artificial life, death and epidemics in evolutionary, generative electronic art

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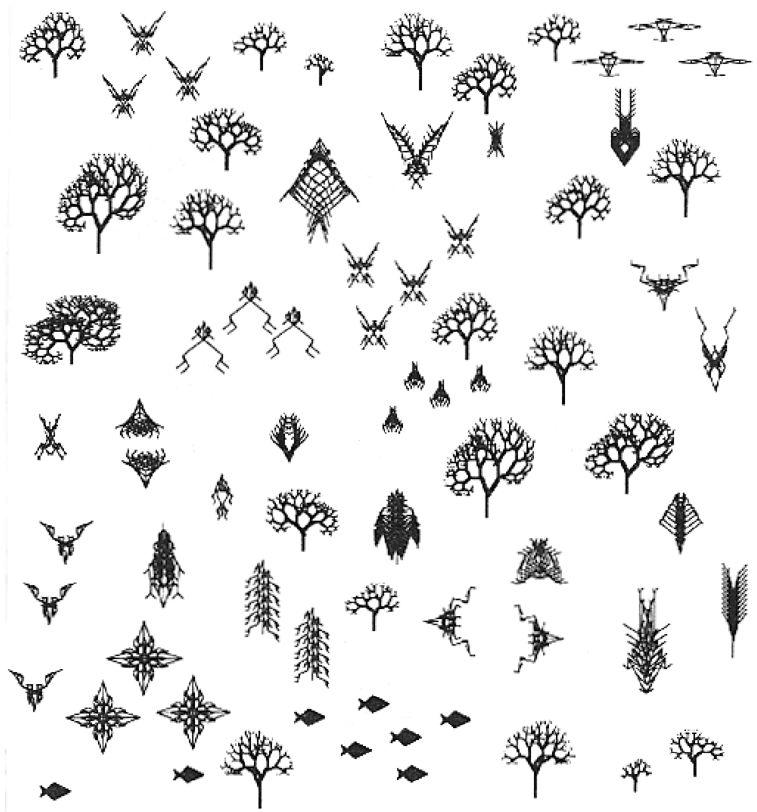
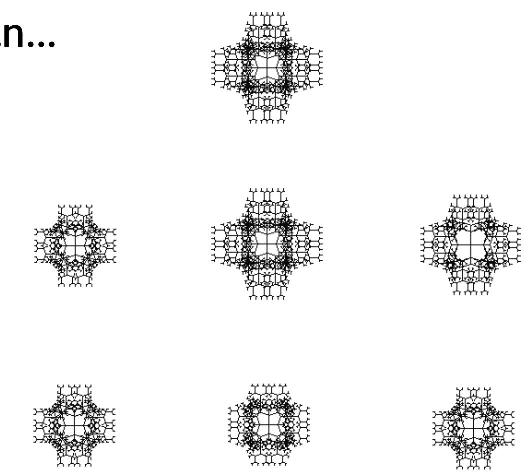
dance of death, woodcut, 1493

I would like the behaviour of my electronic generative systems to lie at *i*.

In the case of an evolutionary system such as Dawkin's Blind Watchmaker,



... is more diverse and more interesting than...



Can we achieve this diversity without human input?

How can we ensure an evolutionary system maintains its diversity indefinitely?

I would prefer an elegant solution where the desired diversity is emergent from the behaviour of the system, rather than imposed by the programmer or user.

Co-evolution has been noted to prevent early convergence of a genetic algorithm population.

The epidemic is a powerful and interesting force in nature and in art.

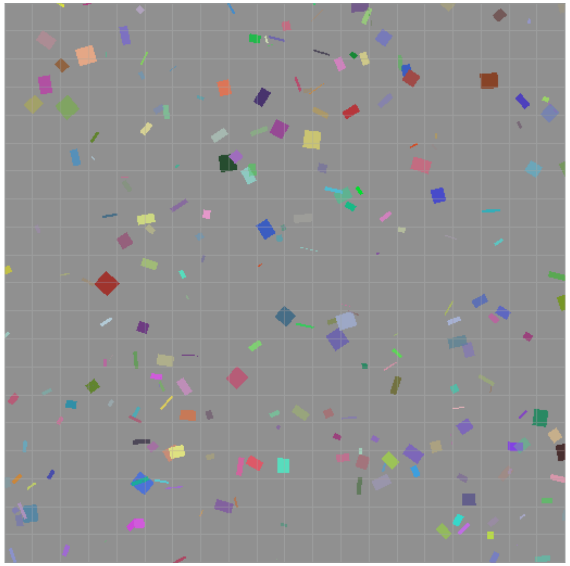
Can epidemics and co-evolution maintain diversity in an electronic ecosystem?

an evolutionary, generative, electronic ecosystem

autumn squares

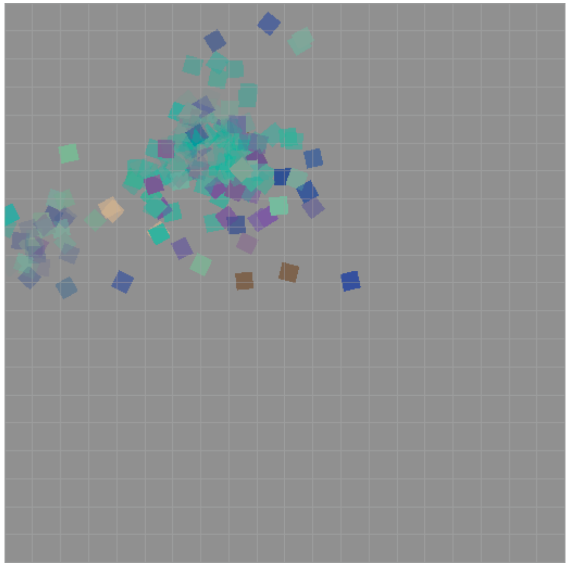
agents : roam a barrier-free torroidal space
acquire energy proportional to their surface area
metabolize energy proportional to their volume and speed
die if they deplete their energy reserves
seek mates with tasteful colour and dimensions
donate energy to their offspring

floating point genes : colour; box dimensions; taste in mates; energy allocation to offspring



convergence

standard genetic algorithm



initial genetic disorder
= diversity (spatial + visual + behavioural)

eventual genetic homogeneity
= uniformity (spatial + visual + behavioural)

incorporate a modified

susceptible	organism may catch a disease from an infectious neighbour
infective	organism may transfer a disease to a susceptible neighbour
removed	organism is no longer susceptible or infectious (removed from the epidemic process through death or immunity)

