filterscape:

Energy recycling in a creative ecosystem

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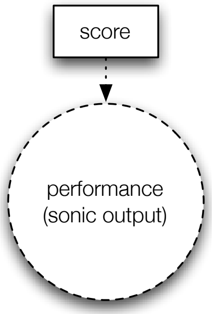
CEMA

[electro-acoustic] music >> << evo-musart

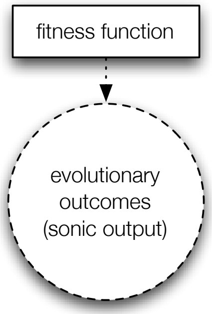
context

traditional

scored performance



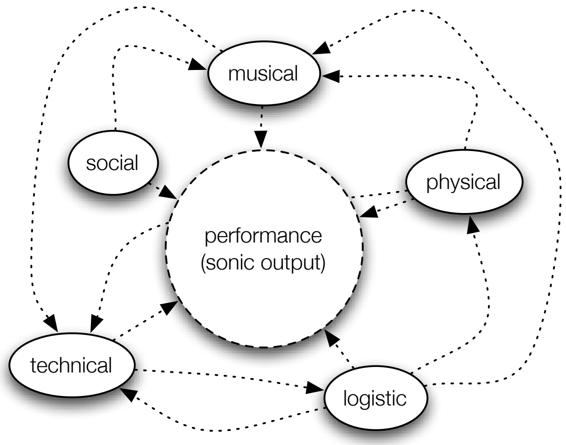
evolution with a fitness function



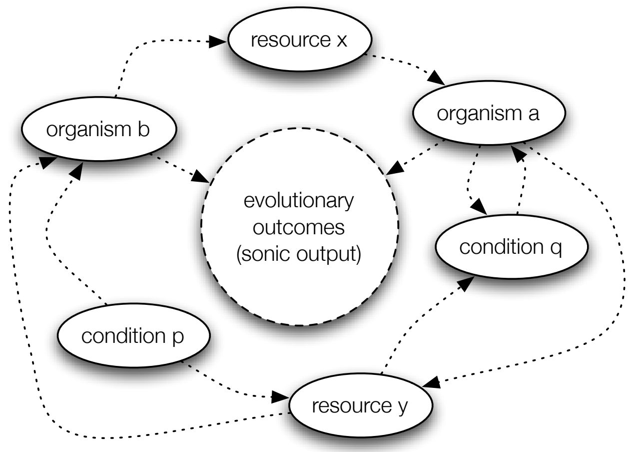
- outcome is largely influenced by predetermined factors

ecosystemic

Hypothetical network of relations between components of a performance situation that affect sonic outcomes



Hypothetical network of relations between ecosystem components that influence evolutionary outcomes

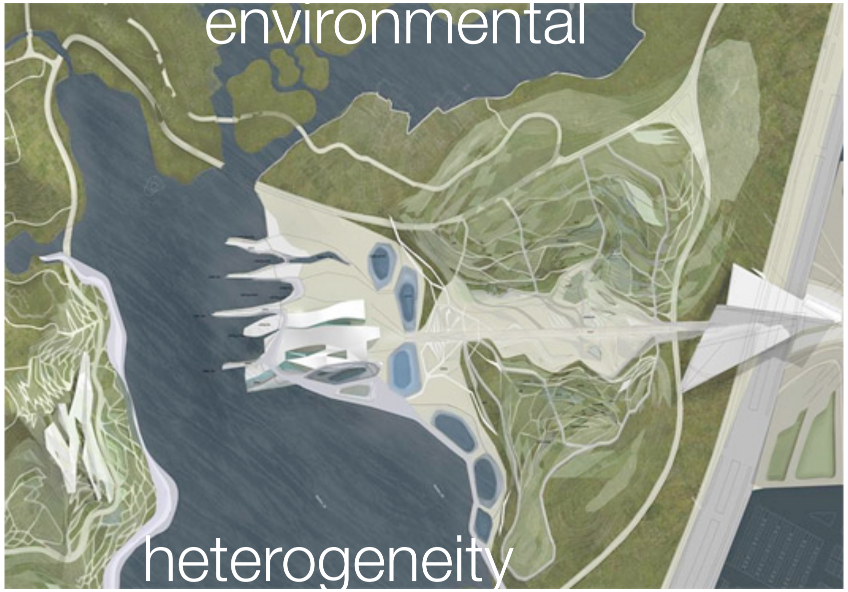


- outcome is contingent upon the interacting components and emerges at run/play time

