Defining Emotionally Salient Regions using Qualitative Agreement Method

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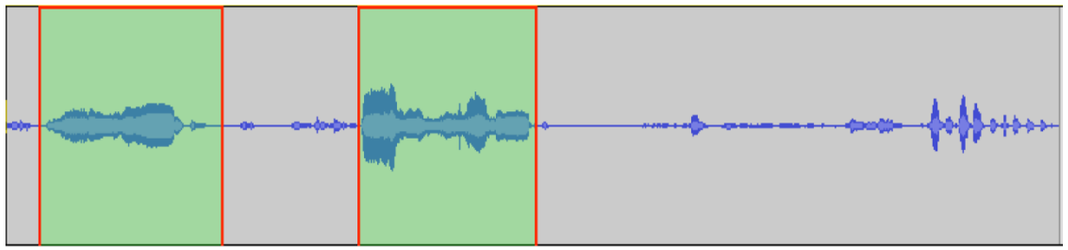
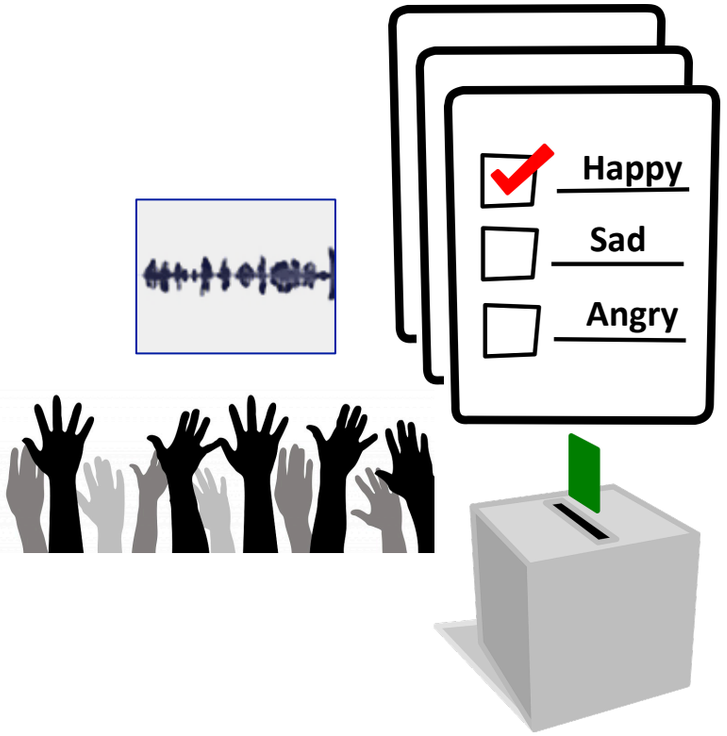
Motivation

- Expressive behavior recognition important for human computer interaction
- Human interaction is fairly neutral with few segments conveying emotion
- Need for dynamic systems that
  - are time continuous in nature
  - can detect salient regions that deviate from neutral
- Previous studies have focused on
  - continuously predicting emotional dimensional values Gunes & Schuller 2013
  - points of change of emotion Huang et al. 2015



Barriers

- Unreliable Emotional labels Cowie & Cornellius 2003, Busso et al. 2013



- Perceptual evaluation complex Cowie 2009
  - Unreliable labels affect performance of classifiers, predictors Metallinou & Narayanan 2013

- Creating labels, for salient regions, from scratch is expensive, time consuming

Goal

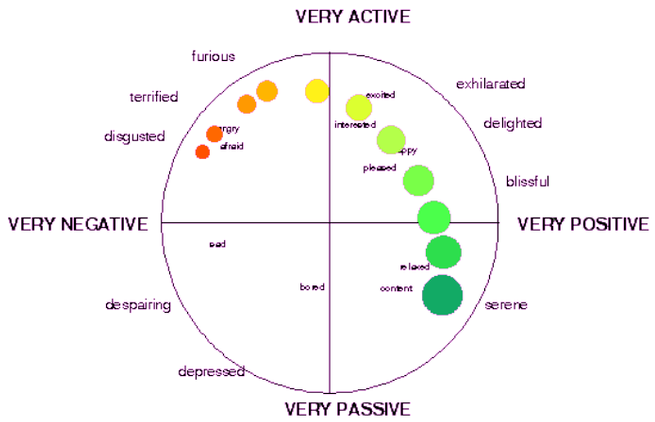
- Framework for defining reliable labels describing emotionally salient regions (hotspots)
  - Use existing perceptive evaluations (e.g. continuous time evaluations)
  - Easily extended to multiple databases
- We exploit the Qualitative Agreement (QA) method to define hotspots
  - We show that hotspots defined with QA capture individual, relative trends
  - Better than the baseline of averaging traces to form one absolute score

SEMAINE database

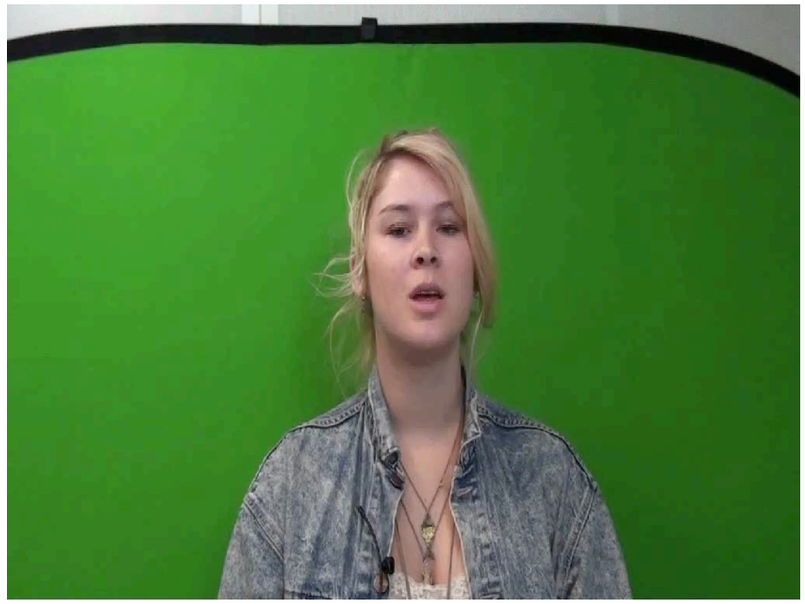
- Emotionally colored machine-human interaction McKeown et. al 2012
  - Sensitive artificial listener framework
  - Only solid SAL used (operator was played with another human)
  - 40 sessions, 10 users
- Time-continuous dimensional labels
  - Captured by FEELTRACE Cowie et al. 2000
  - We focus on arousal and valence dimensions
  - 6 evaluators for each session, evaluations range [-1,1]

