

Experiments in musical similarity

hamish.allan@gold.ac.uk

What is musical similarity?

- Melodic
- Rhythmic
- Harmonic
- Timbral

What is musical similarity?

- Chronological
- Artist
- Lyrical
- Cultural

What is musical similarity?

- Subjective
- Context-based
- Asymmetric
- Multi-resolution

Aspects of similarity

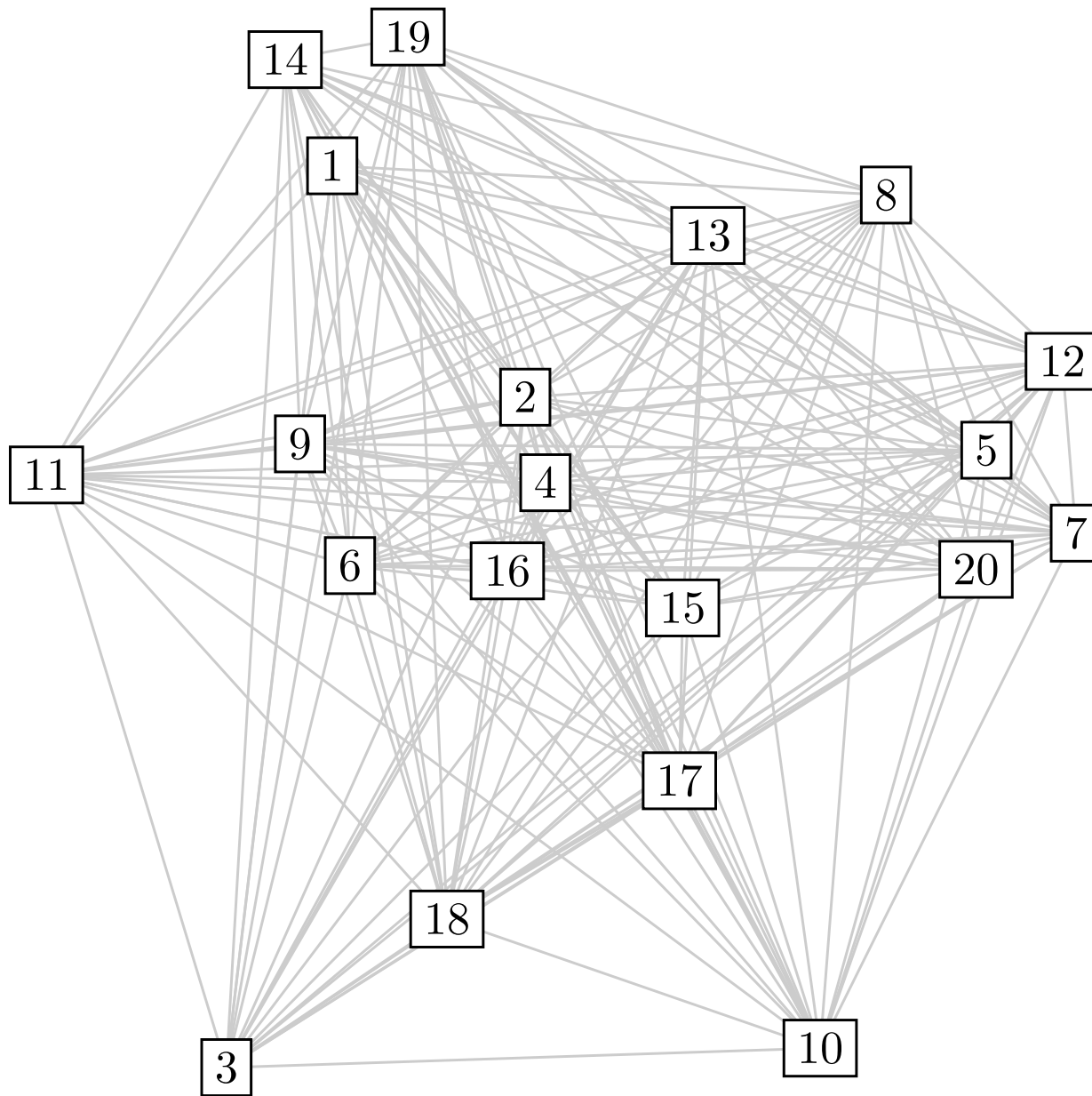
“These pieces of music are similar in a way that appeals to me. Find me music that is similar in the same way.”

- User does not need a musical vocabulary or even conscious awareness of what aspects they are interested in

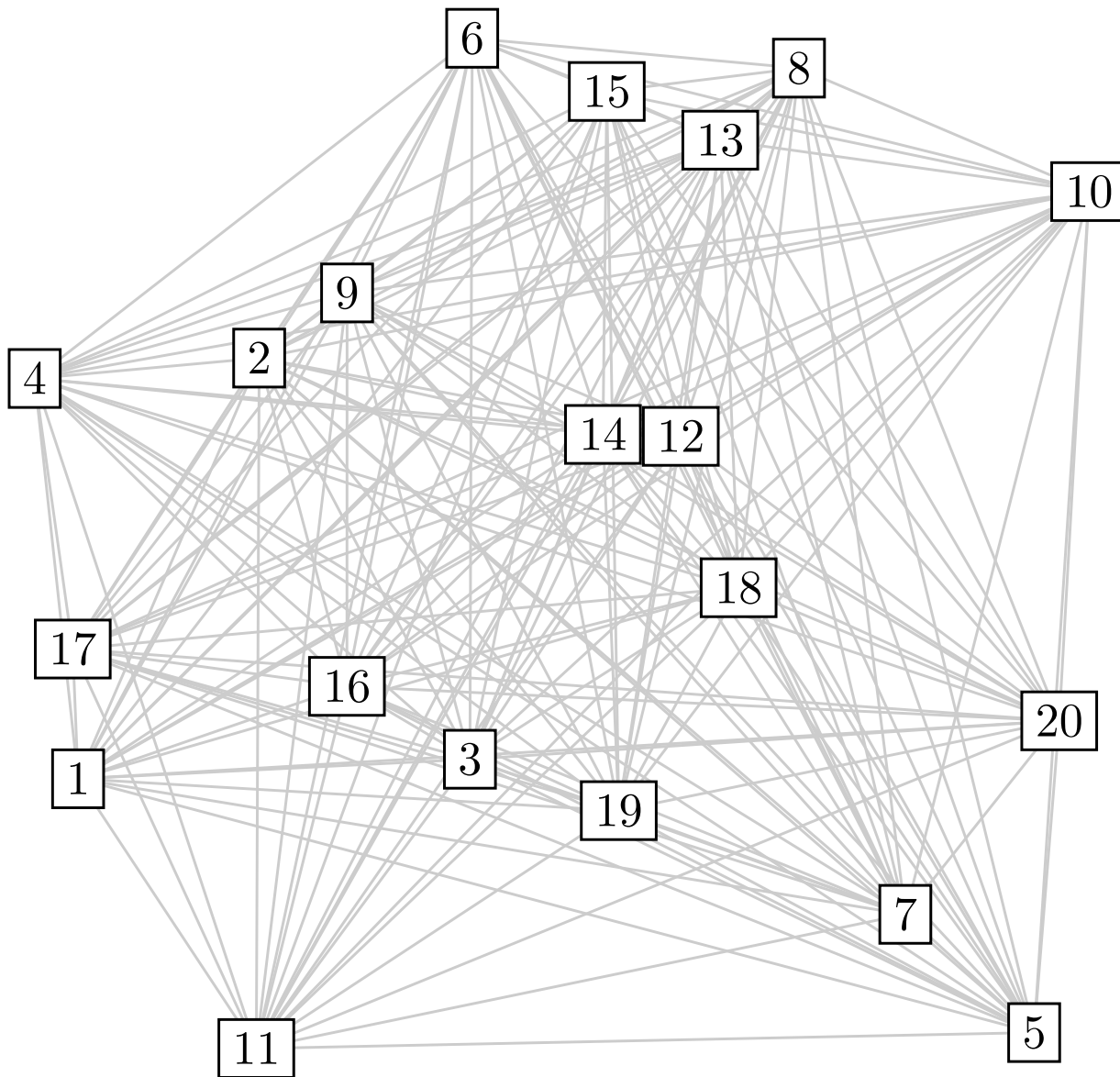
Combination of measures

- Assume existing perceptually valid similarity measures for various different aspects
- Try to achieve coverage for everything users might hear
- Reduced example: 20 excerpts, 4 measures

