

Tutorial



Recent Advances and Challenges in Facial Micro-Expression Analysis

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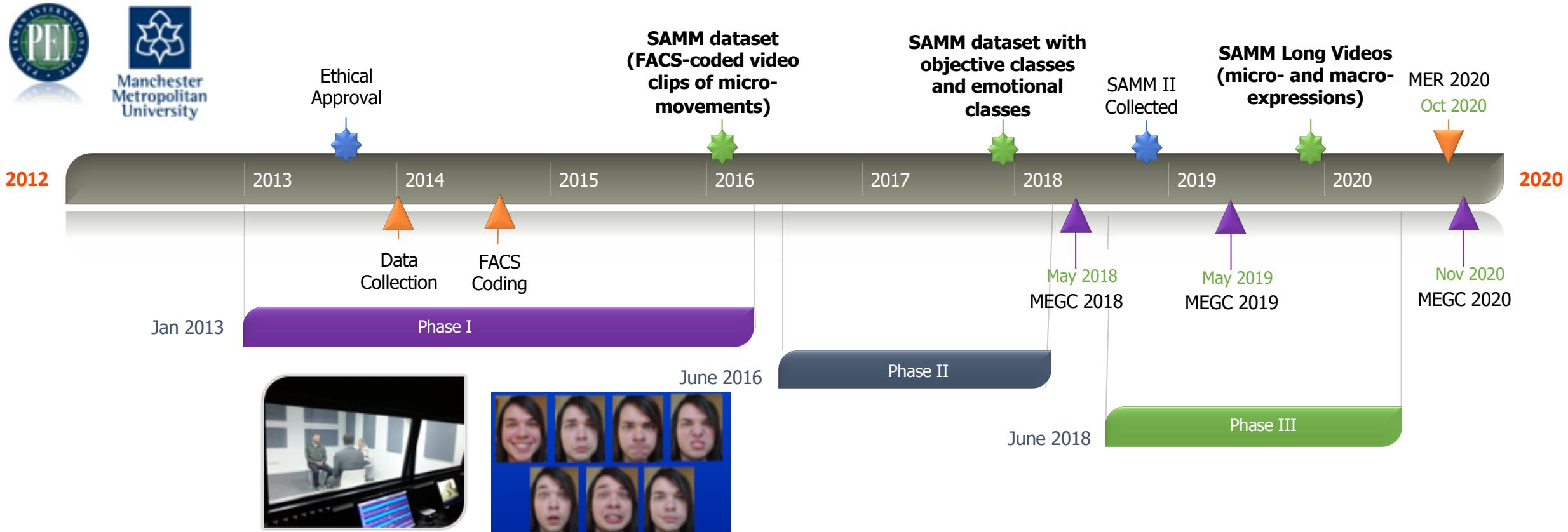
Speaker: Dr. Moi Hoon Yap, Reader in Computer Vision

Spontenous Actions and Micro-facial Movements (SAMM) Dataset

Manchester Metropolitan University



The Development Process of SAMM



Facial Expressions

- **Facial Expressions**

- 7 basic emotions: Happy, Sad, Anger, Disgust, Fear, Surprise and Contempt
- Pioneered by Paul Ekman [1]
- Work on facial expression recognition highly influenced by psychological research in emotion

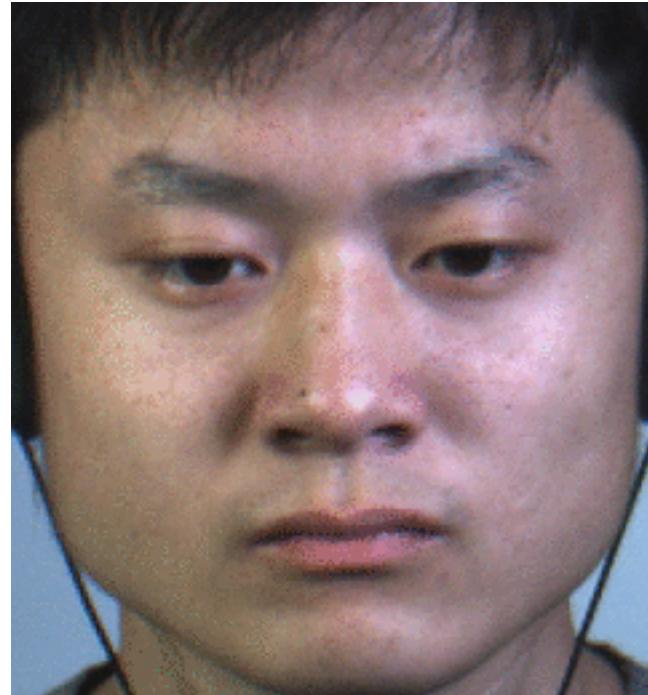


- **Facial Micro-expressions**

- Occurs when a person attempts to suppress a facial expression
- Very short in duration, generally lasting no longer than ½ second [2]

Why Facial Micro-expressions?