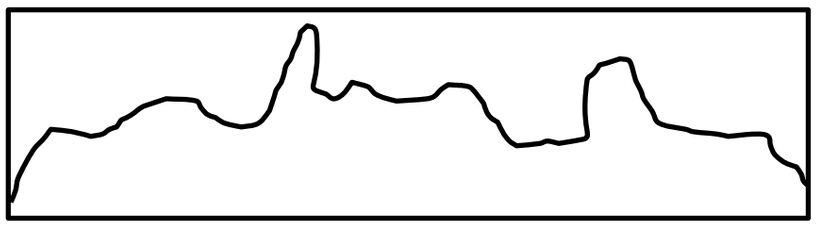
User

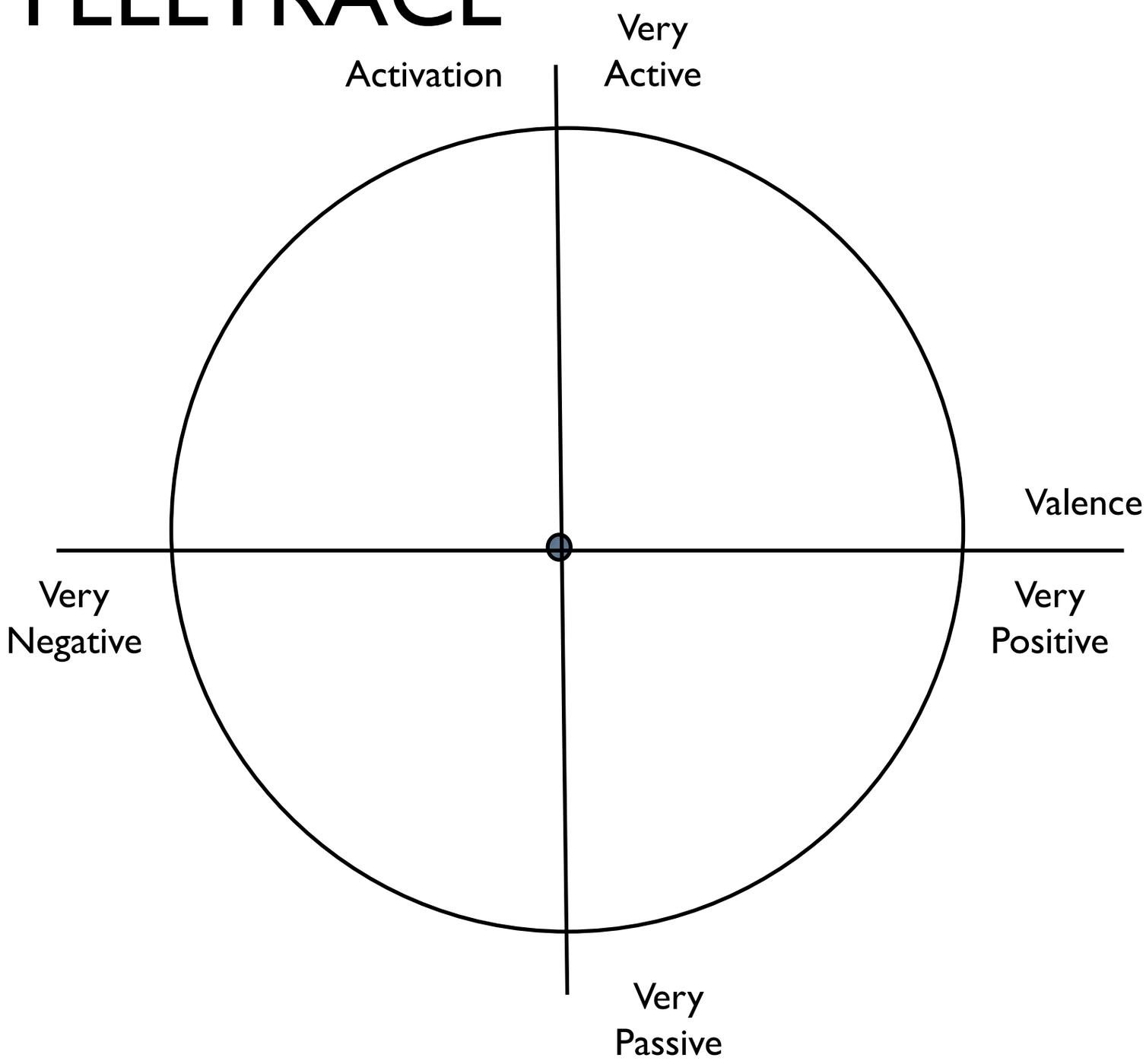
Operator



FEELTRACE






Activation
Very
Active
Valence
Very
Negative
Very
Positive
Very
Passive

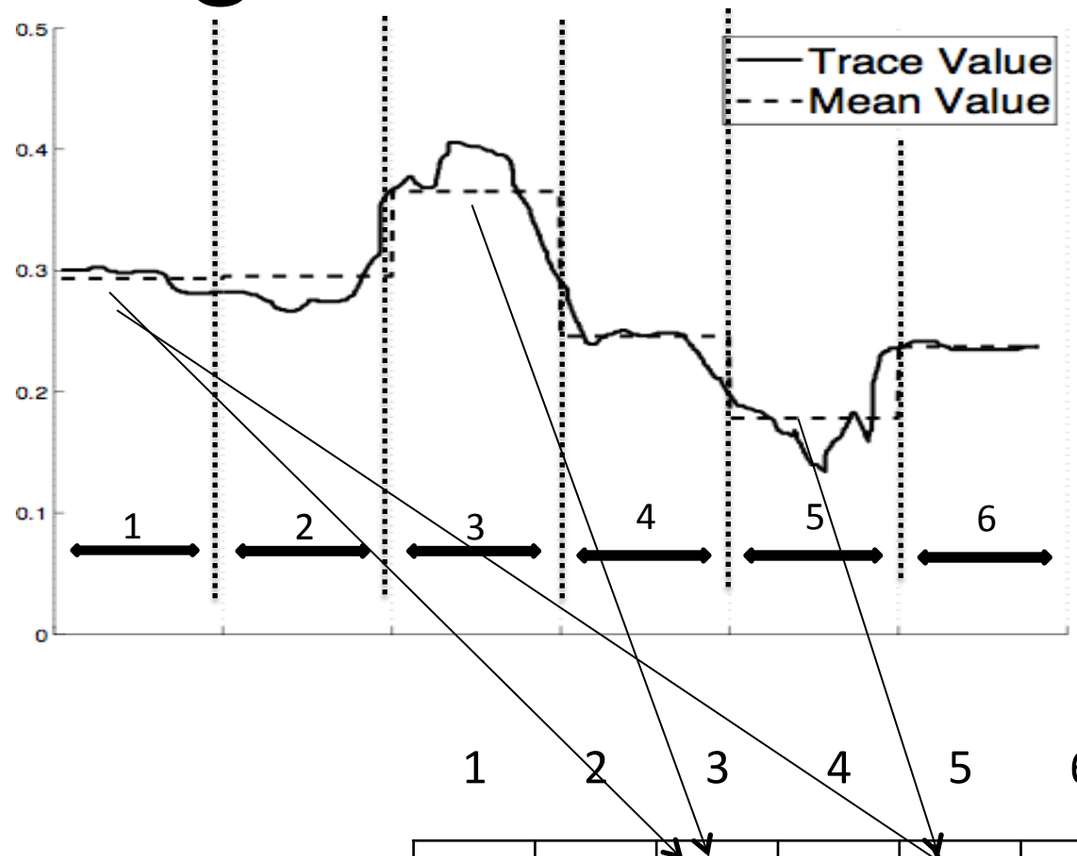
Hotspot Definition

- Hotspots defined as segments having high or low levels of emotional attribute
  - Eg. Valence hotspots – Very negative or very positive emotions

- Proposed method for definition ? **Qualitative Agreement (QA)**
- QA - Promising results for ranking emotions Parthasarathy et al. 2016