>> how could diversity (synchronic and diachronic) be maximised within an evolutionary ecosystemic approach ?

inspiration

evolving diversity



competitive

co-evolution

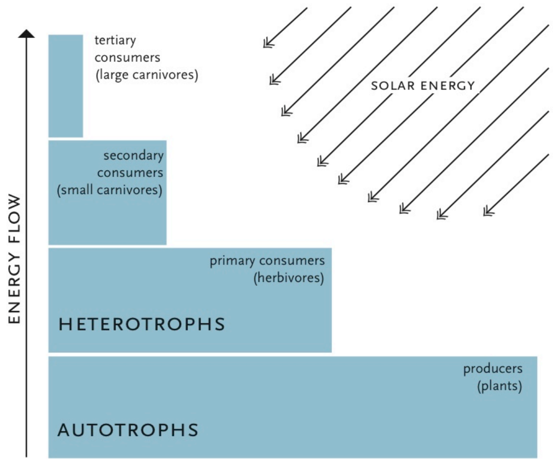
>> how could we promote the evolution of cooperative interactions ?

energy recycling and cooperative interactions

An energy model provides a natural means of implicit fitness assessment.

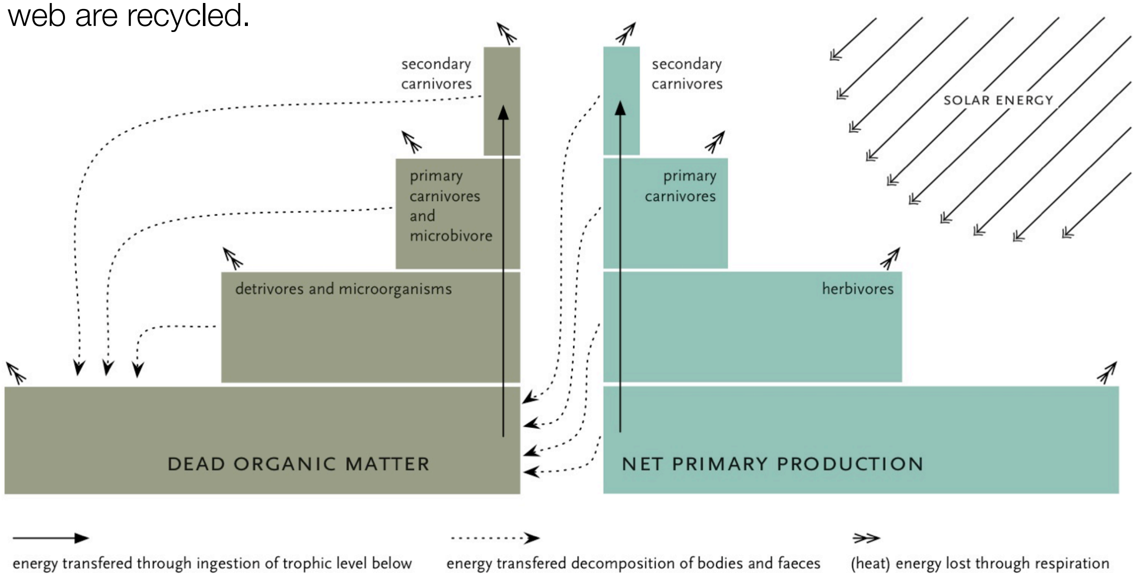
Standard agent-based approaches tend to model the flow of energy up through the trophic levels of the grazer system.

This supports competitive interactions as organisms battle for resources.



Energy flow through the grazer system

In real world ecosystems, the grazer system is coupled to a decomposer system through which the bodies and faeces of all organisms in the food web are recycled.



