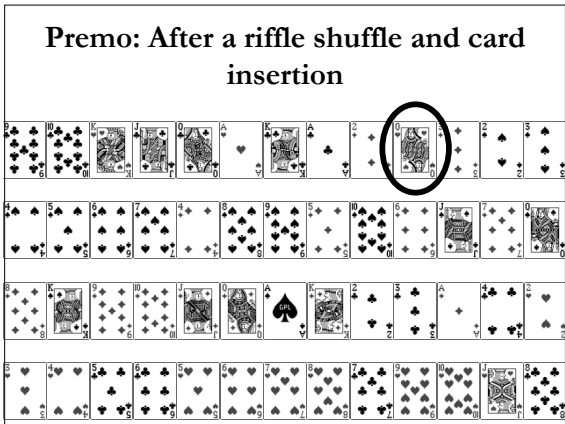
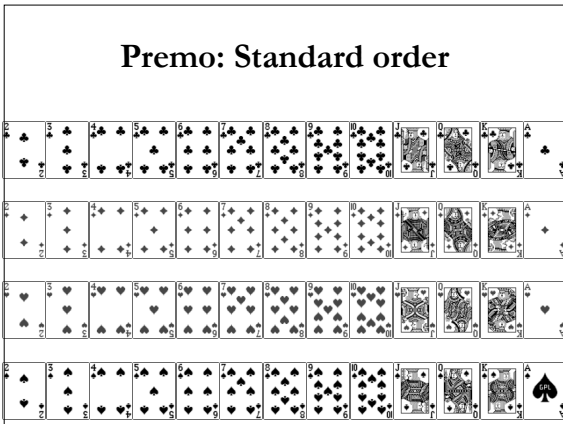
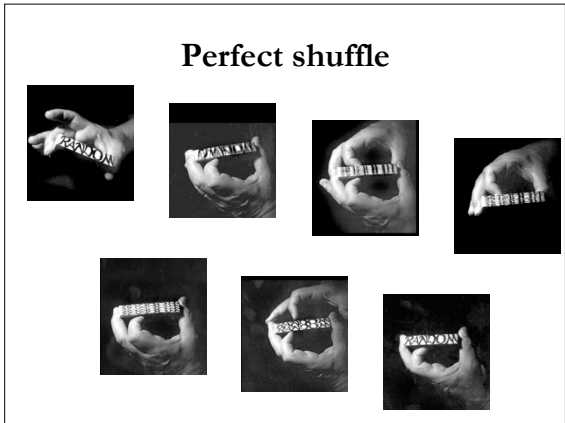
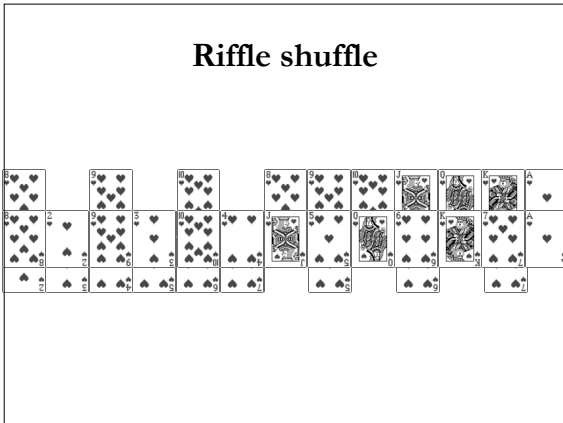


Random shuffling

- generate random permutation, where all permutations have a uniform random distribution
- shuffling \approx inverse sorting (!)
- ordered set $S = \langle s_1, \dots, s_n \rangle$ to be shuffled
- naïve solution
 - enumerate all possible $n!$ permutations
 - generate a random integer $[1, n!]$ and select the corresponding permutation
 - practical only when n is small

Random sampling without replacement

- guarantees that the distribution of permutations is uniform
 - every element has a probability $1/n$ to become selected in the first position
 - subsequent position are filled with the remaining $n - 1$ elements
 - because selections are independent, the probability of any generated ordered set is $1/n \cdot 1/(n-1) \cdot 1/(n-2) \cdot \dots \cdot 1/1 = 1/n!$
 - there are exactly $n!$ possible permutations
 - generated ordered sets have a uniform distribution

