A *Virtual* Guide to the Makam Universe

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Extended Abstract

Music theory scholars have long sought to understand the harmonic connections within different musical structures. Visual models of pitch-set relationships have emerged as a useful tool in this pursuit, offering a panoramic perspective that allows for a holistic view of the musical universe. In particular, network models can reveal previously unrecognized pathways within the web of harmonious relations, offering a broader understanding of the underlying connections and patterns that govern musical composition.

One famous example of such a model is the tone-network "tonnetz" proposed by Leonhard Euler in the 18th century. This model later became the foundational framework for many theoreticians, including Hugo Riemann, who demonstrated his principles of harmonic motion and transformational models in the 19th century through the conceptual basis provided by the "tonnetz." Similar representations can be found in the theoretical corpus of Turkish makam music, such as Kemani Hızır Ağa's overlooked treatise *Tefhimü'l Makâmât fi Tevlidi'n Nagâmât* or 'Explanation of Makams in the Generation of Melodies' from the 18th century. In this treatise, one can see the linking of *perde* and makam structures as well as their inter-relationships with other systems.

This presentation will present a virtual model for mapping the makams universes of Turkish music according to their harmonic relations, that is, according to their common and/or related substructures. Through interactive algorithmic applications, this virtual cartography illustrates the harmonic relationships between the various makam constellations and reveals all the possible pathways that allow transitioning from one makam to another. The network model presented here is in some ways similar to what Abu Shumays proposed in his 2013 article "Maqam Analysis: A Primer," but goes further by recognizing and including various relationships, transformations and topographies between different substructures. After reviewing some basic concepts and terminology, the first part of the presentation will explain the methodology of determining the relationships between various makam systems. Here we will present common

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nuclear elements and certain relationship principles that mutate such elements, creating alternative bridges with other makam systems.

In a nutshell, the primary material of makam is *perde* (pl. *perdeler*), which in some cases can refer to a specific frequency – as in Western notion of pitch -, or can encompass a range of frequencies that can vary according to the makam it is used in and its function in the melody. Thus a *perde* can be either stable or unstable (movable/dynamic) depending on the musical context. Stable *perdeler* possess melodic-axis qualities, either as a finalis, a reciting-tone (dominant), or a suspended cadence; all of which can be used as anchoring pivots while transforming larger tetrachordal structures. These modular building blocks of makam - similar to Greek *genus/genera* or Arabic *jins*/*ajna* - will be referred to as it is popularly used in Turkish; *çeşni* (meaning flavor).

The three main transformational categories (each having various subtypes) we would be proposing are (1) *Intraconnected*, including any displacement of the axis(s) and, therefore, the change or expansion/contraction of the *çeşni* structure to the 'neighboring' systems (as in $Rast^{Rast}$ to $Segâh^{Segâh}$, or $Nevâ^{Buselik}$ to $Hüseyni^{Kürdî}$); (2) *Transference*, in which the primary axis *perde* changes, but the *çeşni* structure remains the same (as in $Dügâh^{Buselik}$ to $Nevâ^{Buselik}$); and, (3) *Fixed-axis*, in which one or two of the axis *perde* remain constant while the *çeşni* structures change (as in $Dugâh^{Uşşak}$ to $Dugâh^{Sabâ}$ or to $Dugâh^{Hicaz}$…etc.). Through our research, we have discovered that pathways exist between different makam structures and, in certain cases, within a single makam depending on the specific melodic path (*initiation*, *development*, *closure*), or *seyir*, of each individual makam. In this respect, our model treats makam as specific progressions of $Perde^{Çeşni}$ structures.

In order to provide a more comprehensive understanding of such underlying connections, we have designed a single-page web application to showcase various *makam* and *çeşni* networks. The backend module of our application is developed using Python and the Django framework, and the transformational and relationship algorithms have also been written in Python to enable the visualization of nodes and edges in the frontend. For this model, a network graph proved to be an ideal solution. To create 2D and 3D force-directed network graphs, we have utilized the React framework, JavaScript, and the React-force-graph module. Using this virtual model, we are able to demonstrate different makam-spaces and neighboring constellations, build new *terkibs* (compound makams), and create hyperjumps to the ostensibly remote systems. We believe this work will offer a valuable tool for scholars, students and enthusiasts of makam music alike.