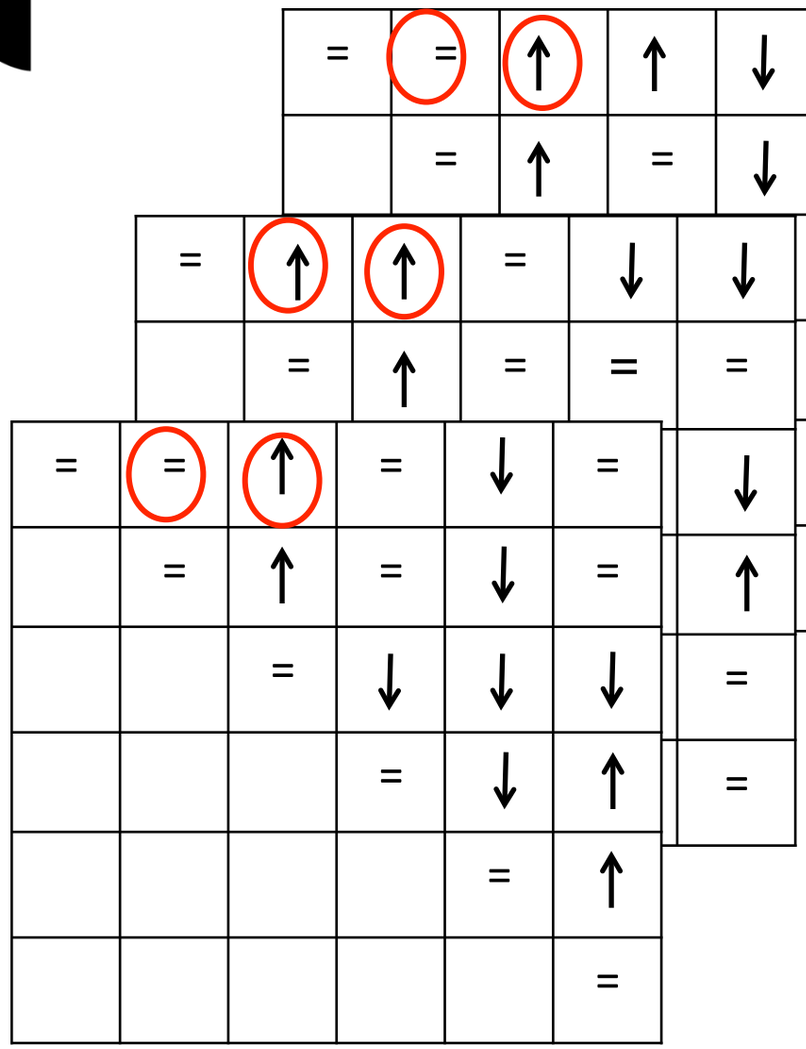
Qualitative Agreement

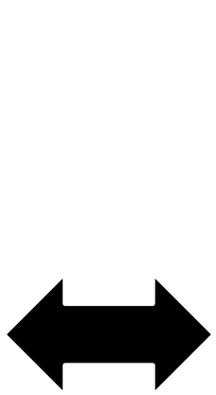
- Proposed by Cowie and McKeown 2010
- Divide trace into discretized bins
  - Mean value (b_i) of trace assigned to the bin
- Form Individual Matrix (IM)
  - Rise $b_j - b_i > t_{threshold}$
  - Fall $b_i - b_j > t_{threshold}$
  - Equal $|b_i - b_j| < t_{threshold}$

