Emotion Recognition from EEG signals using Deep Learning

ONE LINE PITCH OF THE IDEA

Implementing State of the Art algorithms for Emotion Recognition from Multi-Channel EEG brain signals which can help in determining the thoughts and emotions of an individual.


Games


Education


NeuroSky


Wellness


Researchers & Developers

Dimensions of emotion:

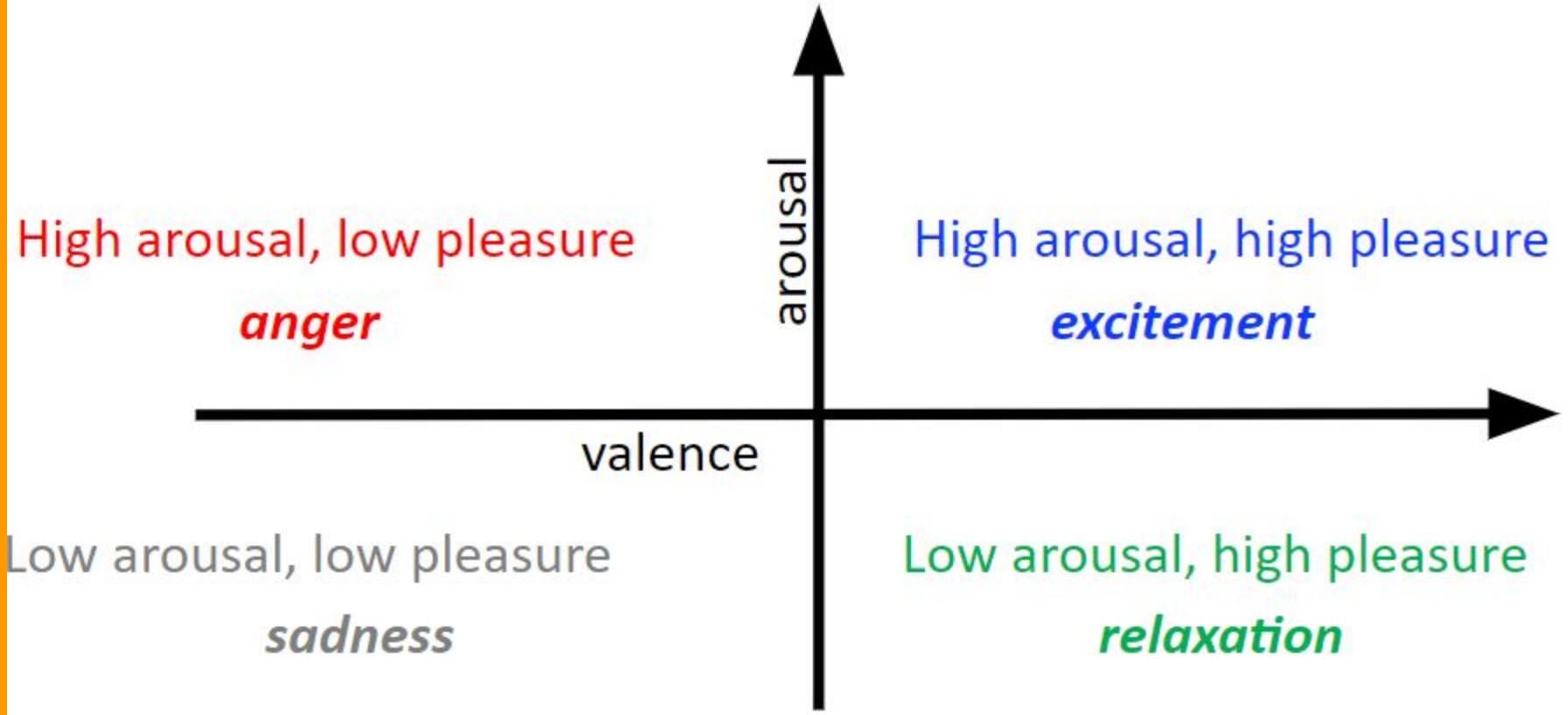
- **Valence** (positive, negative - the pleasantness of the stimulus)
  - 9: happy, pleased, satisfied, contented, hopeful
  - 1: unhappy, annoyed, unsatisfied, melancholic, despaired, or bored
- **Arousal** (strong, weak - the intensity of emotion provoked by the stimulus)
  - 9: stimulated, excited, frenzied, jittery, wide-awake, or aroused
  - 1: relaxed, calm, sluggish, dull, sleepy, or unaroused;
- **Control** (dominance - the degree of control exerted by the stimulus)
  - 9: in control, influential, important, dominant, autonomous, or controlling
  - 1: controlled, influenced, cared-for, awed, submissive, or guided

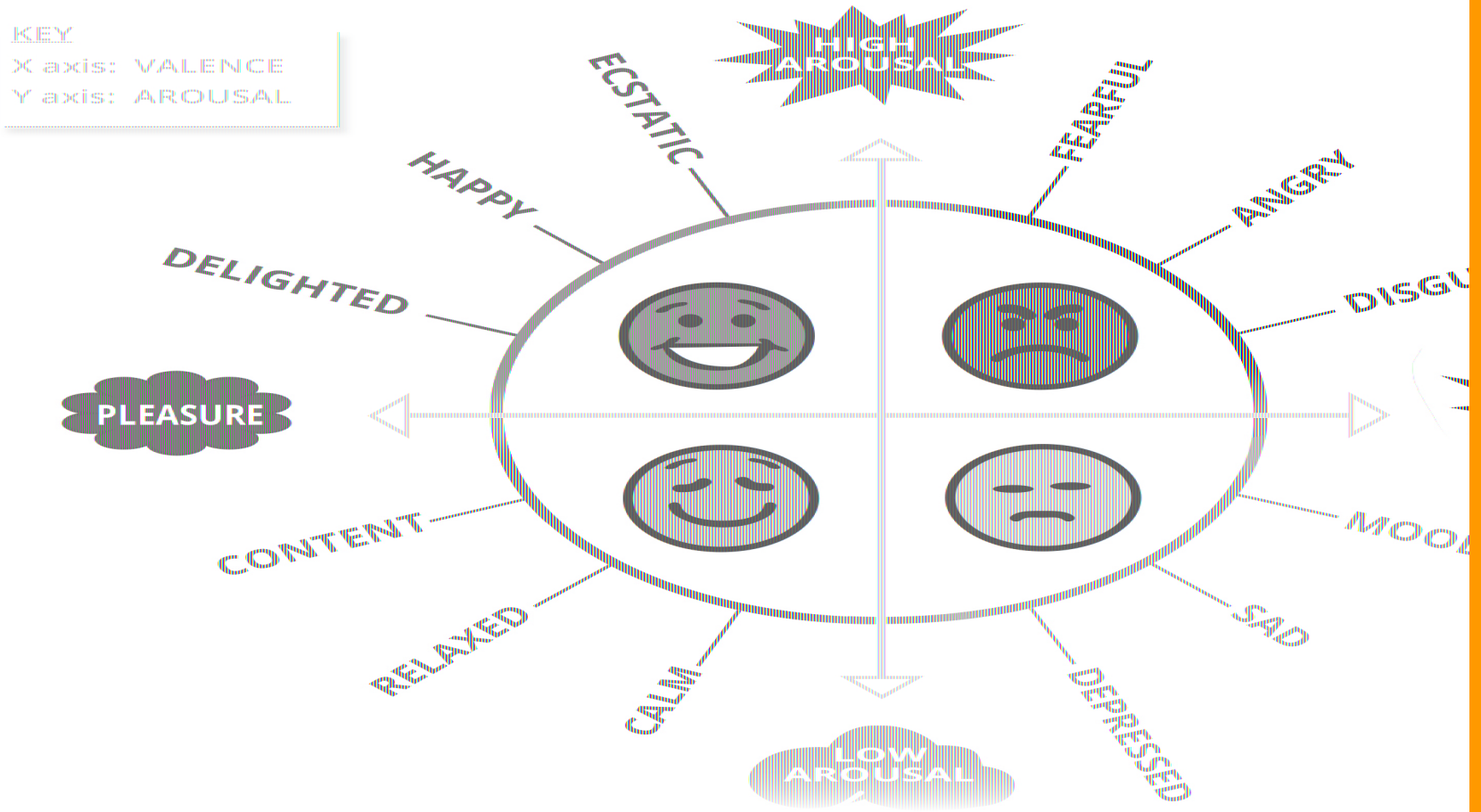
Arousal and Valence from the basic axis for most of emotions.

