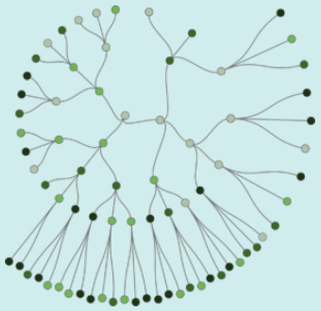
The Sound of Decentralization

Sonifying Computational Intelligence in Sharing Economies



‘desoundralization’ concerns the **sonification** of complex data that exhibit **decentralized computational intelligence**

Questions

display

sonify systems that are too complex or non-intuitive for mainstream thinking, so that they become ’meaningful’ for both specialists and the general public?

compare

demonstrate alternative design patterns for computational intelligence in data-intensive decentralised systems

speculate

probe data-sets and their embedded infrastructure when the latter is largely unknown or too complex/large to be known

foreground

aestheticize attributes that are highly relevant to intelligent decentralized systems (e.g. robustness, scalability, privacy-by-design, fault tolerance, fairness)

I-EPOS

Iterative Economic Planning and Optimized Selections

decentralized

fully decentralized combinatorial optimization deployed over crowdsourced IoT devices

intelligent

agents are structured in self-organized tree topologies over which they perform a bottom-up and top-down networked data-exchange

economic

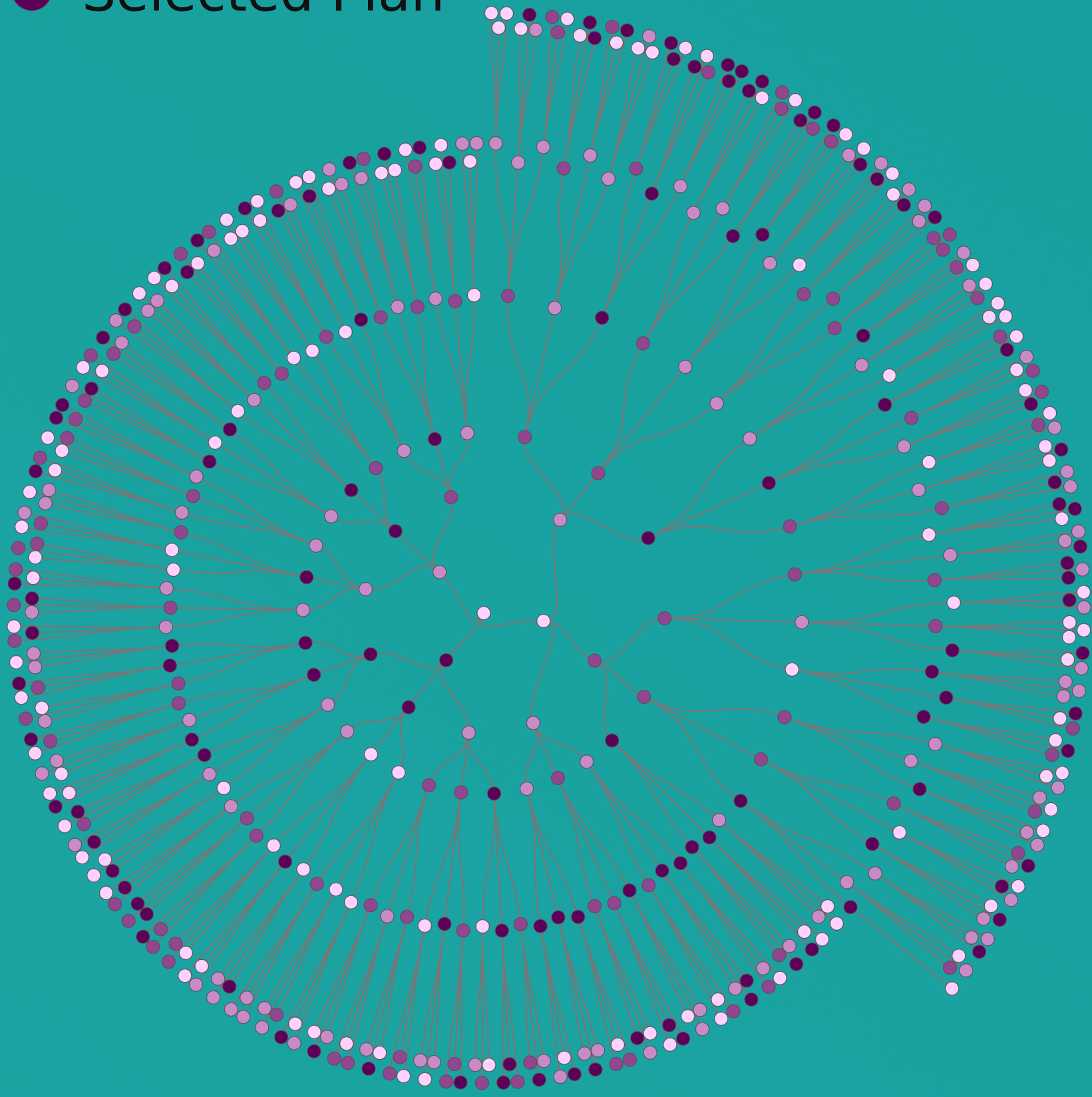
flexible and autonomous scheduling of resources bringing local and global costs in balance

