Network Modeling of Concert Programming Data

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Introduction

Orchestral concert programming involves selecting pieces to be performed, both for specific concerts and across an entire season.

An orchestra's artistic director must balance the length of works, the theme of concerts, the tone of pieces and audience demand; especially important as attendance is decreasing.

Goal and Contribution of this work is to use network models to explore which factors determine if specific composers are programmed together in the same concert.

To our knowledge, this is one of the first quantitative analyses of concert programming data.

Data and Methods

Data: Boston Symphony Orchestra concerts from 1999 to 2018

2464 unique concerts

Focus on composer level covariates:
- Year of birth
- Nationality by region
- Type of Piece

323 unique composers

Methods: data formatted as a directed network, where an edge indicates two composers performed in the same concert

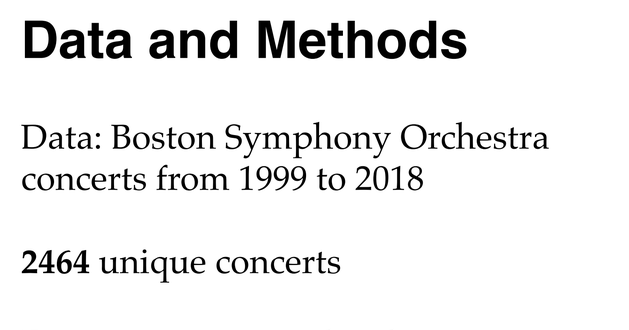

Figure 1: Top 20 composers represented in the data, colored by musical era. The majority of composers performed are from the Romantic or Modern eras.

Model

Probit social relations regression model with additive and multiplicative effects (AME)

Able to capture dyad and triad dependence

$Y_{ij} = 1$ if composer i performed before composer j in a concert

$$z_{ij} = \beta_r^T X_{ri} + \beta_c^T X_{ci} + a_i + b_j + u_i^T v_j + \epsilon_{ij}$$
$$Y_{ij} = \mathbf{1}(z_{ij} > 0)$$

$$\Sigma_{ab} = \begin{bmatrix} \sigma_a^2 & \sigma_{ab} \\ \sigma_{ab} & \sigma_b^2 \end{bmatrix}$$

$$(a_1, b_1), \ldots, (a_n, b_n) \overset{iid}{\sim} N(0, \Sigma_{ab})$$

$$\Sigma_\epsilon = \sigma_\epsilon^2 \begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix}$$

$$\{(\epsilon_{ij}, \epsilon_{ji}) : i \neq j\} \overset{iid}{\sim} N(0, \Sigma_\epsilon)$$

$$(u_1, v_1), \ldots, (u_n, v_n) \overset{iid}{\sim} N_R(0, \Psi)$$

Results

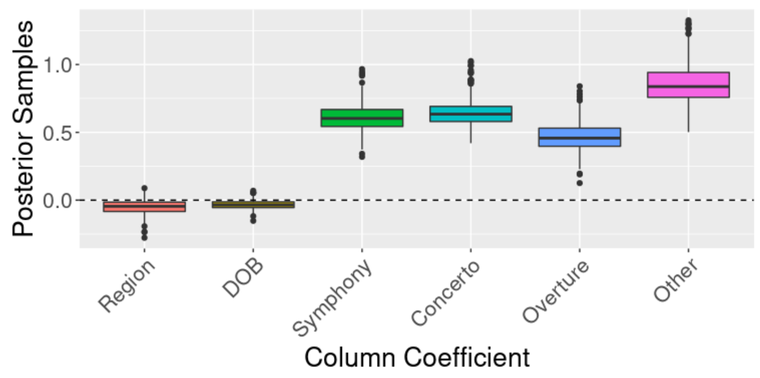

Figure 2: **Column Covariates** - The type of piece, which is highly correlated with piece length, is the most significant covariate in predicting which composers will be performed together.