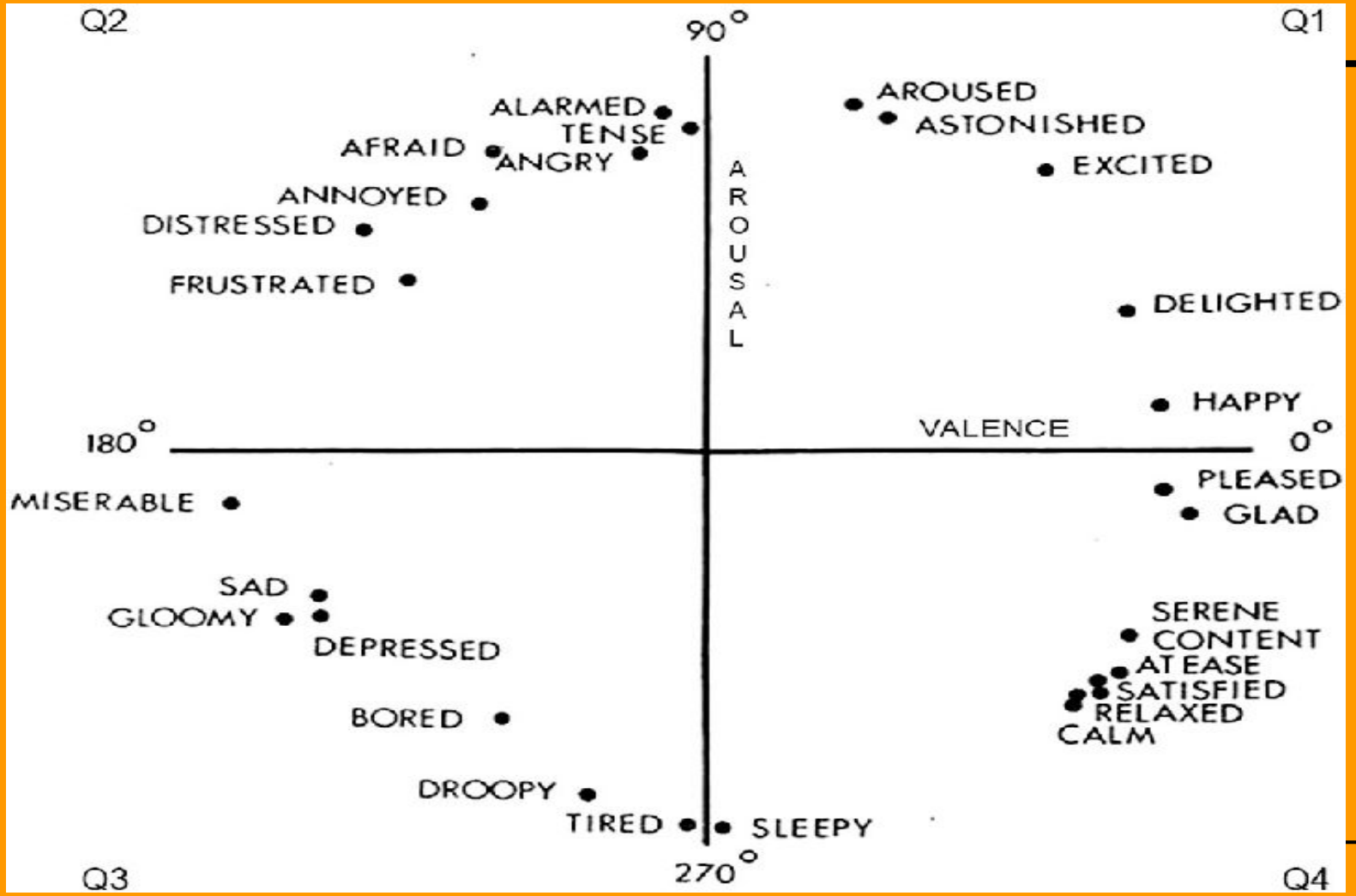
Dominance detects the control on the mind.

Liking and Familiarity detect how much a person likes or is familiar with something. This is used for lie detection.

Valence/Arousal Dimensions




KEY
X axis: VALENCE
Y axis: AROUSAL
HIGH AROUSAL
ECSTATIC
HAPPY
DELIGHTED
FRANTIC
ANGRY
PLEASURE
CONTENT
RELAXED
CALM
LOW AROUSAL


Q2
90°
Q1
ALARMED
TENSE
AFRAID
ANGRY
ANNOYED
DISTRESSED
FRUSTRATED
AROUSED
ASTONISHED
EXCITED
DELIGHTED
HAPPY
AROUSAL
VALENCE
180°
0°
MISERABLE
PLEASED
GLAD
SAD
GLOOMY
DEPRESSED
SERENE
CONTENT
AT EASE
SATISFIED
RELAXED
CALM
BORED
DROOPY
TIRED
SLEEPY
Q3
270°
Q4

Specialised application software!

- Specialised military and police applications.
- For training (tracking cadet’s mental state).
- Detecting stress in drivers, pilots, cadets.
- For criminal interrogation (will keep a check on crime rate).
- Lie detection (polygraphs test can be faked but brain signals can’t be).
- Would prove to be a **MAJOR ADVANTAGE**.

Groundbreaking innovation in the field of healthcare!