S I R model of disease transmission

into autumn squares

basic S I R model of disease transmission is presented as a set of differential equations and assumes :

random mixing of agents (no spatial model of susceptibles)

the probability of a new case of the disease is proportional to the number of susceptibles * number of infectives

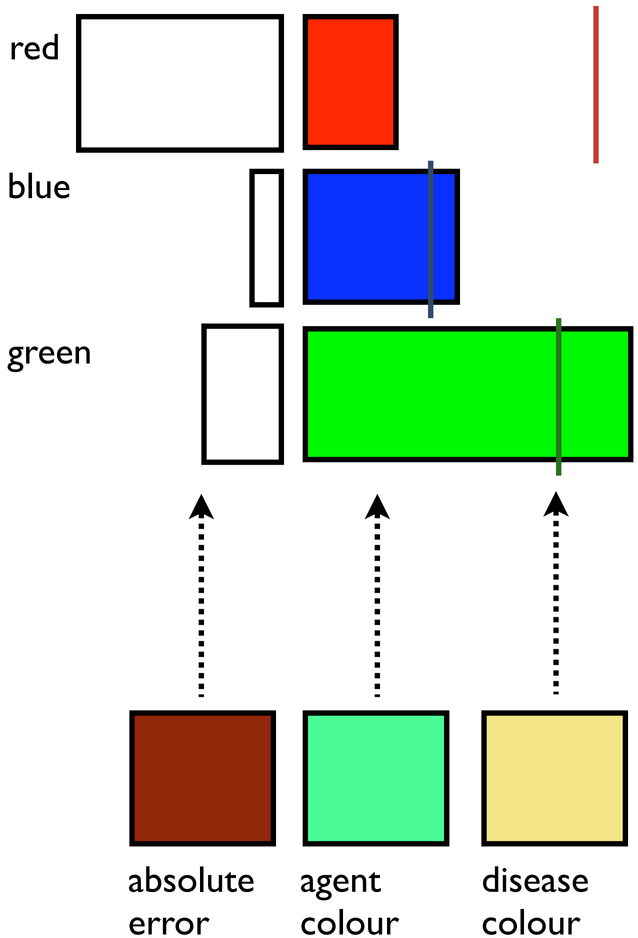
in the S I R model presented in this paper :

a spatial model allows the emergence of agent sub-communities

disease transmission characteristics are emergent from the agents' spatial interactions

disease latent and incubation periods are easily modelled

diseases and agents of many types may co-evolve simultaneously diseases transmission occurs from an infective agent to a susceptible agent during physical contact



disease : infects a susceptible agent with probability proportional to its colour-signature match with the colour of the agent

removes energy from an infected agent by a quantity proportional to its colour-signature match with the colour of the agent

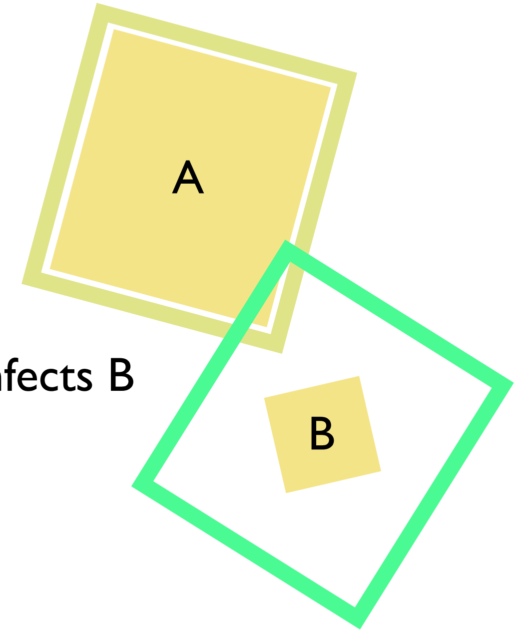
has floating point genes : colour-signature; latent, incubation and infective periods; mutation rate

is mutated after every time step according to its evolvable mutation rate

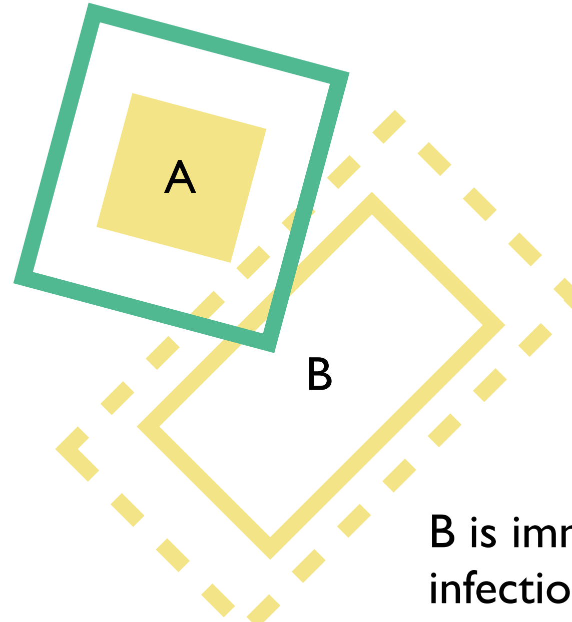
blocks secondary infection of its host

agents : overcome a disease by having sufficient energy reserves to live through infection

acquire immunity to a disease they survive agents with internal shapes are carrying a disease



