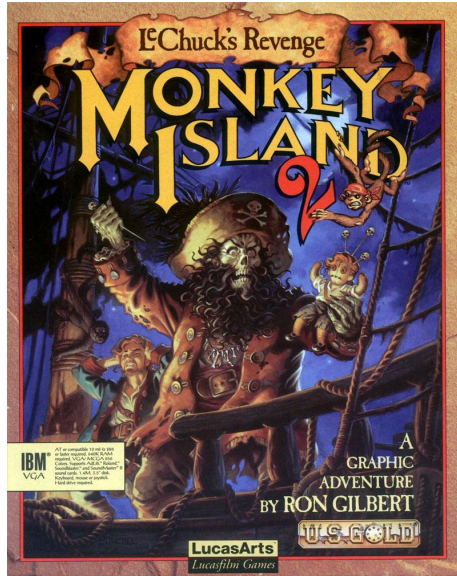
- al messaggio si aggiunge non solo un ID ma anche un comando.
  - il sistema resta in ascolto
  - se il lettore MIDI incontra un hook il sistema esegue il comando specificato nello stesso
- esempio:* salti, trasposizioni, abilitazione/disabilitazione di strumenti



# MUSE™



## iMuse: testiamolo



## caratteristiche di un moderno audio engine

fmod.studio



## Switching

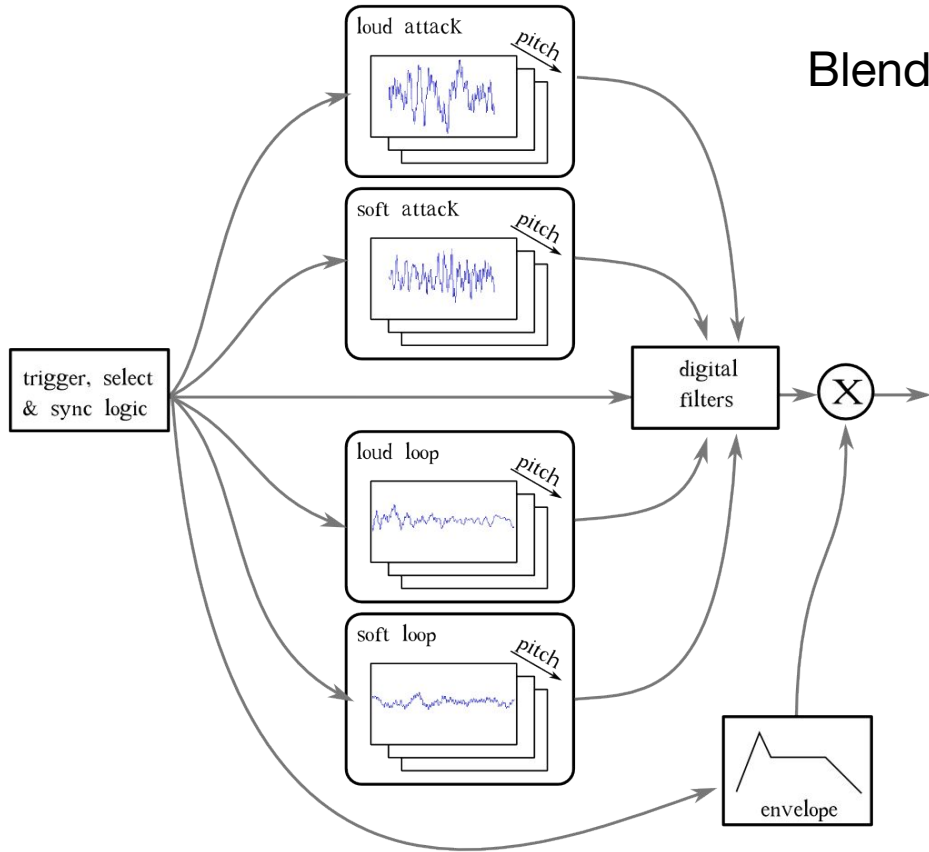
- polyphony;
- voice allocation;
- voice stealing;
- narrazione;





Random

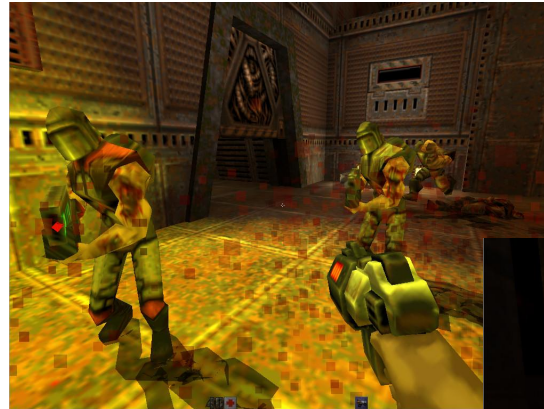
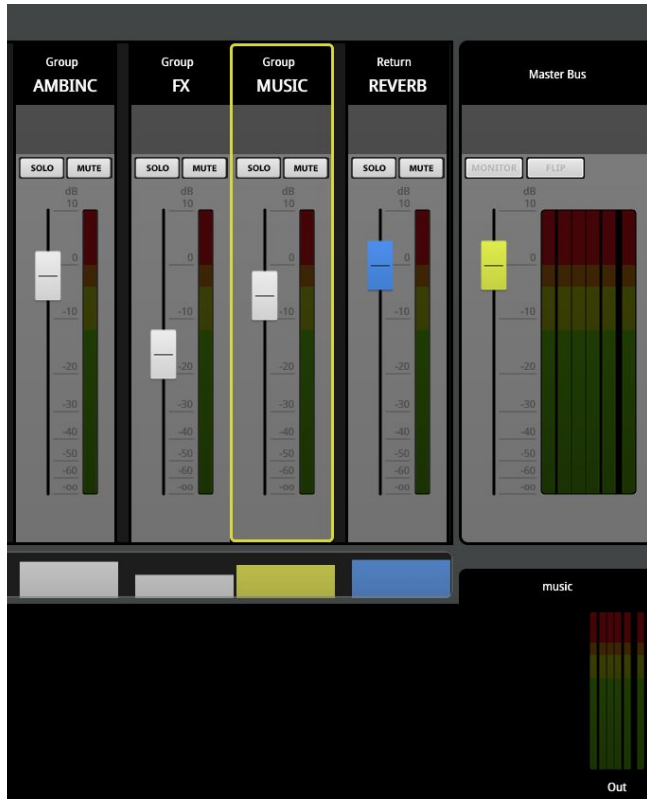