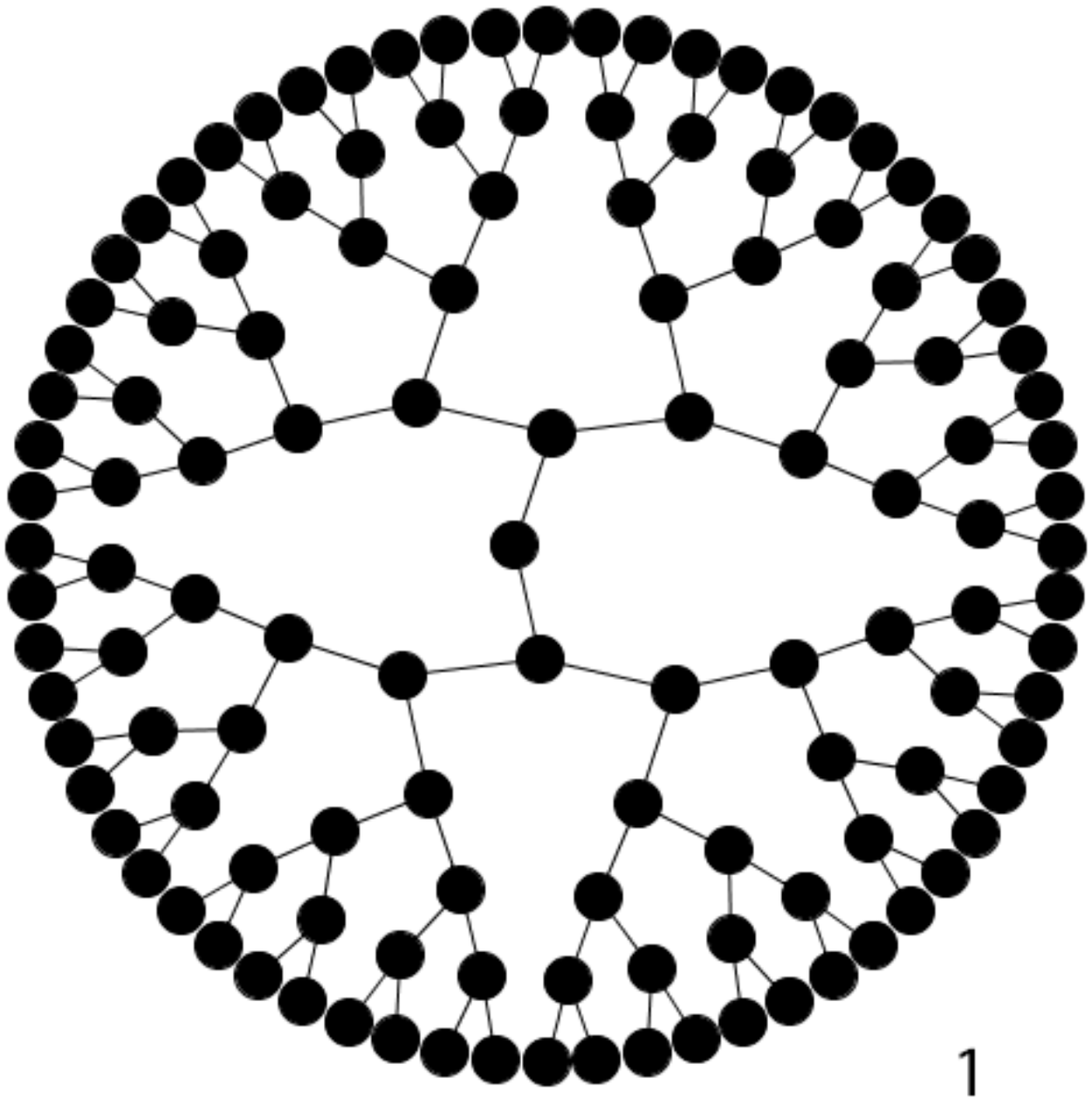
non-intrusive

addresses or eschews issues of trust, privacy-intrusion, surveillance, discrimination and undermining of autonomy