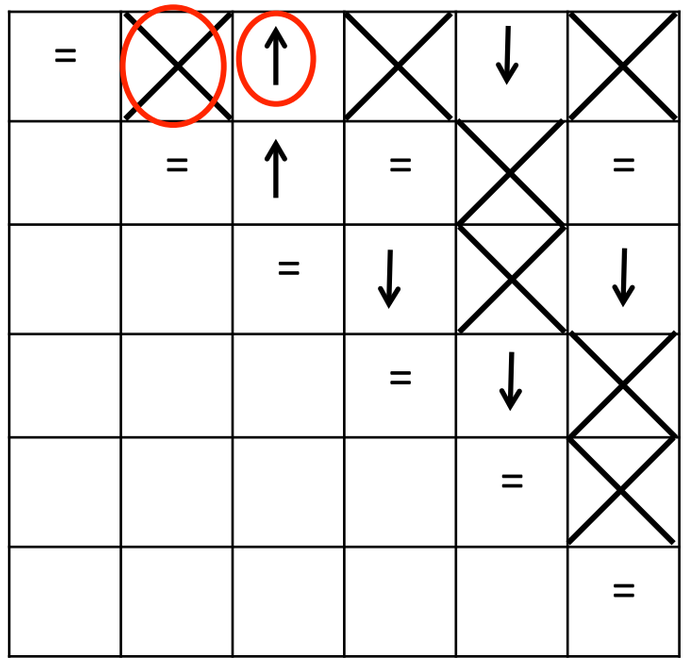


	1	2	3	4	5	6
1	=	=	↑	=	↓	=
2		=	↑	=	↓	=
3			=	↓	↓	↓
4				=	↓	↑
5					=	↑
6						=

Qualitative Agreement



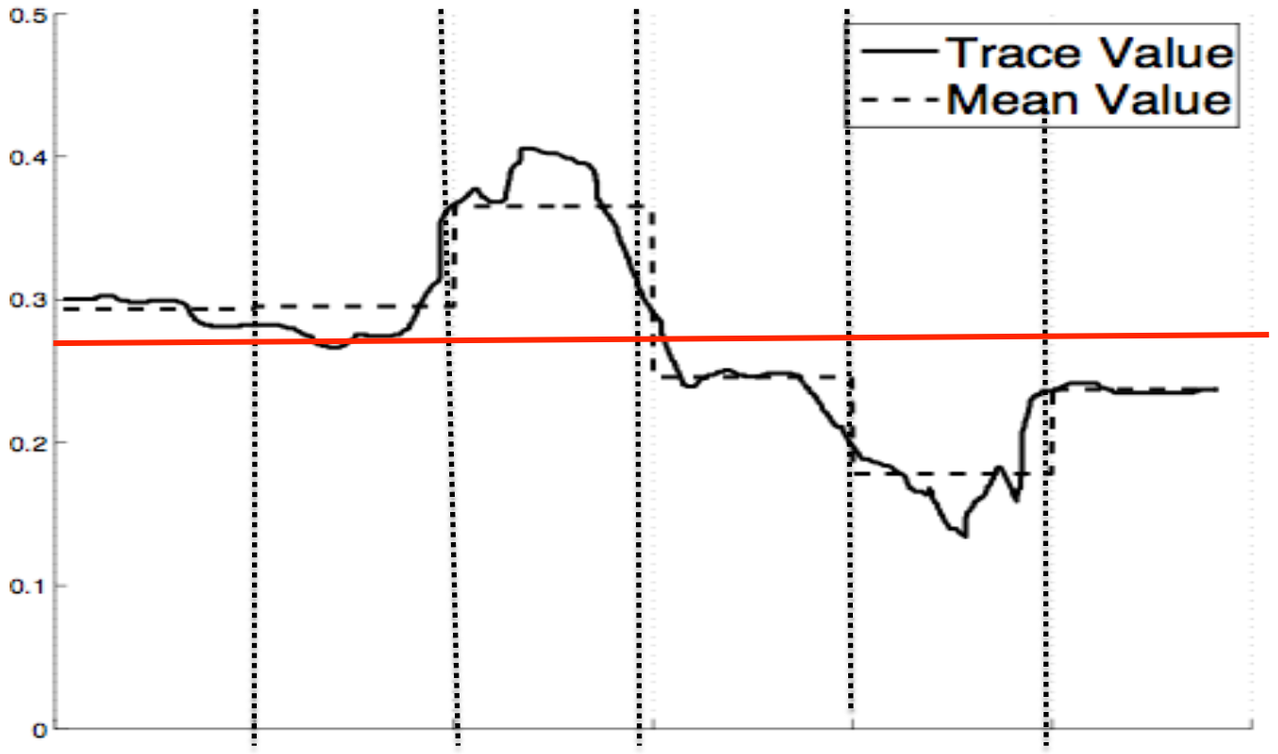


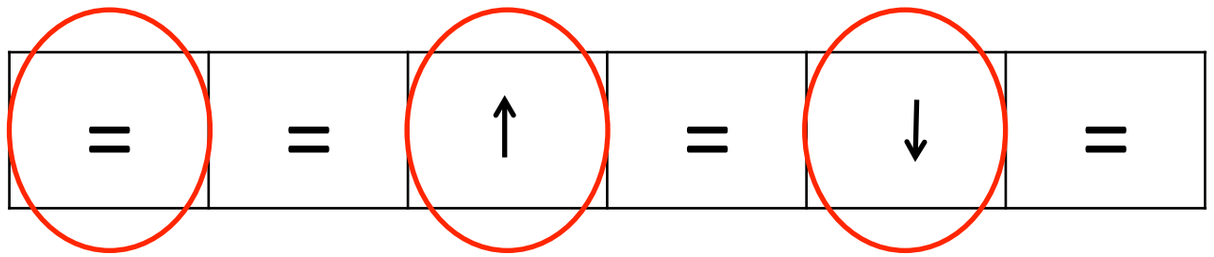


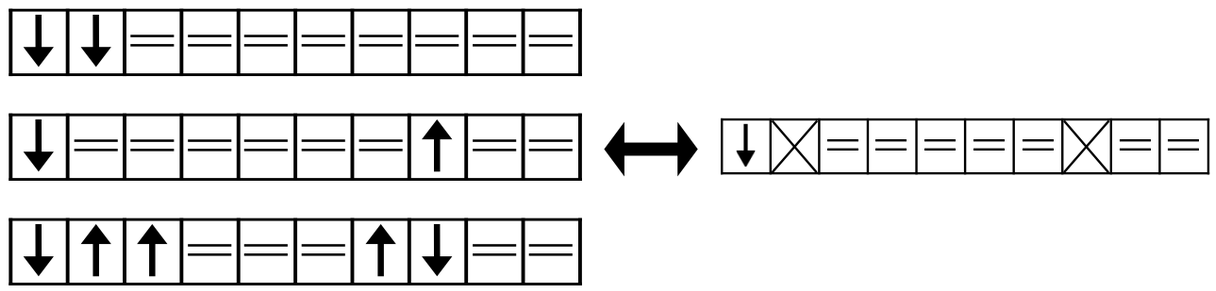
- Combine different individual matrices to form a consensus matrix (CM) to find agreement between raters
  - If X% agree on trend in IM set that to CM
  - Otherwise not considered

Qualitative Agreement – Hotspot Detection

- How to adapt QA for hotspot detection ?
- Compare with median value instead of bins
- Form individual vector (IV) for each rater
  - High $b_i - b_{median} > t_{threshold}$
  - Low $b_{median} - b_i > t_{threshold}$
  - Neutral $|b_i - b_{median}| < t_{threshold}$
- Consensus Vector (CV) – X % agreement



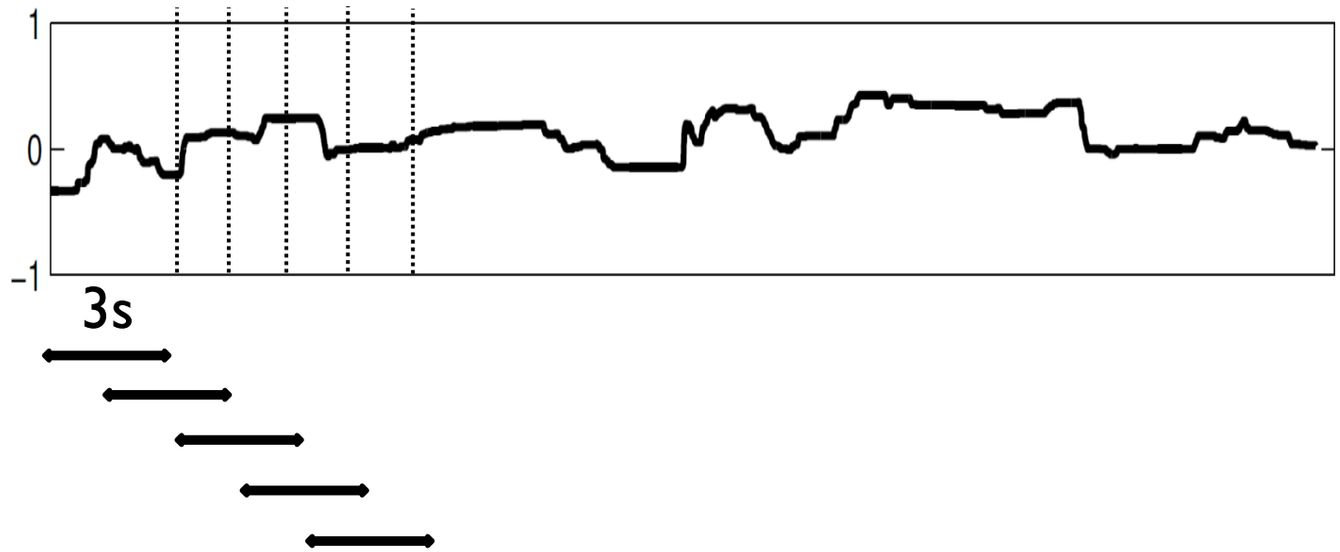




Parameters – Length of Bin

$$b_i - b_{median} > t_{threshold}$$

- Length of bin (L) set to 3s

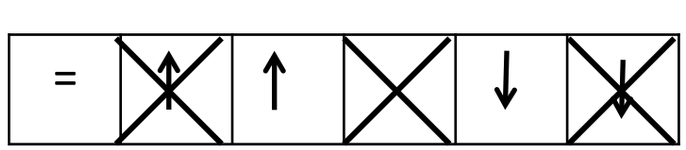


- Successive bins shifted by 250ms with 2.75s overlap
  - Gives reliable, continuous bins for hotspots, regression tasks

Parameters – Agreement Consensus

$$b_i - b_{median} > t_{threshold}$$

- Agreement – 66% (4 out of 6 raters)

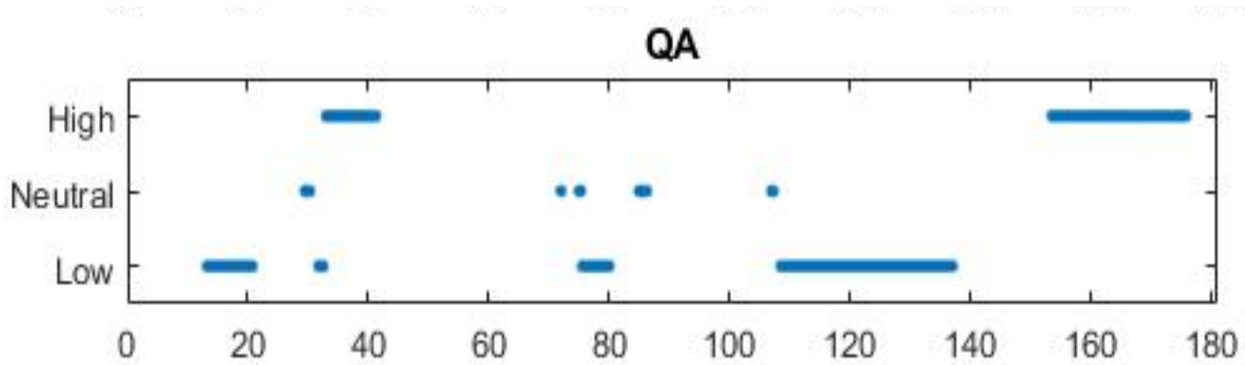


Parameters - $t_{threshold}$

$$b_i - b_{median} > t_{threshold}$$

$t_{threshold}$ = 0.0[illegible]