A infects B



B is immune to infection from A

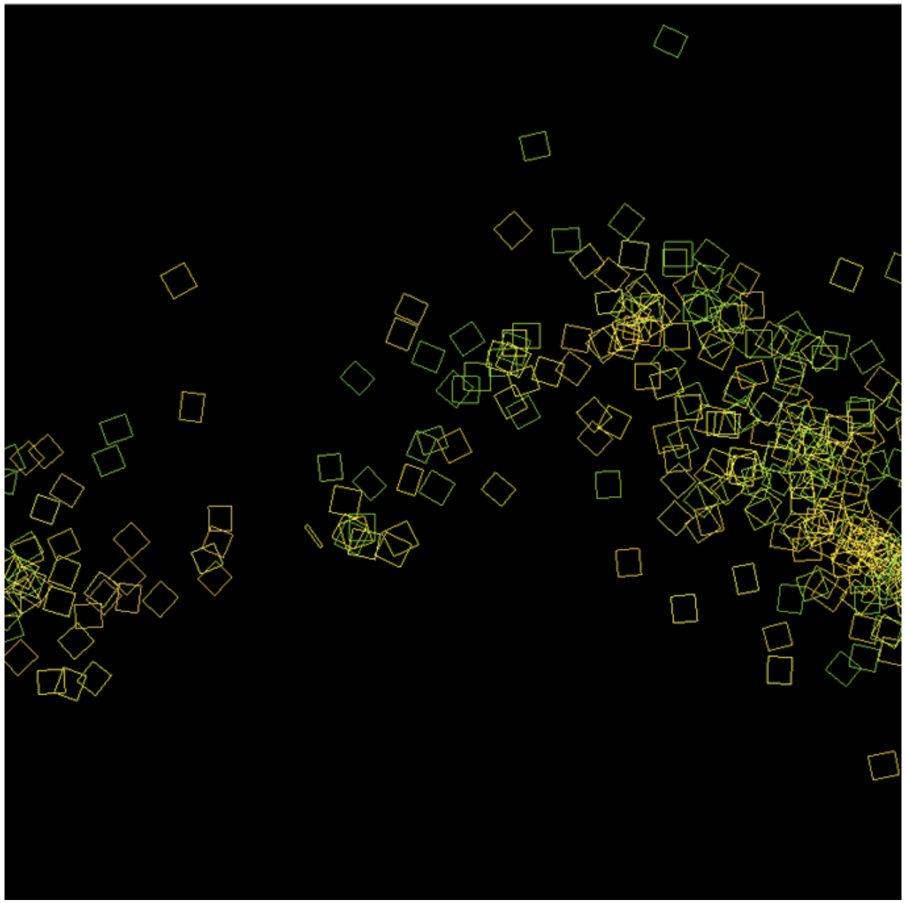
devastation of the disease is represented by the proportion of the agent that is filled by a square or diamond

filled diamond orientation indicates disease latency period : the agent is not infective

disease incubation often follows latency period : the agent is infective but does not show symptoms

filled square orientation indicates that the agent is infective

dotted outline represents immunity to a disease of the outline's colour results : no epidemiological model



genetically impoverished population

uniformity of agent

- dimension
- position
- mating preferences
- colour

This occurs often after as few as 2500 time steps.