- Detecting mental state of babies, autistic / mentally paralysed patients / specially abled people / patients in coma / trauma patients / feedback for how someone is being treated.
- Psychology and Neurology in diagnosis of patients.
- Helping psychiatrists to deal with patients better as they'll have a better understanding of their emotion.
- Indicating post traumatic stress disorders, major depression and anxiety.
- Researches show with the help of valence, arousal and dominance, we can measure levels of burnout and productivity.
- Fits / Seizure diagnosis.

Future Enhancements

Education

- Detecting confusion in students (would enhance e-learning).
- Webinar feedbacks.

Honest Feedbacks

- Sentiments towards politicians, products, countries, ideas, personalities, ideologies,movies, music, games, etc.

Luxury Uses

- Automating lighting conditions and room environment (fragrance, temperature etc.) according to the emotions user is experiencing.

Evolutionary in Entertainment & Gaming Industry :-

Could generate great revenues by having a gripping effect on the players / viewers:

- Making games more interactive based on user's emotional state and indulgence. Example: first person shooters, strategy games, racing, arcade, fighting, RPG, open-world games, virtual reality, altering the storyline to player's interests.

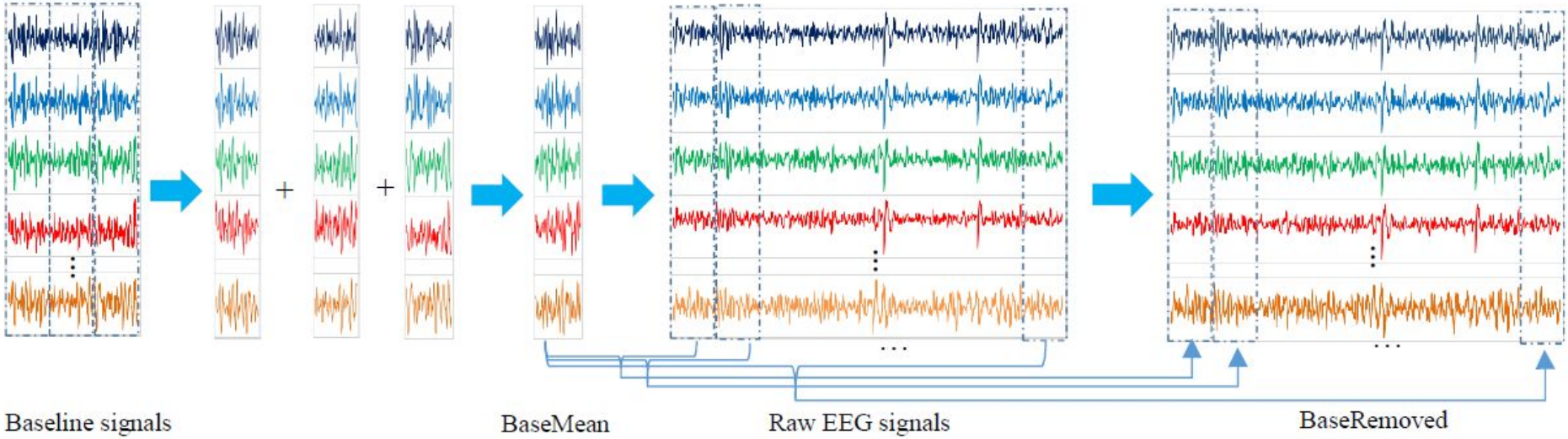
Better than MRI's and invasive BCI's

Facebook is currently investing a lot in BCI program outlining their goal to build a non invasive, wearable device that lets people type by simply imagining themselves talking.