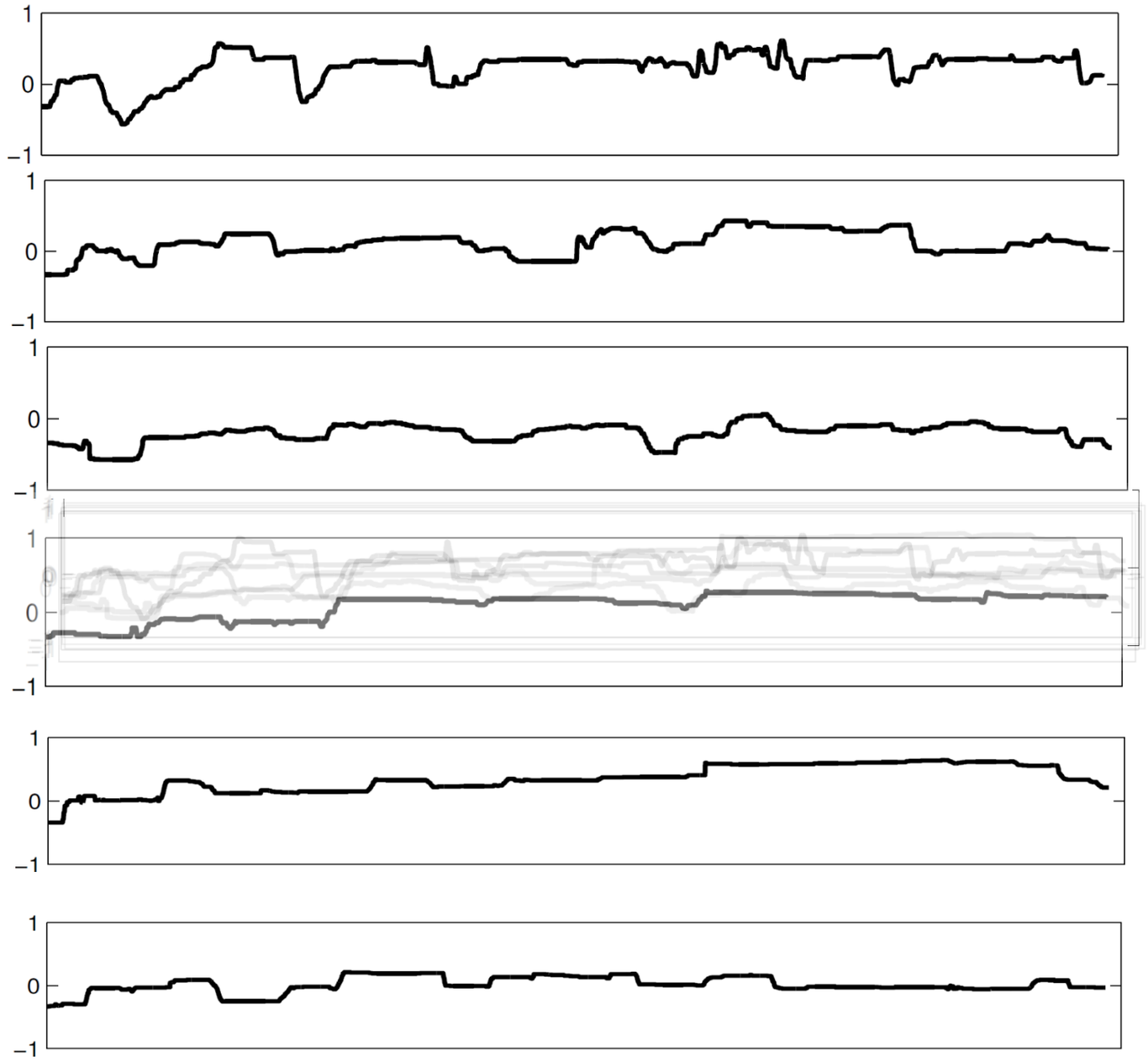
- $t_{threshold}$ = [0.025, 0.050, 0.075, 0.100, 0.125, 0.150, 0.175, 0.200]



- For low $t_{threshold}$ we have more high, low regions
- As $t_{threshold}$ is raised more neutral regions

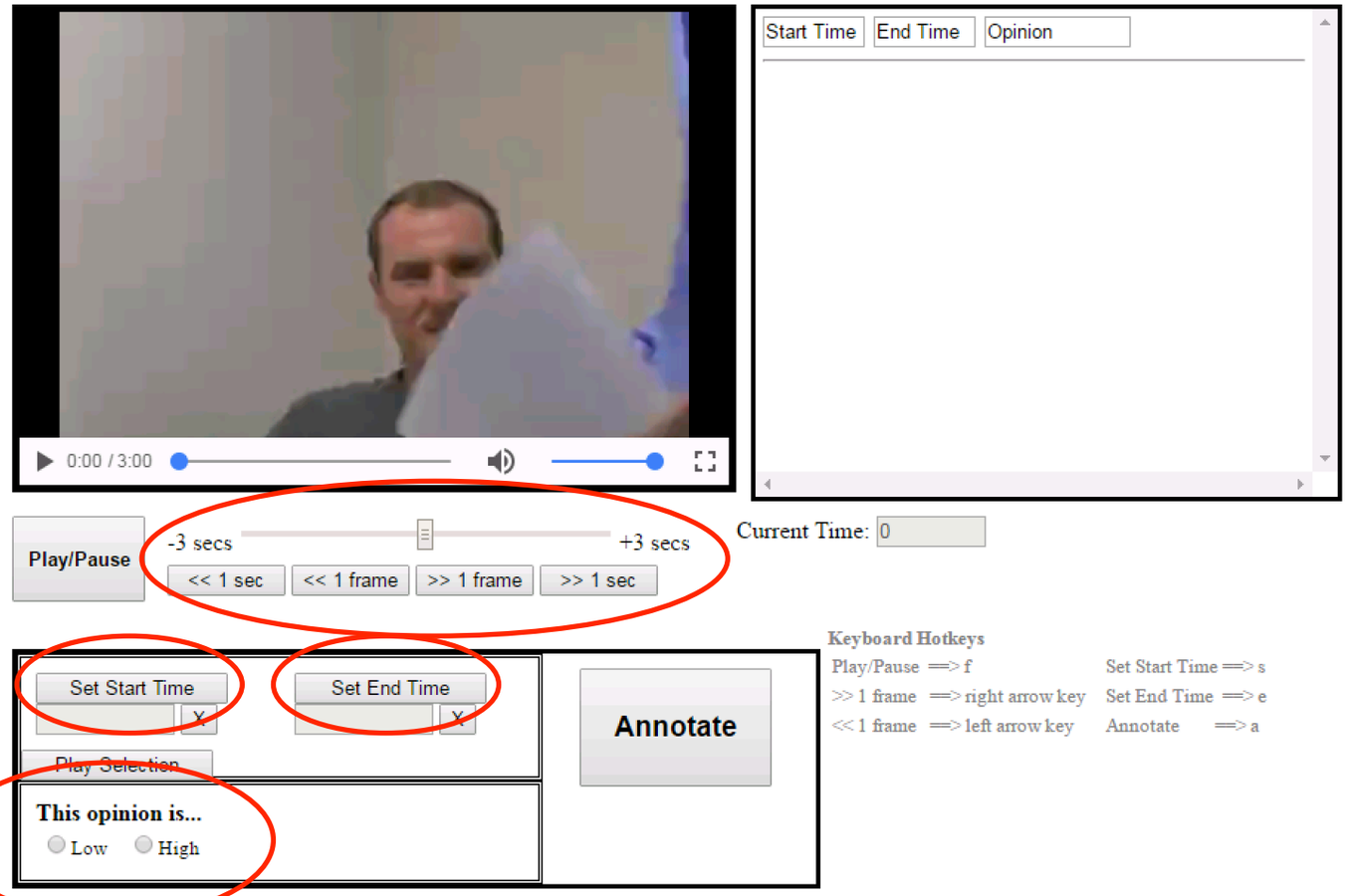
Baseline – Hotspot detection

- 6 evaluations considered individually
- Traces are averaged instead of QA
- Bin length and $t_{threshold}$ same parameters as QA.
- Unlike QA Individual trends are not considered