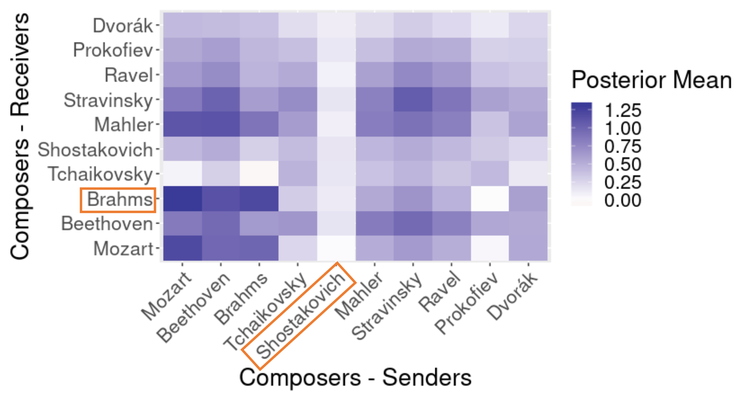

Figure 3: **Multiplicative Effects** - Shostakovich's works tend to be long and "heavy" in tone and are thus unlikely to be performed before other frequent composers. Brahms, however, has many shorter pieces that can be performed after most other composers.

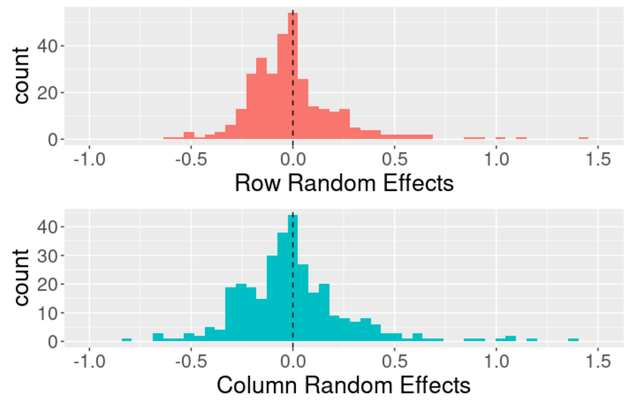

Figure 4: **Additive Random Effects** - Many contemporary composers have negative row and column posterior mean random effects, indicating that new pieces are usually only performed once.

Conclusions

The **type** of composition is the most important factor in determining which composers will be performed together.

Factors such as the style of the piece, reflected in the nationality of the composer and the DOB, appear less important.

Analysis confirms that many new works by contemporary composers are not performed again after the premiere.

Future Work

Including more composer and piece level covariates would allow for a more fine-grained analysis; e.g. type of piece is highly correlated with the length of the piece.

Considering dynamic network approaches would allow for an exploration of how trends have changed over time.

The addition of attendance or revenue data would allow for recommendations to be made in terms of how orchestral concert programming impacts attendance and revenue.

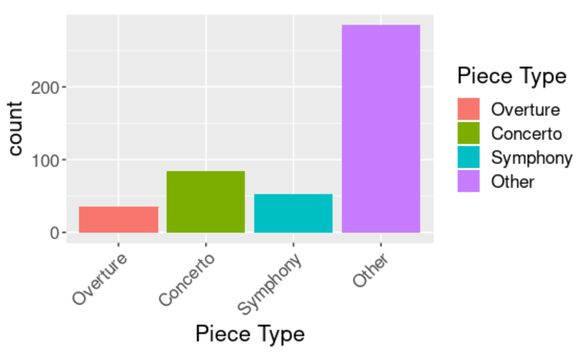

Figure 5: Piece type is a strong proxy for the length of a piece. More fine-grained information about the pieces, like information on length, could allow for a more precise analysis.

References

BSO Archives: https://archives.bso.org/

Peter D. Hoff. Additive and Multiplicative Effects Network Models. *CorRR*, abs/1807.08038, 2018.

Acknowledgements

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https://aky4wn.github.io/