

Emerging Technologies for Effective Teaching & Learning

Continuing Education Program for Next Education India Pvt Ltd
Conducted by Educational Technology, IIT Bombay
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Next. Education[™]
Transforming Education

Introduction to Multimodal Learning Analytics

Ritayan Mitra

Activity : Reflect on the following questions

- 1) What are the key contributors to student learning?
- 2) How do you know your students have learned (concept/topic/subject etc.)?

Think for 2 minutes and then share with class.

What goes into learning?



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Learning environment

Curriculum
Teacher
Student

Test scores

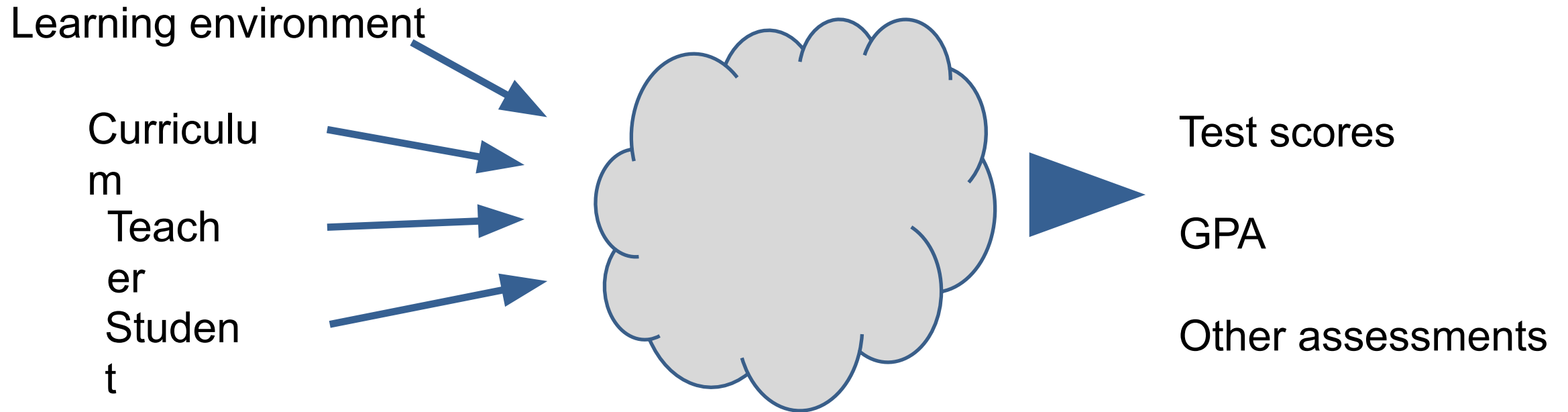
GPA

Other assessments

What goes into learning?



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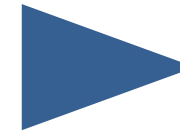
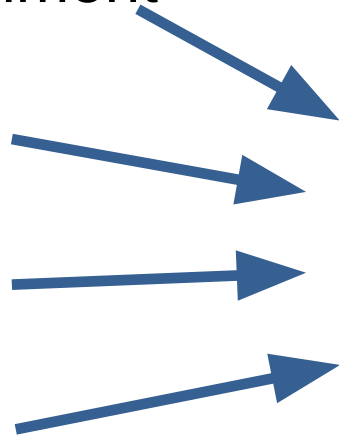
What goes into learning?