Hotspot ground truth

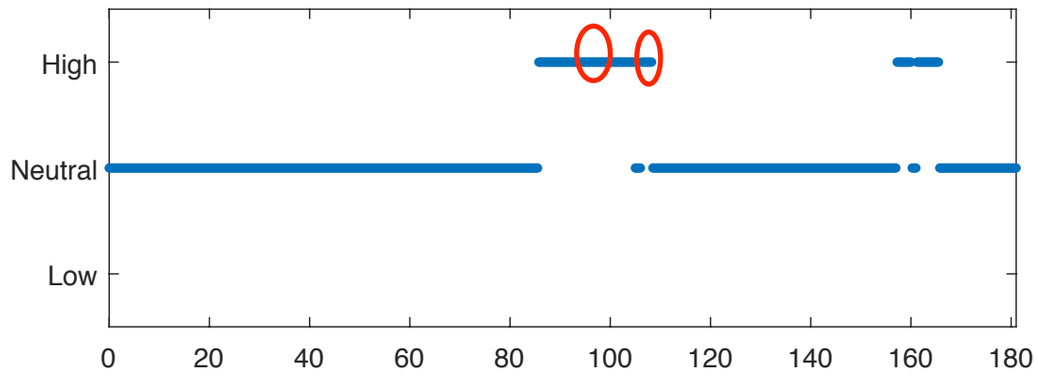
- Ground-truth established from scratch by perceptual evaluation
  - 16 sessions (8 arousal, 8 valence)
  - Evenly divided between 4 characters covering different emotions
  - Task – Select hotspot segments marking regions evaluator perceived as emotionally high or low, rest neutral, after watching entire clip

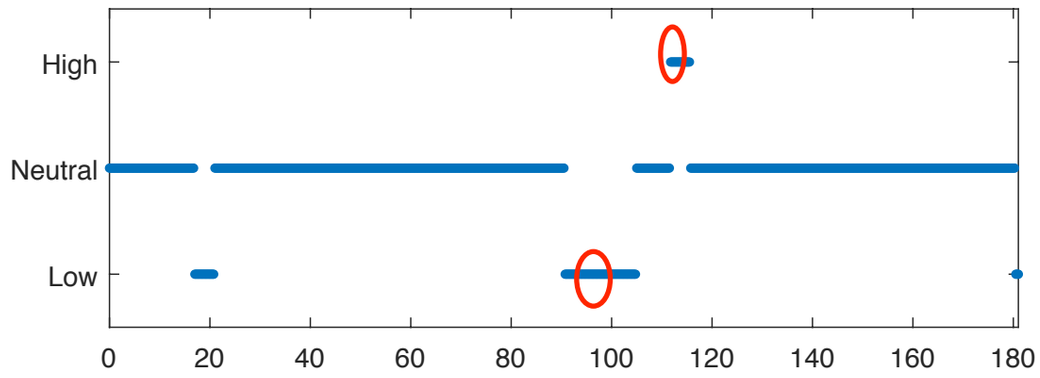


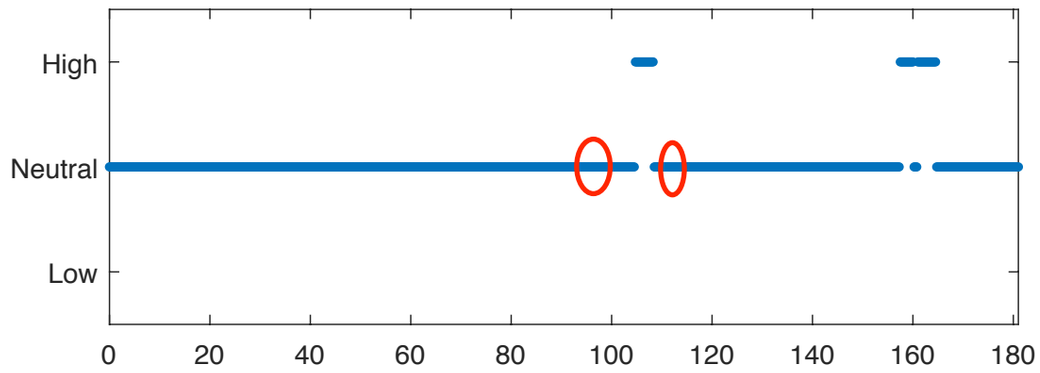
OCTAB Toolkit Park et al. 2012

Hotspot ground truth

- 3 evaluators
  - Fuse annotations by simple majority (2 out of 3)
  - Segments without agreement – no label
- Independently for arousal and valence







Hotspot ground truth

- Percentage hotspot
  - Around 5% of total traces annotated as hotspot
- Consistency – Fleiss Kappa
  - Used for measuring agreement between raters. [-1,1] corresponding to perfect disagreement and agreement
- Overall K and Region-wise K for Low, Neutral, High region
- Low values of K indicates the complexity of the task
- Time demanding

Dimension	Percentage of Ground truth hotspots			
	Low	Neutral	High	WA
Arousal	1.7%	93.4%	3.5%	1.4%
Valence	2.2%	95.6%	1.6%	0.6%

Dimension	Region-wise K			Overall K
	Low	Neutral	High	
Arousal	0.0651	0.1375	0.1938	0.1355
Valence	0.0778	0.1145	0.2256	0.1212

Results

- Proposed definition of hotspots compared to ground truth hotspot
- Process similar to Voice Activity Detection
  - Evaluation done with metrics used for VAD
- Hit Rate – Recall of neutral and emotional regions

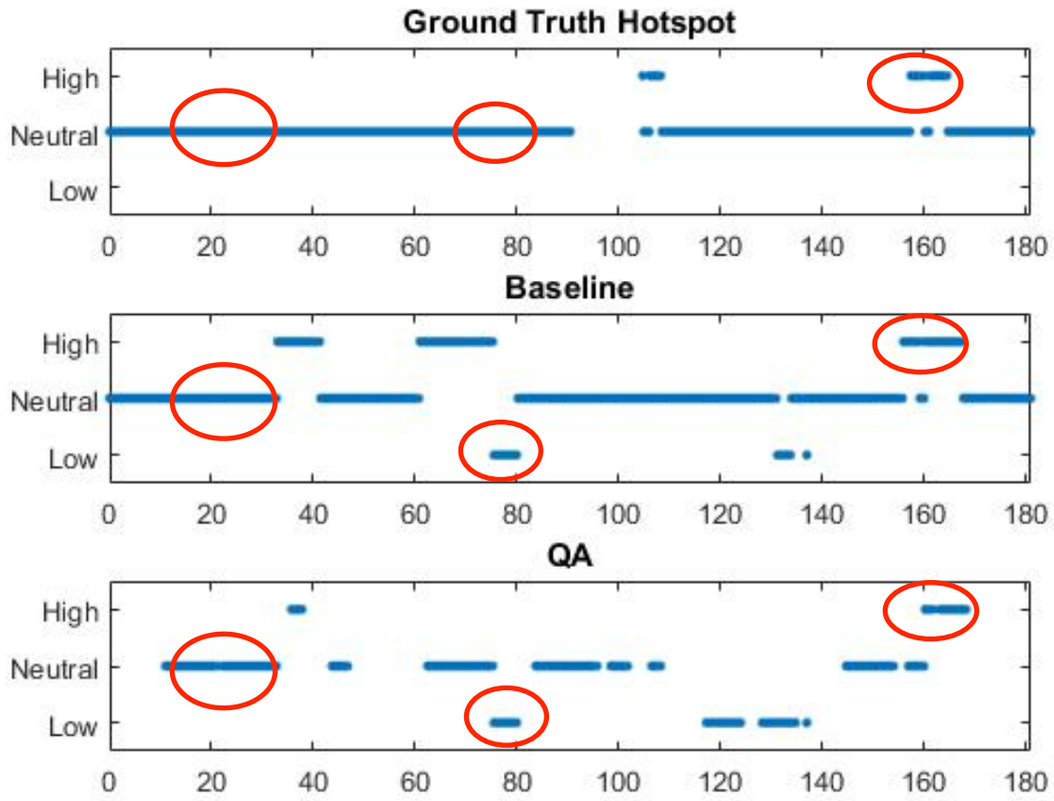
$$H_{h,l} = \frac{N_{high,low}^{pred}}{N_{high,low}^{ref}}$$