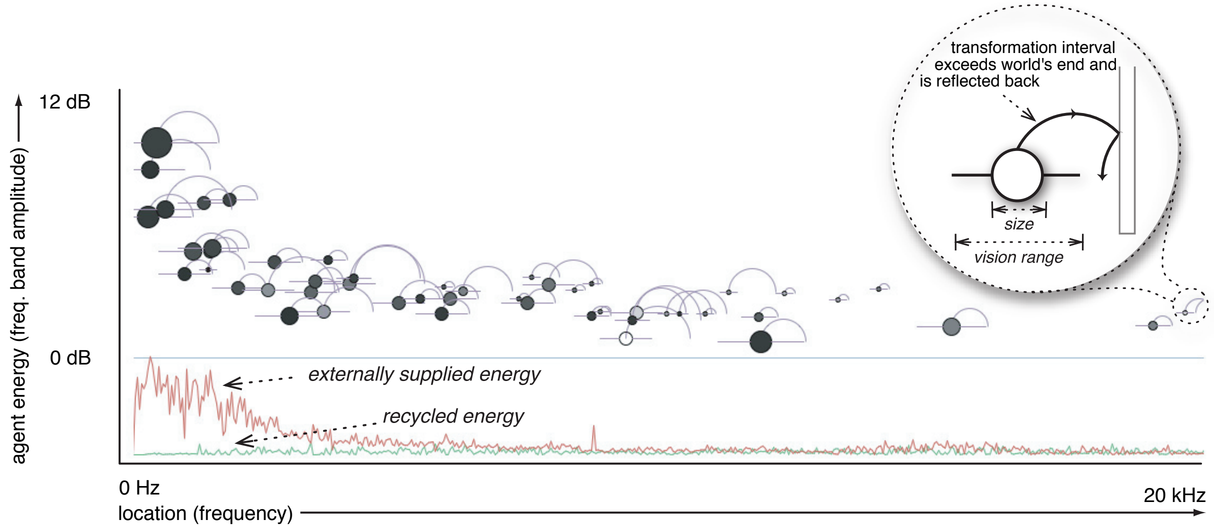
Energy flow through the coupled grazer and decomposer systems

>> Could an energy model incorporating recycling support cooperative interactions ?

model

Filterscape

An evolving population of agents traverses a spectral filter, extracting energy from one band and depositing it in another



spectral filter

Resources are supplied externally either a) uniformly or b) non-uniformly. Unused resources accrue.

Agents are specified by:

- **size** (determines metabolic rate and vision range)
- **transformation interval** (determines location of recycled deposit relative to current position)

and initialised with an energy endowment, E.

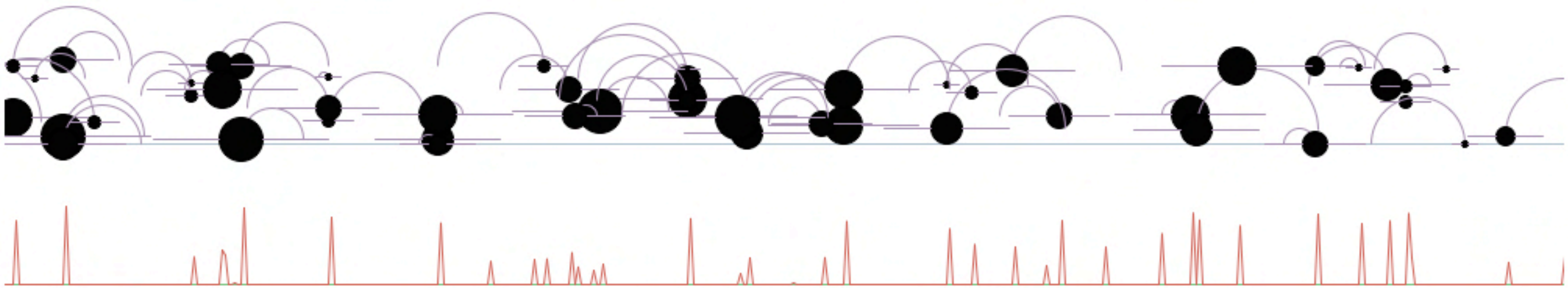
Agents survive by navigating to and consuming resources of either type.

- 50% of the resources at current location are converted into internal energy.
- movement has a energetic cost in proportion to distance.
- a metabolic living cost is imposed according to size.
- a fraction of this waste energy is redeposited at the location specified by the transformation interval.

Haploid A-sexual reproduction occurs when an agent's energy levels exceed E by X%.

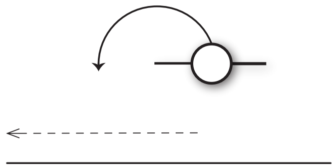
- 50% of the parent's energy is given to the child. Size and transformation interval are creep mutated.

Death occurs when an agent's energy level reaches zero.



evolved strategies

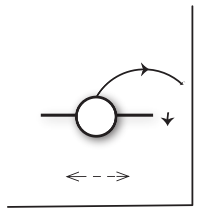
glide



Agents traverse space gathering resources.

Sonically:
Creates continuous frequency sweeps as agents move up and down the filter.