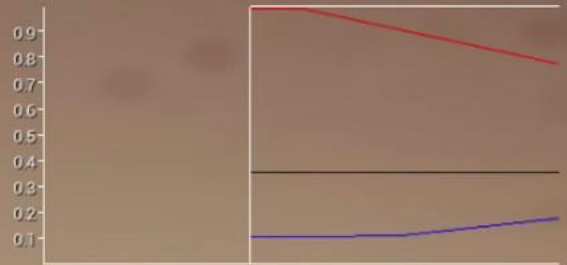


# Mixer, grouping and Buses

riconfigurabile rapidamente (snapshot)



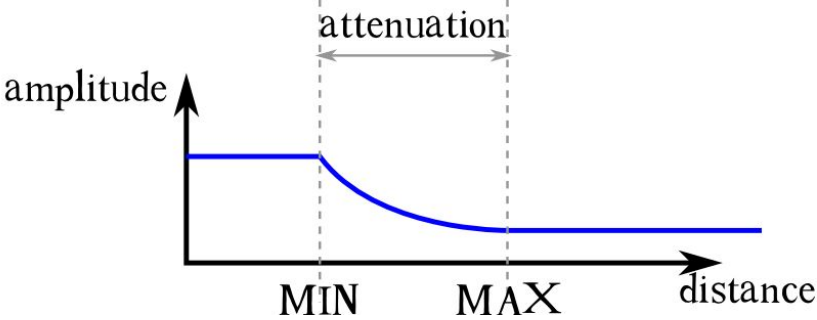
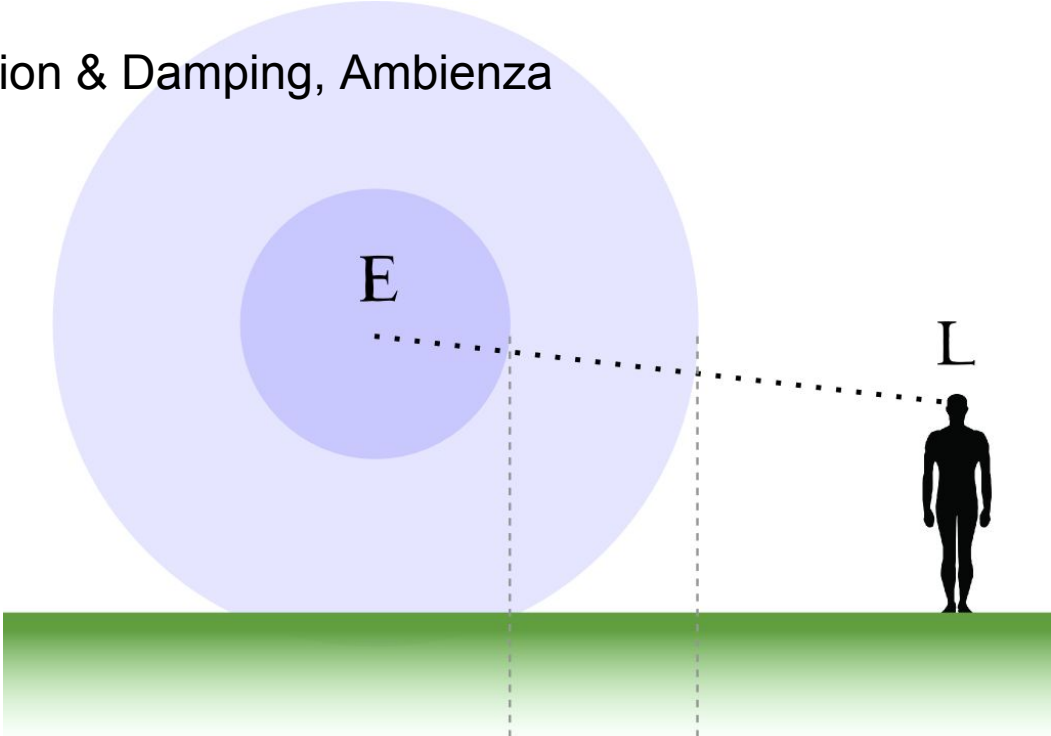
# Real Time controllers



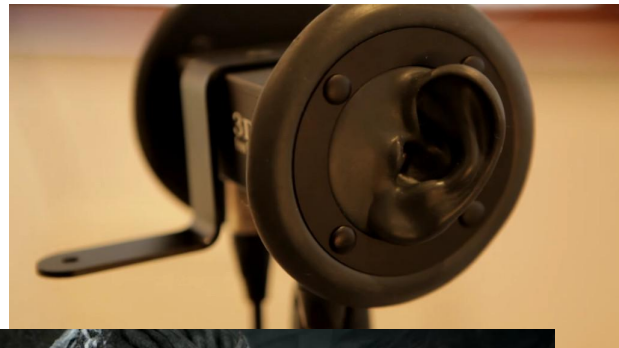
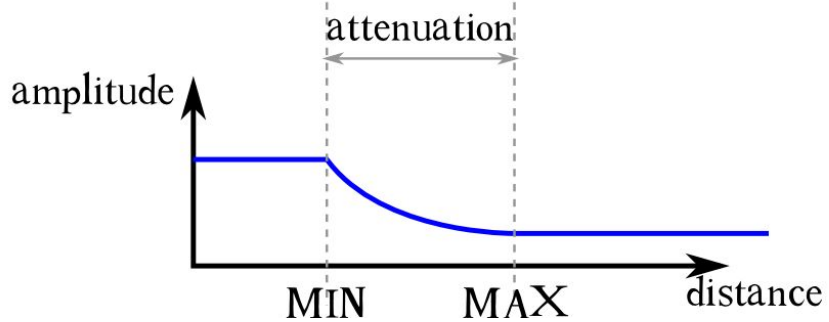
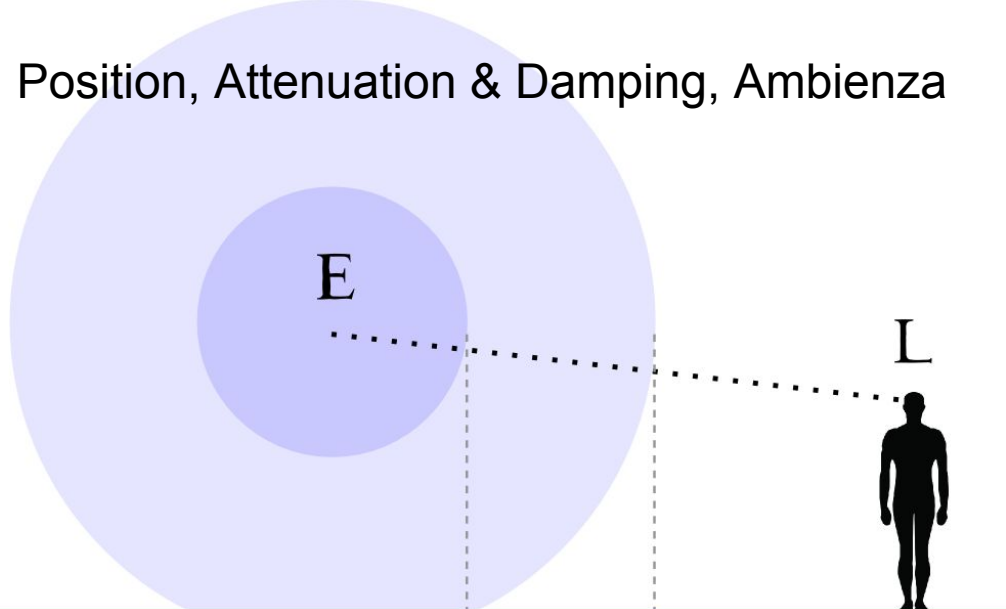
Time  
Health  
Tokens & States  
Target Intensity