1 2 3 4

Selected Plan

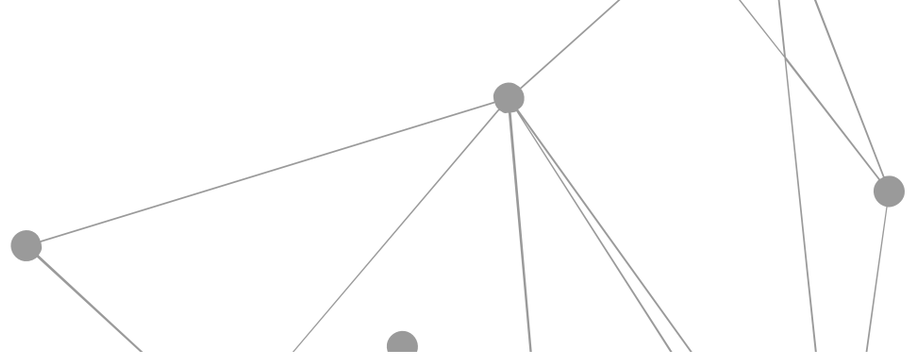


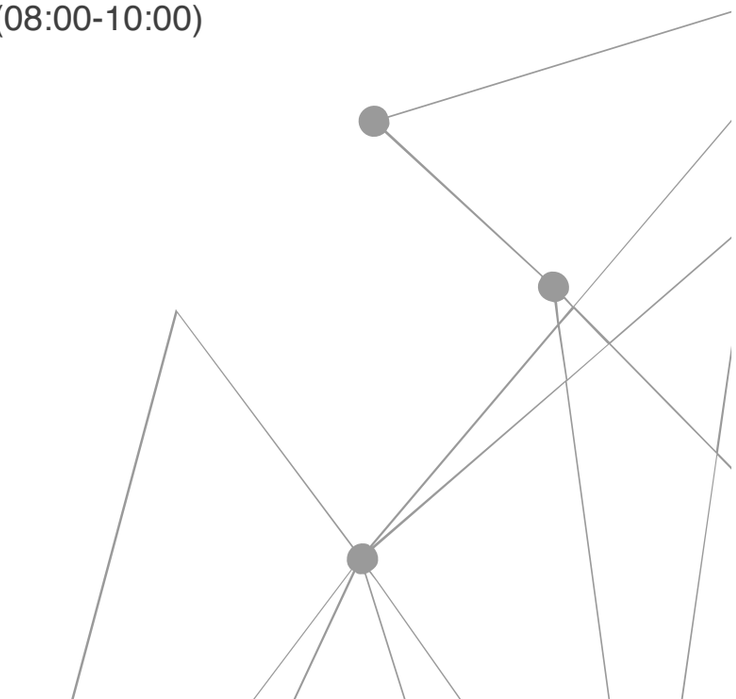


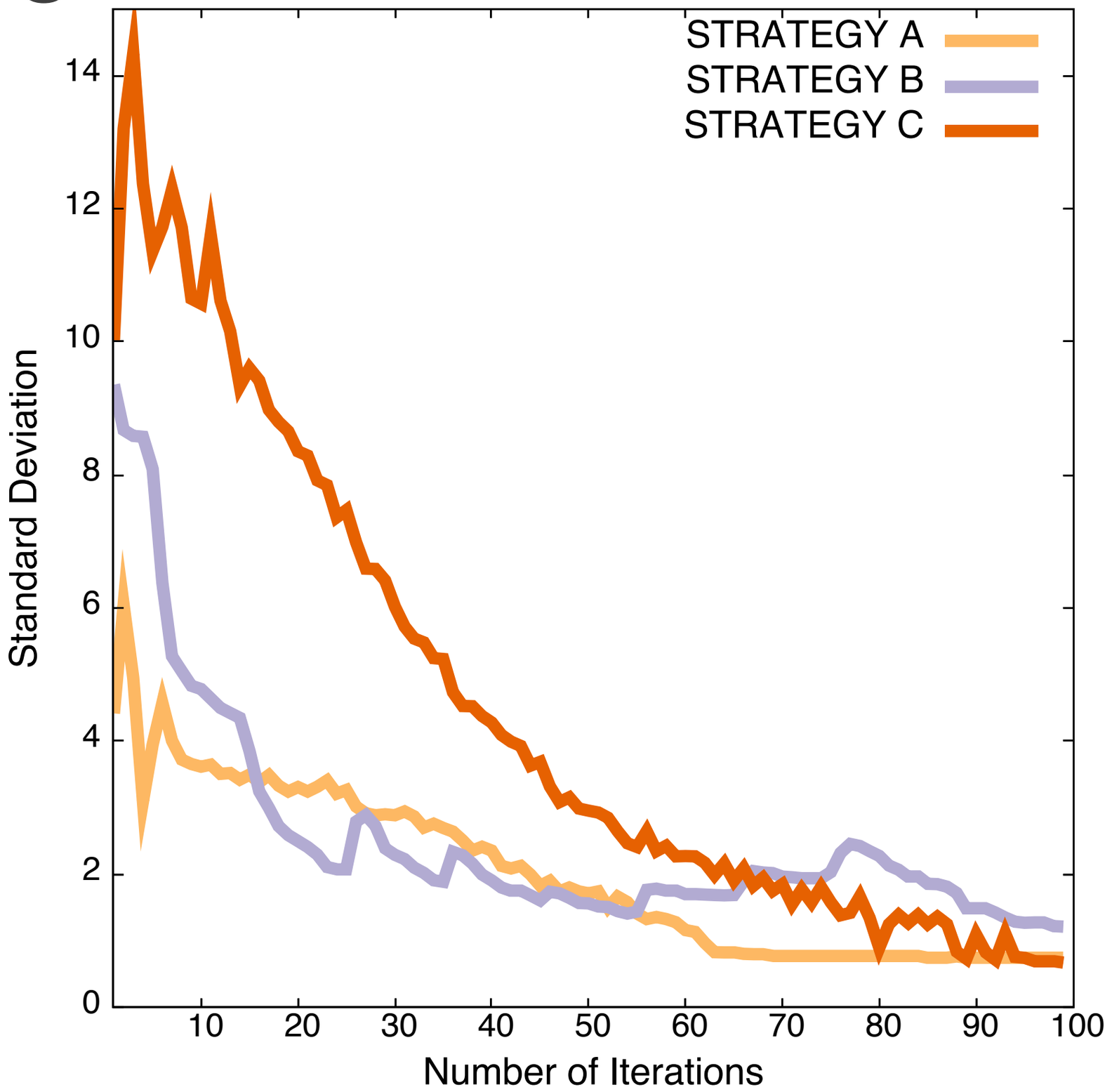
Bike Sharing

Hubway Data Visualization Challenge

concerning trips from 1000 extracted unique users recorded for the Hubway bicycle sharing system in Paris and showing the available bicycle stations at a two-hour morning time slot (08:00-10:00)