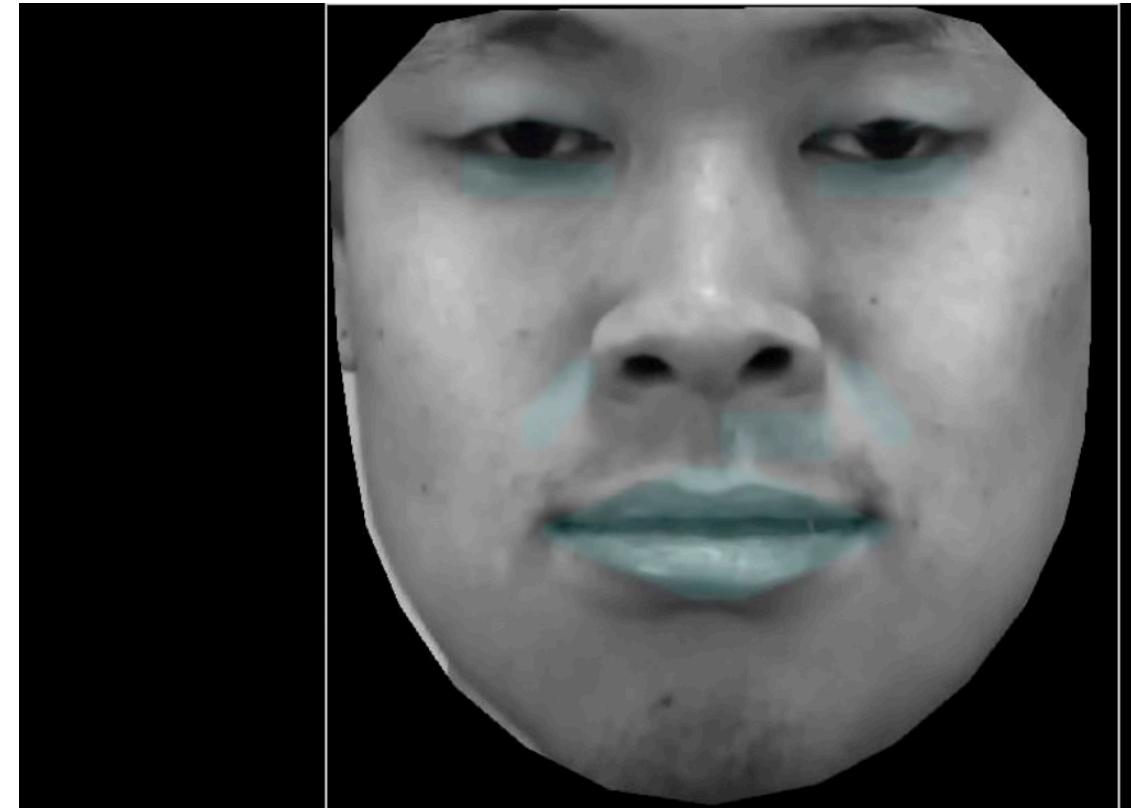
- **Facial Micro-expressions**



Why SAMM?

• Why Facial Micro-expressions?

- Being able to extract micro-movements when someone is attempting to hide true feelings would help real-world application of security and deception detection
- To help people with health problems such as depression or facial paresis. This approach works to help people who cannot readily identify the problems they are facing day to day
- To train humans to better understand micro-expressions by combining technological approaches and allow for improved integration of cross-discipline research



Why SAMM?

- Limited Datasets available in this field

Dataset	Participants	Resolution	FPS	Samples	Emotion Classes	FACS Coded	Ethnicities
Polikovsky [14]	11	640×480	200	13	7	Yes	3
USF-HD [21]	N/A	720×1280	29.7	100	4	No	N/A
YorkDDT [22]	9	320×240	25	18	N/A	No	N/A
CASME [25]	35	640×480, 1280×720	60	195	7	Yes	1
SMIC [24]	20	640×480	100 and 25	164	3	No	3
CASME II [26]	35	640×480	200	247	5	Yes	1
SAMM [27]	32	2040×1088	200	159	7	Yes	13
CAS(ME) ² [28]	22	640×480	30	250 macro, 53 micro	4	No	1

The making of SAMM Dataset

● Ethics

- Approved by Research Ethics Committee at The Manchester Metropolitan University (SE121318A1)
- All participants signed informed consent to take part and for their images to be published for research.

● Equipment

- Camera: Basler Ace acA2000-340km, with a grey-scale sensor, set to record at 200fps, resolution 2040 x 1088
- 32 inch flat screen TV to display stimuli

● High-Speed Data Capture

- Frame grabber: A RAID array of independently tested solid state drives to avoid frame drop
- Software: IO industries Streams 7



The making of SAMM Dataset

- **Lighting**

- Two lights that contained an array of Light Emitting Diodes (LEDs)
- Illuminance of 1750 lux at 50cm

- **Experimental Setup**

- Observer controlled the equipment and use one way mirror room and intercom system for communication

- **Questionnaires**

- Before experiment: to find suitable stimuli
- After experiment: for self-report on emotion experience