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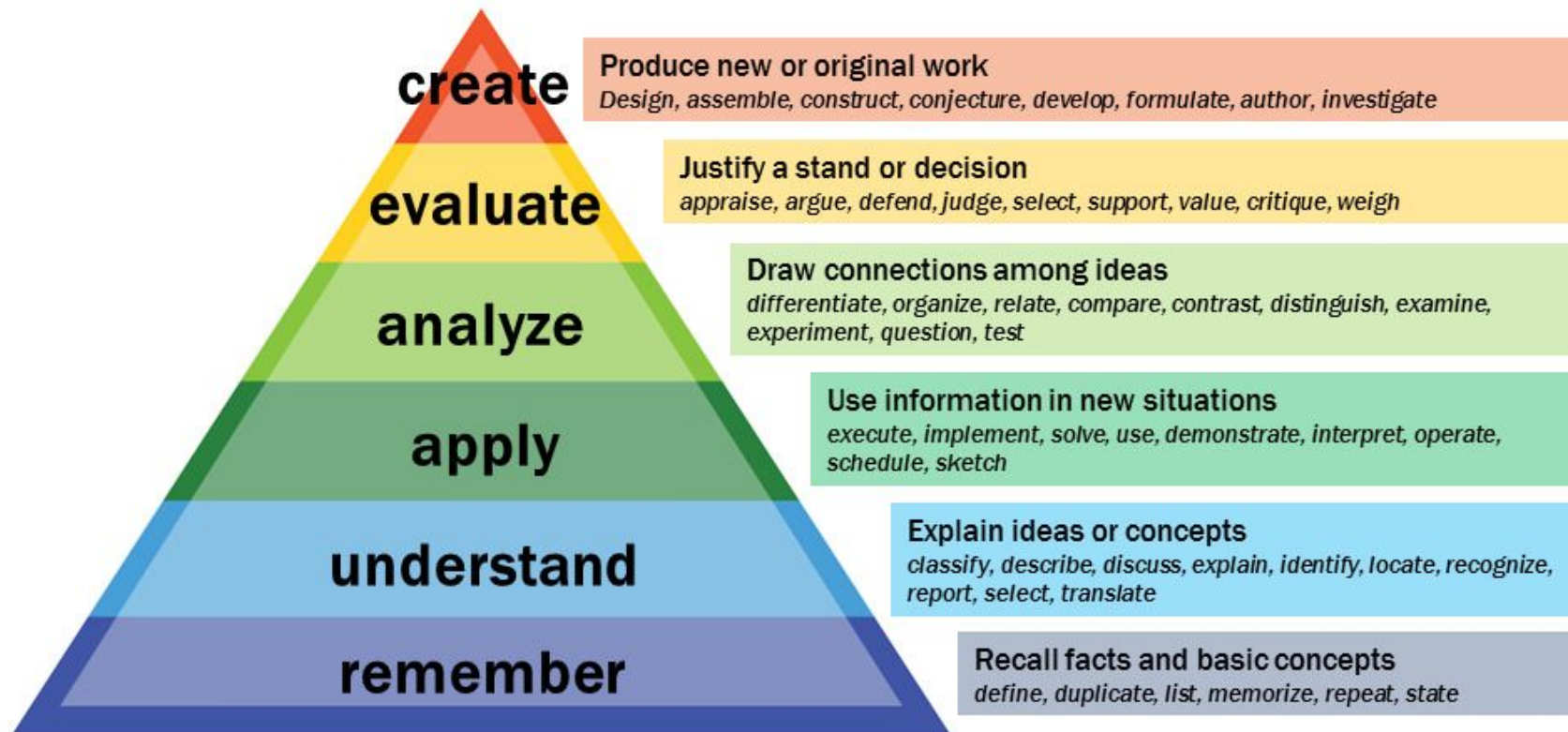
Question: What processes go into learning?

The CAMM processes (COGNITION)



