Magne Skålevik
Brekke & Strand
www.akutek.info

Can concert hall preference be predicted and explained?

ROOM ACOUSTICAL PARAMETER VALUES AT LISTENERS' EARS

Introduction

- Why do some halls sound better than others?
- Demand for prediction of listeners' response
  - Planning of new concert halls
  - Amendments in existing halls

Previous work

- Subjective rank-ordering of 58 concert halls Beranek (2003)
- Comparison with hall-averages of measured parameters
  - => preferred values
  - => significant parameters
- However: Few listeners experience hall-average conditions (Skålevik 2008), e.g.:
  - Musikverein Vienna, 90% seats differ noticeably from hall-average conditions, 5 parameters, ISO3382

Different approach

- Listening quality not represented by hall-averages
- Instead – evaluate listening quality at listeners' ears
  - At a given seat, let listening quality be described by a set of parameter values
- Quality of hall calculated from quality of seats

Objective Hall Rank

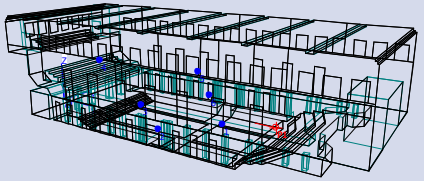
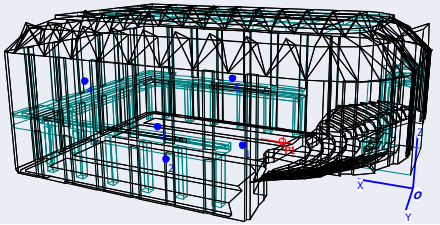
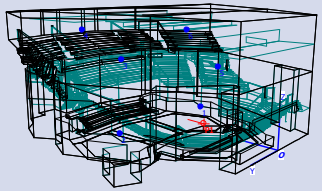
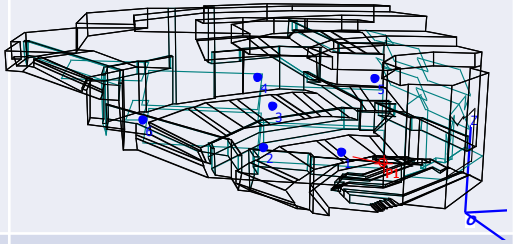
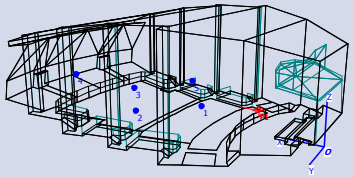
- Choose a set of N critical parameters
  - Let value ranges found in top-ranked halls (Vienna, Amsterdam) define "acceptable" parameter values
- Acquire data from at least 10 positions per hall
- In each position:
  - If all N values are acceptable, then Seat Rank = 1
  - If one value is not acceptable, then Seat Rank = 2
  - If k values are not acceptable, then Seat Rank = 1+k
- Objective Hall Rank=X-percentile of {Seat Rank}
  - Assuming X% "extreme" seats, generally avoided by respondents in Beranek's rank-ordering

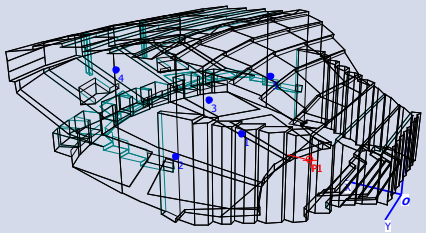
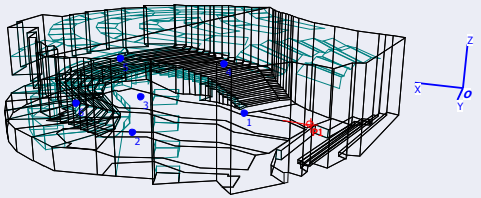
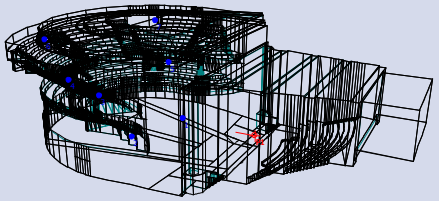
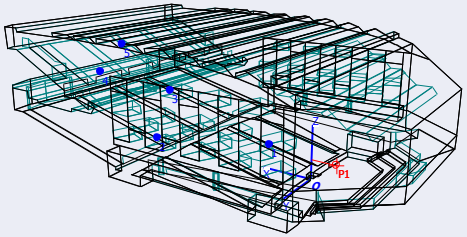
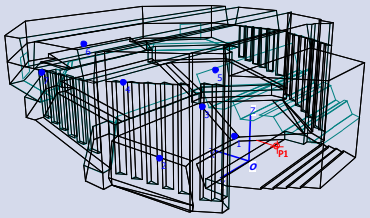
Parameters' relevance test