$$H_{neu} = \frac{N_{neu}^{pred}}{N_{neu}^{ref}}$$

$$H_{ov} = \frac{H_{h,l} + H_{neu}}{2}$$

Results

- Emphasis on recall on both high, low as well as neutral regions

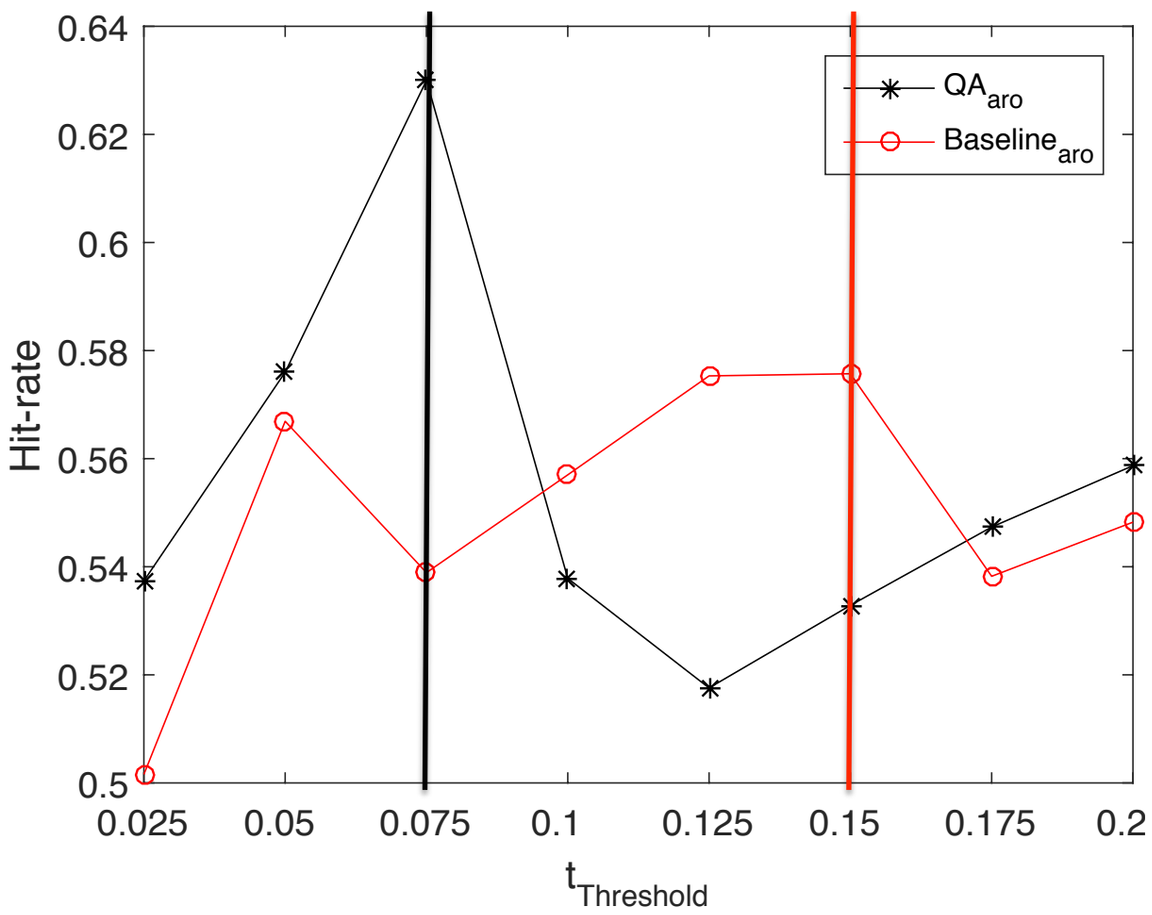


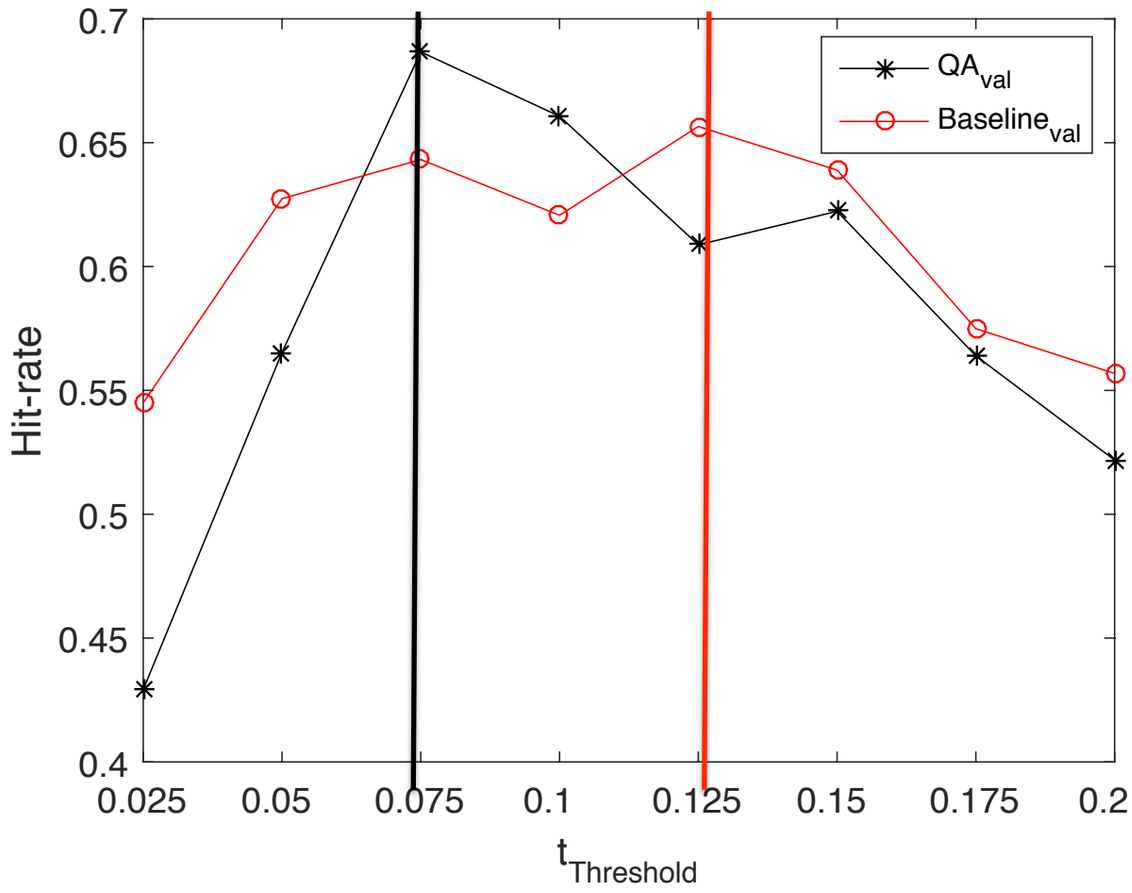
- False hotspot detection affects $H_{neu} = \frac{N_{neu}^{pred}}{N_{neu}^{ref}}$

- Good definition increases both rate of both recalls, captured by $H_{ov} = \frac{H_{h,l} + H_{neu}}{2}$

Best Definition?

- Which threshold gives best hitrates ?