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Bloom's Taxonomy

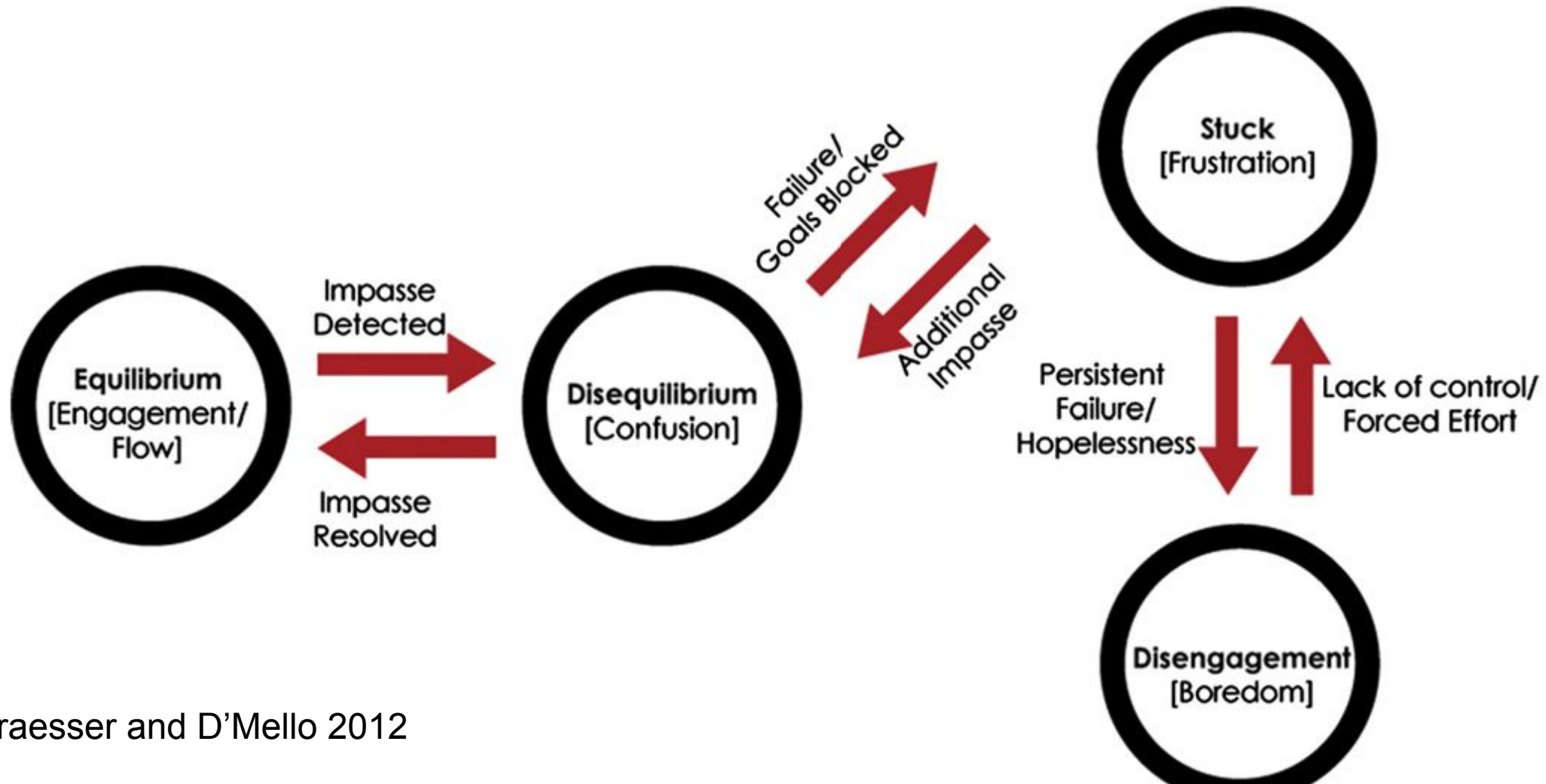


Vanderbilt University Center for Teaching

The CAMM processes (AFFECT)



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Graesser and D'Mello 2012

The CAMM processes (METACOGNITION)



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Do I understand the concept being taught?

How well do I understand - good, average or poor?

How can I test how much I understood?

What aspect do I not understand?

What should I do in order to learn that aspect?

How does this new knowledge help me understand concept X better?

Now, do I understand concept X better than I did before?



The CAMM processes (MOTIVATION)



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Now let's look at one of the input variables

Where do we learn?



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Where do we learn?



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Where do we learn?



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Where do we learn?



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Where do we learn?



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Where do we learn?



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Where do we learn?



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Activity: Raise your hand if you disagree



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The process of learning can be very complex and we need special tools to study it



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So how do we study this complex process?

Traditional Methods



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- Classroom observation
- Think alouds
- Retrospective self-reflection
- Experience sampling method



But new age technology and computational firepower allow us to do more than just triangulation

LAK Conference 2013

Multimodal Learning Analytics

Paulo Blikstein

Stanford University Graduate School of Education and (by courtesy) Computer Science

520 Galvez Mall, CERAS 232 Stanford, CA – 94305 – USA

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ABSTRACT

New high-frequency data collection technologies and machine learning analysis techniques could offer new insights into learning, especially in tasks in which students have ample space to generate unique, personalized artifacts, such as a computer program, a robot, or a solution to an engineering challenge. To date most of the work on learning analytics and educational data mining has focused on online courses or cognitive tutors, in which the tasks are more structured and the entirety of interaction happens in front of a computer. In this paper, I argue that multimodal learning analytics could offer new insights into students' learning trajectories, and present several examples of this work and its educational application.

would be particularly useful in a time when the need for scalable project-based, interest-driven learning and student-centered pedagogies is growing considerably [e.g., 5]. Both K-12 and engineering education [10, 11], within a transformed societal and economic environment, now demand higher level, complex problem-solving rather than performance in routine cognitive tasks [15]. These approaches have been advocated for decades [9, 12, 16, 18] but failed to become scalable and prevalent, and came under attack during the last decade [e.g., 13, 14]. Automated, fine-grained data collection and analysis could help resolve this tension in two ways. First, they could give researchers tools to examine student-centered learning in unprecedented scale and detail. Second, these techniques could improve the scalability of these pedagogies since they make both assessment and formative feedback, which are more complex and laborious in such