# Position, Attenuation & Damping, Ambianza



# Position, Attenuation & Damping, Ambianza

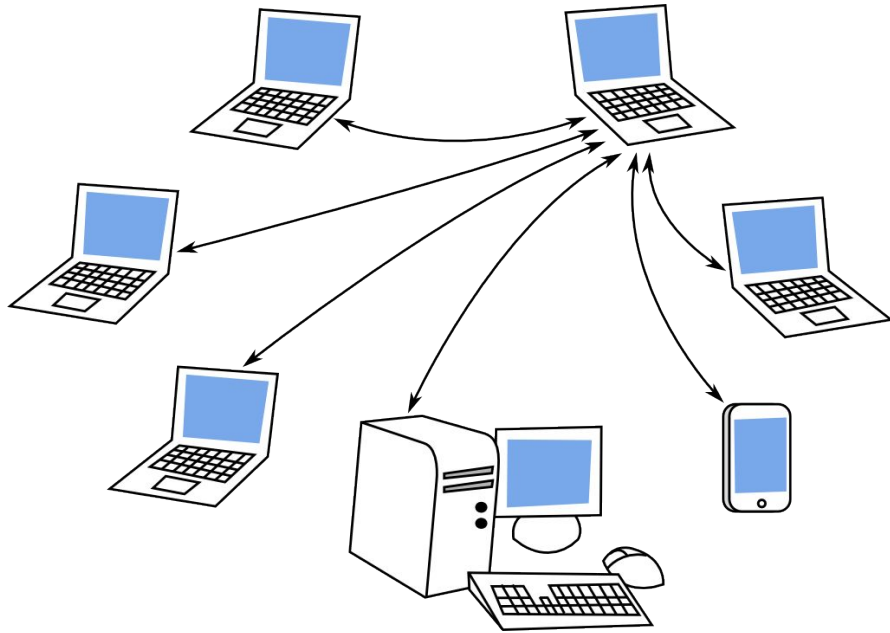




ASK About:  
Voodoo  
Voodoo Murders  
New Orleans  
HerSelf  
MeSSageS  
RequeSt ReSearch  
Exit



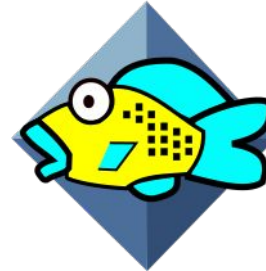
## Alignment



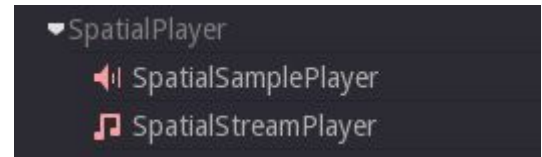
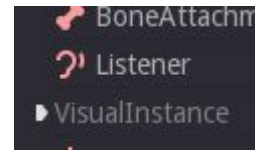
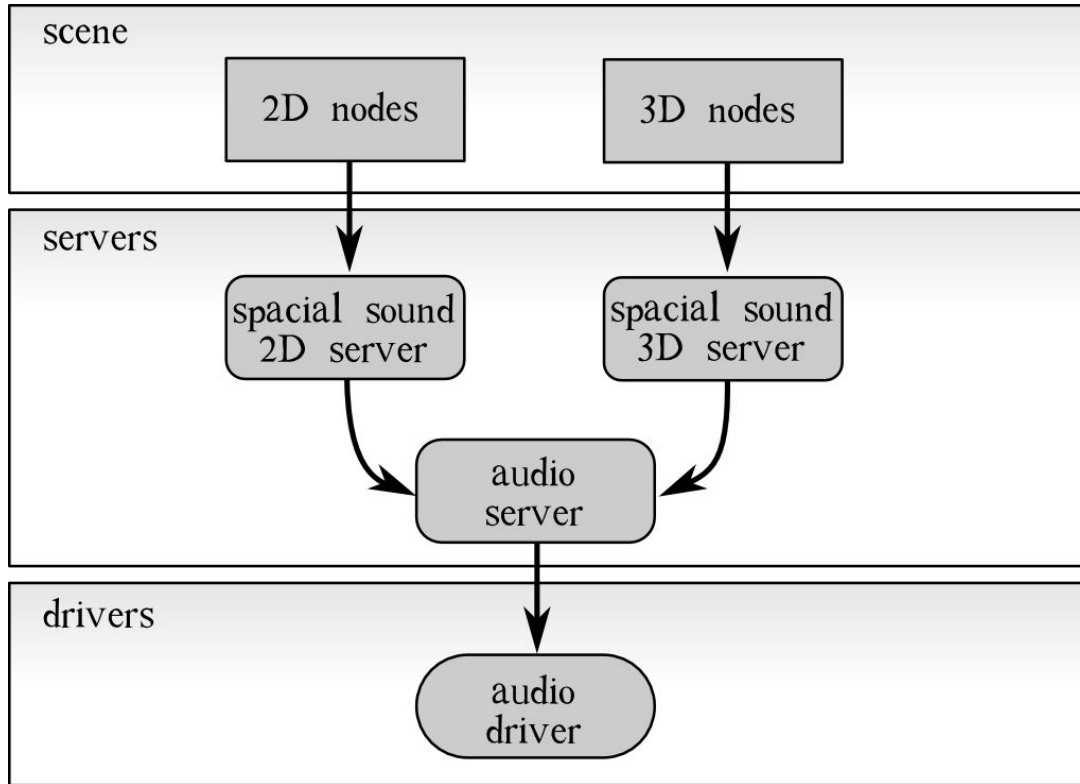
## Decoding data streams