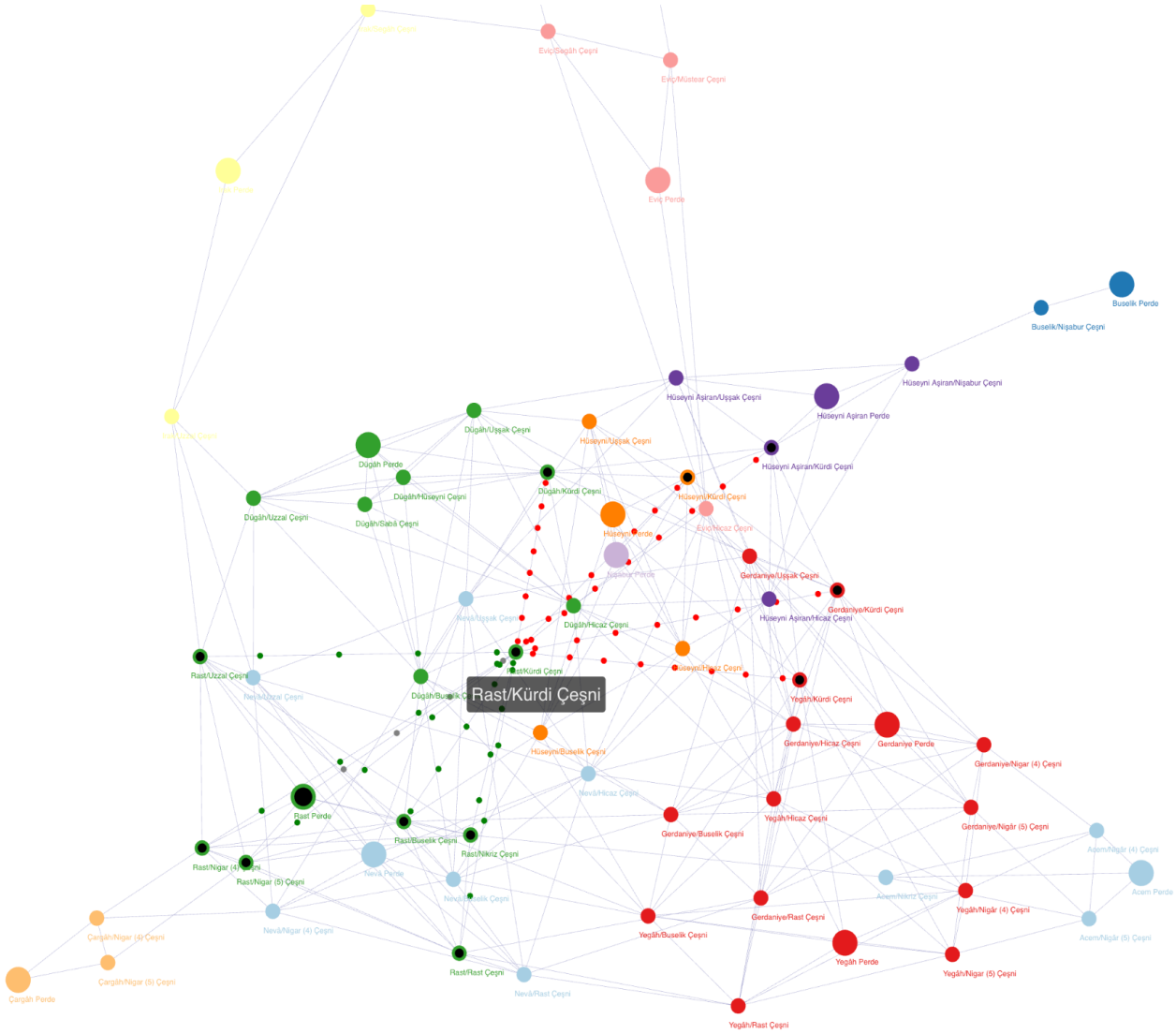

Figure: 2D Force Directed Çeşni Network (In-Development)