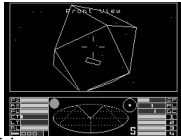



Probability of success: 52 cards, m shuffles, n guesses


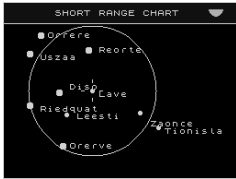
m	2	3	4	5	6	7	8	9	10	11	12	∞
1	997	839	288	088	042	028	023	021	020	020	019	019
2	1000	943	471	168	083	057	047	042	040	039	039	038
3	1000	965	590	238	123	085	070	063	061	059	058	058
13	1000	998	884	617	427	334	290	270	260	254	252	250
26	1000	999	975	835	688	596	548	524	513	505	503	500

cut-off

- Random numbers in games**
- terrain generation
 - events
 - character creation
 - decision-making
 - game world compression
 - synchronized simulation

- Game world compression**
- used in *Elite* (1984)
 - finite and discrete galaxy
 - enumerate the positions
 - set the seed value
 - generate a random value for each position
 - if smaller than a given density, create a star
 - otherwise, space is void
 - each star is associated with a randomly generated number, which used as a seed when creating the star system details (name, composition, planets)
 - can be hierarchically extended
- 
- 

Example: *Elite*

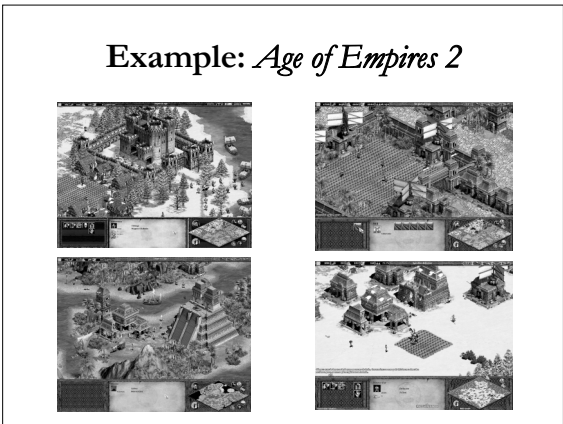
DATA ON LAVE

Distance: 0.0 Light Years
 Economy: Rich Agriculural
 Government: Dictatorship
 Tech. Level: 6
 Population: 2.0 Billion
 (Human Colonies)
 Productivity: 13552 M CR
 Radius (km): 6276 km
 The planet Lave is most well known for its hoopy casinos.

LAWE MARKET PRICES

PRODUCT	UNIT	BUY	SELL
Food	t	2.00	1.90
Textiles	t	2.00	1.90
Alloys/Plates	t	2.00	1.90
Iron	t	2.00	1.90
Aluminum	t	2.00	1.90
Plastic	t	2.00	1.90
Carbon	t	2.00	1.90
Gold	t	2.00	1.90
Silver	t	2.00	1.90
Platinum	t	2.00	1.90
Oil	t	2.00	1.90
Alloy Steel	t	2.00	1.90
Alloy Iron	t	2.00	1.90
Alloy Aluminum	t	2.00	1.90
Alloy Plastic	t	2.00	1.90
Alloy Carbon	t	2.00	1.90
Alloy Gold	t	2.00	1.90
Alloy Silver	t	2.00	1.90
Alloy Platinum	t	2.00	1.90
Alloy Oil	t	2.00	1.90

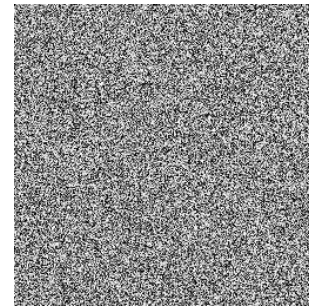
- Random game world generation**
- discrete game worlds
 - example: *Nethack*, *Age of Empires*
 - rooms, passages, item placements
 - continuous game worlds
 - random world is not believable
 - modular segments put together randomly
 - terrain generation



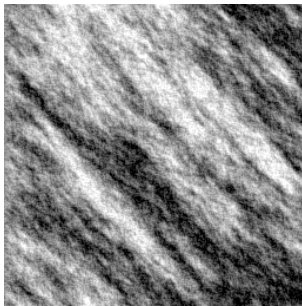
Terrain generation methods

- simple random
- limited random
- particle deposition
- fault line
- circle hill
- midpoint displacement

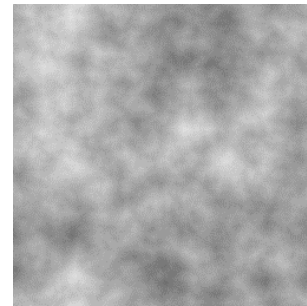
Simple random terrain



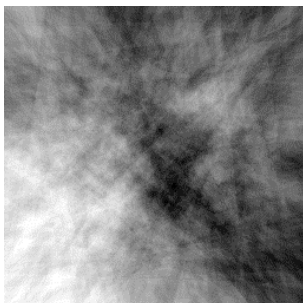
Limited random terrain



Particle deposition terrain



Fault line terrain



Circle hill terrain