- **Stimuli**

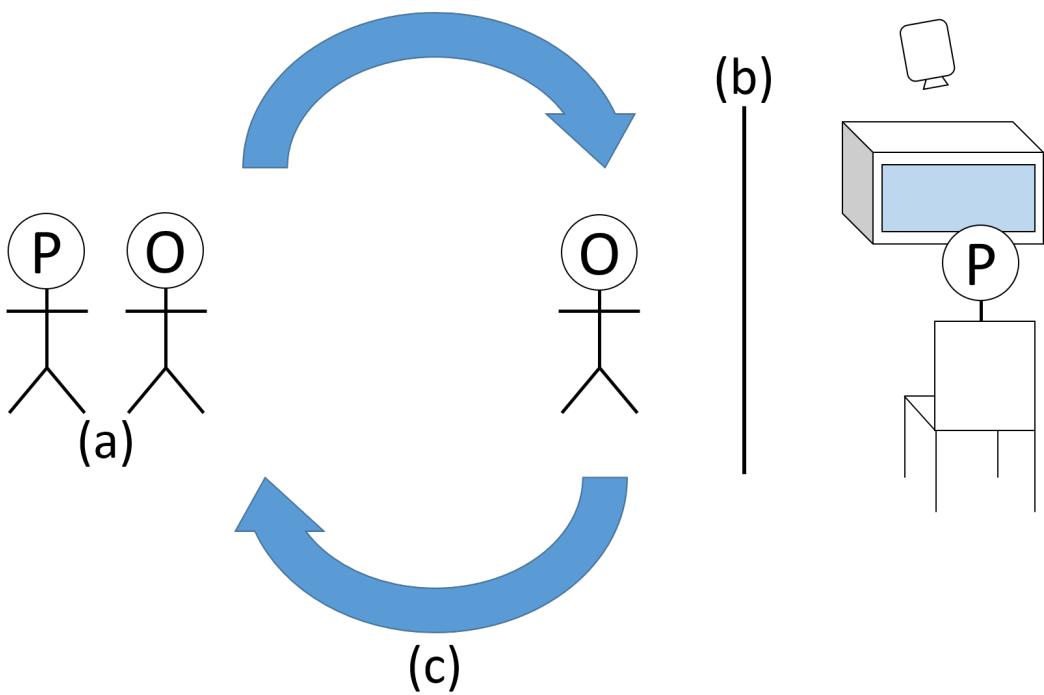
- The majority of the emotional induction stimuli were video clips from the Internet



The making of SAMM Dataset

• Full Process

- Invitation and recruitment
 - Observer recruit Participant and email a questionnaire. Participant to return questionnaire before the experiment.
 - Observer prepares the stimuli and schedule Participant for the experiment
- During experiment
 - Observer (O) gives an overview of the experiment to Participant (P)
 - P sign consent form (if agree)
 - P completes an experiment by watching tailored stimuli while O recording P using high-speed camera
 - P self-report on a questionnaire
 - P thanked and leaves the experiment