results : epidemiological model

genetically diverse population

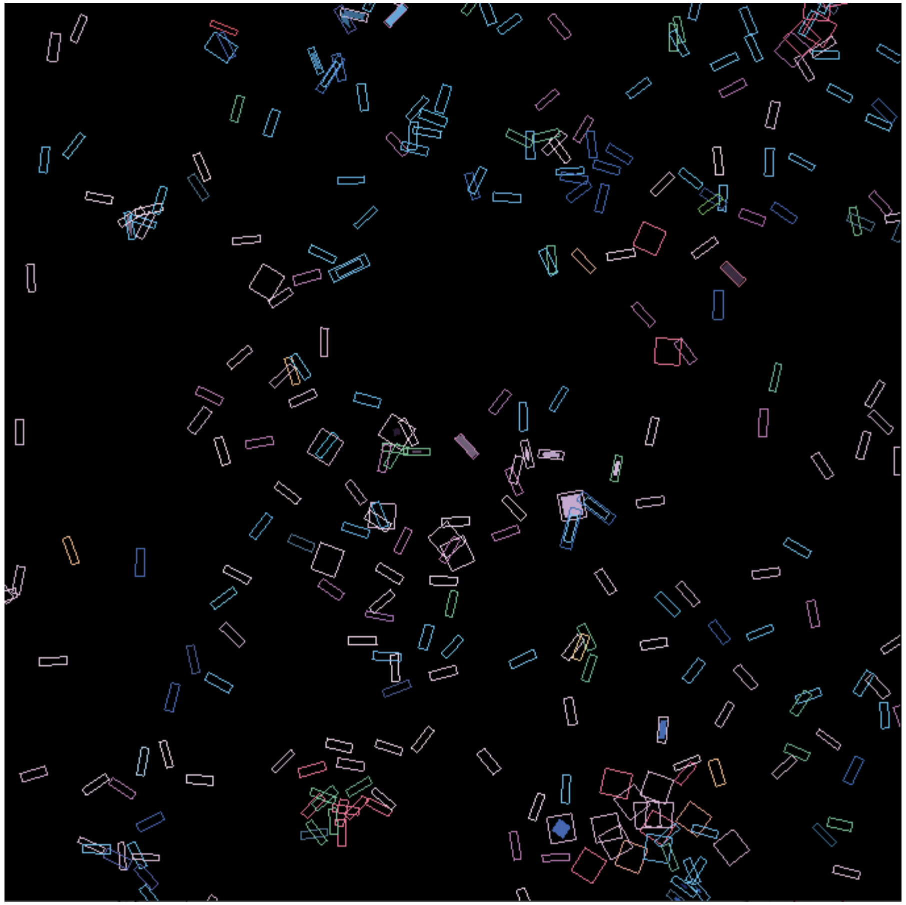
diversity of agent

dimension

position

mating preferences

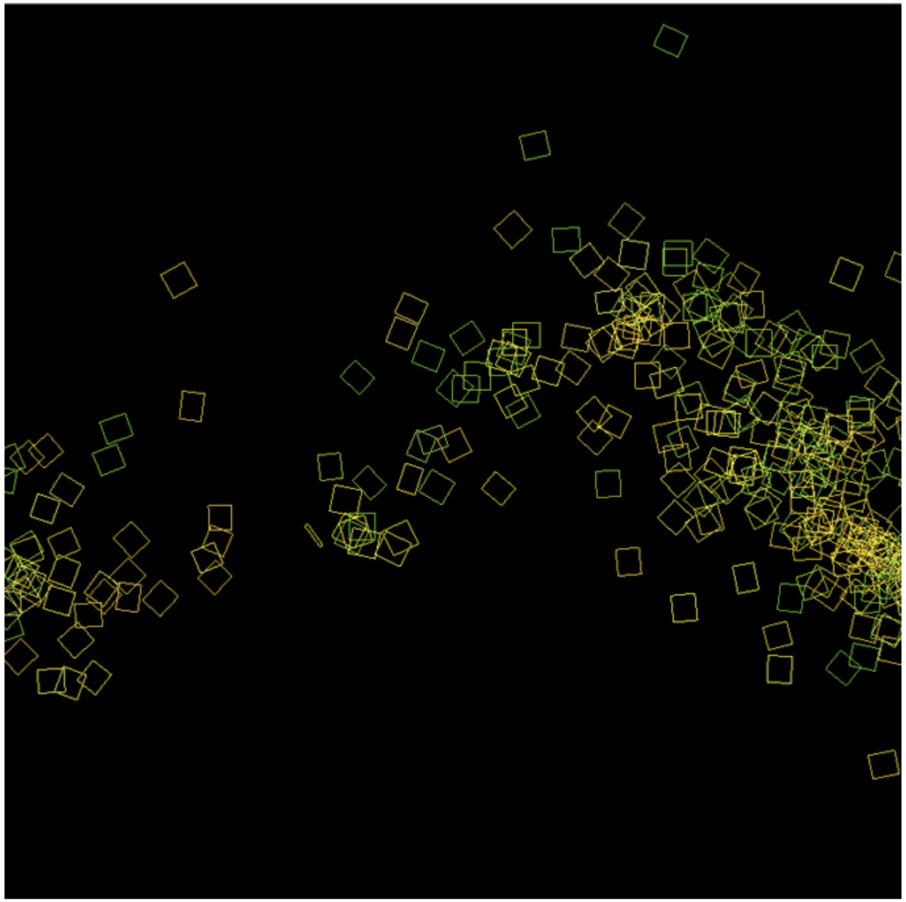
colour



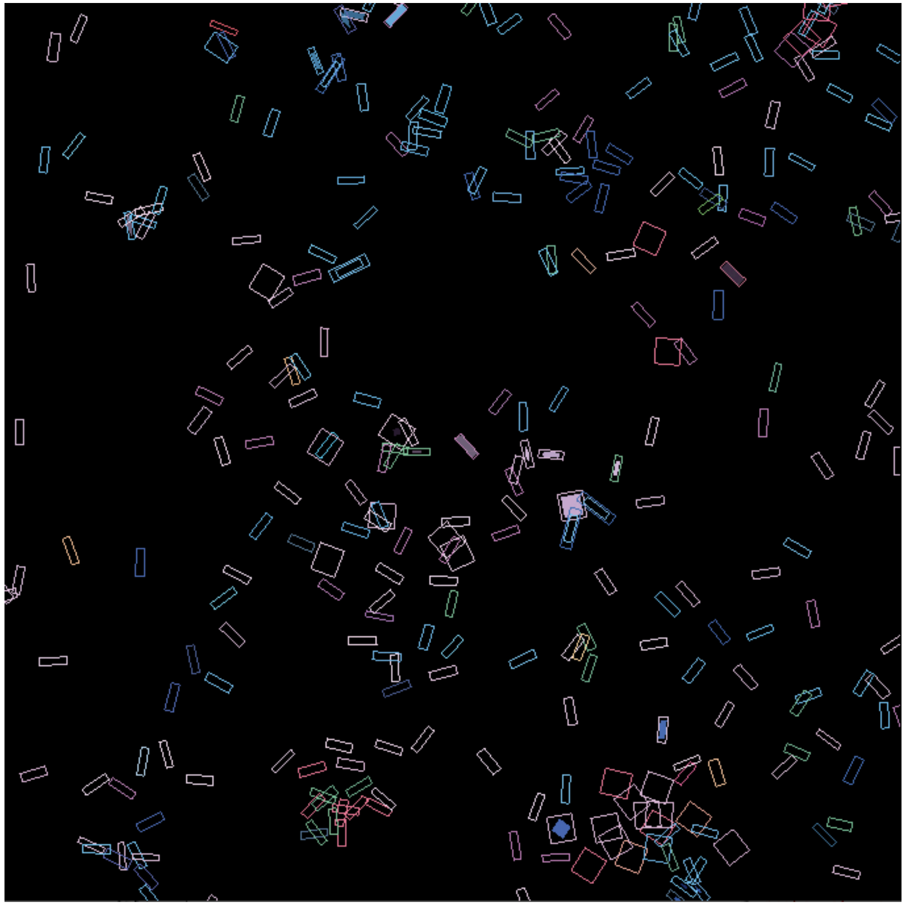
co-evolutionary epidemiological model

This seems to be maintained indefinitely.

results at 14,000 time steps



no epidemiological model



co-evolutionary epidemiological model

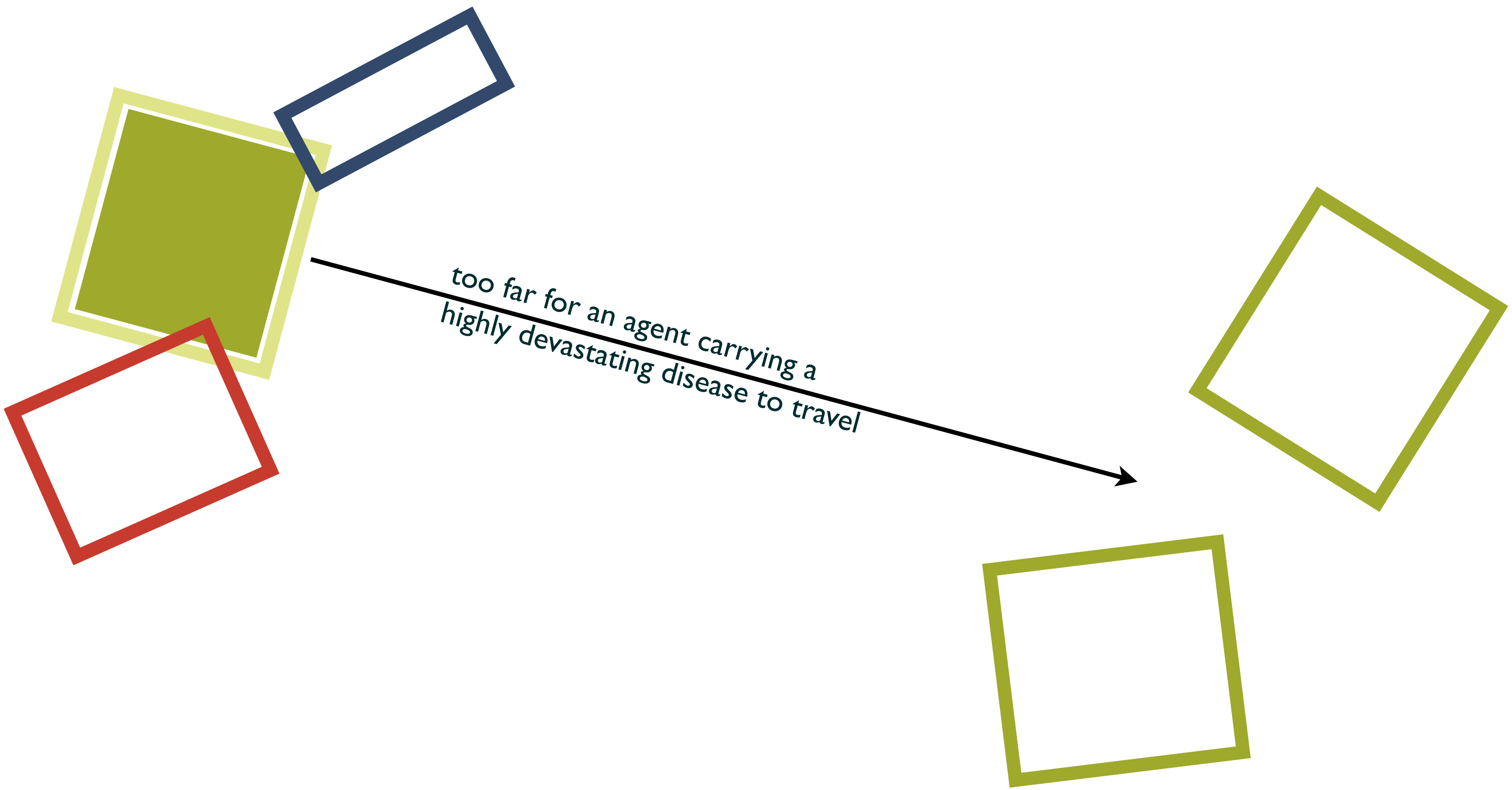
disease elimination : inadequate access to susceptibles