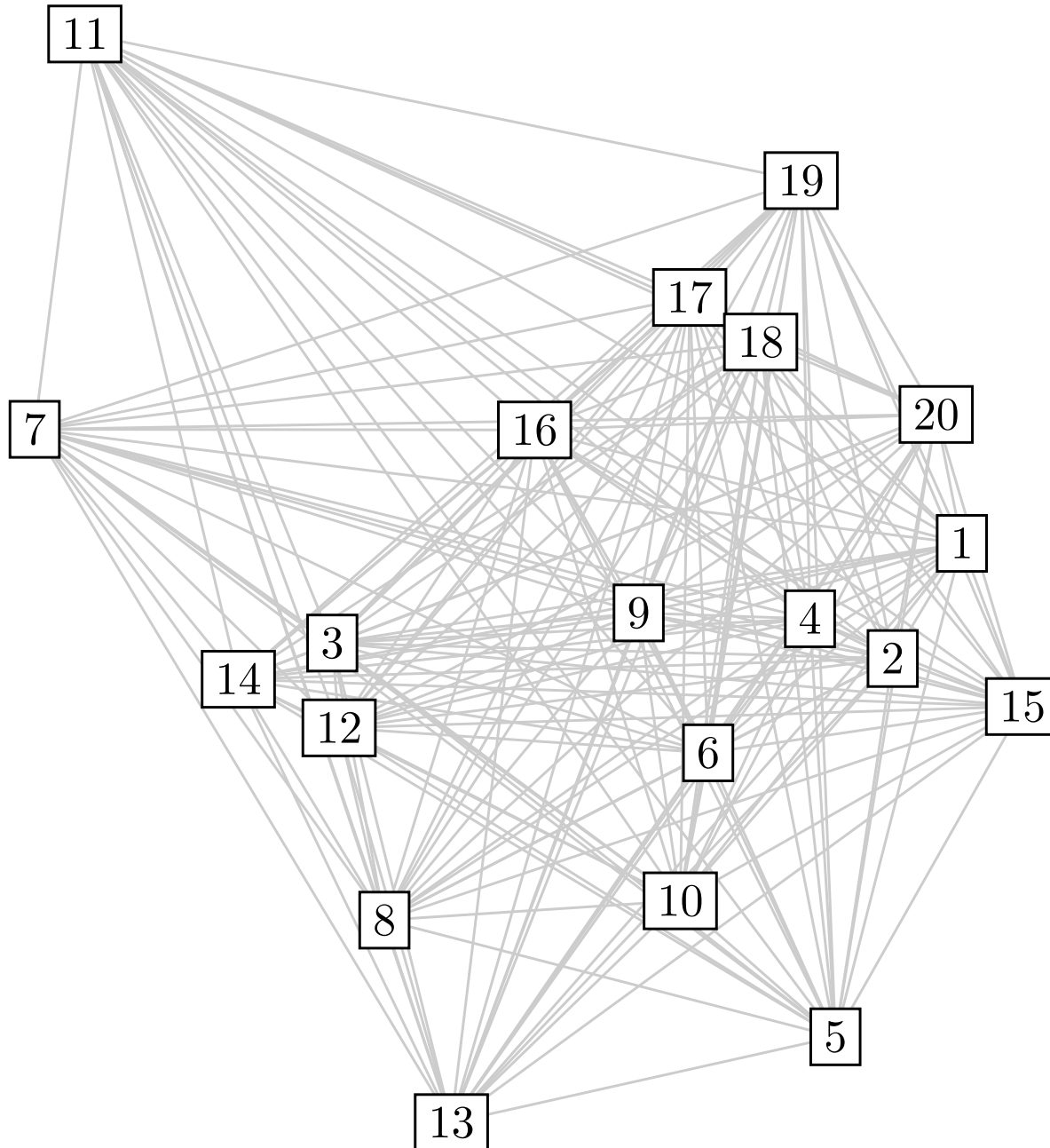
D_1



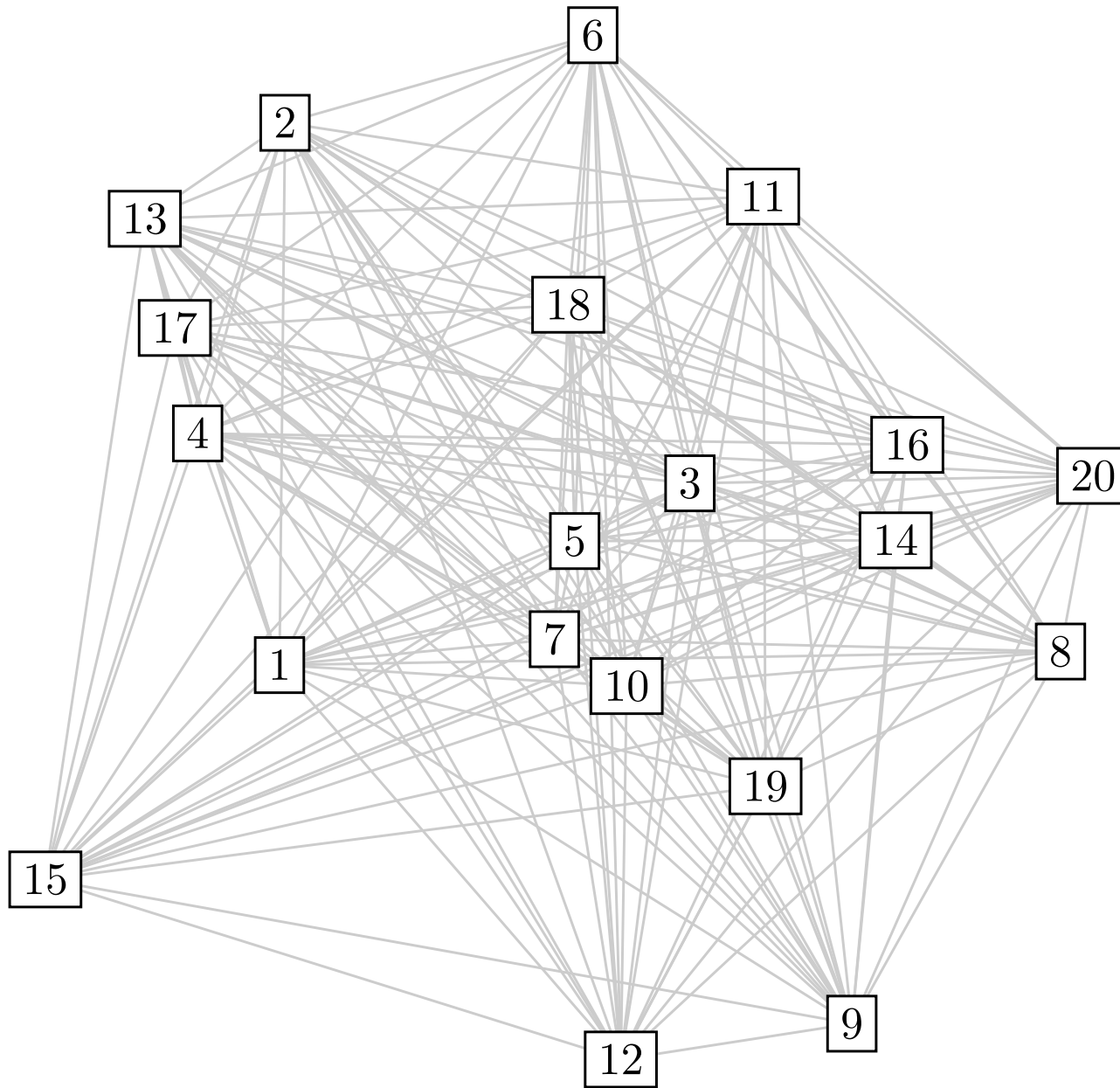
D_2



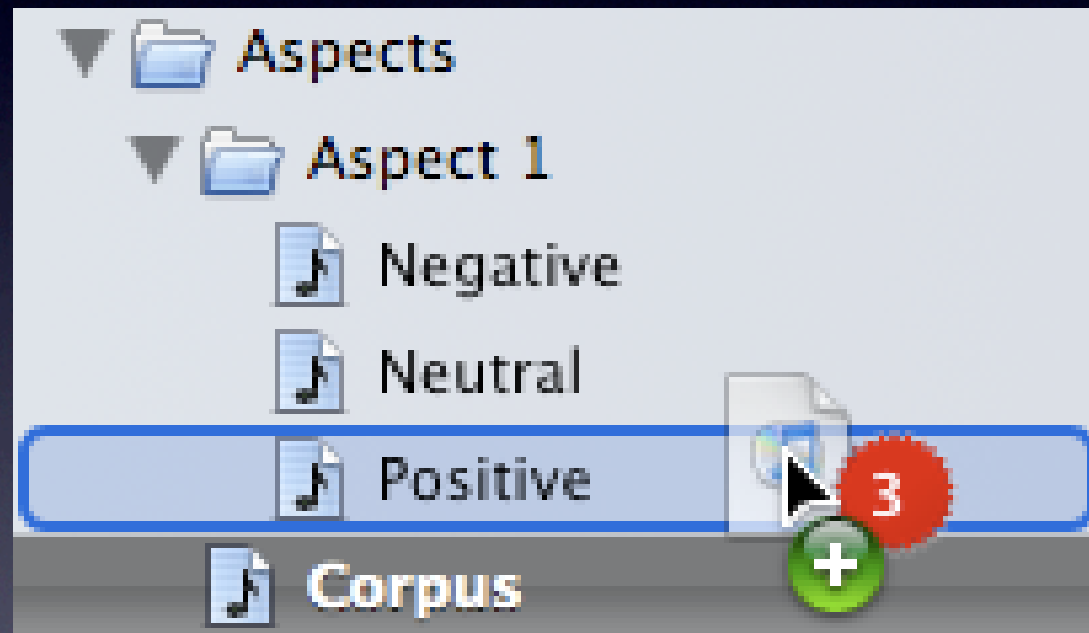
D_3



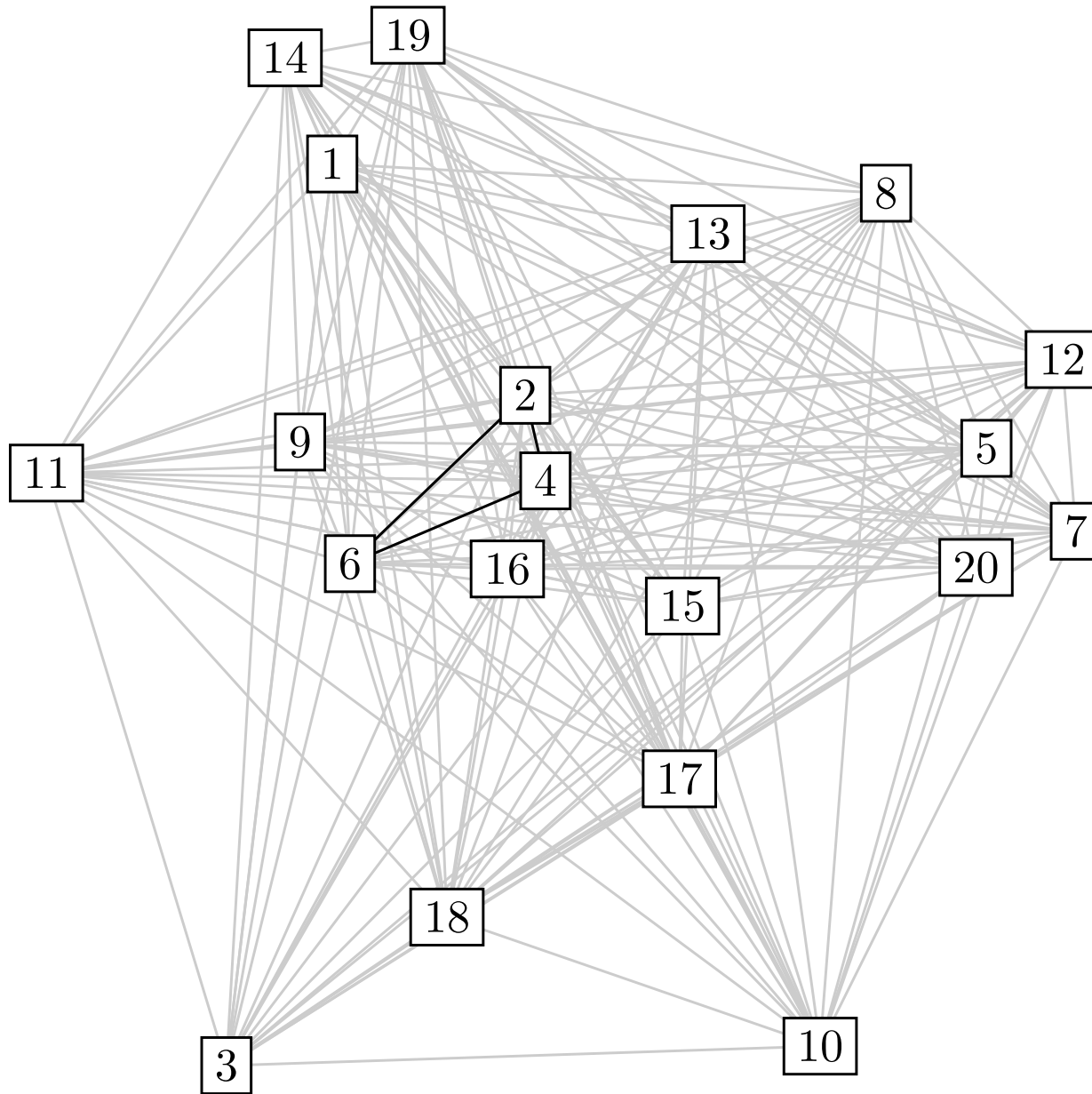