PCM  
ADPCM



## Godot Audio Architecture





3.0

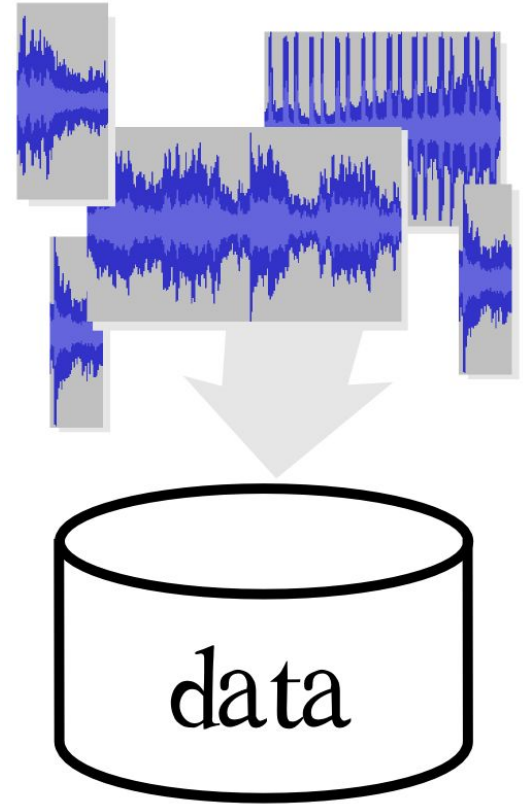
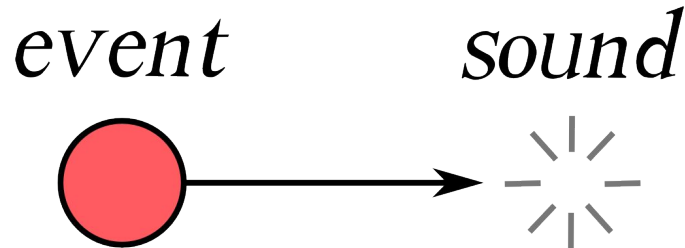


## Modello data driven

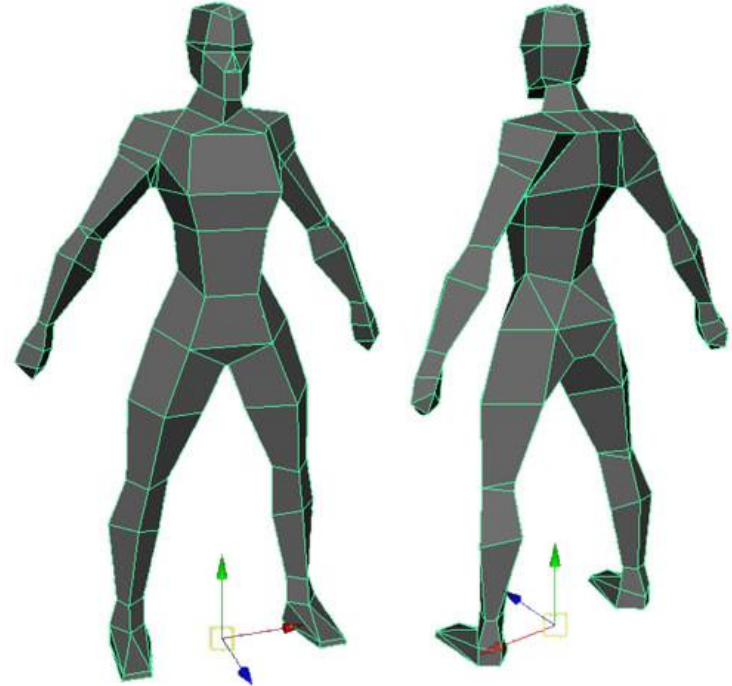
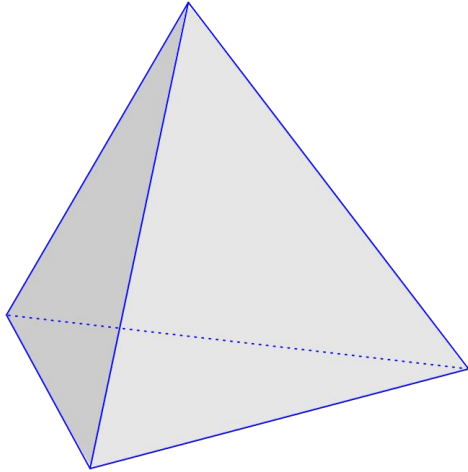
Nell'ultima parte della sua storia, il suono nel videogioco si presenta come un modello guidato dai dati (**data driven model**).

File audio triggerati a seguito del verificarsi di particolari eventi (**event driven system**).