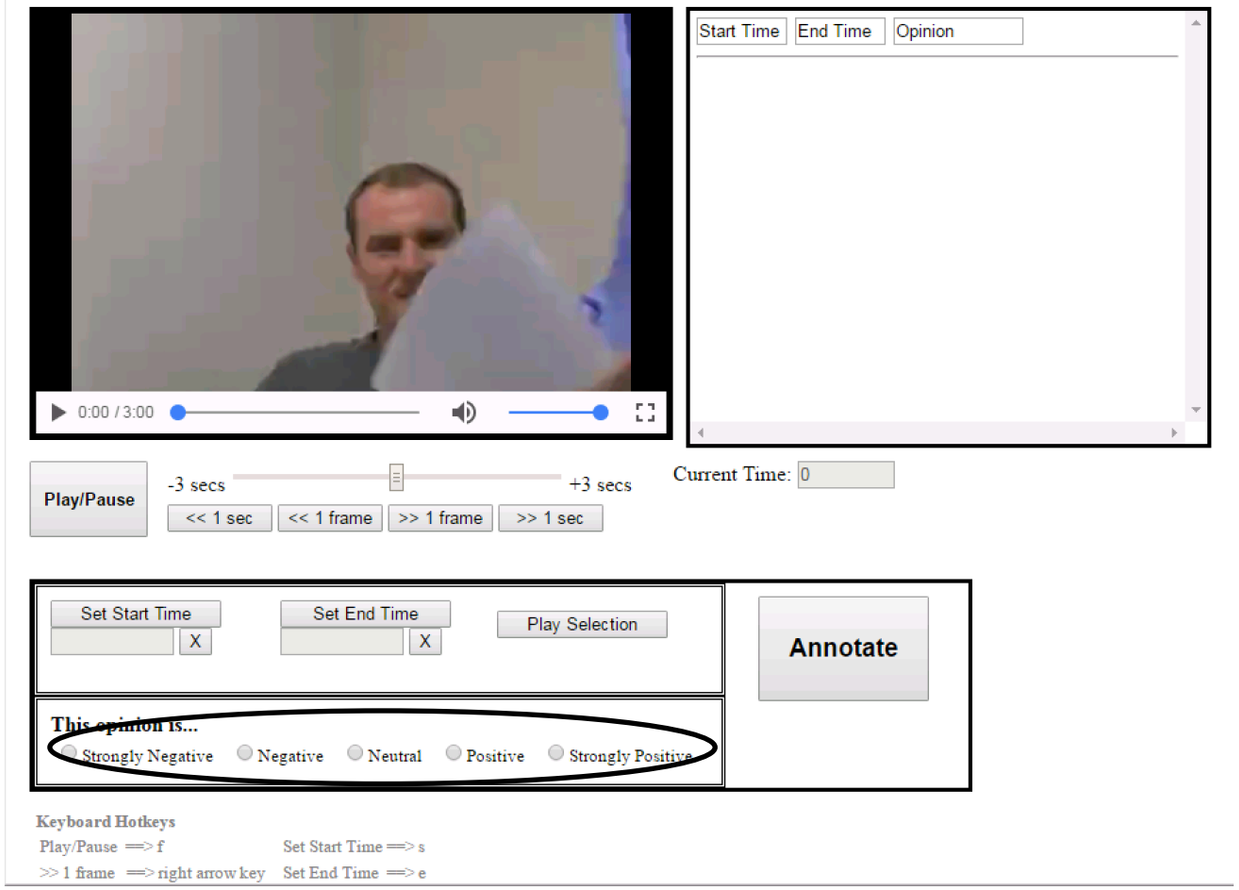


Hit-rate	
Arousal	
Baseline	0.58
QA	0.63

Hit-rate	
Valence	
Baseline	0.66
QA	0.69

Aposteriori Evaluation

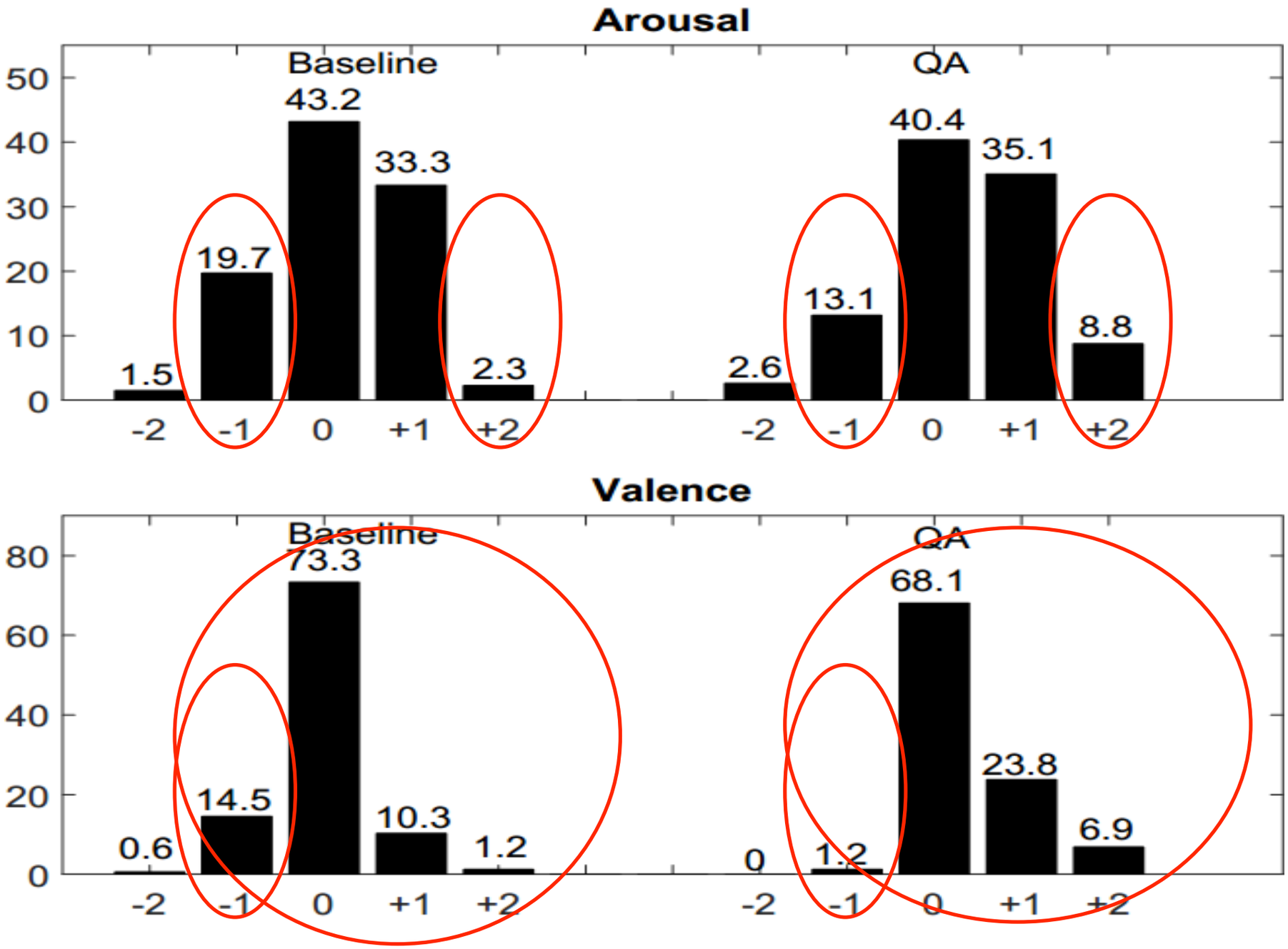
- Second set of evaluations on defined hotspots
- For each dialogue, proposed hotspots for QA, baseline evaluated posteriorly
  - Rate each hotspot once for QA and once for baseline
  - Best thresholds for baseline and QA used
  - 5 likert scale (-2 strongly disagree, 2 strongly agree)



Aposteriori Evaluation

Aposteriori Evaluation

- Reviewers find QA hotspots better



Conclusions

- Definition of emotionally salient regions over continuous time evaluations
- Two methods explored with various parameters
  - Baseline averaging
  - QA
- Hotspots defined through QA closer to ground truth and more agreeable posteriorly

Thanks for your attention!

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Thanks for your attention!

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