

Music Arrangement via Quantum Annealing

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15th January 2025

Durham University

2025-01-15

Music Arrangement via Quantum Annealing

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- Theory
 - Arrangement
 - Quantum annealing
- Methods
- Results
- Conclusions

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Music Arrangement via Quantum Annealing

└ Overview

- Theory
 - Arrangement
 - Quantum annealing
- Methods
- Results
- Conclusions

What is flux?

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What is flux?

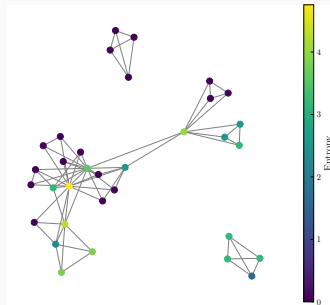
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└ Theory

Theory

Theory



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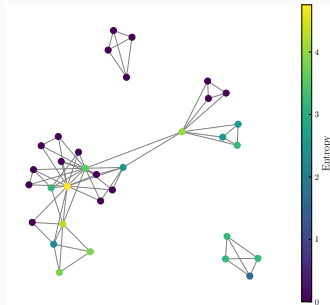
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Music Arrangement via Quantum Annealing

- └ Theory
 - └ Quantum annealing
 - └ Column layout



- Net flux of liquid is zero



Source: Wikimedia Commons

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- └ Theory
 - └ Quantum annealing
 - └ Column layout

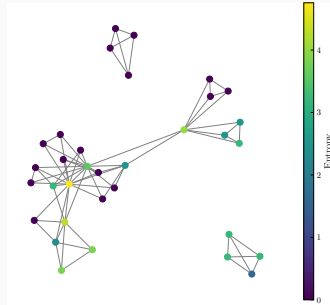
Column layout

- Net flux of liquid is zero



Source: Wikimedia Commons

- Net flux of liquid is zero
- Sources provide net outwards flow



Source: Wikimedia Commons

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- └ Theory
 - └ Quantum annealing
 - └ Column layout

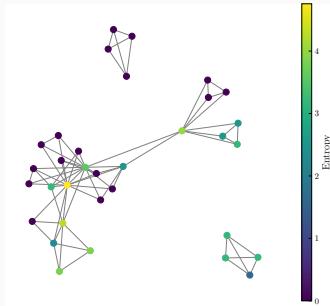
Column layout

- Net flux of liquid is zero
- Sources provide net outwards flow



Source: Wikimedia Commons

- Net flux of liquid is zero
- Sources provide net outwards flow
- Sinks provide net inwards flow



Source: Wikimedia Commons

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- └ Theory
 - └ Quantum annealing
 - └ Column layout

Column layout

- Net flux of liquid is zero
- Sources provide net outwards flow
- Sinks provide net inwards flow



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Methods



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Results



$$\oiint_A \mathbf{E} \cdot d\mathbf{A} = \frac{Q}{\epsilon_0}$$

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└─Results

└─Blocks

$$\oiint_A \mathbf{E} \cdot d\mathbf{A} = \frac{Q}{\epsilon_0}$$

$$\oiint_A \mathbf{E} \cdot d\mathbf{A} = \frac{Q}{\epsilon_0}$$

The *net electric flux* through any **closed** surface is proportional to the **enclosed charge**.

Alert

This is an alert.

Example

This is an example.

$$\oiint_A \mathbf{E} \cdot d\mathbf{A} = \frac{Q}{\epsilon_0}$$

The *net electric flux* through any **closed** surface is proportional to the **enclosed charge**.

Alert
This is an alert.

Example
This is an example.

Equation alignment

$$F = -\frac{GMm}{r^2}$$

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└ Results

└ Equation alignment

Equation alignment

$$F = -\frac{GMm}{r^2}$$

Equation alignment

$$F = -\frac{GMm}{r^2}$$
$$g = -\frac{GM}{r^2}$$

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└ Results

└ Equation alignment

Equation alignment

$$F = -\frac{GMm}{r^2}$$
$$g = -\frac{GM}{r^2}$$

Equation alignment

$$F = -\frac{GMm}{r^2}$$

$$g = -\frac{GM}{r^2}$$

$$g \cdot 4\pi r^2 = -4\pi GM$$

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└ Results

└ Equation alignment

Equation alignment

$$\begin{aligned} F &= -\frac{GMm}{r^2} \\ g &= -\frac{GM}{r^2} \\ g \cdot 4\pi r^2 &= -4\pi GM \end{aligned}$$