Ai suoni riprodotti si applicano **modificazioni in tempo reale**



## Grafica per la ricerca del realismo

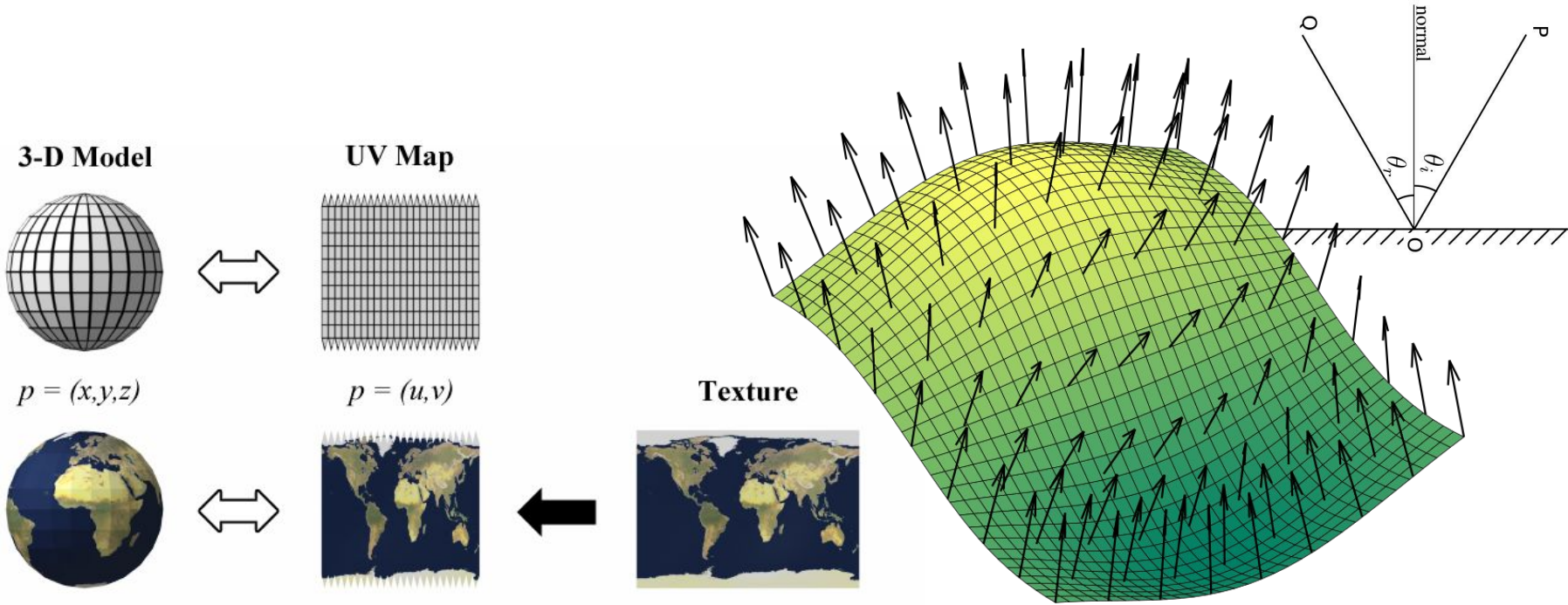


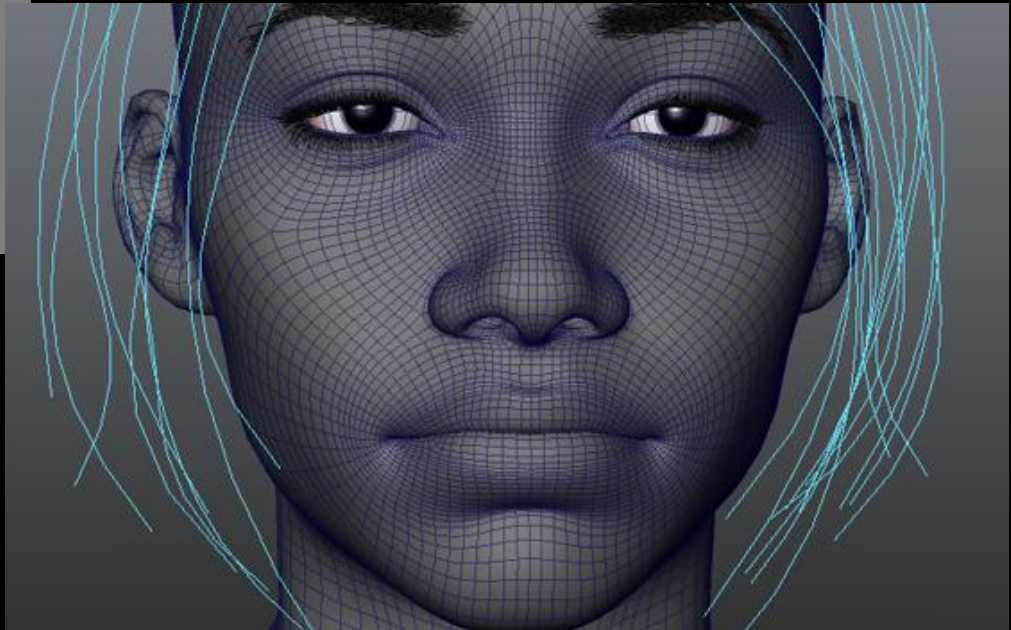
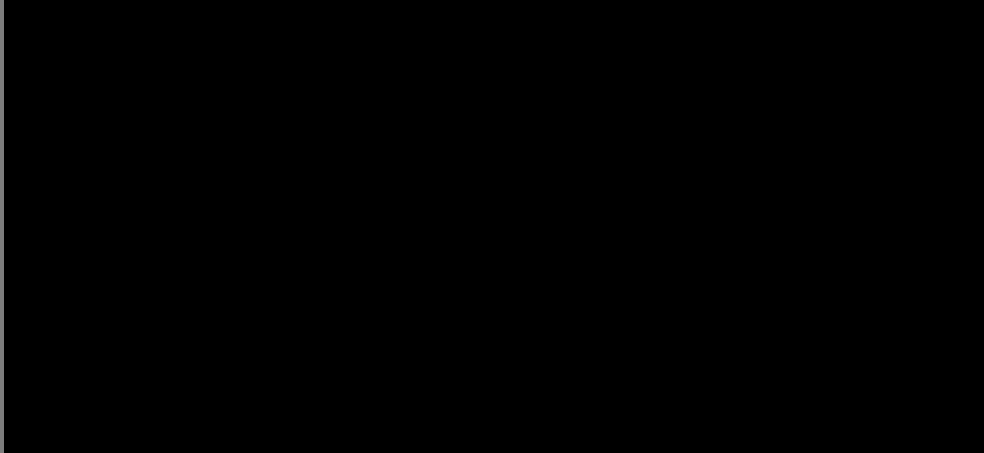
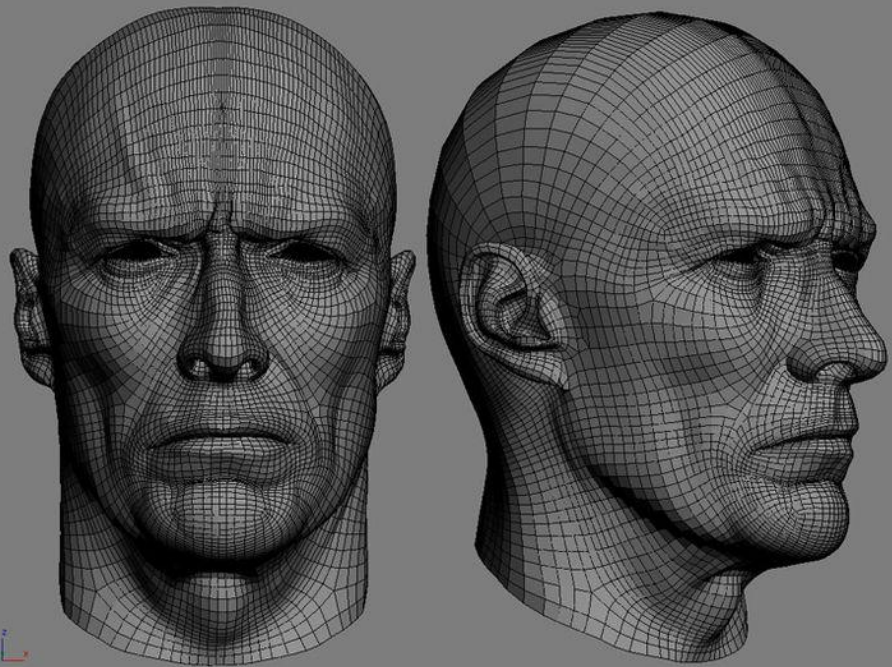