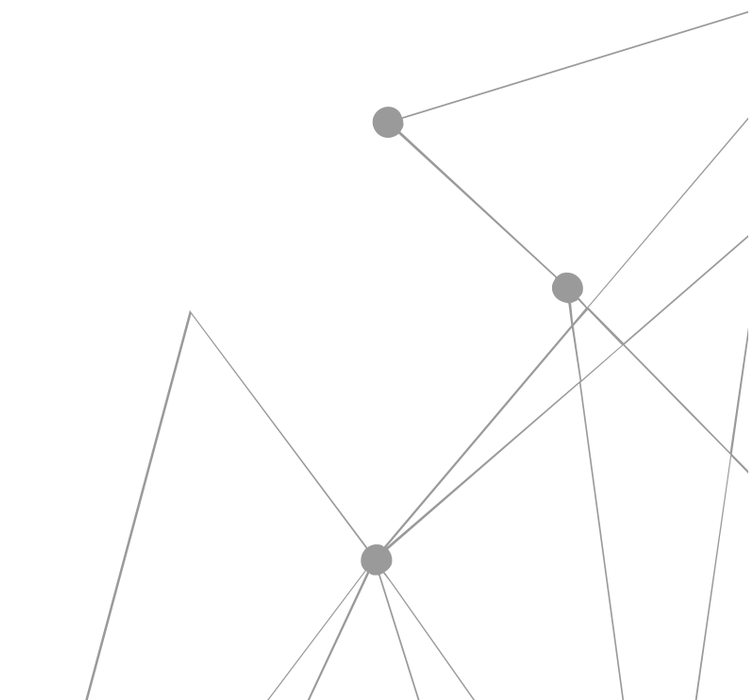


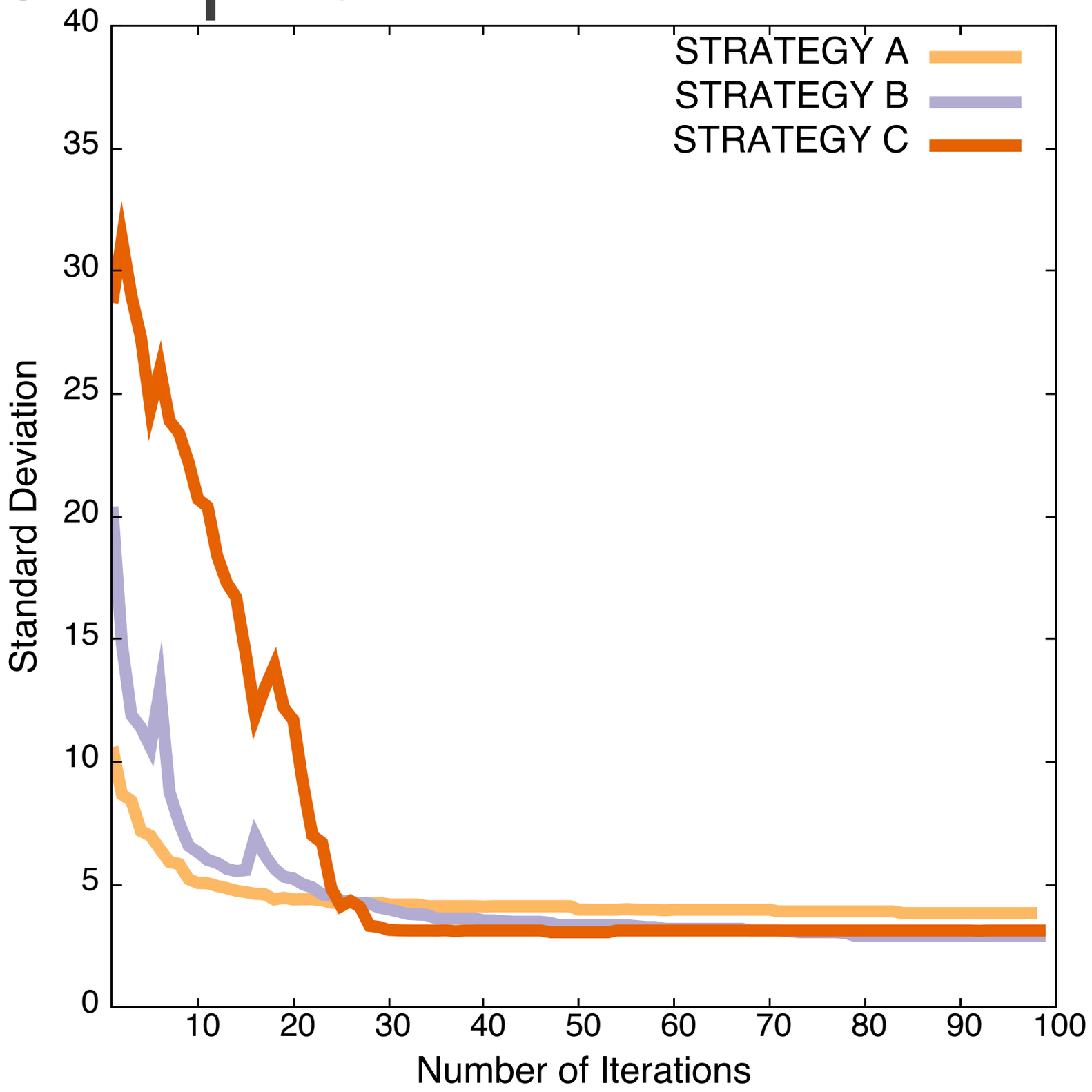


Power Consumption

PNW Smart Grid Demonstration Project

concerning the energy consumption in a series of Pacific Northwest states for the period 23.07.2014, 01:00-12:00, from 493 households with 4 generated plans per agent to choose from





Output data & Strategies

Selected plans-local

the globally optimum plans locally selected by the I-EPOS agents at every iteration

Standard deviation-global

the global evaluation criterion at every iteration, also used as a local minimization criterion in the fitness functions of the agents

Aggregate plans-global

the aggregate, computed by summation, of all selected plans at each iteration

Incentive signal-global

the computed cost signal at every iteration used in the fitness function of the optimization process

Strategy A

agents with a high total number of plans and high standard deviation in the plans are placed on top - agents use all their plans throughout the learning process and perform decision-making with a fitness function expressed with standard gradient descent

Strategy B

agents with a lower number of plans and higher standard deviation are placed on top - their fitness function is expressed in standard gradient descent by considering two plans and adding one more every 10 iterations

Strategy C

agents are randomly placed in the tree topology - they learn with their fitness function ex- pressed in the adam gradiend descent

Sonification as Material Speculation

Our approach to Sonification

has been largely driven by pragmatic and ad-hoc experimentation

aims at results that are simultaneously informative, aesthetically intriguing and effective as means to probe complex, maybe even unknown or unidentified content