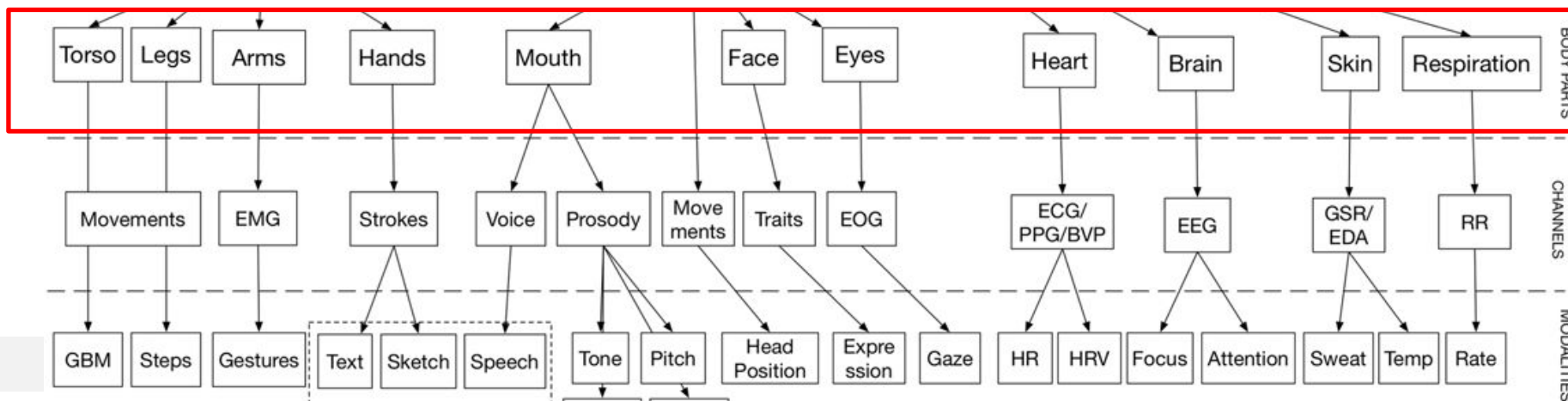
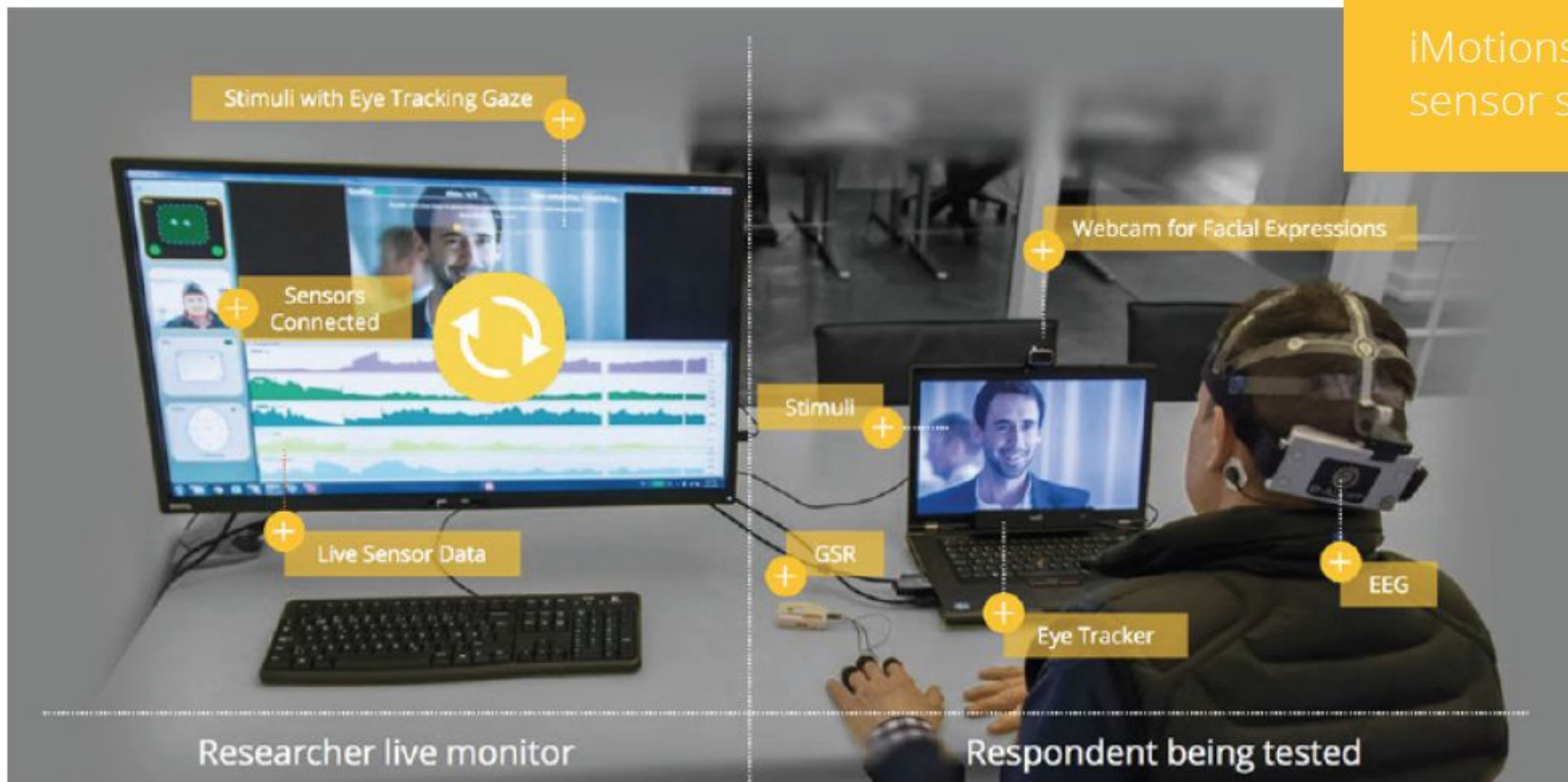
Question: What data can we capture?

Yesterday, in Prof. Ramkumar's session you heard of **log data**. Today, you have seen how learning can be a **complex process** and learnt CAMM processes that go toward learning.