Crash Bandicoot (1996)

Alone in The Dark (1992)







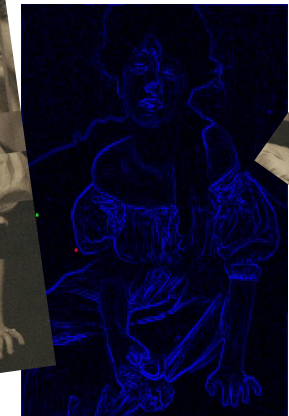
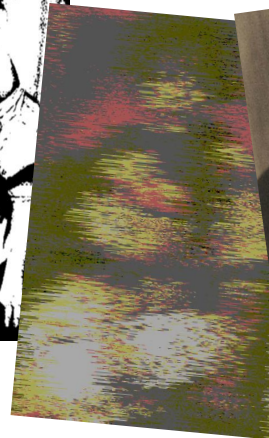
## Suono come processo

- sample audio, di cosa stiamo parlando?
- 2 concezioni di “realismo” contrastanti



## Suono come processo

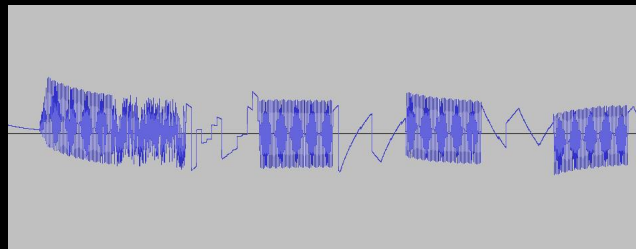
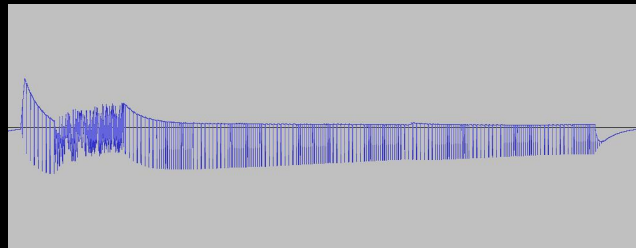
- sample audio, di cosa stiamo parlando?
- 2 concezioni di “realismo” contrastanti





```
10 SI=54272
11 FL=SI
12 FH=SI+1
13 W=SI+4
14 A=SI+5
15 H=SI+6
16 L=SI+24
20 POKE L,15
30 POKE A,16+9
40 POKE H,4*16+4
50 POKE FH,29
55 POKE FL,69
60 POKE W,17
70 FOR T=0 TO 500: NEXT
80 POKE W,0
85 POKE A,0
90 POKE H,0
READY.
```





focus su  
basso livello



focus su  
alto livello

soundo spinge il  
progresso tecnologico



grafica spinge il  
progresso tecnologico

programmatore



compositore/sound  
designer

multitasking



iper specializzazione



## Niente “trucchi” da quattro soldi :P

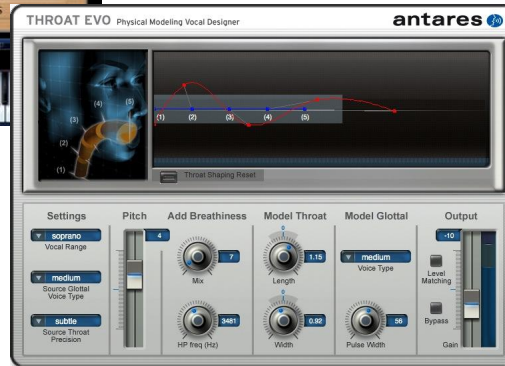
il paradigma data driven non riesce a soddisfare tutte le necessità



# Modelling: Virtual Analog



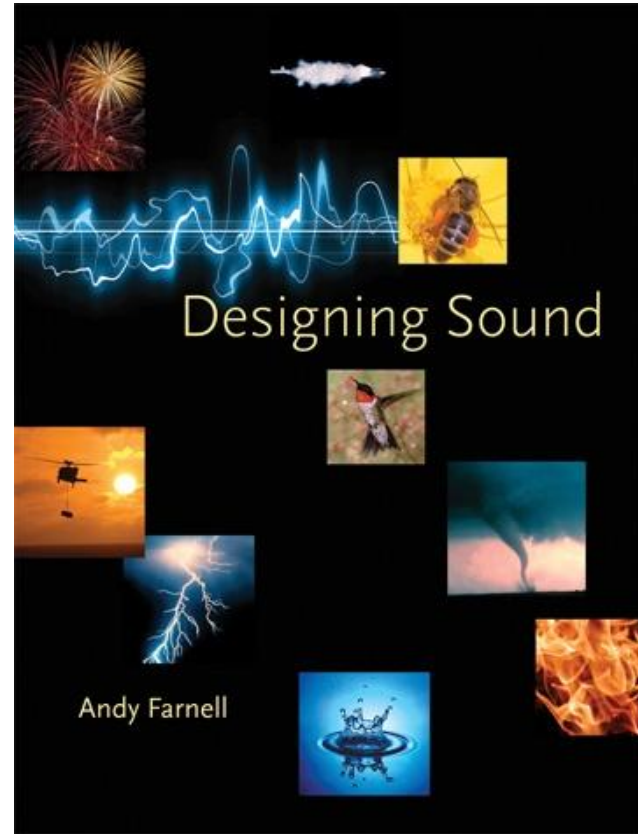
# Modelling: Physical modelling





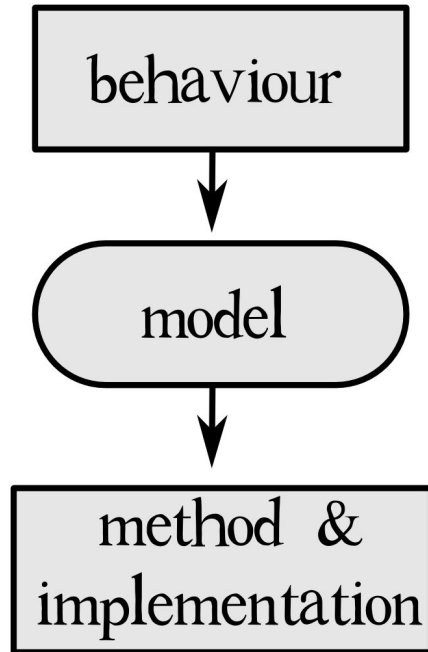
Company	VI Labs	Modartt
Name	<a href="#">Ravenscroft 275</a>	<a href="#">Pianoteq</a>
samples	17000	0
Disk space req.	5.32 GB	40 MB
RAM	4 GB	256 MB