D_4



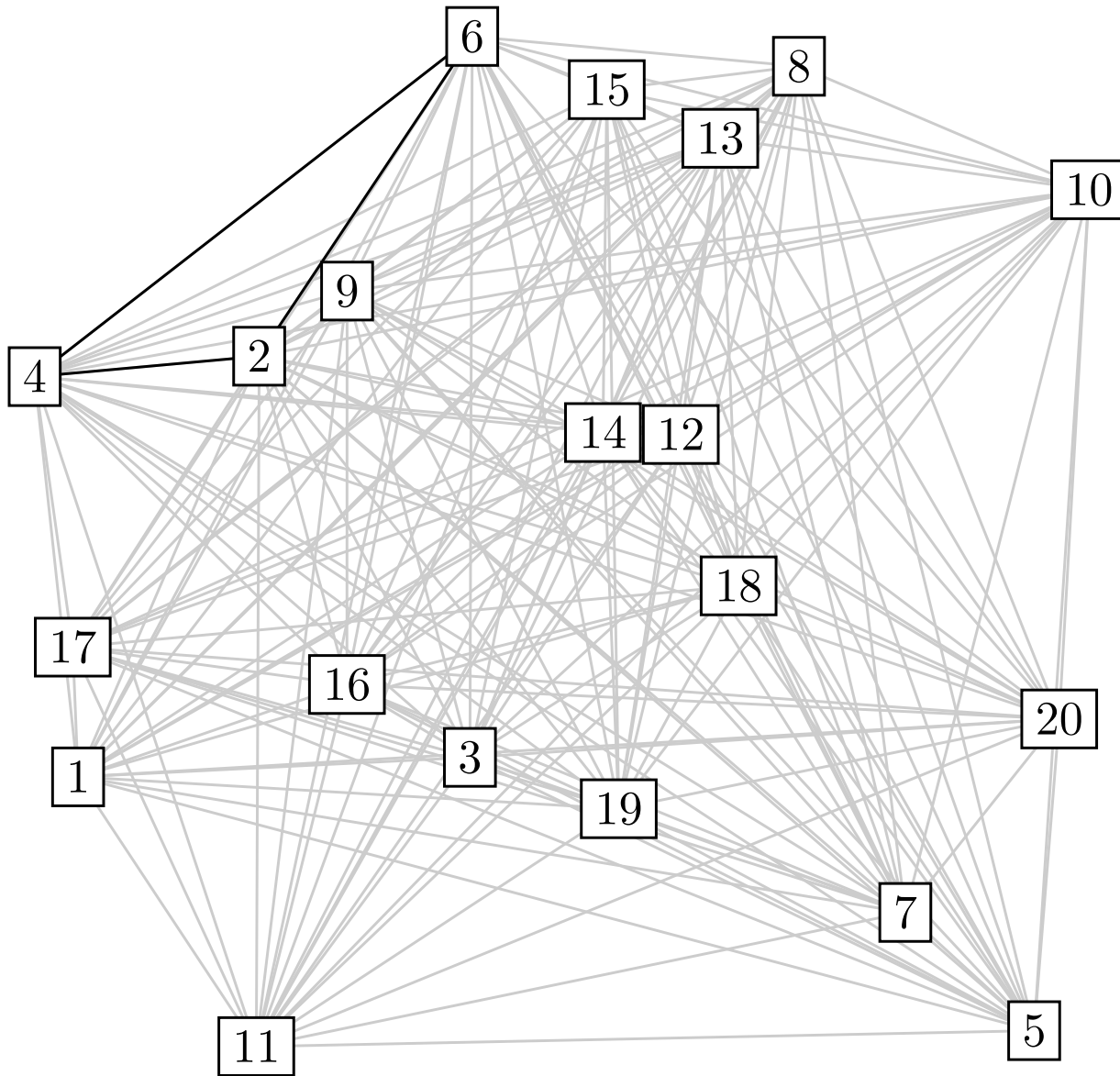
User chooses tracks 2, 4 and 6



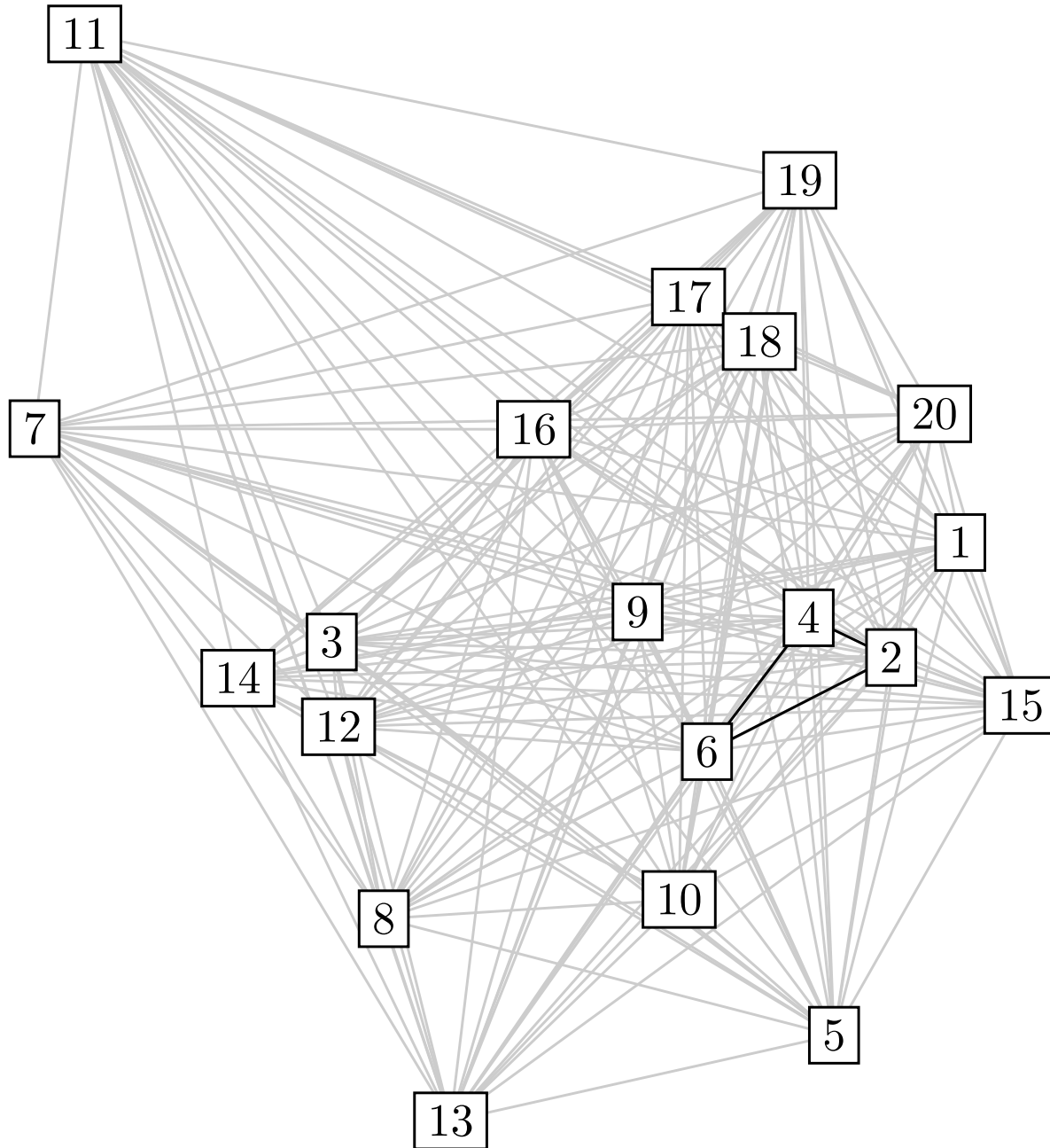
D_1



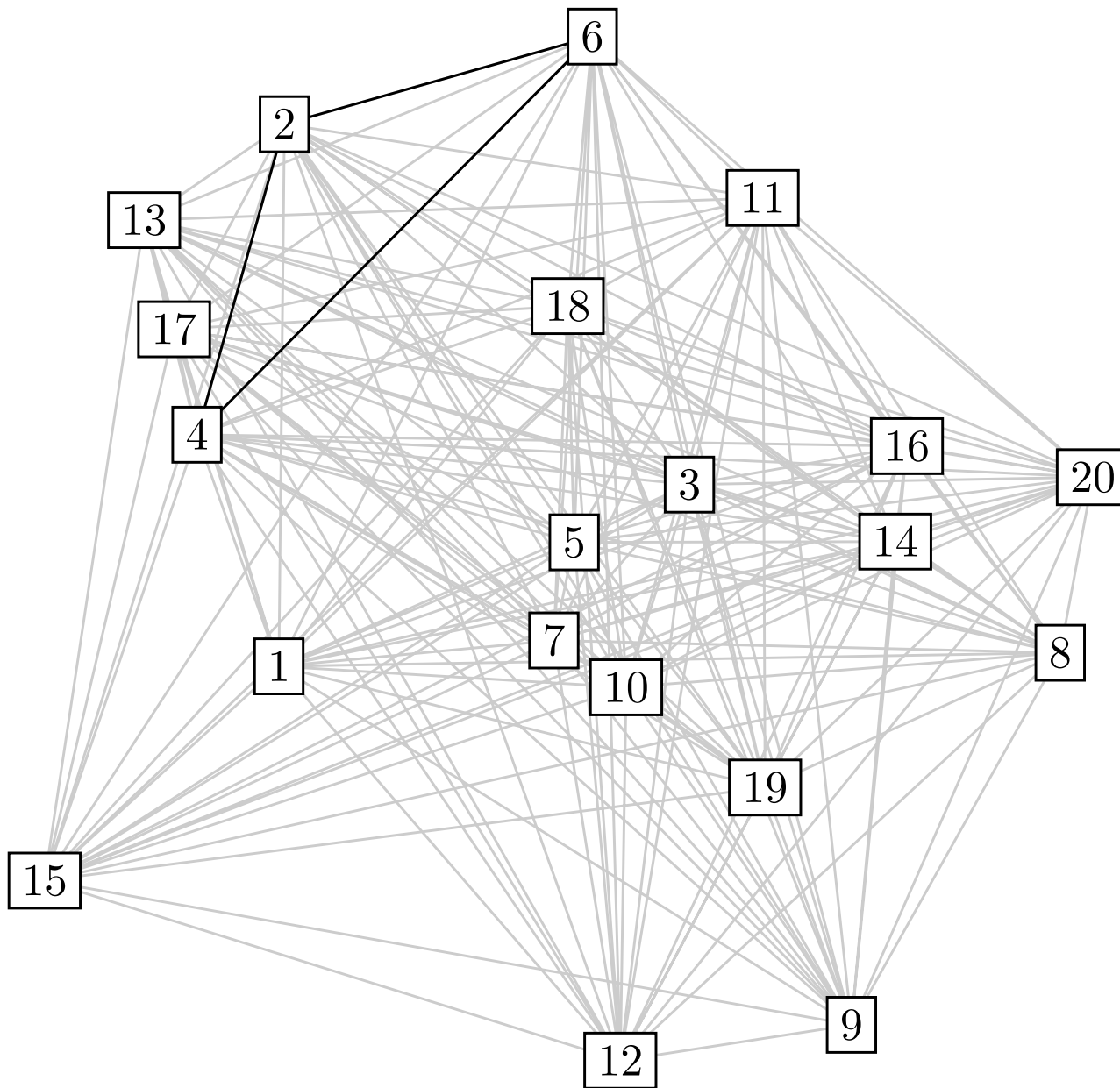