Based on the above can you think of what other types of data we can capture to shed light on the process of learning?



iMotions multi-modal sensor setup

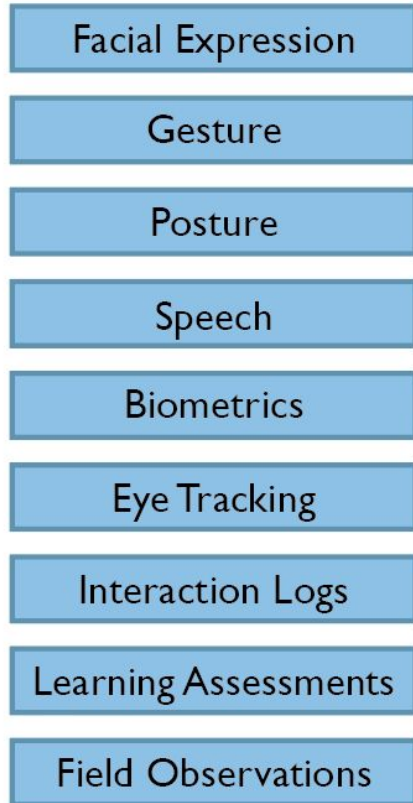


Multimodal data workflow

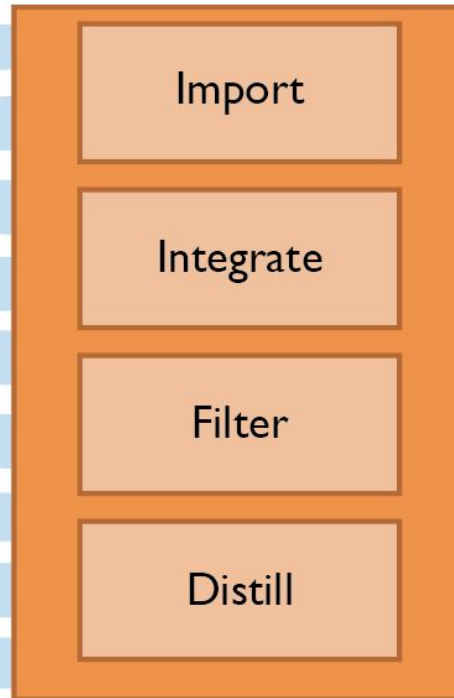


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Data Collection



Data Processing



Data Analysis



Individual channels of data