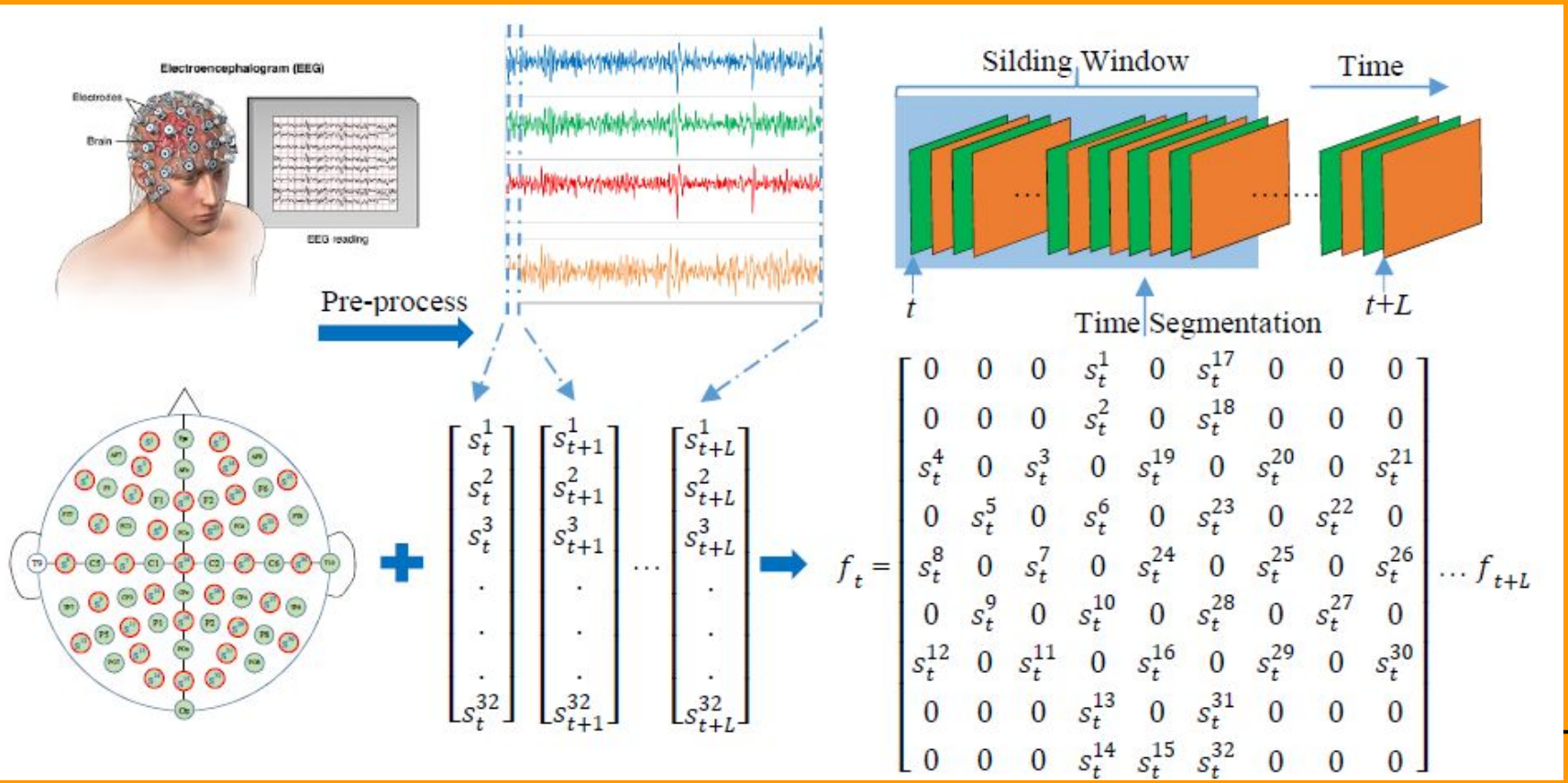
SOLUTION

- As a challenging pattern recognition task, automatic real time emotion recognition based on multichannel EEG signals is becoming an important computer aided method for emotion disorder diagnose in neurology and psychiatry. Traditional machine learning approaches require to design and extract various features from single or multiple channels based on comprehensive domain knowledge
- Consequently , these approaches may be an obstacle for non domain experts. On the contrast , deep learning approaches have been used successfully in many recent literatures to learn features and classify different types of data.
- A hybrid neural network which combines ‘Convolutional Neural Network (CNN)’ and ‘Recurrent Neural Network (RNN)’ has been applied to classify human emotion states by effectively learning compositional spatial temporal representation of raw EEG streams . The CNN module is used to mine the inter channel correlation among physically adjacent EEG signals by converting the chain like EEG sequence into 2D frame sequence. The LSTM module is adopted to mine contextual information.
- Experiments are carried out in a segment level emotion identification task, on the DEAP benchmarking dataset