- For a selection of halls, calculate correlation R^2 between Objective ranking and Beranek's Subjective ranking
- Let R^2 indicate relevance of a parameter-set
  - Measured data input: R^2 indicates explainability
  - Predicted data input: R^2 indicates predictability
- Examples of testing follows….

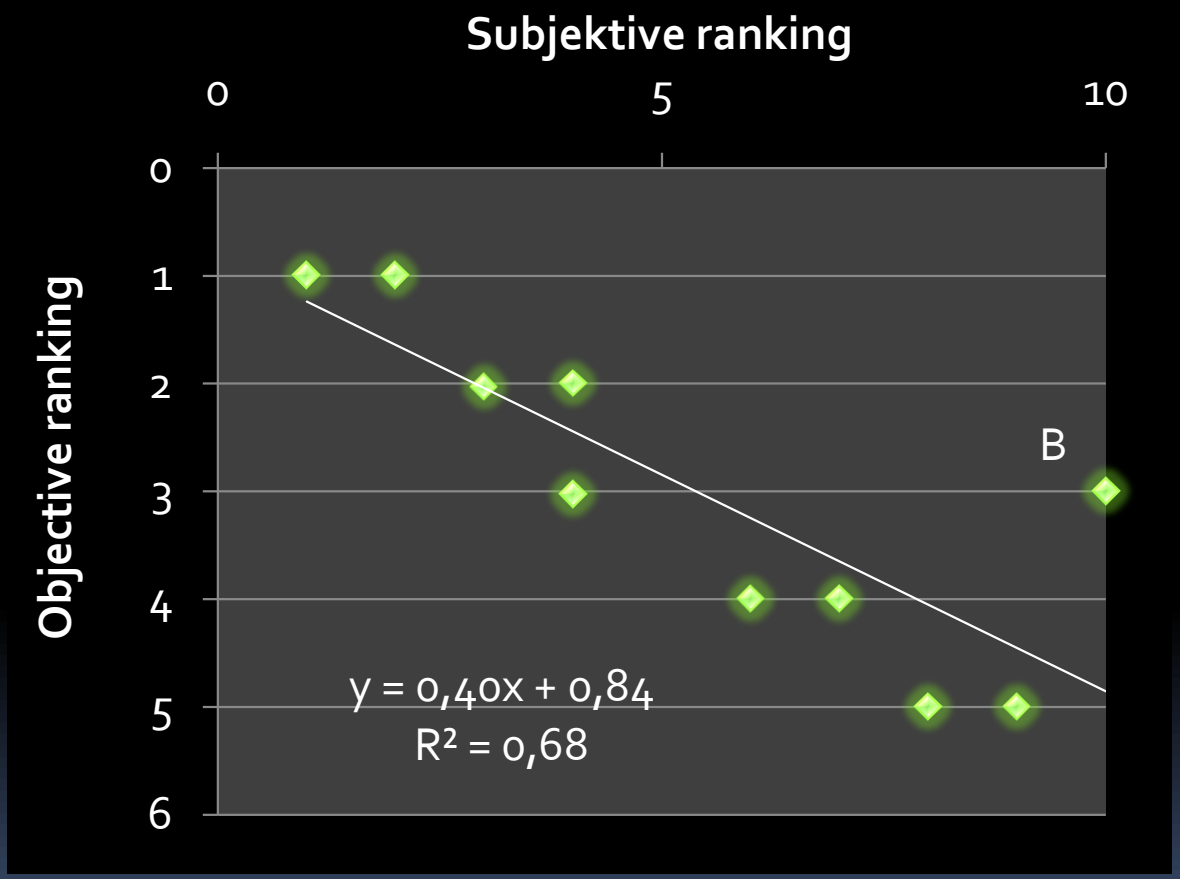
5 aspects, 5 parameters

Listener aspect (subjective / perceived)	Quantity	Just noticeable difference JND
Sound Level	G (dB)	1 dB
Reverberance	EDT (s)	5 %
Clarity	C_{80} (dB)	1 dB
Apparent Source Width	LF	0.05
Envelopment	G_{late}	(1 dB)