entails testing and evaluating different mapping schemata and audio synthesis strategies in order to reveal and to aestheticize complex aspects of the decentralized design and emergent intra/inter-dependencies between localized data

In this way

there is an analogy with well-standardized improvised composition practices that typically concern unique and situated pieces of music meant to be performed in some particular context

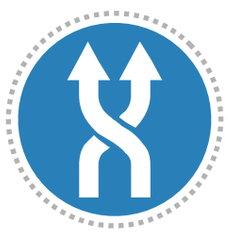
we achieve a certain contextual and material specificity that is relevant to particular decentralized systems and the data they generate

this element of material specificity becomes of paramount importance so that our overall practice could be thought of as a way to speculate about the data under scrutiny

A brief overview of our experiments

generators in parallel

Bike data controlling complex audio generators producing sustained noisy textures in parallel



little (if any) insight

the transition from one iteration to the other is largely unnoticed and no particular change occurs as the data progress to its eventual convergence - the complex inter-dependencies enacted by the coordinated action of hundreds of localized agents are not accounted for

examine the data

mostly zeros with the occasional appearance of ±1 or ±2 scattered across 1000 nodes

granular synthesis

we try percussive sounds arranged in complex configurations of varying density with respect to the localized data

rhythm

the structure of the dataset suggests an intrinsic ‘rythmicity’ that needs to be aestheticized in order to represent the peer-to-peer relationships between the various autonomous agents