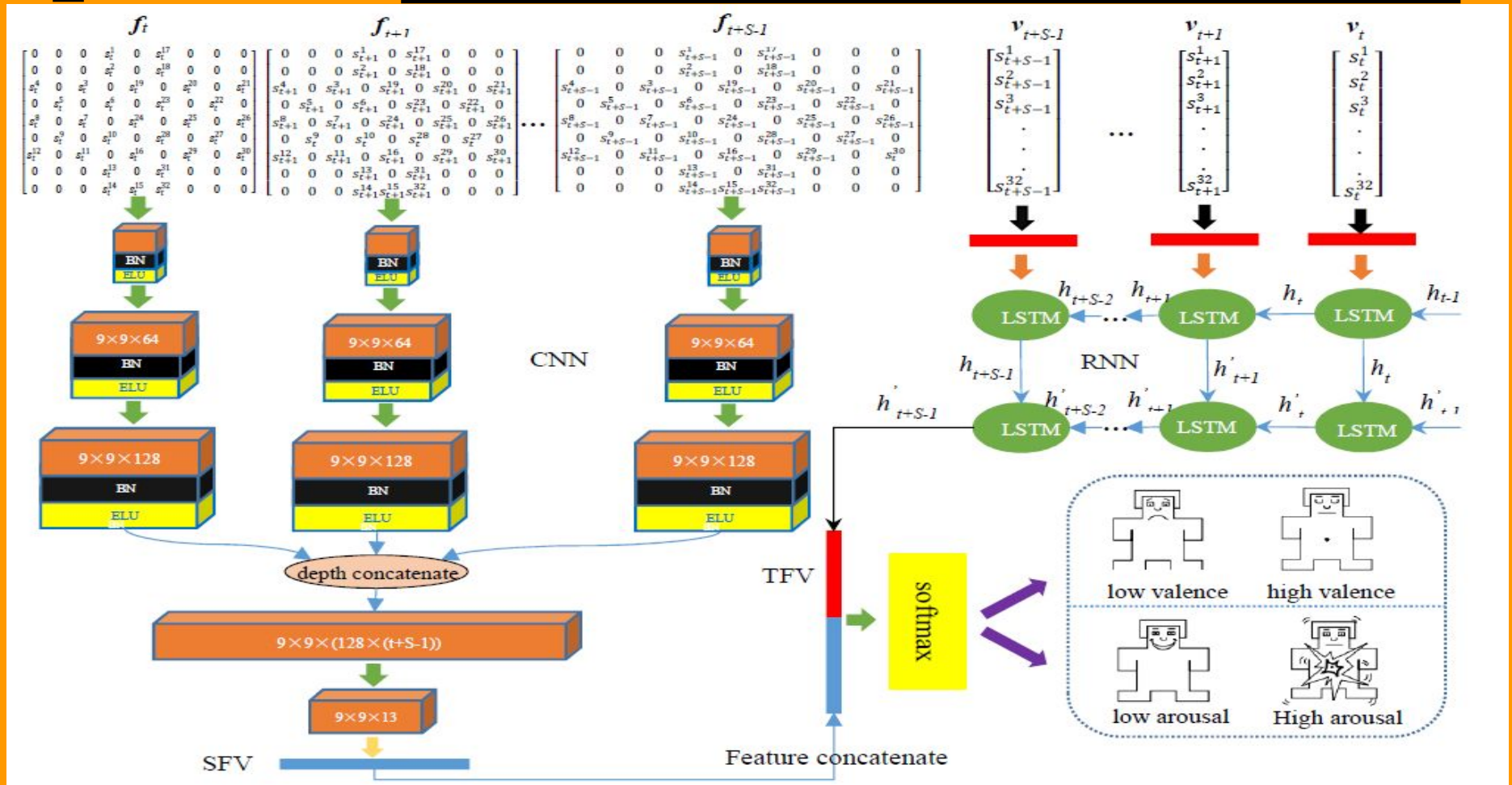
Pre-Processing



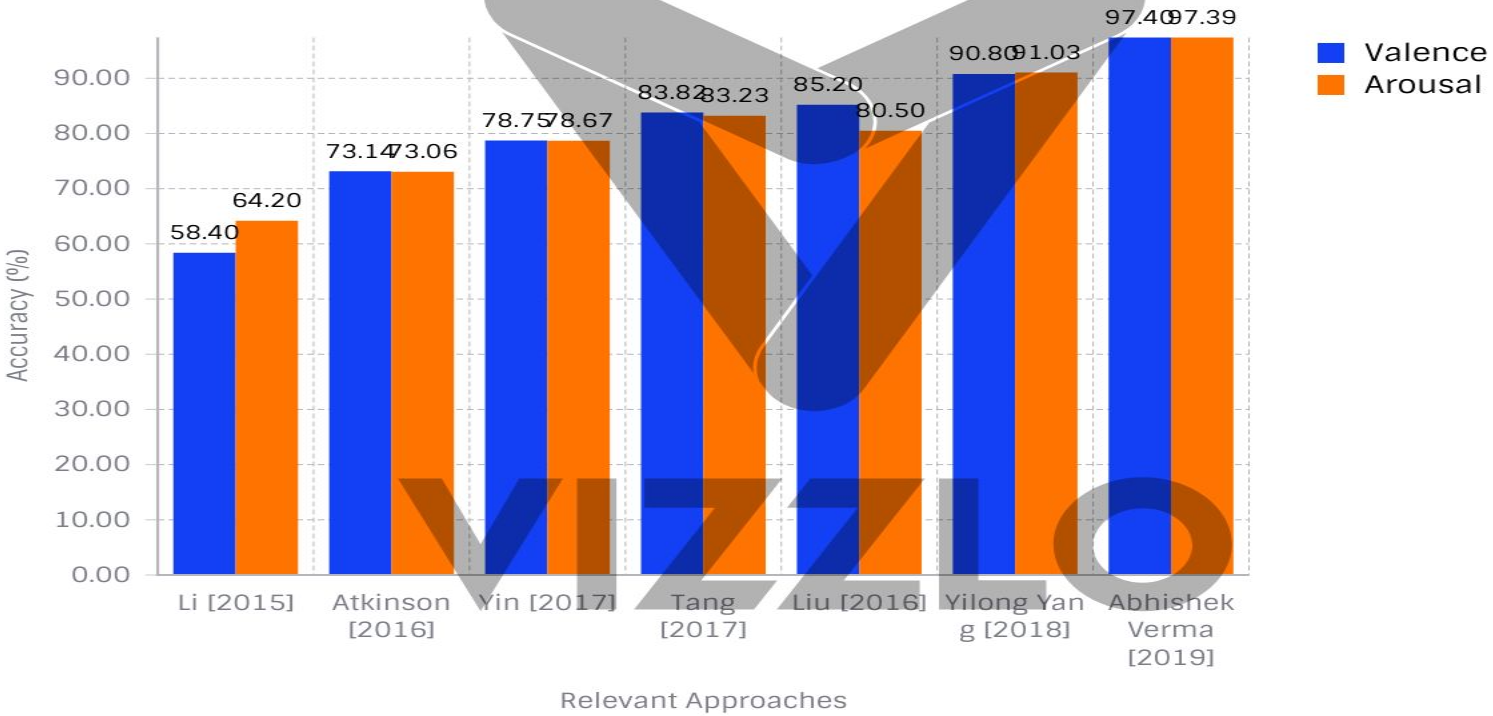
Converting 1-D EEG signals to 2-D frames



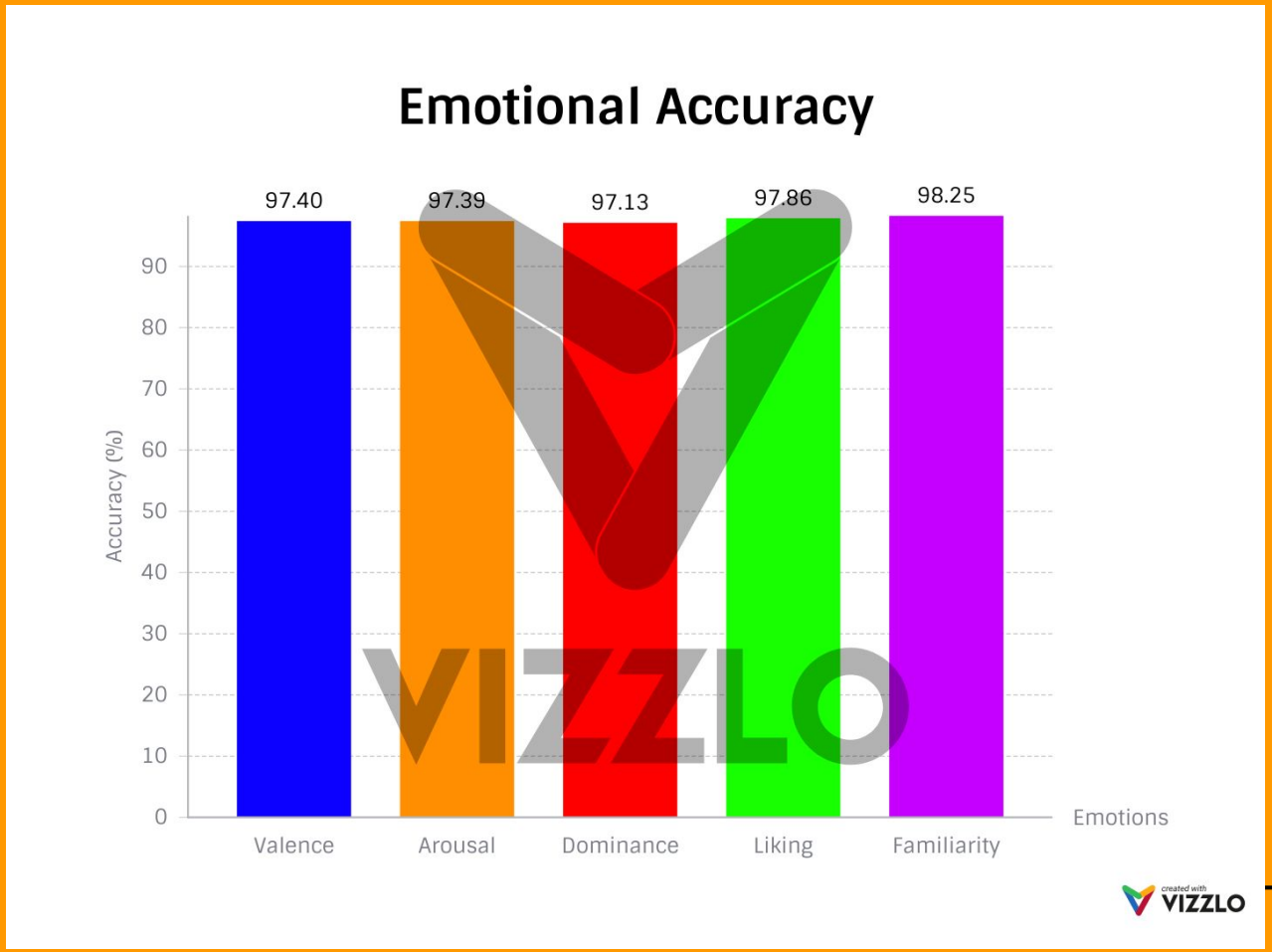
Parallel Convolutional-Recurrent Neural Network