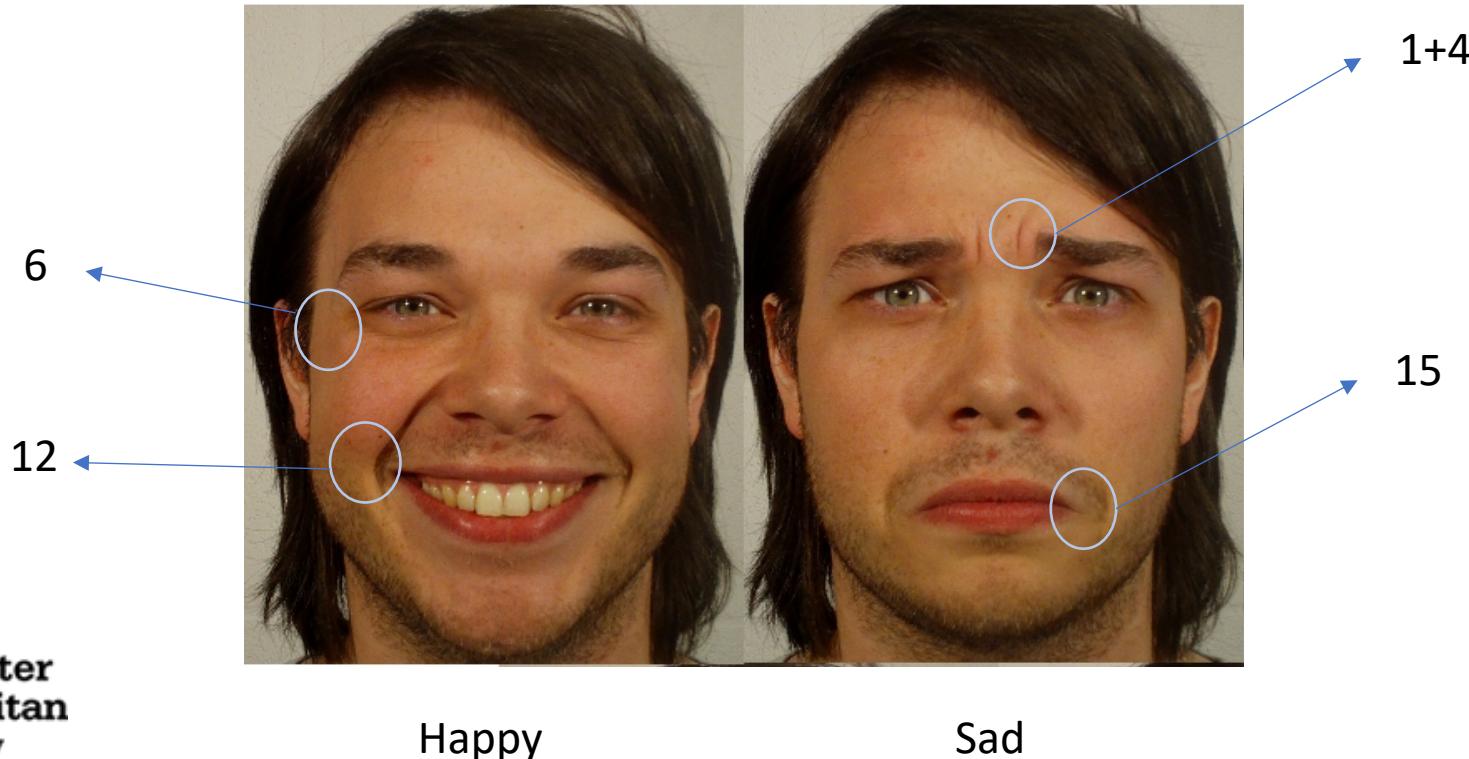
The making of SAMM Dataset



Facial Action Coding Systems – FACS Coding

- **Facial Action Coding Systems**

- SAMM is coded by three certified FACS Coders
- Reliability score: The number of AUs where all coders agreed divided by the total number of AUs scored by all coders (*FACS Investigator's Guide*)



SAMM Dataset

● Summary

- Participants:
 - 32 participants (equal gender split)
 - Mean age: 33.24 years (SD: 11.32)
 - 13 ethnicities
- Image properties:
 - 200 fps
 - 2040x1088 original recording resolution
 - 400x400 facial resolution
- FACS Coding
 - 159 micro-movements
 - FACS reliability score: 0.82

AU	Upper Face		AU	Lower Face	
	No. Of Occurrences			No. Of Occurrences	
	Up to 100 Frames	101 to 166 Frames		Up to 100 Frames	101 to 166 Frames
1	6	5	9	5	1
2	16	7	10	5	3
4	23	14	12	29	13
5	9	8	14	11	7
6	5	0	15	4	1
7	45	14	17	7	6
Other	9	9	20	7	2
			23	1	3
			Other	40	23
Total	113	57	Total	109	59

Subtlety versus Duration

- This is what we expect in micro-expressions: *short duration and subtle*



- This is what we found: *short duration but not subtle*

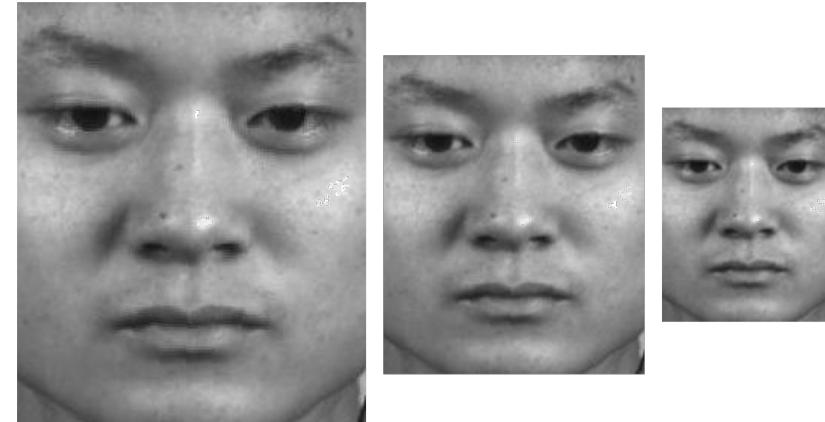


Frame Rate and Resolution

- **What is the best frame rate?**

- **What is the best resolution?**

- **Our study in 2018 showed:**



- LBP-TOP (texture-based features): Perform better in high resolution and high frame rate
- 3DHOG (gradient-based features): Perform better in low specification
- HOOF (optical flow-based features): High frame rate improved recognition rate but increasing resolution did not give a significant improvement

- **How about deep learning?**

Consistency of FACS Coding

- Motivation



**Manchester
Metropolitan
University**

Wen-Jing Yan, Xiaobai Li, Su-Jing Wang, Guoying Zhao, Yong-Jin Liu, Yu-Hsin Chen, and Xiaolan Fu. Casme ii: An improved spontaneous microexpression database and the baseline evaluation. PLoS ONE, 9(1):e86041, 01 2014.

Introduction of Objective Classes

• AU Groups

Each class represents AUs that can be linked to emotion.