D_2



D_3



D_4



Weighting for D_k

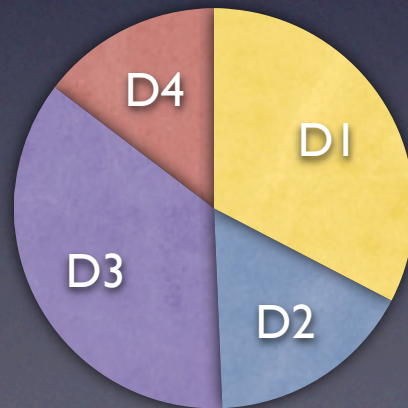
average distance between all tracks in D_k
divided by

average distance between tracks from example set in D_k

Combination of measures

$$D(+\{2,4,6\}) =$$

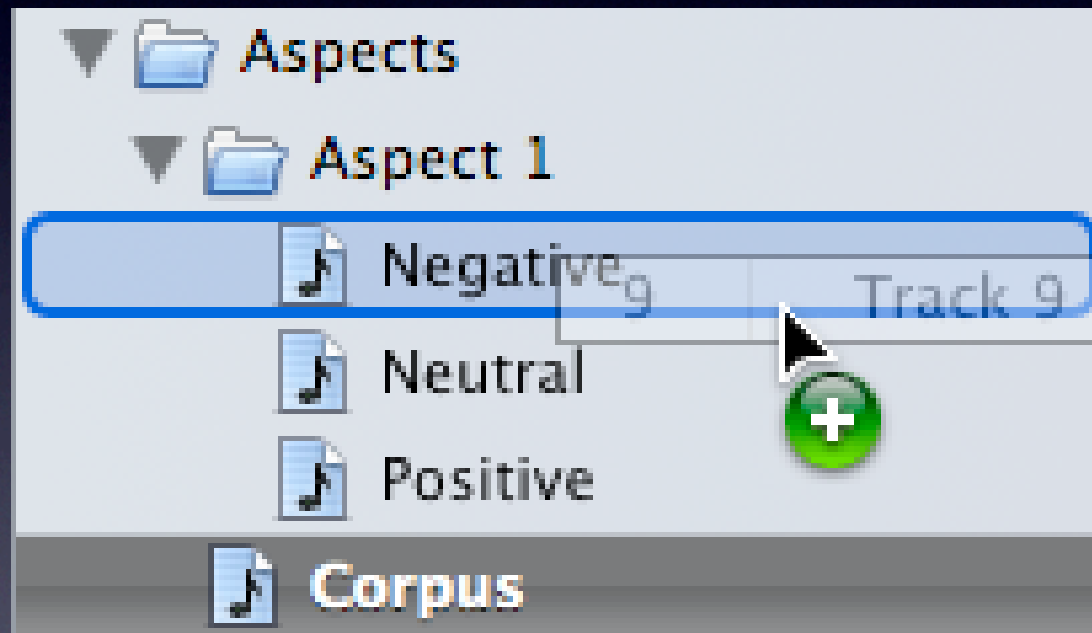
$$3.000 D1 + 1.536 D2 + 3.312 D3 + 1.347 D4$$