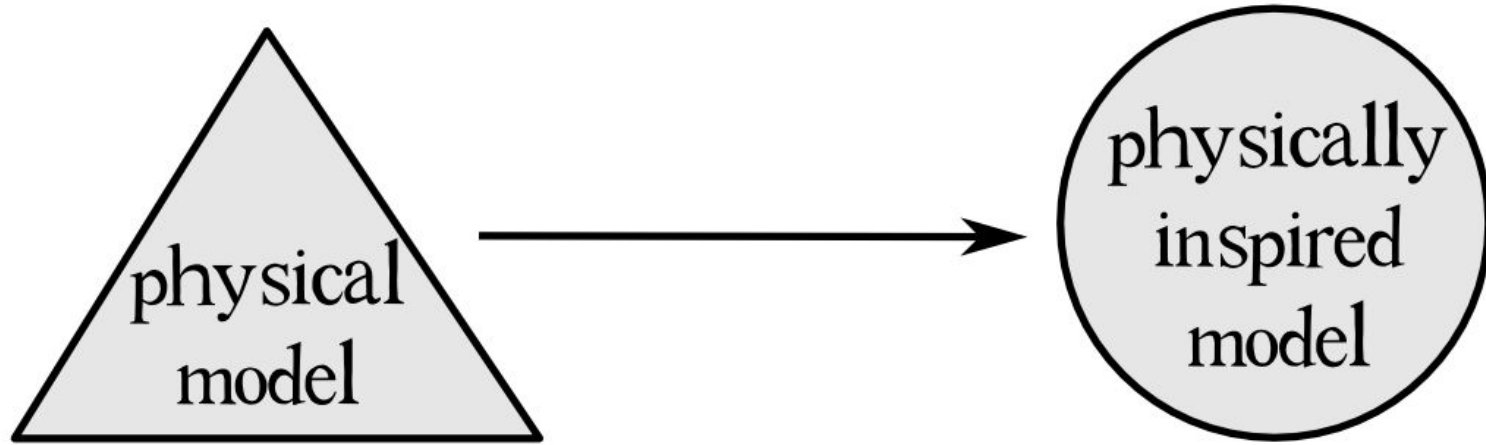


## Suono Procedurale



“**Procedural audio** is non-linear, often synthetic sound, created in real time according to a set of programmatic rules and live input.”

*Andy Farnell*



## Vantaggi:

### Differimento

- recording: decisione prese in anticipo;
- procedurale: molte decisioni sono lasciate al *real-time*;



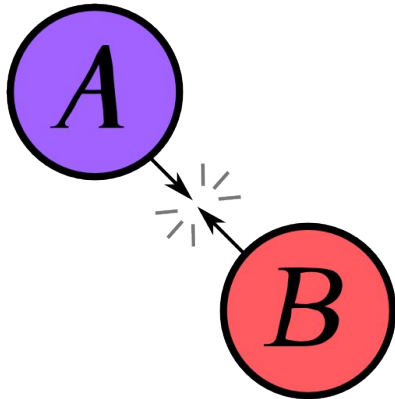
### Variabilità

- modificazione del suono in tempo reale;
- modello completamente parametrico;

## Vantaggi:

### Default forms

- crescita combinatoria
- suono di default associato



### LOAD

- “mipmapping” audio
- modello stratificato
- più layer indipendenti
- psicoacustica



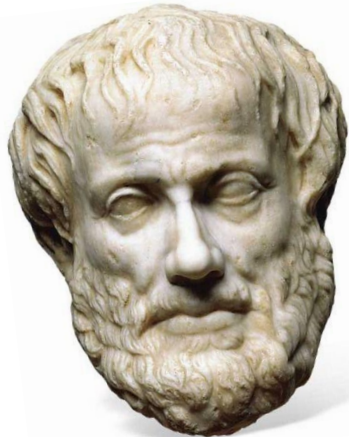
## Svantaggi



- industrial inertia
- new workflows, new skills
- sintesi = falso

do we really need *realism*?

“verosimiglianza & resa vs. reale”  
“ valore aggiunto ”  
Michel Chion



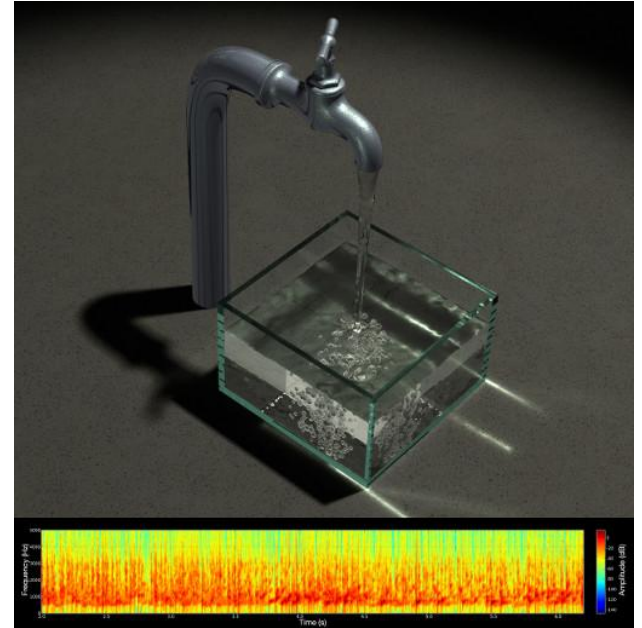
“l'intero è maggiore  
della somma delle sue  
parti”  
*Aristotele, Metafisica*