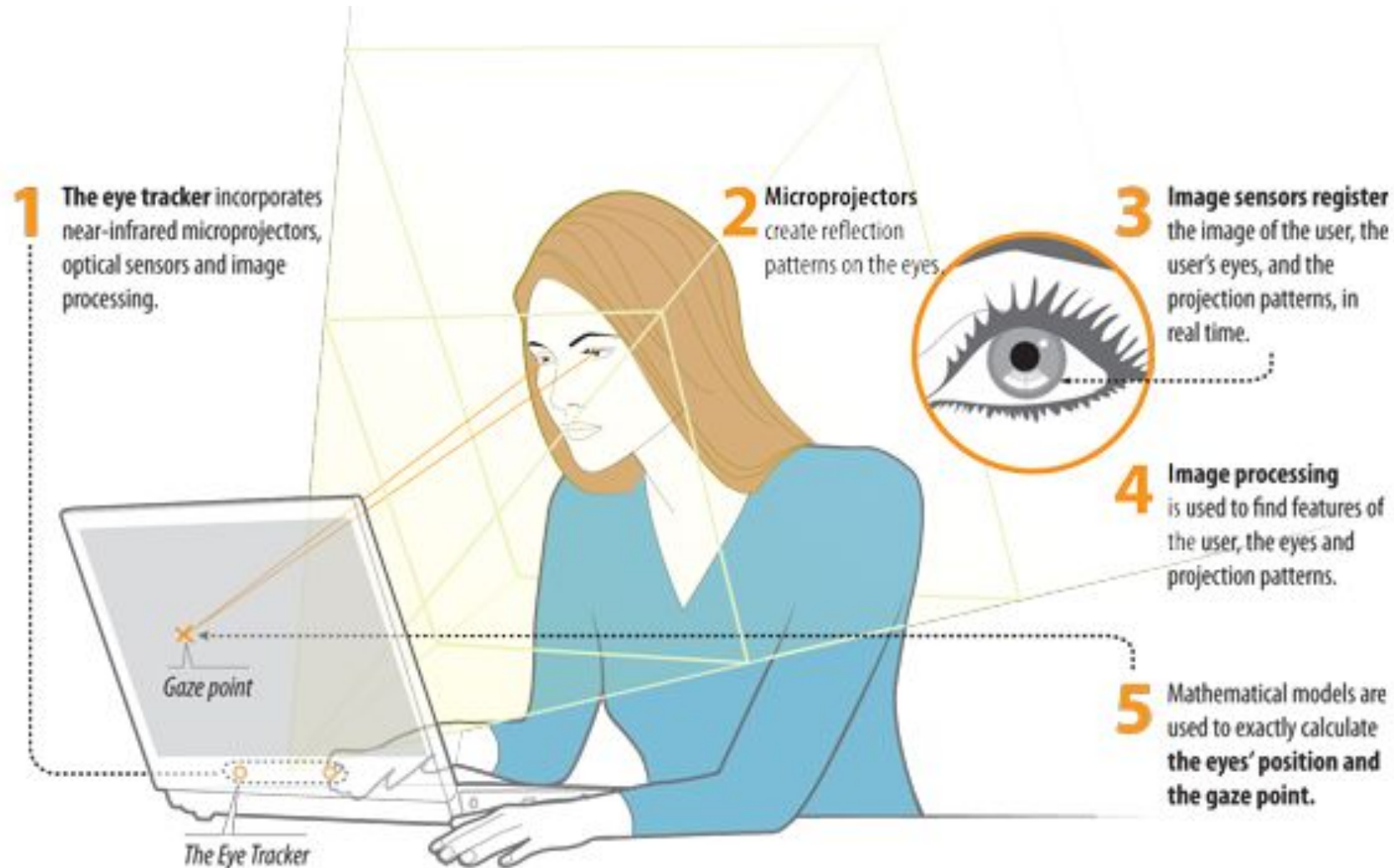


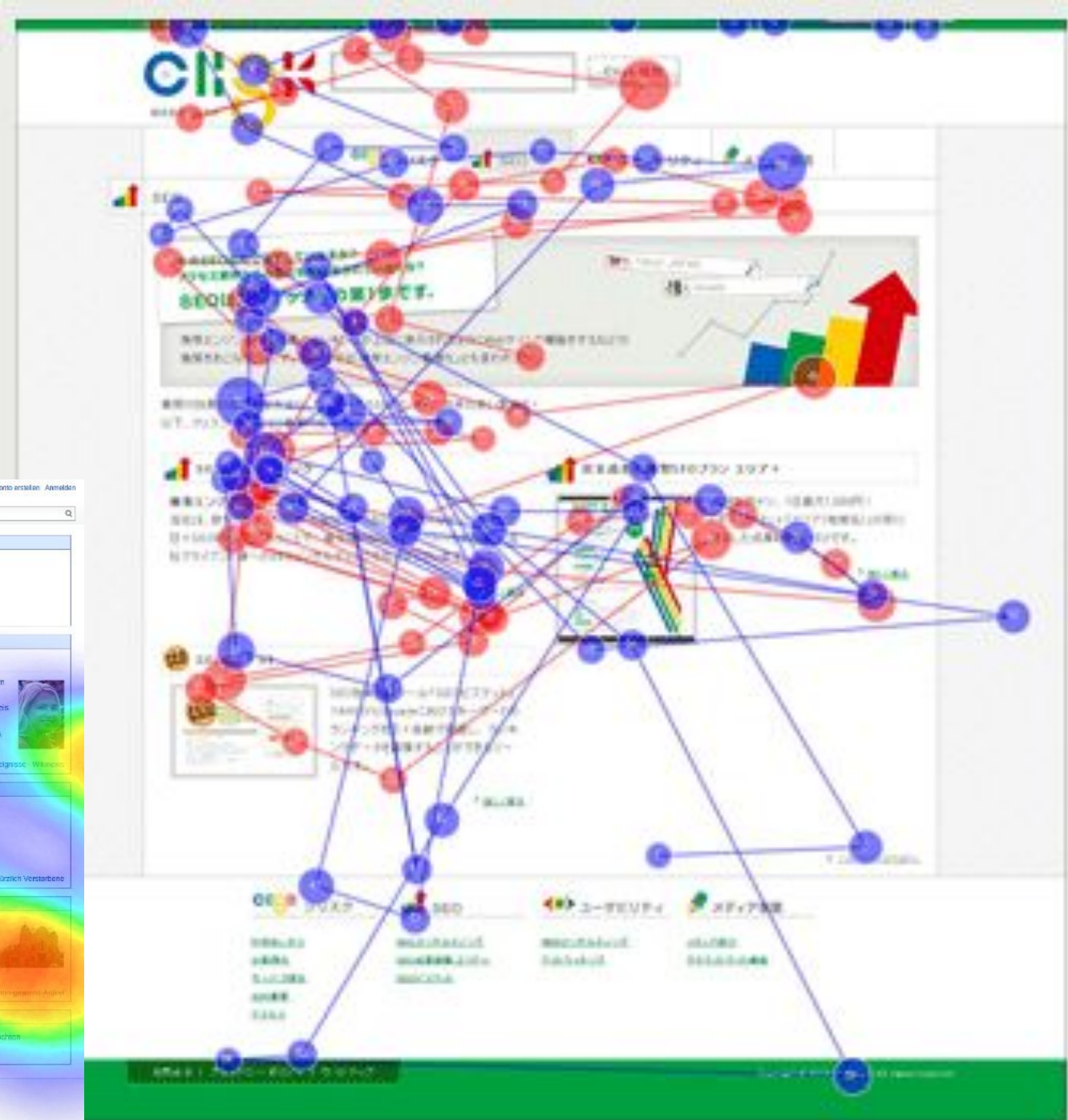
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Eye tracking



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Willkommen bei Wikipedia

Wikipedia ist ein Projekt zum Aufbau einer Enzyklopädie aus freien Inhalten, zu denen du sehr gern beitragen kannst. Seit Mai 2001 sind 2.076.952 Artikel in deutscher Sprache entstanden.