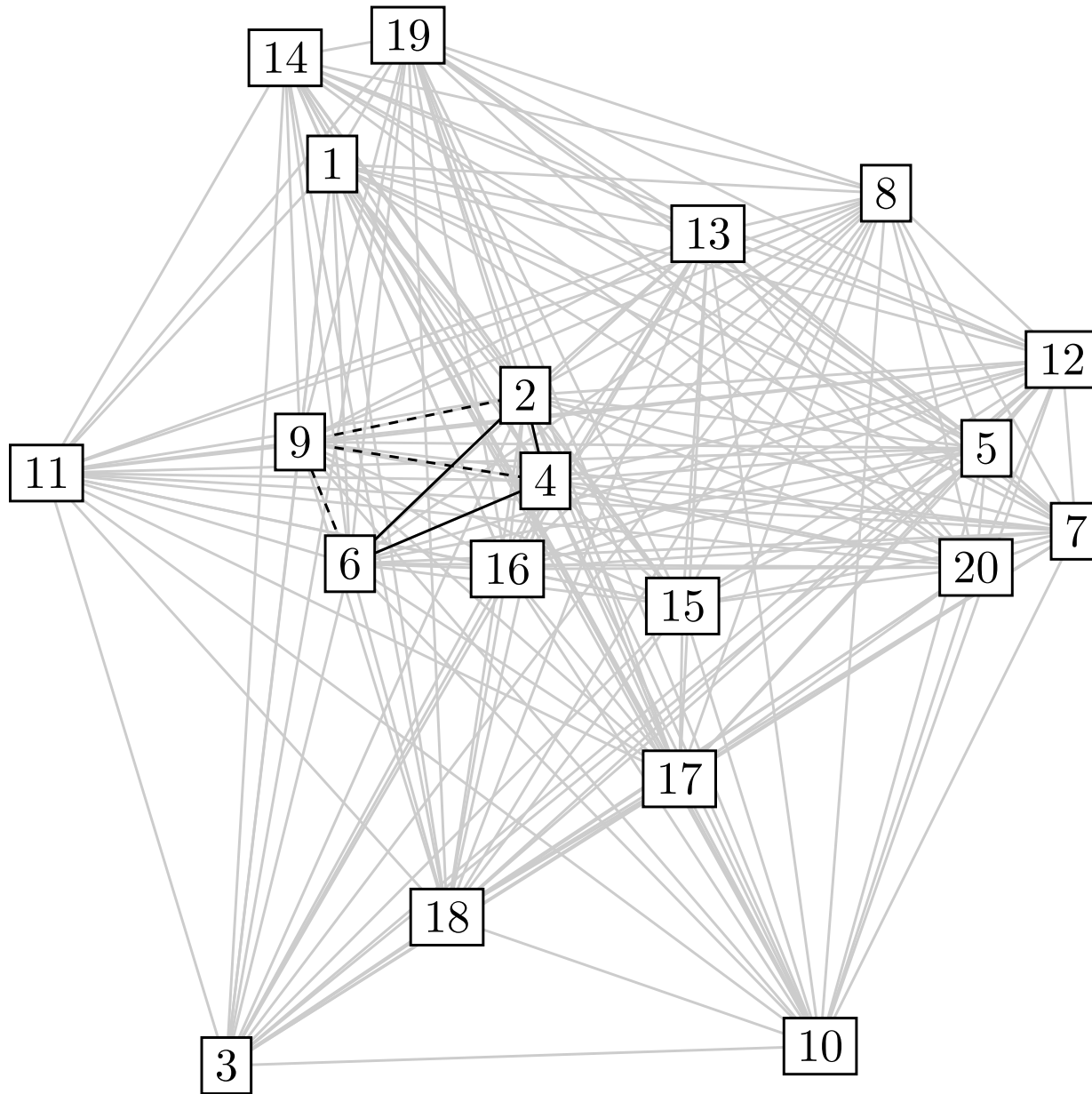
Nearest track

- Nearest track on average to tracks 2, 4 and 6 is track 9
- We report this to the user, but they disagree