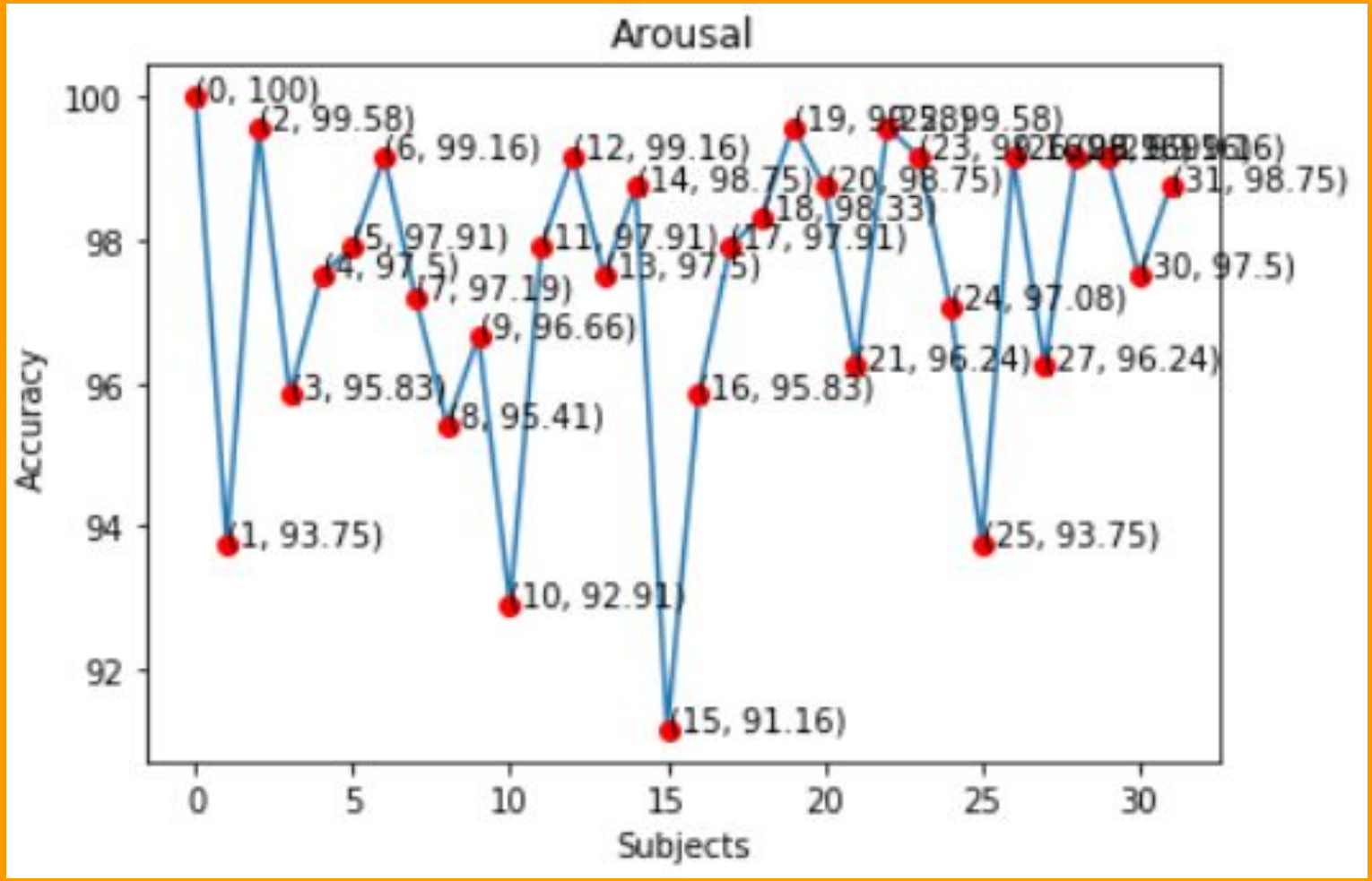


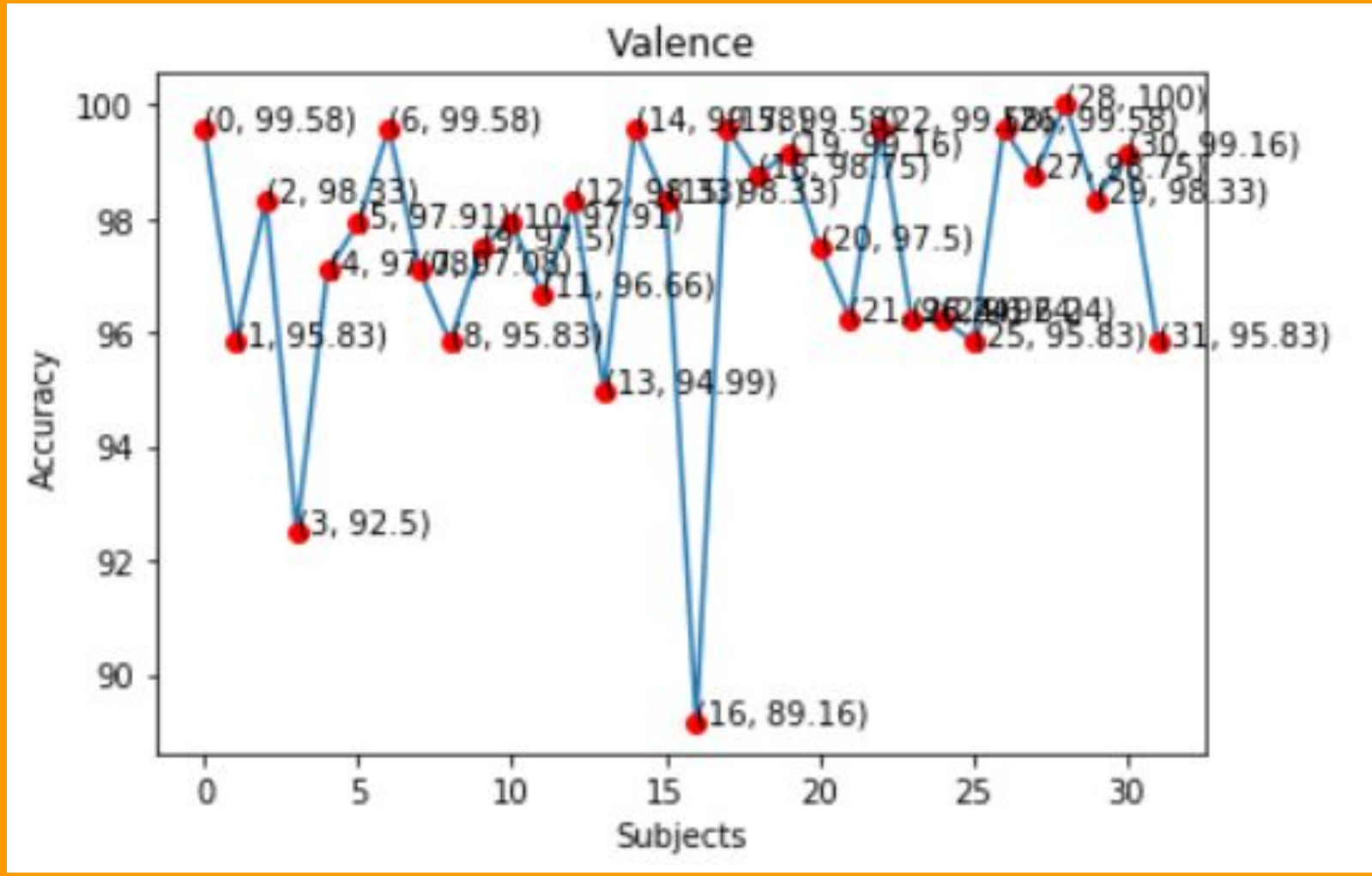
Performance comparison among relevant approaches