disease is too short-lived

population is insufficiently dense for an infective to meet susceptibles

population is genetically diverse

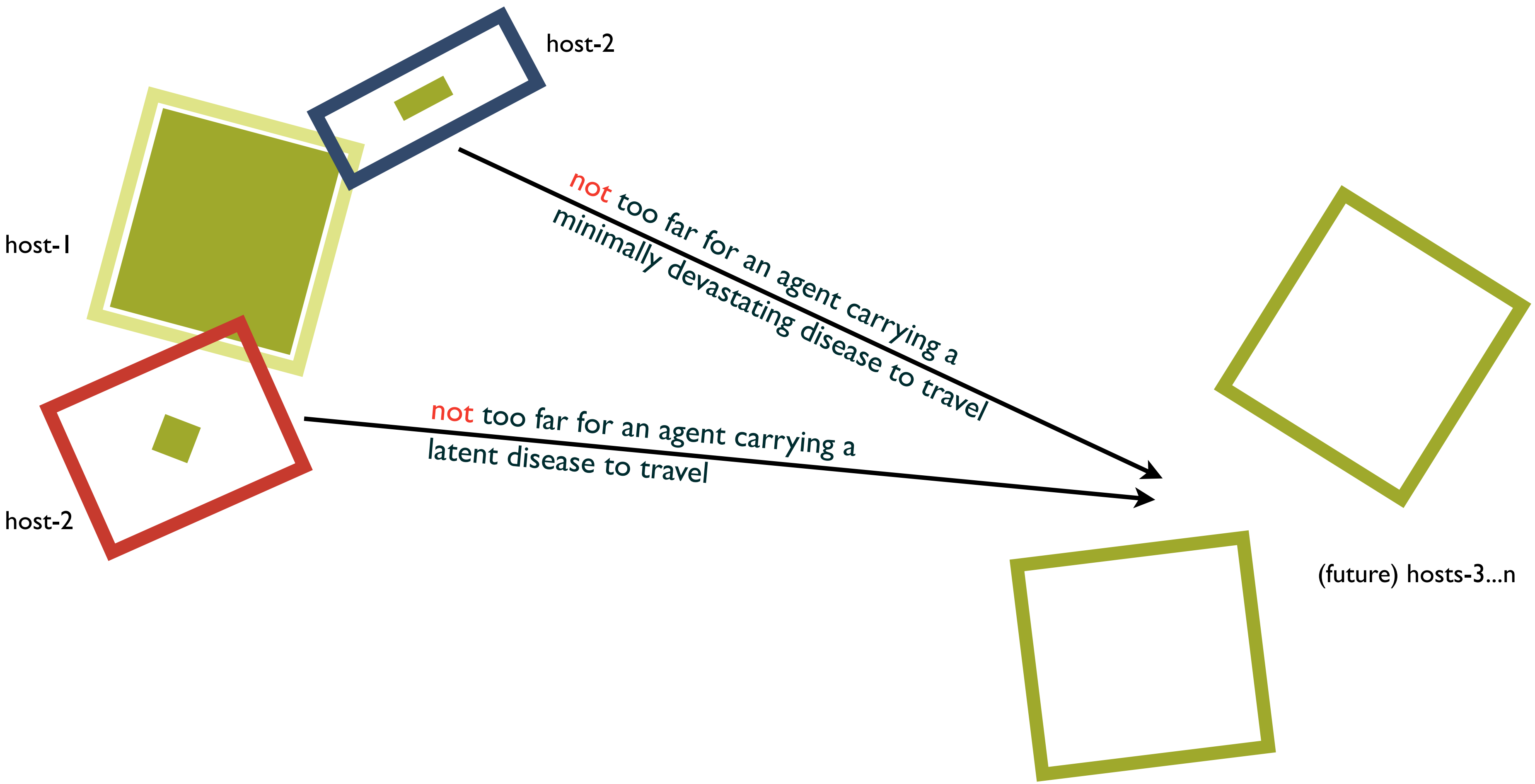
infective does not cohabit with genetically similar susceptibles



disease carrier

the stochastic mechanism permits a disease to infect with low devastation
a susceptible host-2 of a different colour to the original host-1

the host-2 becomes a carrier of the disease to hosts-3...n
for whom the disease is highly devastating