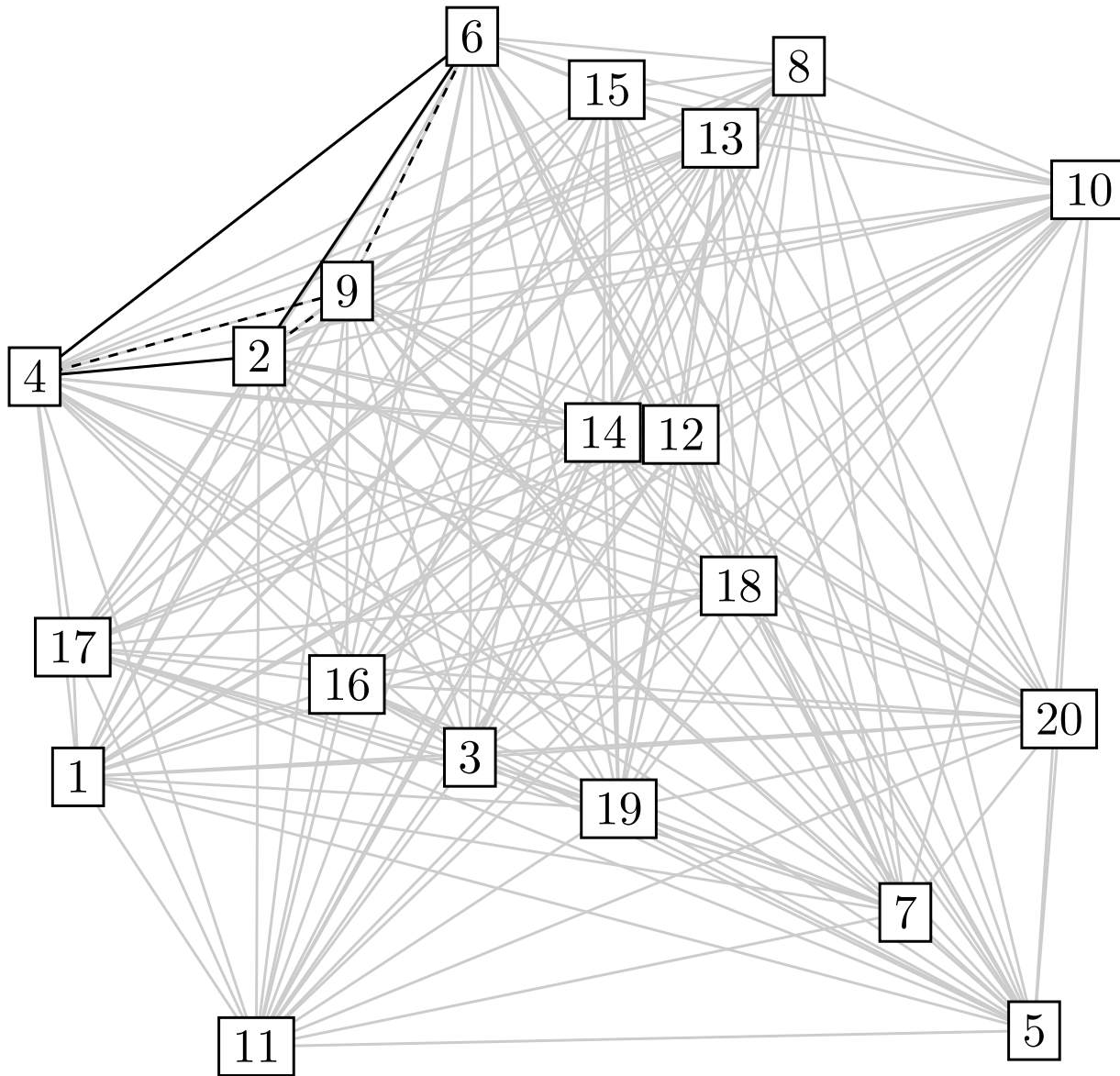
User chooses against track 9



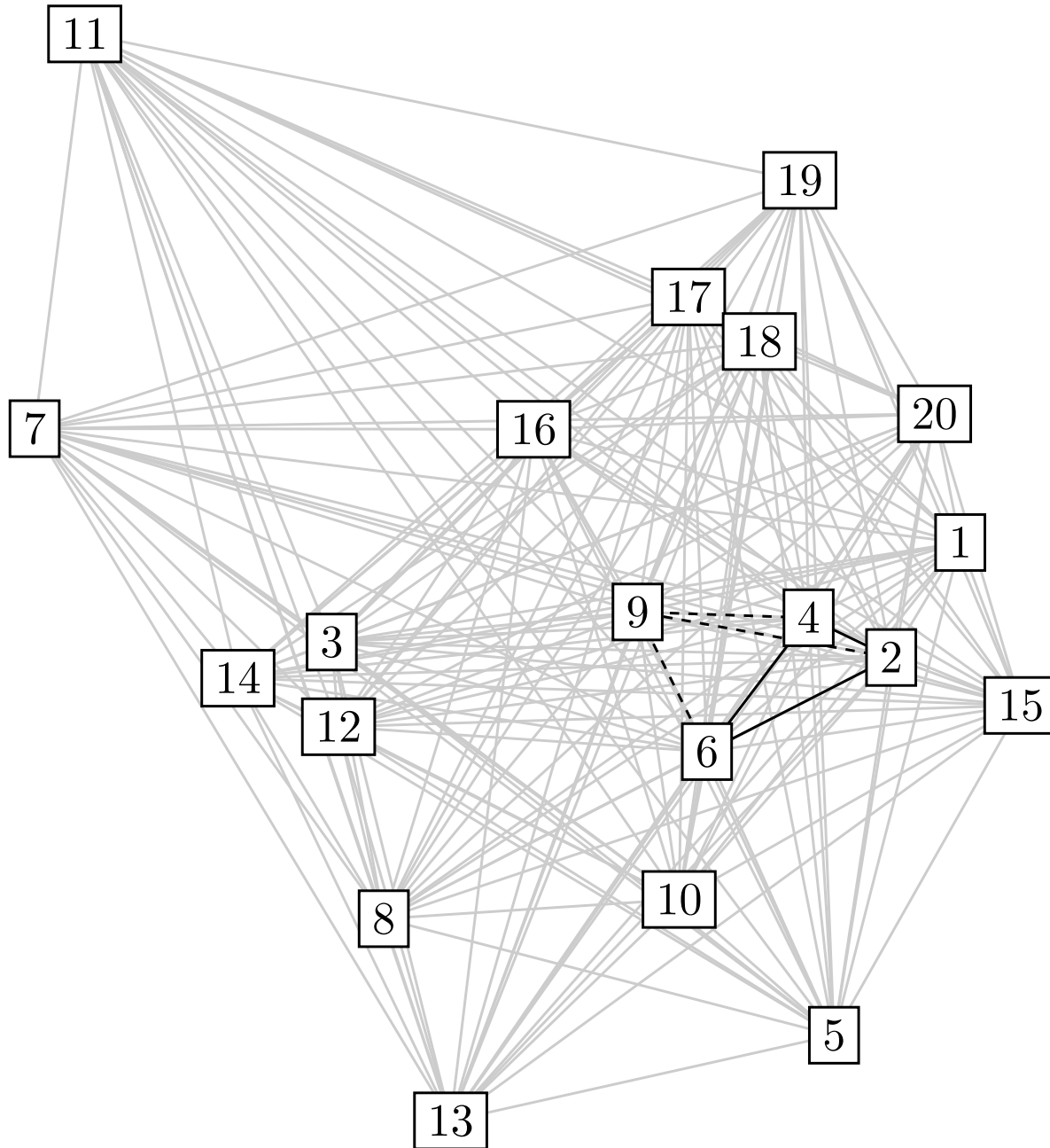
D_1



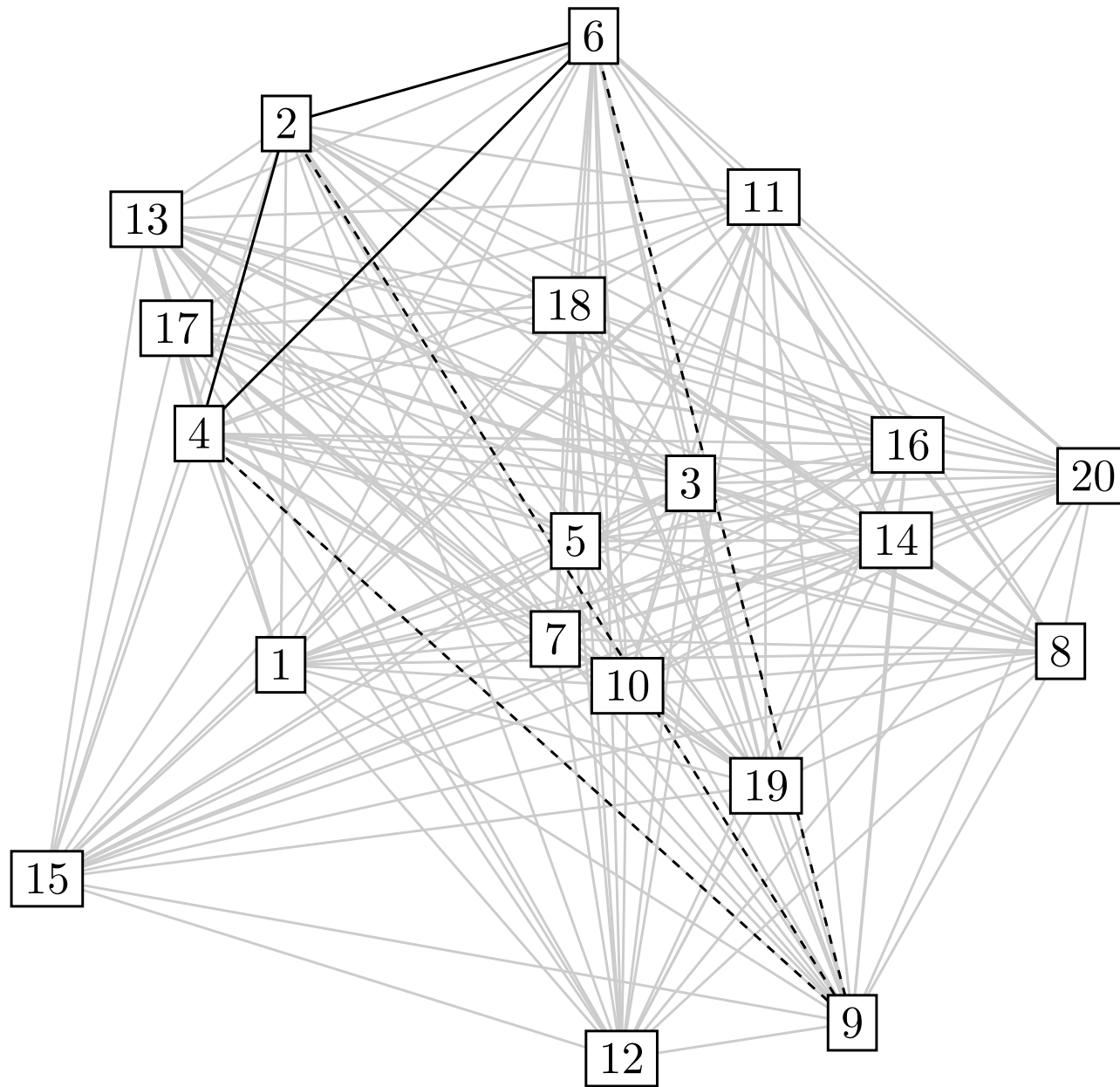
D_2



D_3



D_4



Weighting for D_k

average distance between all tracks in D_k
divided by

average distance between tracks from example set in D_k

Weighting for D_k

average distance between all (+, -) pairs in D_k

multiplied by

average distance between all tracks in D_k

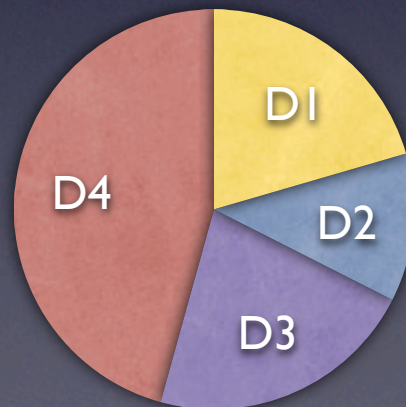
divided by

average distance between tracks from example set in D_k

Combination of measures

$$D(+\{2,4,6\}, -\{9\}) =$$

$$0.462 D_1 + 0.270 D_2 + 0.492 D_3 + 1.030 D_4$$



Initial weighting

- Aspect weighting gives relative salience
- But no reason to weight all equally to start with

Initial weighting

- Study to investigate initial weighting for 'average user'
- $w_1D_1 + w_2D_2 + w_3D_3 + w_4D_4 + \epsilon = D_{\text{study}}$

Study for initial weighting

- Present triads and ask which two are most similar
- Present all permutations of tracks
 - Each pair of tracks in the context of every other track
 - Compensate for presentation order

Study for initial weighting

- Too many permutations for single subject
 - 5 tracks, 60 triads
 - 6 tracks, 120 triads
 - 20 tracks, 6840 triads

Study for initial weighting

- Spread over multiple subjects
 - No multiple permutations of same combination for each subject
 - Each track appearing same number of times for each subject

Study for initial weighting

- 5 pieces, 6 subjects, 10 triads each
- 17 pieces, 60 subjects, 68 triads each
- 21 pieces, 60 subjects, 133 triads each
- 21 pieces, 114 subjects, 70 triads each

Choice of tracks

- Tracks chosen so that for all measures, distribution of distance measure for chosen subset is as near as possible to distribution of whole data set

Pragmatics

- Working with MIDI
 - Listeners do not hear waveforms, they hear musical events
 - Render MIDI to audio for timbral comparisons

Pragmatics

- Working with excerpts rather than whole tracks
 - Choose excerpts with melody and percussion
 - Ignore relationships based on self-similarity

Any questions?

Study for initial weighting

5 pieces, 6 subjects, 10 triads each