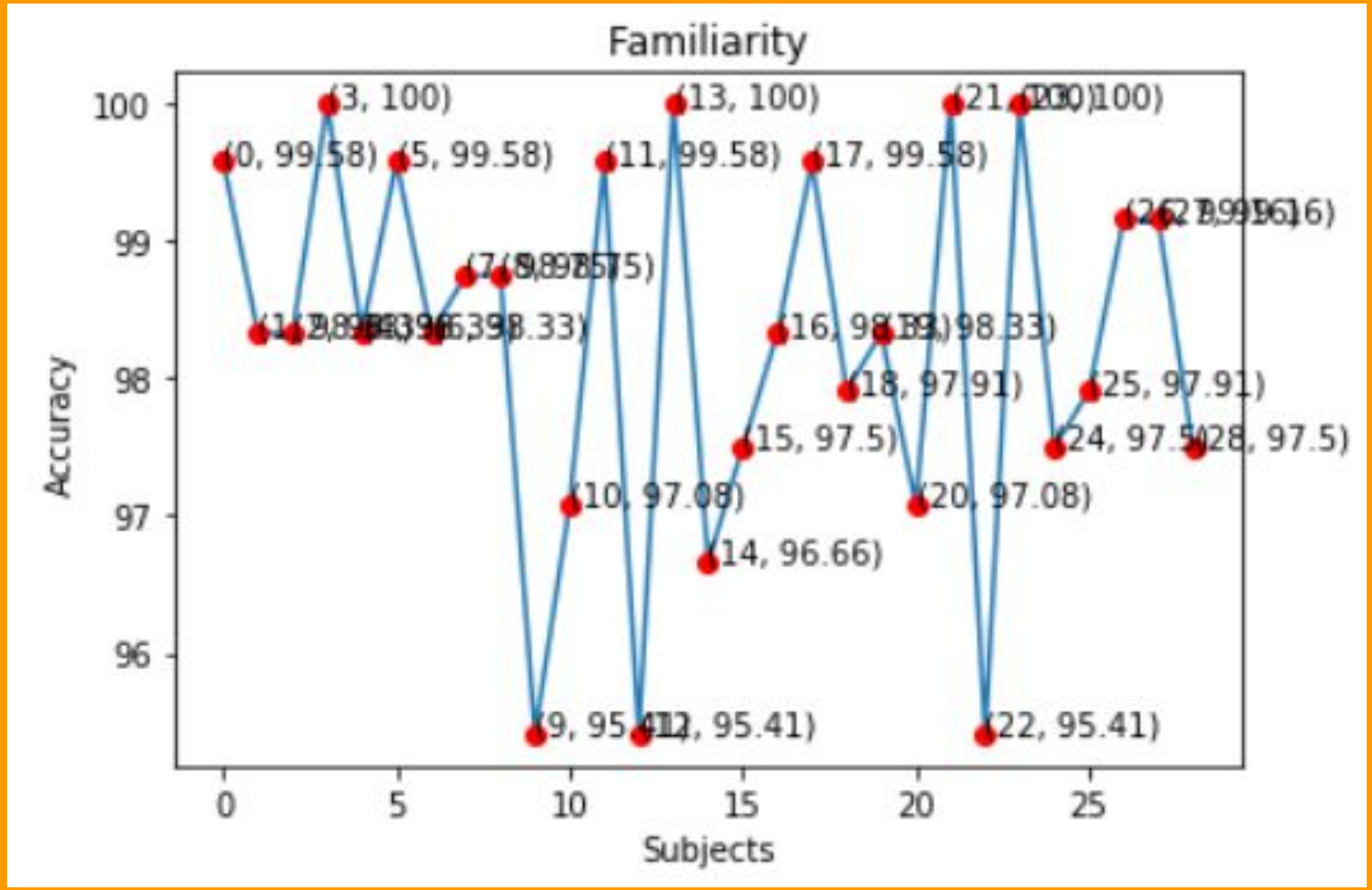


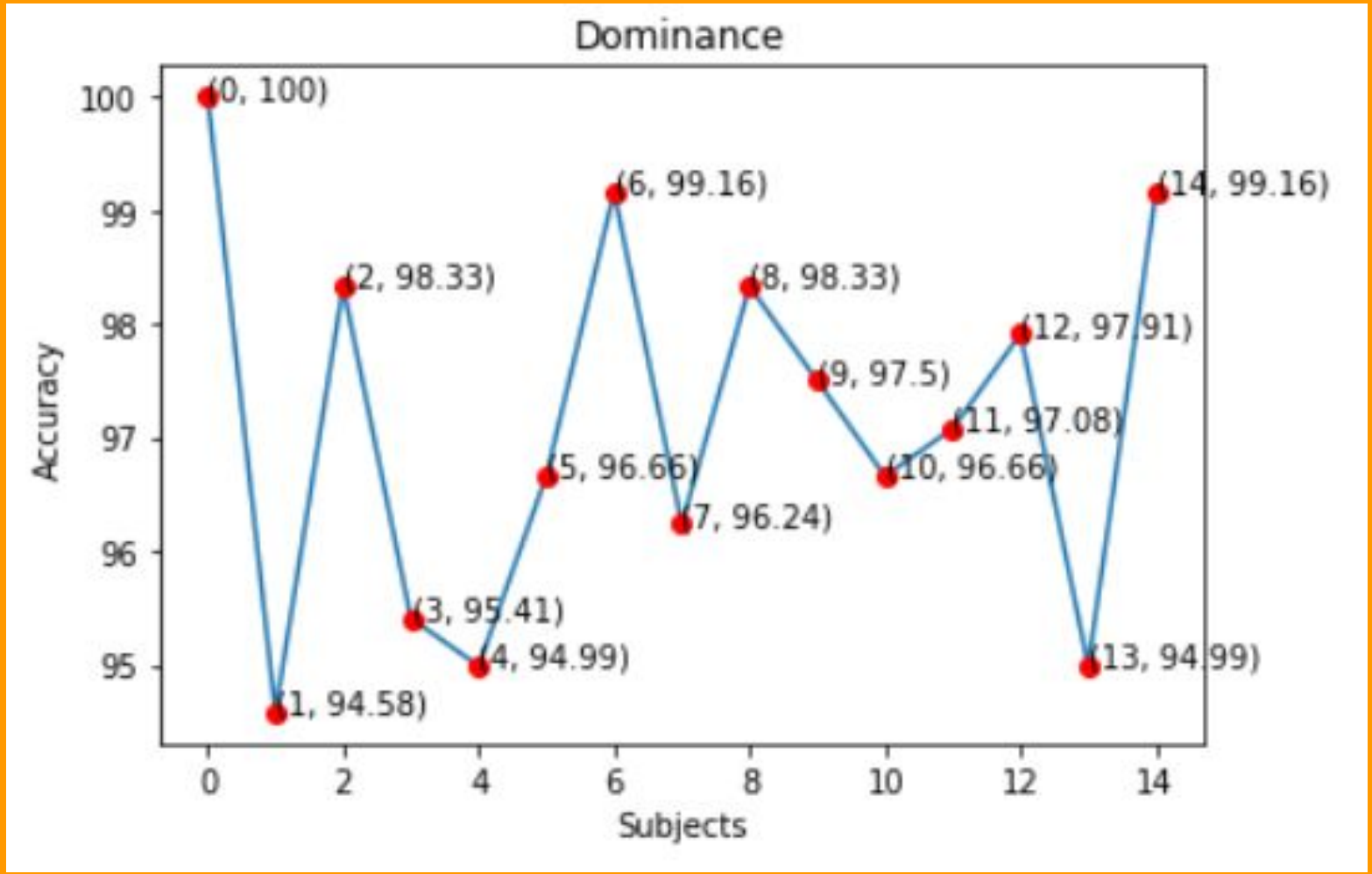
Innovations over other relevant approaches