Geographie · Geschichte · Gesellschaft · Kunst und Kultur · Religion · Sport · Technik · Wissenschaft

Artikel nach Themen · Artikel nach Kategorien · Gesprochene Wikipedia · Archiv der Hauptseite

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Artikel des Tages

Puma war eine brasilianische Automobilmarke. Die Fahrzeugherstellung wurde ursprünglich auf Daimler-Benz-Basis, wechselte nach dem Niedergang dieser Marke zu Technik von Volkswagen ab und endete in ihrer Endphase mit dem Kauf von General Motors. Insgesamt wurden über 20 verschiedene Modelle, die in einer Spezialwerkstatt als auch in einem zentralen Fabrikblock der GM-Werkstätte hergestellt, im brasilianischen Piraí zwischen 1973 und 1981 3596 Pumas (GM-Bussen) hergestellt. Zudem wurden 21.120 Fahrzeuge gebaut. Eine weitere Quelle nennt etwa 22.000 Fahrzeuge. 1996 erwarb Ford die Rechte an der Marke Puma und nutzte den Namen von 1997 bis 2002 für den Ford Puma. In den 1960er- und 1990er-Jahren versuchte Brasilien immer, das Ansehen an die weltweiten und internationalen zu gewinnen. Sichtbarer Ausdruck dafür war, neben der Einführung der neuen Hochdruckpumpe, der Aufbau einer nationalen Automobilindustrie. Um dieses Ziel zu erreichen wurden Kooperationen mit großen Automobilherstellern eingegangen, unter anderem mit Volkswagen. Parallel dazu wurden zur Förderung heimischer Produktionsstätten hohe Importzölle auf fertig produzierte Automobile erhoben. – Zum Artikel ...

Archiv · Weitere exzerptierte und korrigierte Artikel · RSS-Feed

Was geschah am 4. Juli?

- 1187 – In der Schlacht bei den Höhen von Hattin unterliegt das Heer der Kreuzfahrerstaaten gegen die Truppen von Saladin.
- 1873 – Im Deutschen Kaiserreich werden Niederlassungen der Jesuiten durch das Jesuitengesetz verboten.
- 1902 – Vivekananda, hinduistischer Mönch und Gelehrter, stirbt.
- 1921 – Die italienische Filmschauspielerin Gira Lollobrigida (geb. Fanfani, der Muse, Trapes, Der Glöckner von Notre Dame) wird geboren.
- 1997 – Die NASA-Gonde Pathfinder landet auf dem Mars.

Weitere Ereignisse · Bildergalerie

Schon gewusst?

- Die „Kühlerkäse“ der Zisterzienser nicht östlich gelegentlich als illegaler Abo-Steuerspielplatz.
- In der Sommer-Serie *Alte und Antike* Magazine geht es um antike römische Niederlassungen in der Schweiz.
- Das berühmte Eifelturm war der erste seiner Art auf amerikanischem Boden.
- Der Puma-Gürtel-Signet ist eines der schönsten Landschaftsbilder Italiens.