ACD	ABE	ACE	BCD	BDE	ABD	ABC	ADE	BCE	CDE
ADC	AEB	AEC	BDC	BED	ADB	ACB	AED	BEC	CED
CAD	BAE	CAE	CBD	DBE	BAD	BAC	DAE	CBE	DCE
CDA	BEA	CEA	CDB	DEB	BDA	BCA	DEA	CEB	DEC
DAC	EAB	EAC	DBC	EBD	DAB	CAB	EAD	EBC	ECD
DCA	EBA	ECA	DCB	EDB	DBA	CBA	EDA	ECB	EDC

Study for initial weighting

5 pieces, 12 subjects, 5 triads each

ACD	ABE	ACE	BCD	BDE	ABD	ABC	ADE	BCE	CDE
ADC	AEB	AEC	BDC	BED	ADB	ACB	AED	BEC	CED
CAD	BAE	CAE	CBD	DBE	BAD	BAC	DAE	CBE	DCE
CDA	BEA	CEA	CDB	DEB	BDA	BCA	DEA	CEB	DEC
DAC	EAB	EAC	DBC	EBD	DAB	CAB	EAD	EBC	ECD
DCA	EBA	ECA	DCB	EDB	DBA	CBA	EDA	ECB	EDC

Study for initial weighting

6 pieces, 6 subjects, 20 triads each

ABC ABE ADE AEF ADF BCD BCF BDF CDE CEF ABD ABF ACE ACD ACF BCE BDE BEF CDF DEF
ACB AEB AED AFE AFD BDC BFC BFD CED CFE ADB AFB AEC ADC AFC BEC BED BFE CFD DFE
BAC BAE DAE EAF DAF CBD CBF DBF DCE ECF BAD BAF CAE CAD CAF CBE DBE EBF DCF EDF
BCA BEA DEA EFA DFA CDB CFB DFB DEC EFC BDA BFA CEA CDA CFA CEB DEB EFB DFC EFD
CAB EAB EAD FAE FAD DBC FBC FBD ECD FCE DAB FAB EAC DAC FAC EBC EBD FBE FCD FDE
CBA EBA EDA FEA FDA DCB FCB FDB EDC FEC DBA FBA ECA DCA FCA ECB EDB FEB FDC FED

Study for initial weighting

6 pieces, 12 subjects, 10 triads each

ABC	ABE	ADE	AEF	ADF	BCD	BCF	BDF	CDE	CEF	ABD	ABF	ACE	ACD	ACF	BCE	BDE	BEF	CDF	DEF
ACB	AEB	AED	AFE	AFD	BDC	BFC	BFD	CED	CFE	ADB	AFB	AEC	ADC	AFC	BEC	BED	BFE	CFD	DFE
BAC	BAE	DAE	EAF	DAF	CBD	CBF	DBF	DCE	ECF	BAD	BAF	CAE	CAD	CAF	CBE	DBE	EBF	DCF	EDF
BCA	BEA	DEA	EFA	DFA	CDB	CFB	DFB	DEC	EFC	BDA	BFA	CEA	CDA	CFA	CEB	DEB	EFB	DFC	EFD
CAB	EAB	EAD	FAE	FAD	DBC	FBC	FBD	ECD	FCE	DAB	FAB	EAC	DAC	FAC	EBC	EBD	FBE	FCD	FDE
CBA	EBA	EDA	FEA	FDA	DCB	FCB	FDB	EDC	FEC	DBA	FBA	ECA	DCA	FCA	ECB	EDB	FEB	FDC	FED

Study for initial weighting

6 pieces, 24 subjects, 4 triads each
6 pieces, 10 subjects, 12 triads each

ADF	ACE	BCD	BEF	ABD	ACF	BCE	DEF	ABE	ADE	BCF	CDF	ABF	ACD	BDE	CEF	ABC	AEF	BDF	CDE
AFD	AEC	BDC	BFE	ADB	AFC	BEC	DFE	AEB	AED	BFC	CFD	AFB	ADC	BED	CFE	ACB	AFE	BFD	CED
DAF	CAE	CBD	EBF	BAD	CAF	CBE	EDF	BAE	DAE	CBF	DCF	BAF	CAD	DBE	ECF	BAC	EAF	DBF	DCE
DFA	CEA	CDB	EFB	BDA	CFA	CEB	efd	BEA	DEA	CFB	DFC	BFA	CDA	DEB	EFC	BCA	EFA	DFB	DEC
FAD	EAC	DBC	FBE	DAB	FAC	EBC	FDE	EAB	EAD	FBC	FCD	FAB	DAC	EBD	FCE	CAB	FAE	FBD	ECD
FDA	ECA	DCB	FEB	DBA	FCA	ECB	FED	EBA	EDA	FCB	FDC	FBA	DCA	EDB	FEC	CBA	FEA	FDB	EDC