Equation alignment

$$F = -\frac{GMm}{r^2}$$

$$g = -\frac{GM}{r^2}$$

$$g \cdot 4\pi r^2 = -4\pi GM$$

$$g \oint\!\!\!\oint_A dA = -4\pi GM$$

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└ Results

└ Equation alignment

Equation alignment

$$\begin{aligned} F &= -\frac{GMm}{r^2} \\ g &= -\frac{GM}{r^2} \\ g \cdot 4\pi r^2 &= -4\pi GM \\ g \oint\!\!\!\oint_A dA &= -4\pi GM \end{aligned}$$

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Equation alignment

$$\oiint_A \mathbf{g} \cdot d\mathbf{A} = -4\pi GM$$

The gravitational flux through any closed surface is proportional to the enclosed mass.

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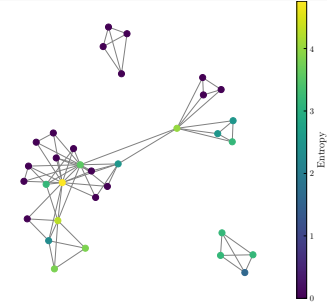
└ Results

└ Equation alignment

Equation alignment

$$\oiint_A \mathbf{g} \cdot d\mathbf{A} = -4\pi GM$$

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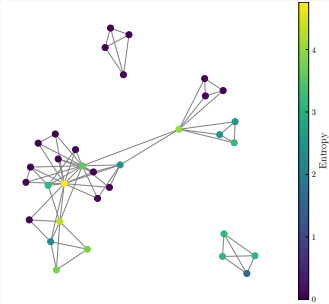
└ Results

└ Apperance sync



Source: Wikimedia Commons

- Volume rate of flow equal to divergence



Source: Wikimedia Commons

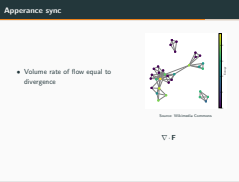
$$\nabla \cdot \mathbf{F}$$

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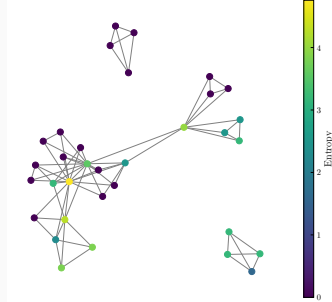
└ Results

└ Apperance sync



Apperance sync

- Volume rate of flow equal to divergence
- Summed over entire volume



Source: Wikimedia Commons

$$\iiint_V \nabla \cdot \mathbf{F} dV$$

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└ Results

└ Apperance sync

Apperance sync

- Volume rate of flow equal to divergence
- Summed over entire volume

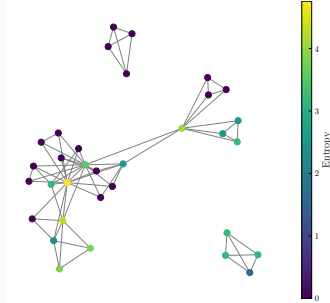


Source: Wikimedia Commons

$$\iiint_V \nabla \cdot \mathbf{F} dV$$

Apperance sync

- Volume rate of flow equal to divergence
- Summed over entire volume
- Equal to net flow across the boundary



Source: Wikimedia Commons

$$\iiint_V \nabla \cdot \mathbf{F} dV = \oiint_A \mathbf{F} \cdot d\mathbf{A}$$

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└ Results

└ Apperance sync

Apperance sync

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Source: Wikimedia Commons

$$\iiint_V \nabla \cdot \mathbf{F} dV = \oiint_A \mathbf{F} \cdot d\mathbf{A}$$

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Conclusions

Equation gather

$$\begin{aligned}\nabla \cdot \mathbf{E} &= \frac{\rho}{\varepsilon_0} \\ \nabla \cdot \mathbf{B} &= 0 \\ \nabla \times \mathbf{E} &= -\frac{\partial \mathbf{B}}{\partial t} \\ \nabla \times \mathbf{B} &= \frac{1}{c^2} \frac{\partial \mathbf{E}}{\partial t} + \mu_0 \mathbf{I}\end{aligned}$$

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└─ Conclusions

└─ Equation gather

Equation gather

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