Class	Action Units
I	AU6, AU12, AU6+AU12, AU6+AU7+AU12, AU7+AU12
II	AU1+AU2, AU5, AU25, AU1+AU2+AU25, AU25+AU26, AU5+AU24
III	A23, AU4, AU4+AU7, AU4+AU5, AU4+AU5+AU7, AU17+AU24, AU4+AU6+AU7, AU4+AU38
IV	AU10, AU9, AU4+AU9, AU4+AU40, AU4+AU5+AU40, AU4+AU7+AU9, AU4 +AU9+AU17, AU4+AU7+AU10, AU4+AU5+AU7+AU9, AU7+AU10
V	AU1, AU15, AU1+AU4, AU6+AU15, AU15+AU17
VI	AU1+AU2+AU4, AU20
VII	Others

Class	CASME II	SAMM	Total
I	25	24	49
II	15	13	28
III	99	20	119
IV	26	8	34
V	20	3	23
VI	1	7	8
VII	69	84	153
Total	255	159	415

Introduction of Objective Classes

- Confusion matrix on Original CASME II classes compared to Objective Classes: Improved accuracy
- Objective Classes for SAMM and CASME II. Additionally, introduction of Emotional Classes for SAMM

	Happiness	Disgust	Surprise	Repression	Others
Happiness	39.47	4.76	0.00	30.77	5.77
Disgust	2.63	60.32	12.50	7.69	18.27
Surprise	5.26	4.76	75.00	0.00	1.92
Repression	23.68	1.59	4.17	50.00	2.88
Others	28.95	28.57	8.33	11.54	71.15

	I	II	III	IV	V
I	76.19	10.53	2.94	11.11	6.25
II	0.00	42.11	1.96	7.41	18.75
III	4.76	21.05	83.33	29.63	6.25
IV	4.76	15.79	8.82	48.15	0.00
V	14.29	10.53	2.94	3.70	68.75

The First Facial Micro-expression Grand Challenge

- **Shanghai China, May 2018:** To promote interactions between researchers and scholars not only from within this niche area of facial micro-expression research, but also including those from broader, general areas of expression and psychology research



How to access to objective classes coding?

- Refer to MEGC2018 website:

<http://www2.docm.mmu.ac.uk/STAFF/m.yap/FG2018Workshop.htm>

- Or directly download the guidelines from:

http://www2.docm.mmu.ac.uk/STAFF/m.yap/files/MEGC_Guidelines.pdf

Objective Class	CASME II	SAMM
I	25	24
II	15	13
III	99	20
IV	26	8
V	20	3
VI (not used)	1	7
VII (not used)	69	84
Total (I+II+III+IV+V)	185	68

The Second Facial Micro-expression Grand Challenge

- Lille France, May 2019: Regular papers, Challenges in recognition and spotting



The Second Facial Micro-expression Grand Challenge

Challenge I: Spotting

Database	ME Sequences	Resolution	Frame rate (fps)
CAS(ME) ²	32	640×480	30
SAMM	79	2040×1088	200

Note: SAMM Long Videos for this version was an one-off released for the challenge. It is different from SAMM Long Videos with micro- and macro-expressions.

Challenge II: Recognition

Emotion Class	SMIC	CASME II	SAMM	3DB-combined
Negative	70	88 [†]	92 [‡]	250
Positive	51	32	26	109
Surprise	43	25	15	83
TOTAL	164	145	133	442

[†]Negative class of CASME II: Disgust and Repression.

[‡]Negative class of SAMM: Anger, Contempt, Disgust, Fear and Sadness.

Details: <https://facial-micro-expressiongc.github.io/MEGC2019/>

SAMM Long Videos

- **A Spontaneous Facial Micro- and Macro-Expressions Dataset**

- **Motivation:**

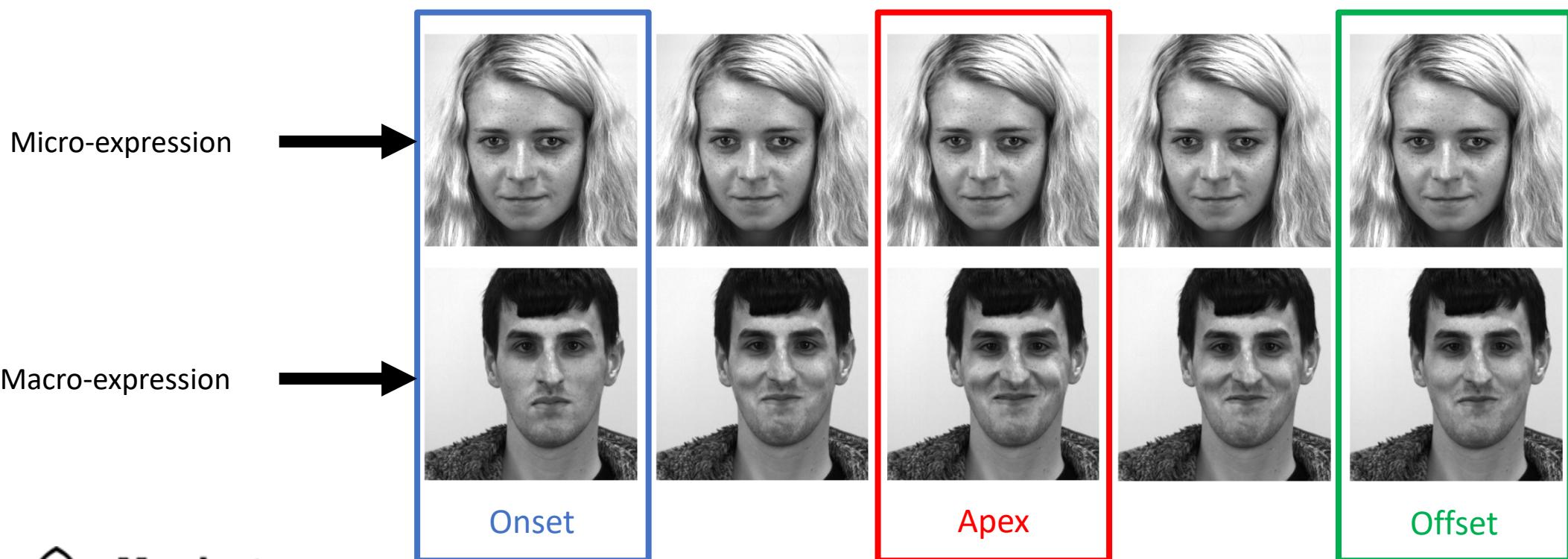
- Limited amount of micro-expression based datasets
- Especially long video dataset (only one annotated publicly available dataset, CAS(ME)²)