complexity emerges

a series of simultaneous inter-dependent evolving ‘rhythms’ between the localized data and their system-wide quantified effects are revealed albeit not effectively accounted for

fine-tuning

we experiment with different granular synthesis generators and mapping schemata trying to phenomenologically articulate the way local and global features of the system interrelate and inter-depend

energy data

inspired by the oscillating nature of a/c current we attempt to map the Energy data to numerous simultaneously sounding sine-wave oscillators

failure

we only get semi-periodic oscillations between the very same timbres

examine the data

floating point numbers that seem arbitrarily volatile but largely oscillate around certain fixed attractors

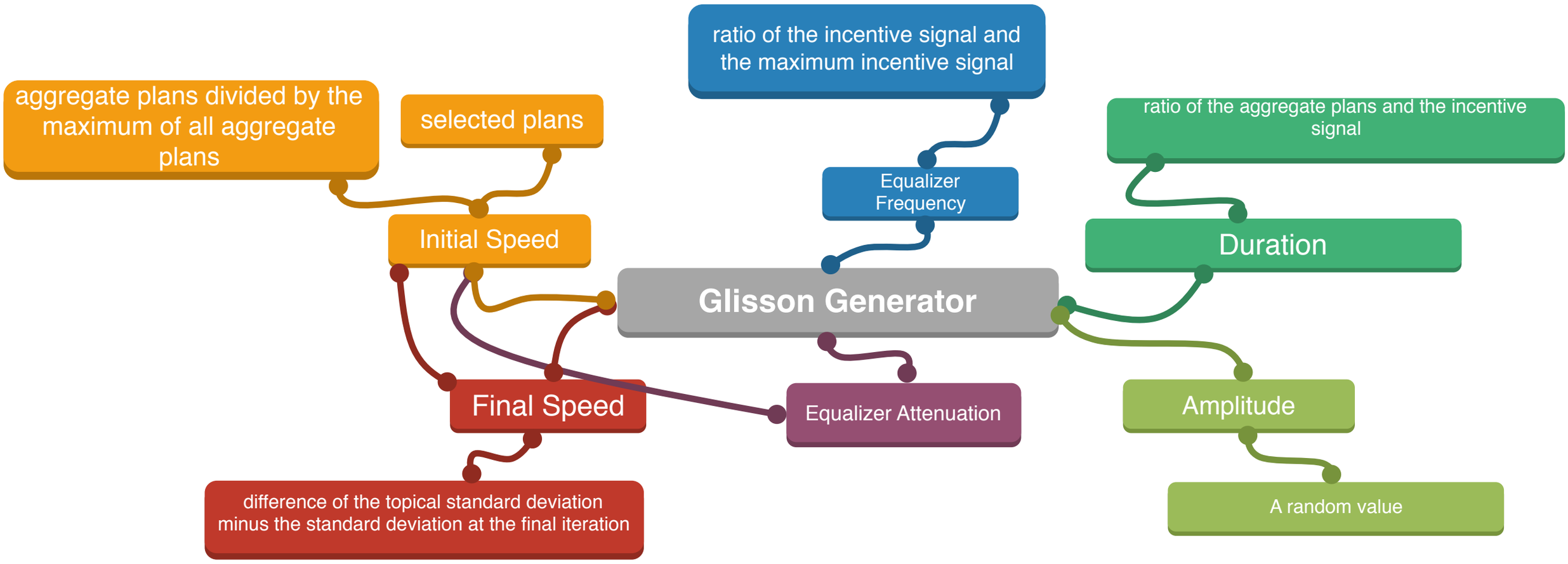
experiment

more experiments - all largely result in semi-periodic textures—a strong indication that the variance and volatility of the localized data is rather limited