Concert hall	Volume	Seats	RT (occ)	
Musikverein, Vienna	15000	1700	2.0	
Concertgebouw, Amsterdam	19000	2000	2.0	
St David, Cardiff	22000	2000	2.0	
Gasteig, Munich	30000	2500	1.9	
Konserthus, Gøteborg	12000	1300	1.6	

Concert hall	Volume	Seats	RT (occ)	
Festspielhaus, Salzburg	15500	2200	1.5	
Liederhalle, Stuttgart	16000	2000	1.6	
Usher Hall, Edinburg	16000	2500	1.3	
Royal Festival Hall, London	22000	2900	1.5	
Barbican, London	18000	2000	1.7	

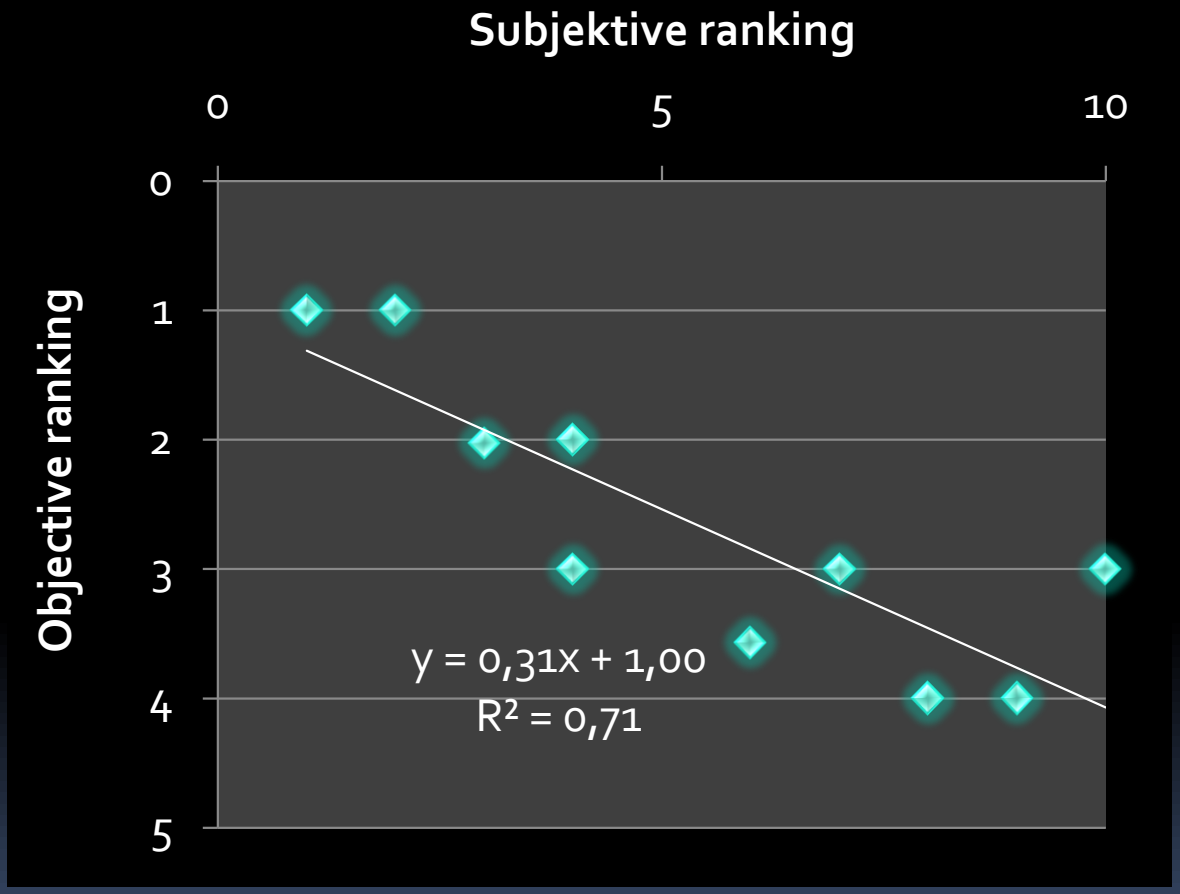
5 parameters measured



R^2=0.68

10 halls, 116 positions, X=27%

EDT G C G_{late} measured



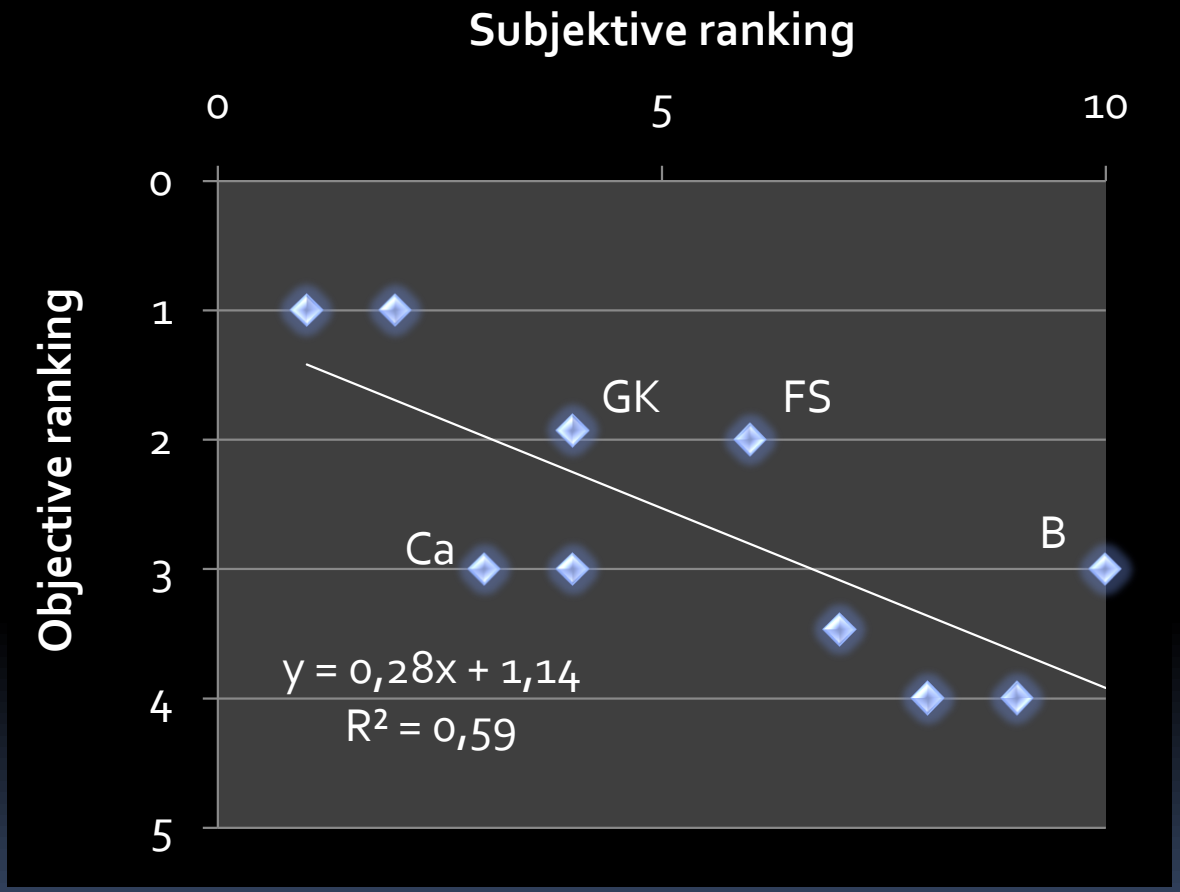
R^2=0.71

10 halls, 116 positions, X=27%

Now imagine…

- …only Musikverein and Concertgebouw existed
- Could the subjective ranking of the 8 next halls be predicted?