Arousal
Accuracy
Subjects
100
98
96
94
92
0
5
10
15
20
25
30
(0, 100)
(2, 99.58)
(6, 99.16)
(12, 99.16)
(14, 98.75)
(20, 98.75)
(31, 98.75)
(18, 98.33)
(5, 97.91)
(11, 97.91)
(17, 97.91)
(4, 97.5)
(13, 97.5)
(30, 97.5)
(7, 97.19)
(24, 97.08)
(9, 96.66)
(21, 96.24)
(27, 96.24)
(3, 95.83)
(16, 95.83)
(8, 95.41)
(1, 93.75)
(25, 93.75)
(10, 92.91)
(15, 91.16)


Valence
Accuracy
Subjects
100
98
96
94
92
90
0
5
10
15
20
25
30
(0, 99.58)
(6, 99.58)
(28, 100)
(2, 98.33)
(30, 99.16)
(29, 98.33)
(20, 97.5)
(11, 96.66)
(31, 95.83)
(13, 94.99)
(3, 92.5)
(16, 89.16)


Familiarity
Accuracy
Subjects
100
99
98
97
96
0
5
10
15
20
25
(3, 100)
(13, 100)
(0, 99.58)
(5, 99.58)
(11, 99.58)
(17, 99.58)
(15, 97.5)
(10, 97.08)
(14, 96.66)
(20, 97.08)
(18, 97.91)
(25, 97.91)
(24, 97.5)
(28, 97.5)
(22, 95.41)


Dominance
Accuracy
Subjects
100
99
98
97
96
95
0
2
4
6
8
10
12
14
(0, 100)
(1, 94.58)
(2, 98.33)
(3, 95.41)
(4, 94.99)
(5, 96.66)
(6, 99.16)
(7, 96.24)
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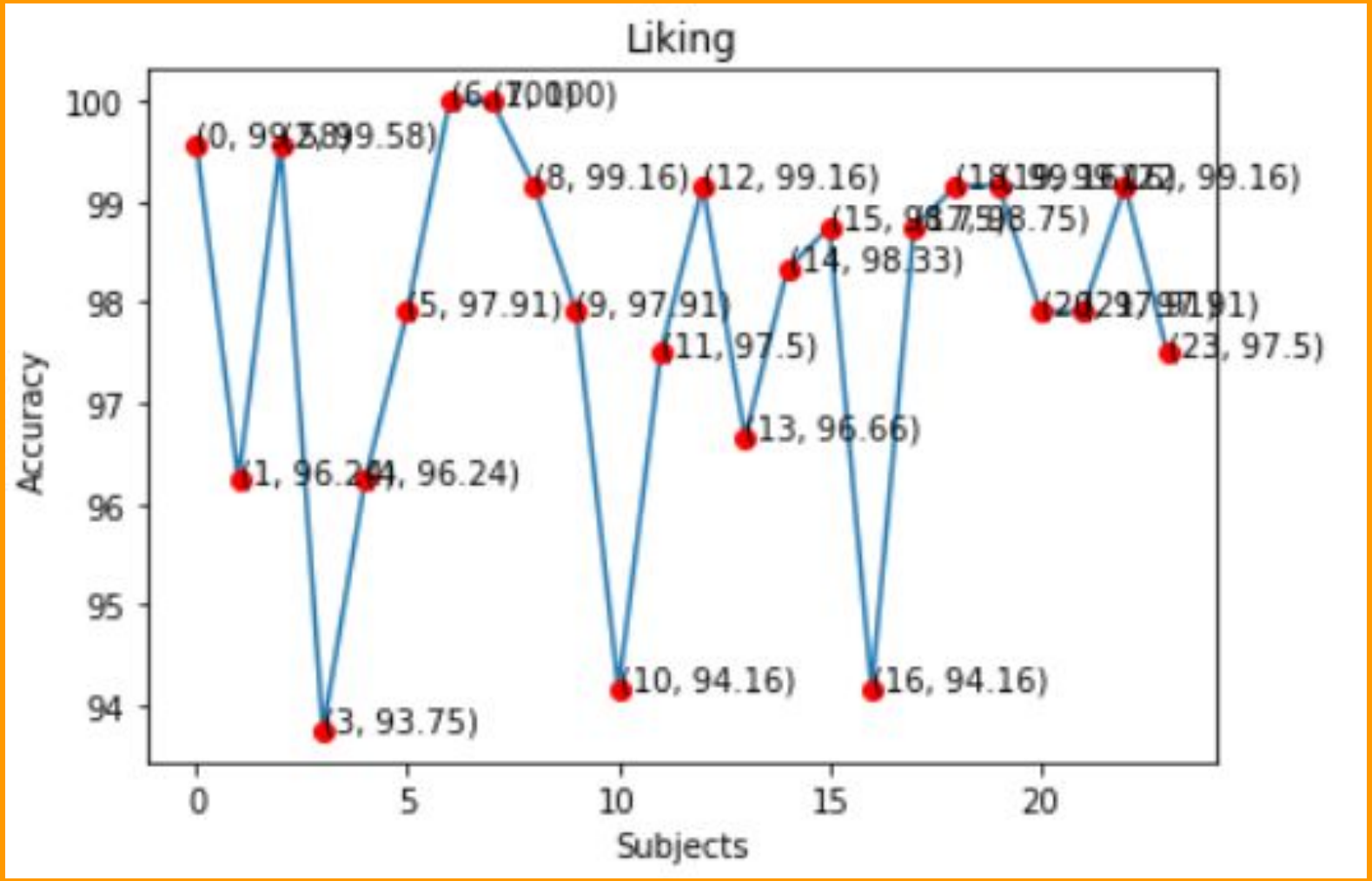
(14, 99.16)


Liking
Accuracy
Subjects
100
99
98
97
96
95
94
0
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20
(0, 99.58)
(1, 96.24)
(3, 93.75)
(4, 96.24)
(5, 97.91)
(8, 99.16)
(9, 97.91)
(10, 94.16)
(11, 97.5)
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(13, 96.66)
(14, 98.33)
(16, 94.16)
(23, 97.5)

THANK YOU