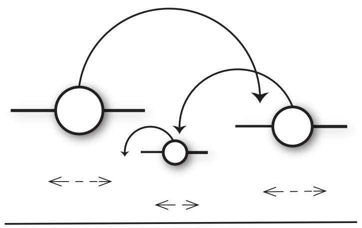
loiter



Agents loiter at an edge and re-gather recycled resourced that are reflected at the edge of the bounded world.

Sonically:
Creates a quiet drone (whilst loitering) followed by either silence, or a large sweep up or down the frequencies (during population explosion).

cluster



Agents form **mutualistic** clusters, taking up each other's recycled resources.

Sonically:
Creates spectral clusters that drift through frequency space.

- Without recycling, only gliding behaviour is observed.

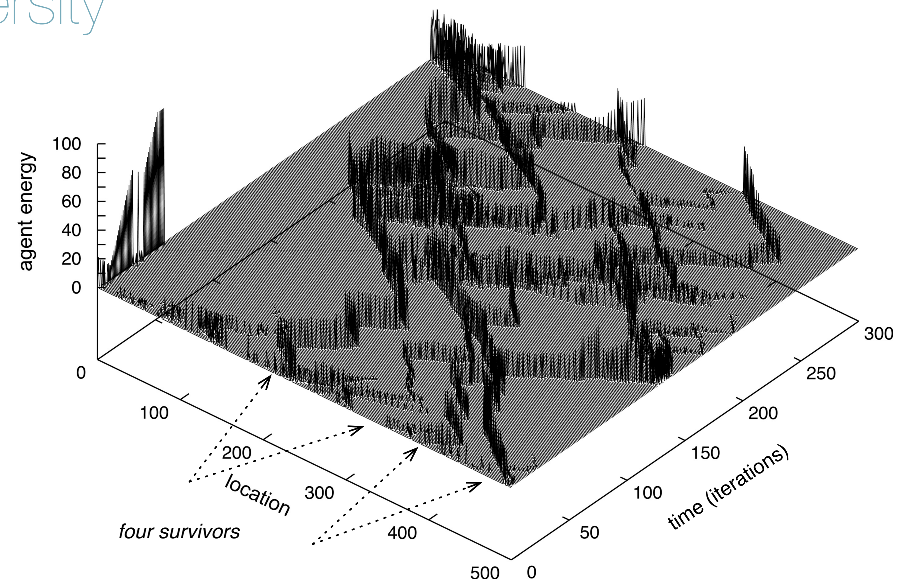
- Loitering and clustering are unstable and are influenced by the distribution of resources in the world.

>> How does resource distribution affect the viability of each strategy ?

heterogeneity and spatial diversity

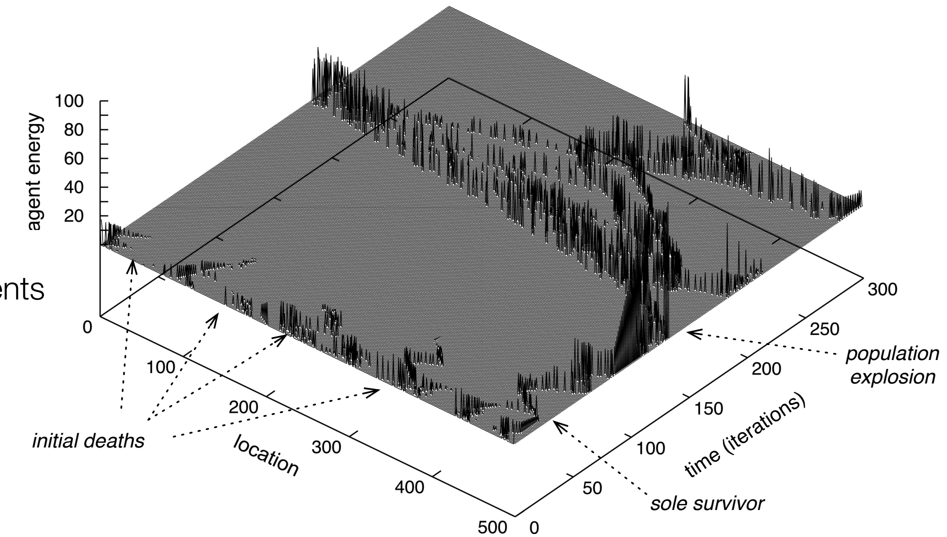
Uniform resource distribution

- Gliding strategy is prevalent.
- Populations move smoothly back and forth in space