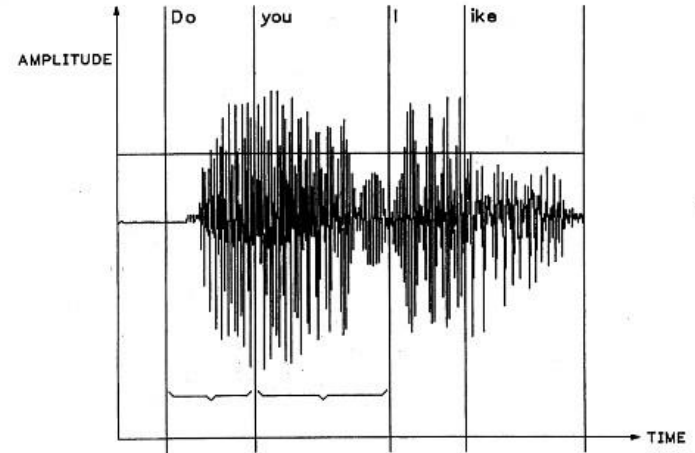
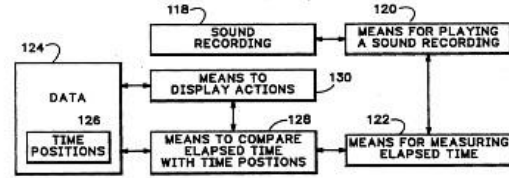
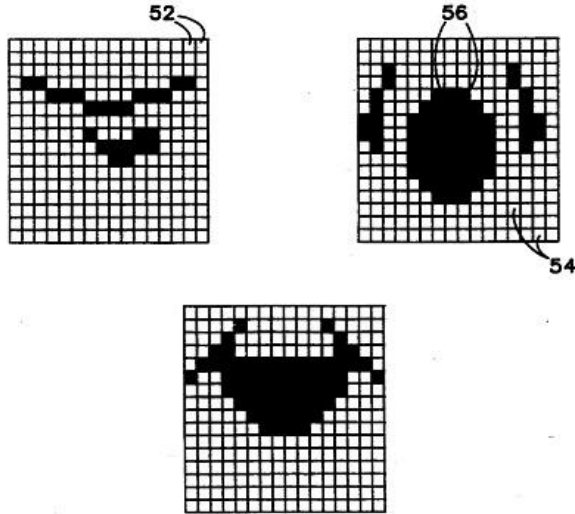
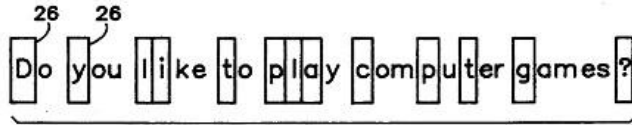
## Il futuro

Nella computer graphics: rigging, textures, animazione, modellazione, light, visual fxs

[fracture sound](#), [friction](#), water and [bubbles](#), fire, [crumpling](#), [impatti](#), [acustica ambientale](#)



# Animation driven by audio

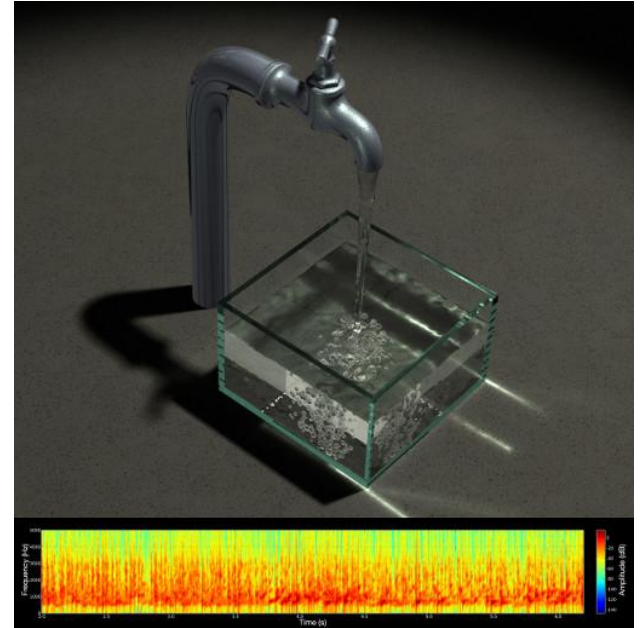




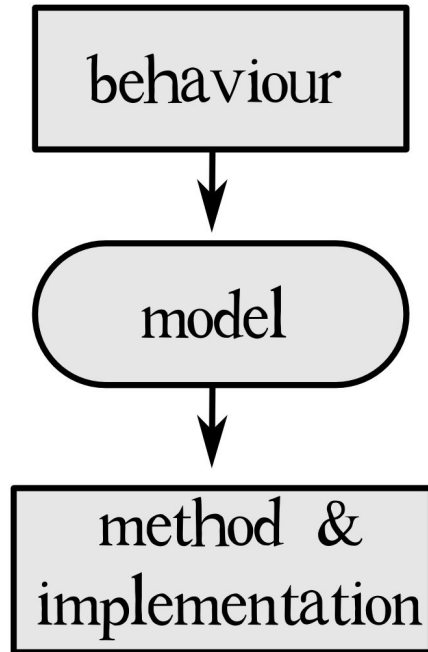


## Il futuro

c'è poi chi si specializza nel processo inverso ([inverse foley](#)) con [risultati sorprendenti](#).



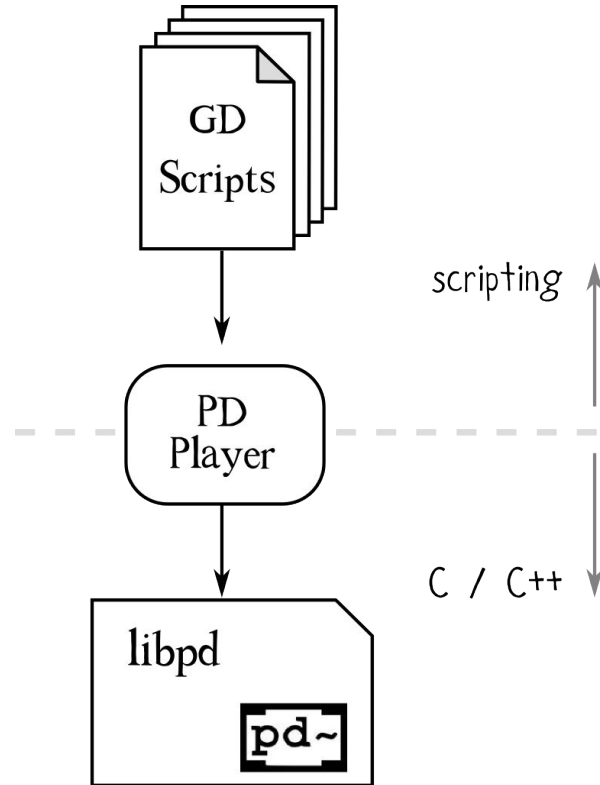
## Esempi: Audio Procedurale, Game Audio Middleware



- Layer di implementazione
- Diversi tipi di linguaggi per l'implementazione
- PureData (Chuck, Supercollider, CSound, etc...)
- fmod

Godot:  
**libpd / PureData**  
integration

<https://github.com/Limulo/godot>





# Valentina Lorè & Nicola Ariutti

aka `limulo.net`

<b>website</b>	<a href="http://www.limulo.net">http://www.limulo.net</a>
<b>mail</b>	<code>info@limulo.net</code>
<b>twitter</b>	<code>@limulo_lab, @v1a111e1, @nicolaariutti</code>



THANK YOU

follow us @  
[www.limulo.net](http://www.limulo.net)