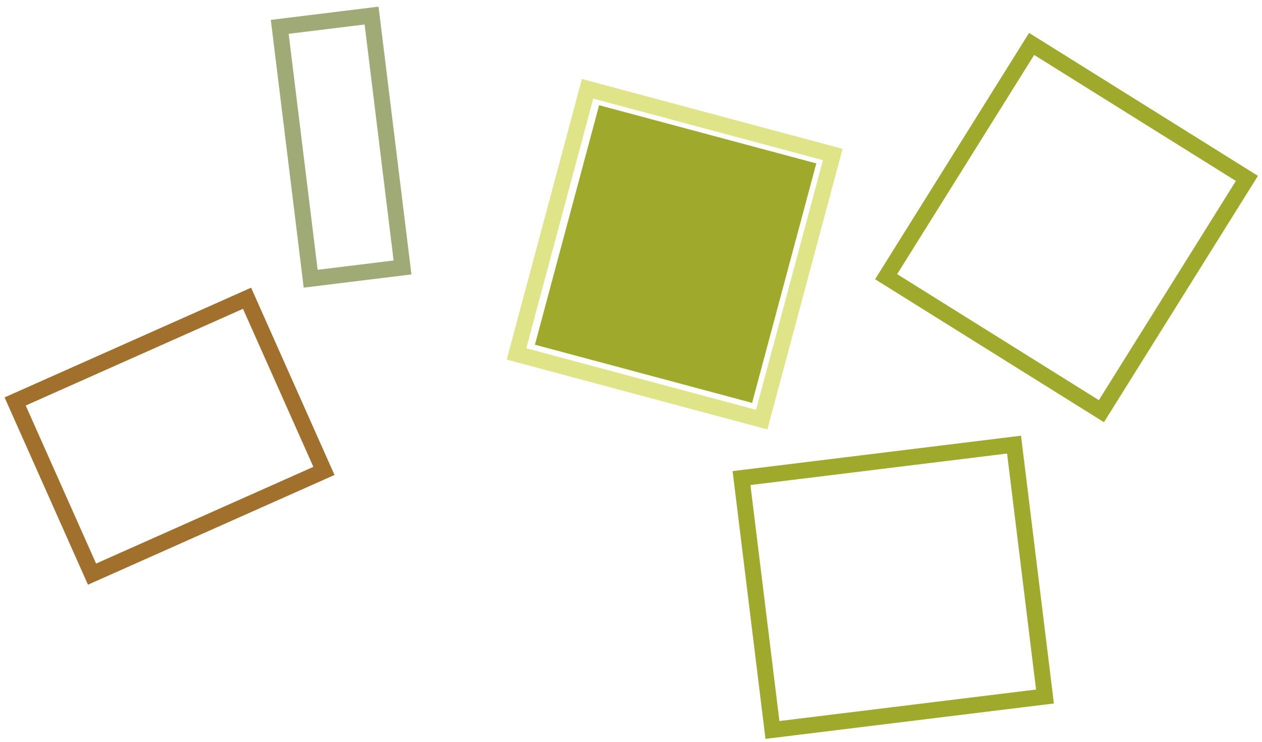
disease spread : adequate access to susceptibles