A COMPARISON BETWEEN SAMM LONG VIDEOS AND CAS(ME)²

Dataset	SAMM Long Videos	CAS(ME) ²
Number of Long Videos	147	87
Number of Videos with micro	79	32
Resolution	2040×1088	640×480
Frame rate	200	30
Number of Macro-expressions	343	300
Number of Micro-expressions	159	57

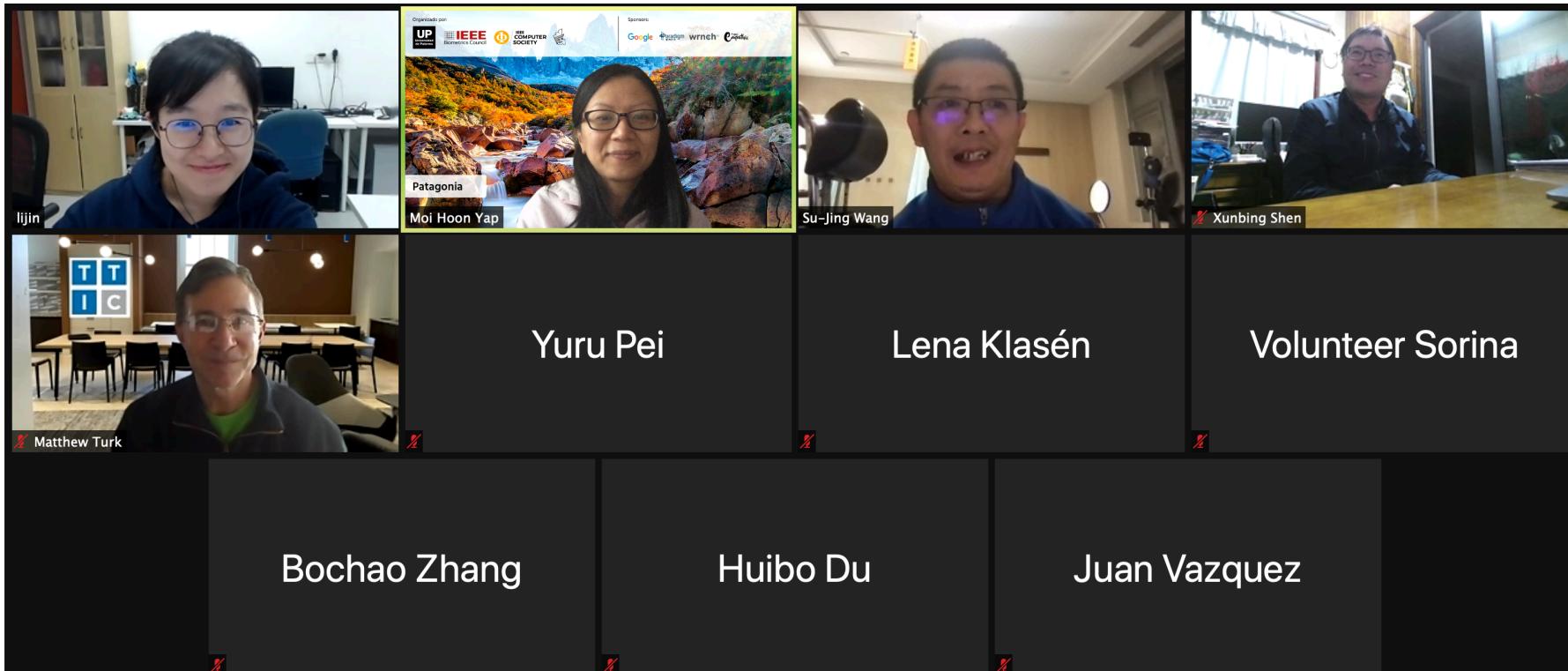
SAMM Long Videos

- First released: December 2019
- Micro- and Macro-Expressions



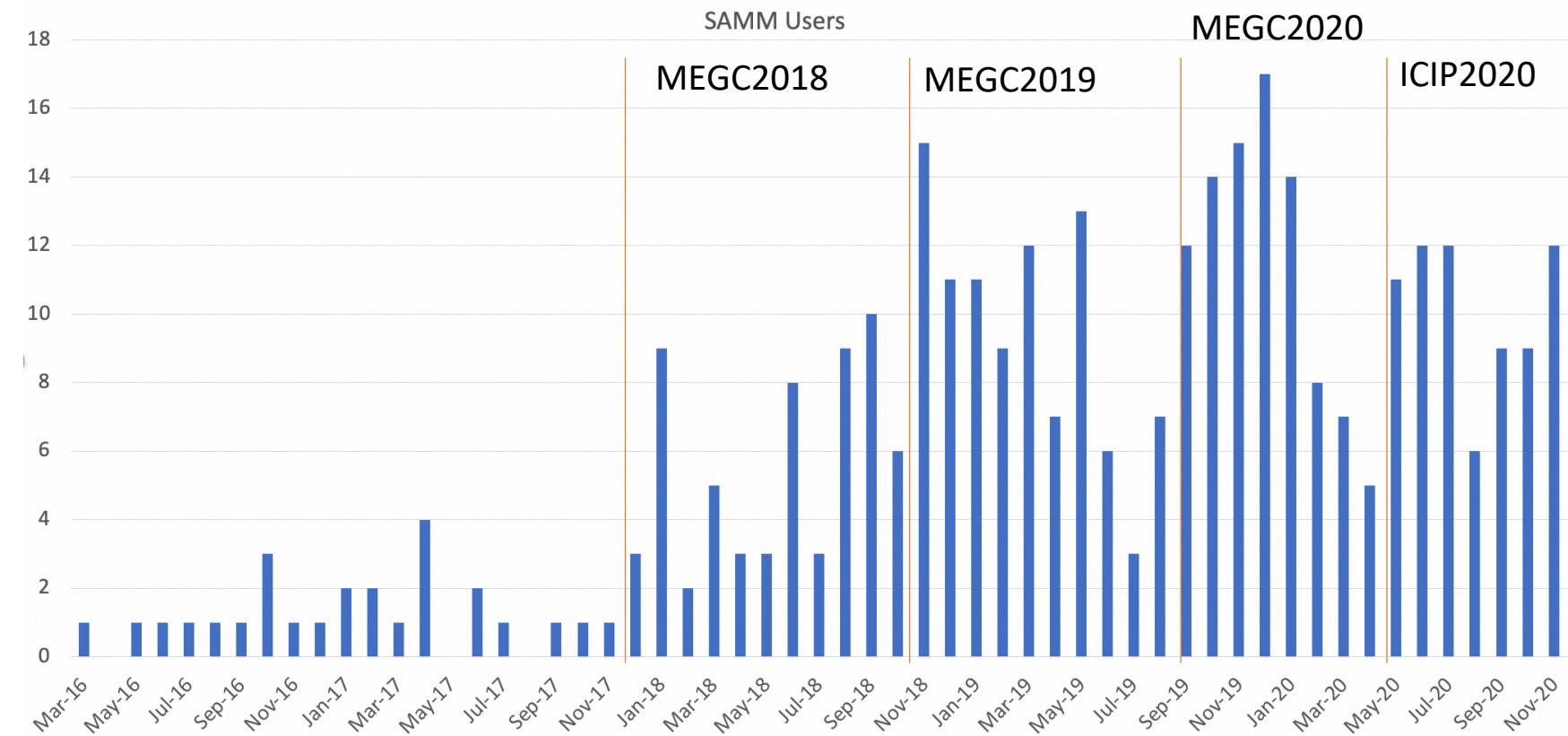
The Third Facial Micro-expression Grand Challenge