5 parameters Odeon 10

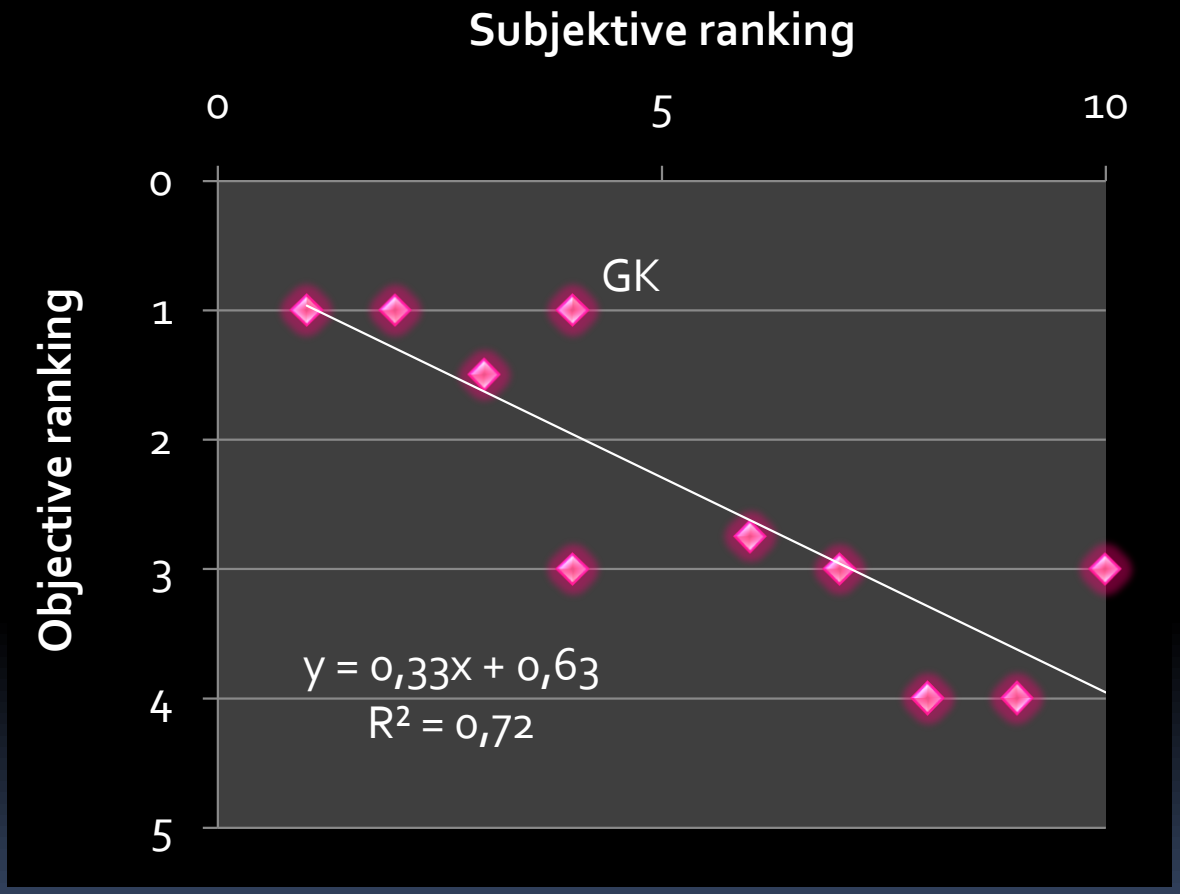


R^2=0.59

10 halls, 116 positions, X=23%

EDT G C G_{late}

TVr-estimates T from Odeon



R^2=0.72

10 halls, 116 positions, X=25%

What's new?

- New method for testing parameter sets
  - Explainability
  - Predictability
- Parameter-values at listeners' ears
  - Instead of hall averages
- No multiple linear regression
- Inter-dependent parameters allowed

Conclusion

- The test method shows promising possibilities in evaluating suggested criteria
- Current objective criteria needs further critical examination, examples:
  - Barbican Hall bottom-rank unexplained
  - Cardiff hall would have been designed differently, given ISO 3382 parameters at the time
- More extensive discussion given in paper

ICA 2010

BREKKE STRAND

Thank you

More info?

The www center for search, research and free sharing in acoustics

www.akutek.info

magne.skalevik@brekke-strand.no