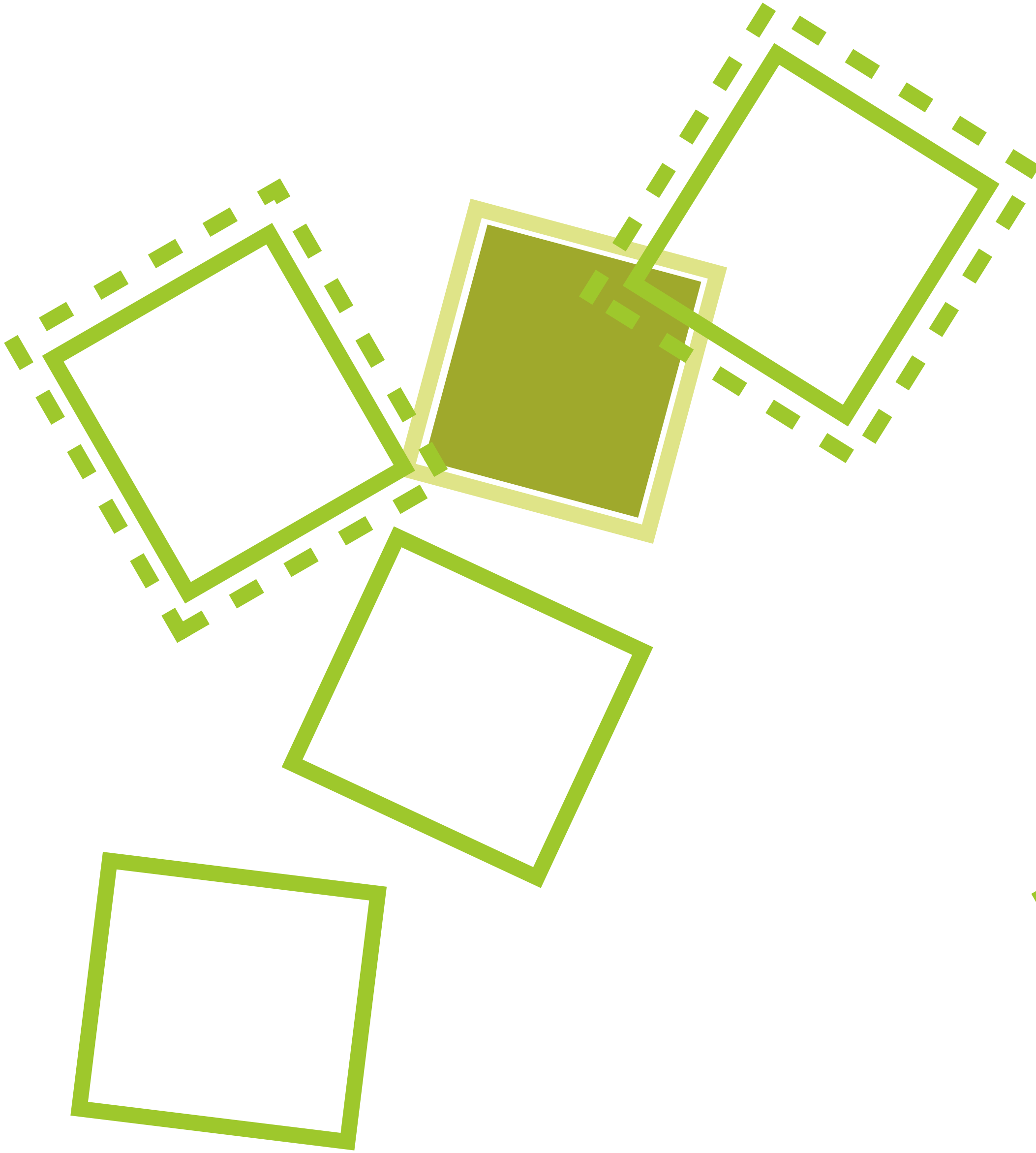
disease is long-lived

population is dense

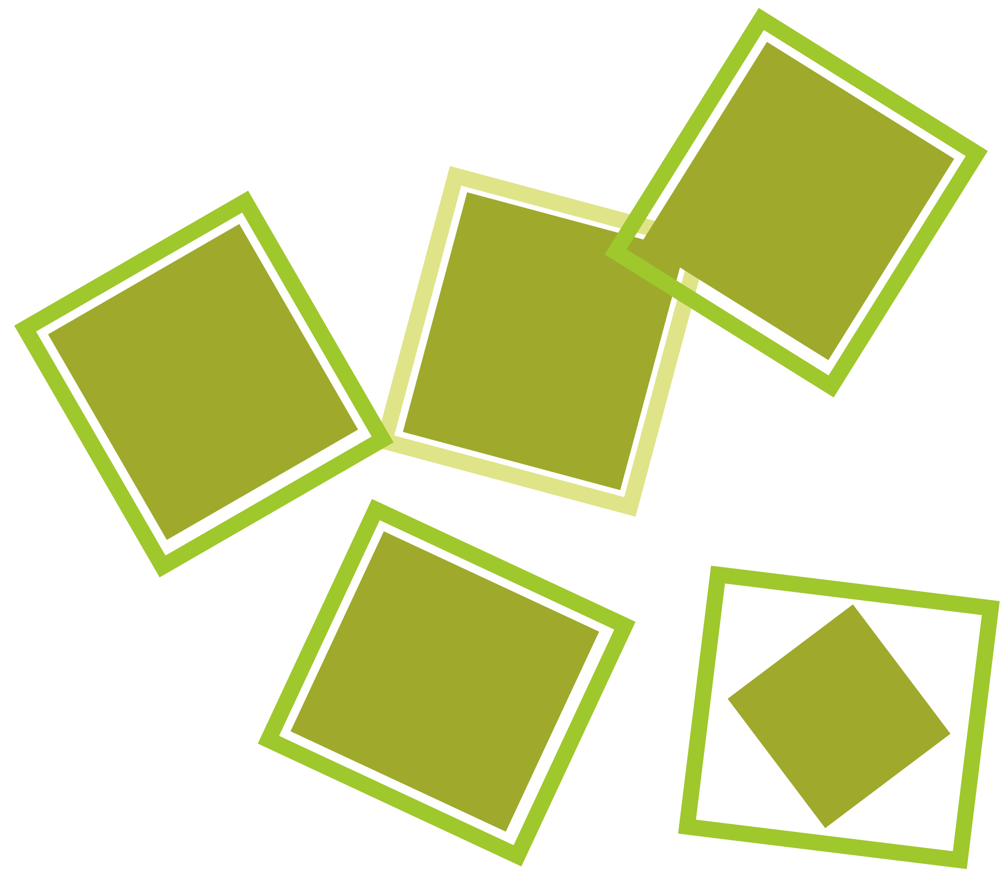
population is genetically homogeneous

infective cohabits with genetically similar susceptibles

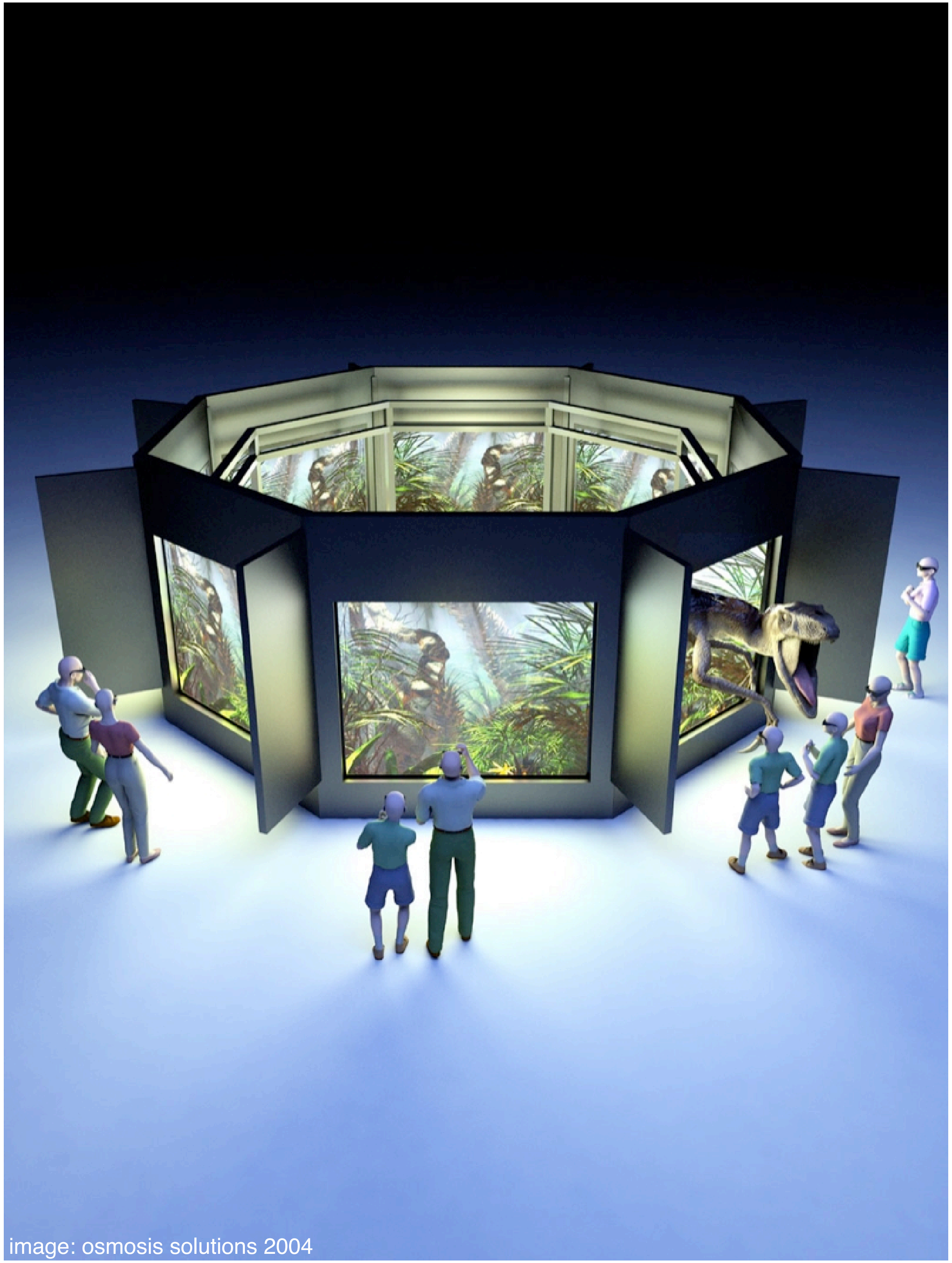




disease rapidly finds susceptibles :
wipes out the population and its supply of susceptibles