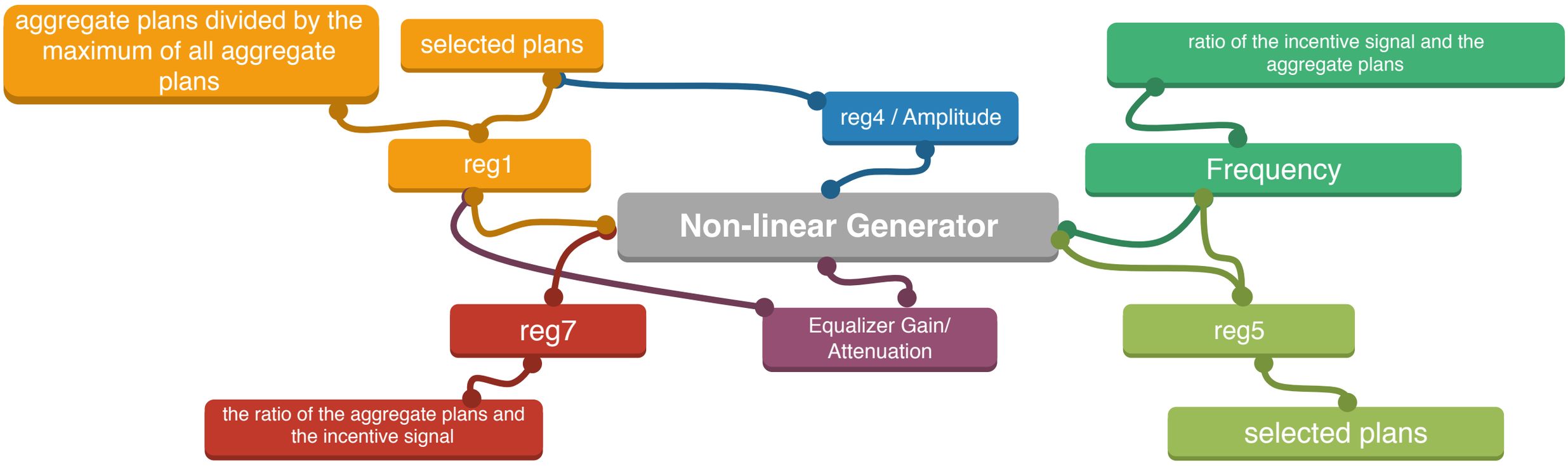
non-linearity

we successfully try complex and non-linear generators that would accentuate subtle changes and occasionally behave in an unpredictable fashion, in this way properly representing all stable, bi-stable and divergent states of the system

Bicycle Data



Energy Data


aggregate plans divided by the maximum of all aggregate plans
selected plans
reg1
reg4 / Amplitude
Non-linear Generator
reg7
Equalizer Gain/ Attenuation
the ratio of the aggregate plans and the incentive signal
ratio of the incentive signal and the aggregate plans
Frequency
reg5
selected plans

Global Mappings

spatial image

the sonic image gradually progresses from monophony to a wide sonic image (stereo or multichannel) with respect to the number of elapsed iterations

speed

the overall speed is calculated as a fraction of the difference between the standard deviation of the last iteration and that of the current, so that the whole system becomes progressively slower (or faster, if desired)

Results

aestheticize

we can delineate the complexities of decentralized systems as manifested both microscopically and macroscopically, bring forth the most important micro-modulations at play, speculate on the importance of certain attributes and present our findings in a very straightforward phenomenological fashion that also holds artistic merit

probe

employing ratios and other mathematical formulas owe can both sustain the complex nexi of micro-modulations that give rise to certain phenomena, as well as to examine particular properties and how they interrelate with macroscopic attributes of the system under scrutiny

understand

it may be impossible for non-specialists to fully understand the deeper implications of such systems, yet, it is becomes possible for both experts and the general public to appreciate the various processes at play in their proper granularity and, to immediately perceive how the overall convergence of the system translates to microscopic modulations in the locally-generated data and vice-versa

Future Research

interactive

we intent to sonify interactive decentralized systems where users/audiences are able to select local plans at will and with respect to some feedback on system-wide state

real-time

we intent to sonify decentralized systems in real time so that the at any given time the audio is evocative of the various micro-modulations at play and they immediate (or possibly future) system-wide effects

multi-media

we intent to experiment with the simultaneous mapping of data to a series of modalities, such as light, image and audio, in order to better delineate properties of the system that pure sonification might fail to represent

Thank You

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