- Virtual, November 2020: Regular papers and challenge in Spotting



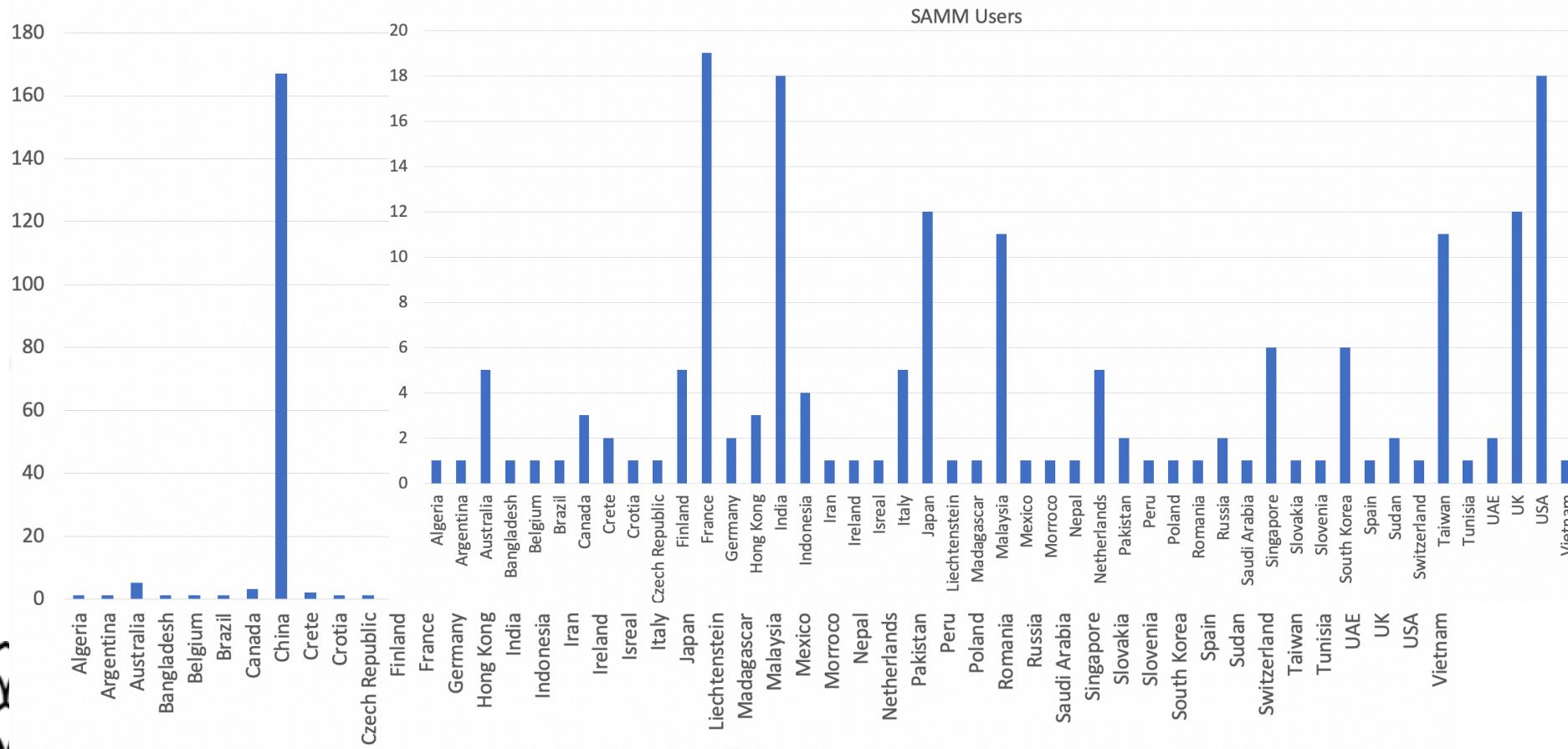
SAMM Users

• Based on 30th November 2020 statistics



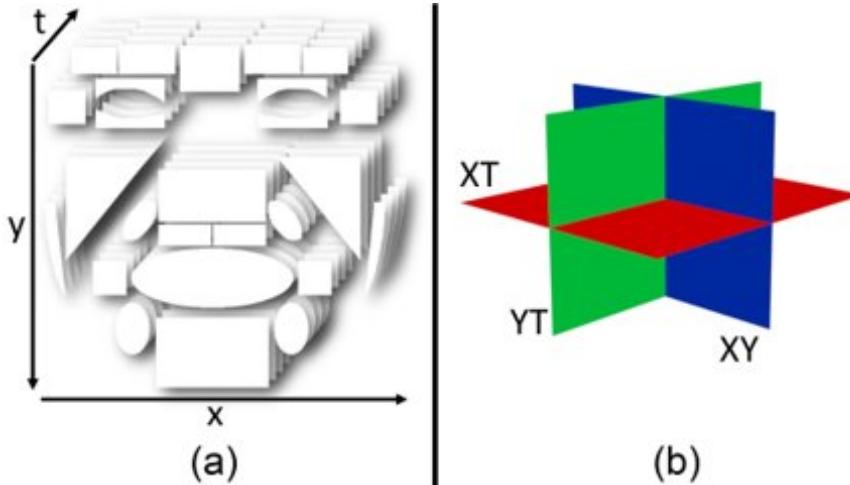
SAMM Users

- Based on 30th November 2020 statistics



Challenges

- Limited datasets
- FACS Coding for new dataset
- In-the-wild data almost impossible to collect
- Difficulty of detecting subtle motion
- End-to-end deep learning method
- Real-time processing
- Optimisation
- Real-world applications



Davison, A.K., Yap, M.H., Costen, N., Tan, K., Lansley, C. and Leightley, D., 2014, September. Micro-facial movements: An investigation on spatio-temporal descriptors. In *European conference on computer vision* (pp. 111-123). Springer.

Davison, A.K., Yap, M.H. and Lansley, C., 2015, October. Micro-facial movement detection using individualised baselines and histogram-based descriptors. In *2015 IEEE International Conference on Systems, Man, and Cybernetics*(pp. 1864-1869). IEEE.

Davison, A., Merghani, W., Lansley, C., Ng, C.C. and Yap, M.H., 2018, May. Objective micro-facial movement detection using facs-based regions and baseline evaluation. In *2018 13th IEEE international conference on automatic face & gesture recognition (FG 2018)* (pp. 642-649). IEEE.

Merghani, W. and Yap, M.H., Adaptive Mask for Region-based Facial Micro-Expression Recognition. In *2020 15th IEEE International Conference on Automatic Face and Gesture Recognition (FG 2020)(FG)* (pp. 428-433). IEEE Computer Society.

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Thanks!



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IMAGE METRICS