disease can’t find susceptibles :
neighbours are already immune



Virtual ROOM

8 x polarized stereoscopic screens

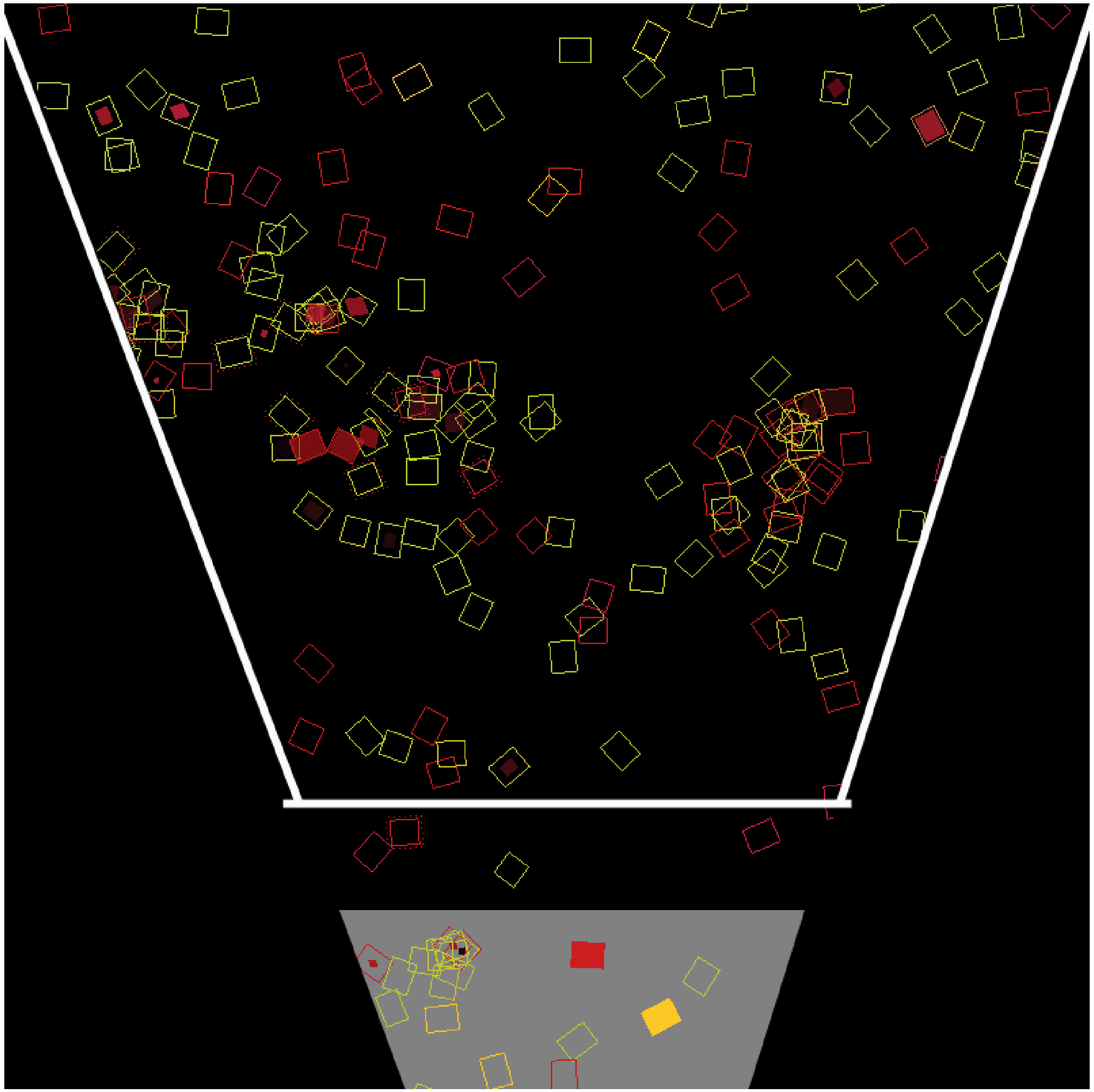
8 x dolby 5.1 audio

sections may present independent or related, interactive or linear audio-visual material

an Australian collaboration between

Swinburne University
Monash University*
Royal Melbourne Institute of Technology
Museum of Victoria
Adacel

* the author & Jon McCormack



work in progress...

add : 8 x video cameras

monitor human traffic in each camera

human clothing = infectious disease

clothing colour = colour-signature

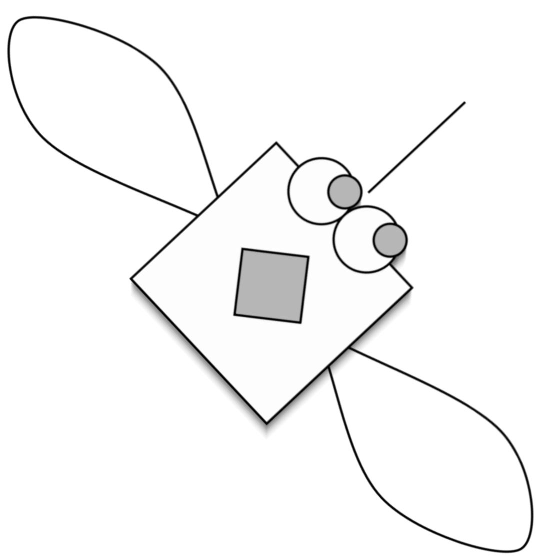
humans are responsible for introducing disease into a virtual population and altering the ecosystem conclusions

the SIR model has been extended and incorporated into a virtual, agent-based evolutionary ecosystem

the inclusion of the epidemiological model has transformed the behaviour of the ecosystem :

virtual diseases improve the genetic and spatial diversity of the agents

the system and its elements exhibit similarities to the behaviour of real-world ecosystems when faced with the challenge of overcoming epidemics



a distributed, self-organizing system has been developed to preserve the diversity of a population of virtual agents

it is hoped that the system may be utilized in an interactive artwork where the agents have interesting visual representations

Stay healthy!