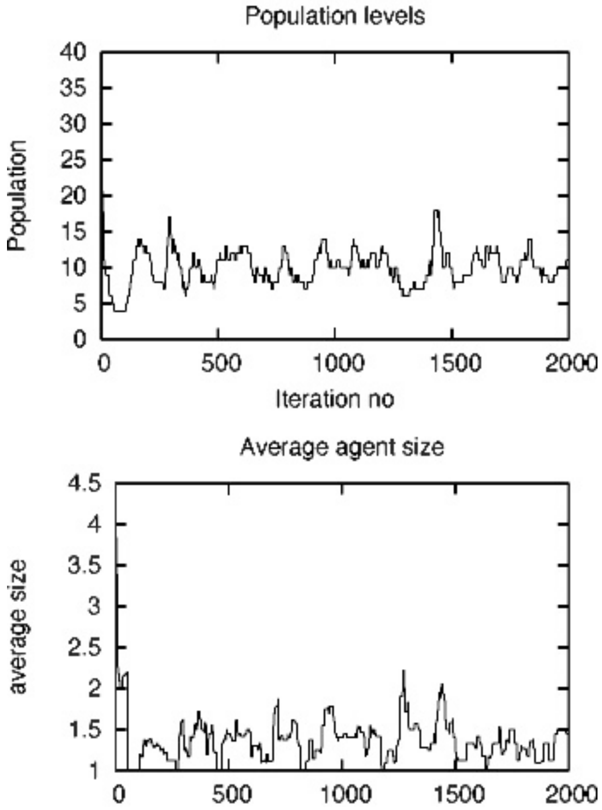
Non-uniform resource distribution

- All three strategies evolve.
- Loitering behaviour produces large spatial movements

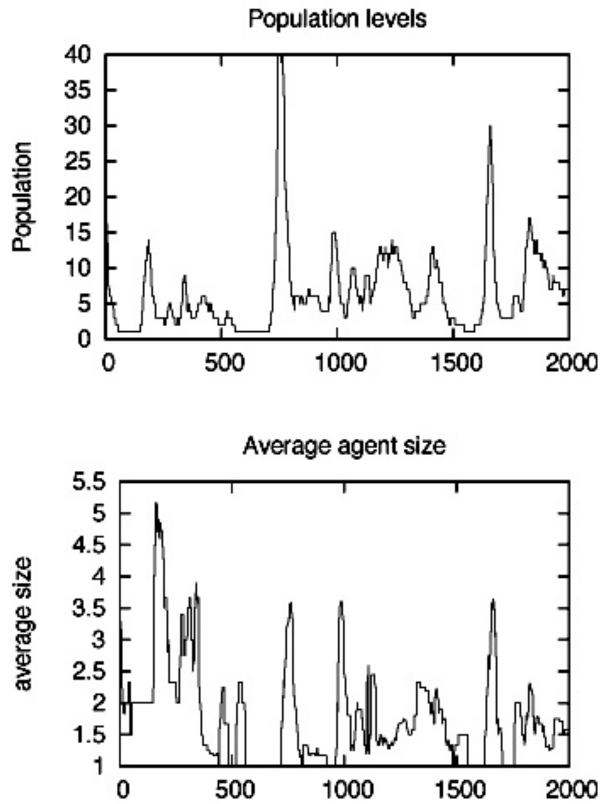


The non-uniform resource distribution promotes diversity in survival strategy, creating greater movement spatially.

heterogeneity and population diversity



Uniform resource distribution



Non-uniform resource distribution

The survival strategies that evolve under a non-uniform resource distribution generate greater variation in population levels and agent size, creating diversity in sonic dynamics at the meso and macro levels.

summary

Filterscape illustrates how energy recycling can increase synchronic diversity in a sonic ecosystem.

Experimental manipulation of resource allocation demonstrates how the appearance of these strategies can be selectively influenced by altering basic structural properties of the world.

These results support the hypothesis that heterogenous environments can support a wider range of dynamics than homogenous spaces.

future work

Here, incoming and recycled energy types are equivalent.

The next step is to differentiate between incoming and recycled energy and introduce a variety of resource types.

Sonically this would mean constraining agent's nutritional requirements to specific frequency bands, or samples with distinct spectro-morphological signatures.

conclusion

Ecosystemic metaphors are increasingly influential in electronic arts.
Energy recycling is a fertile route for those interested in developing diversity in evolutionary music and art

>> questions ?