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Schwesterprojekte

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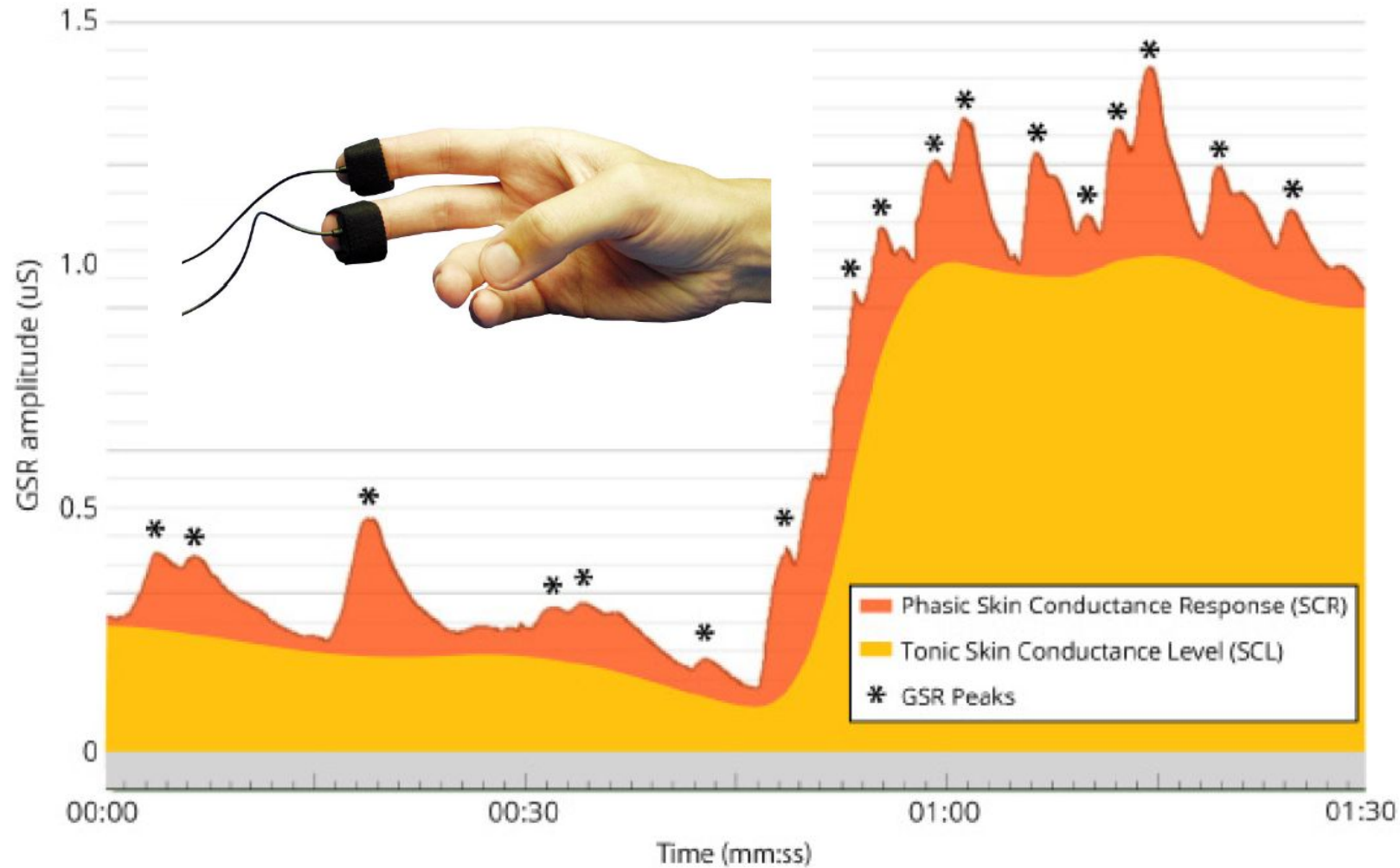
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Galvanic skin response (GSR)



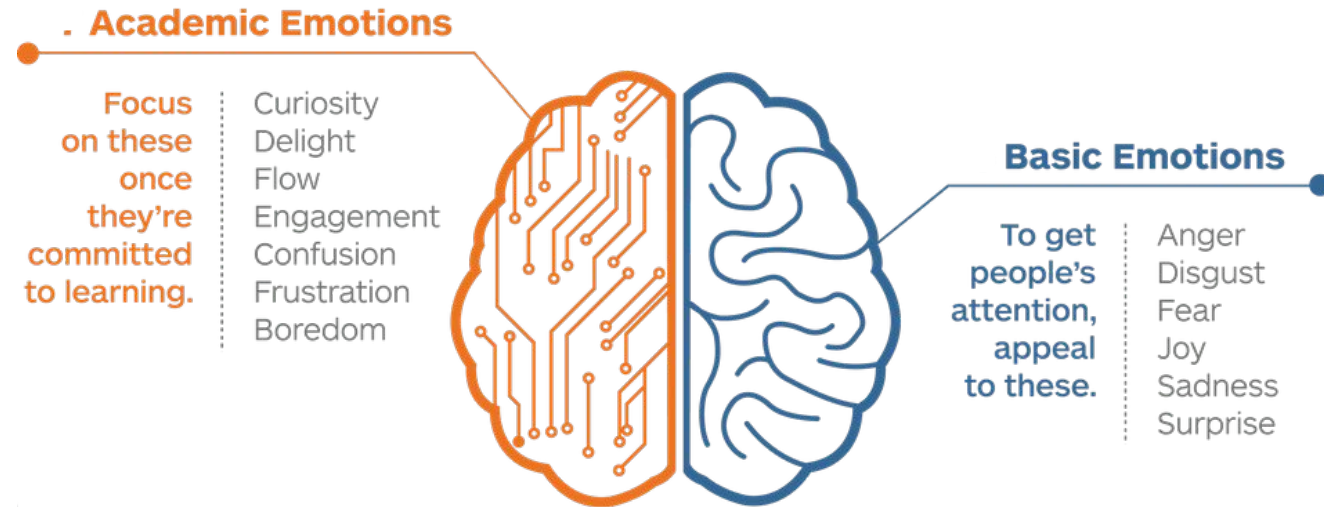
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Facial emotion recognition



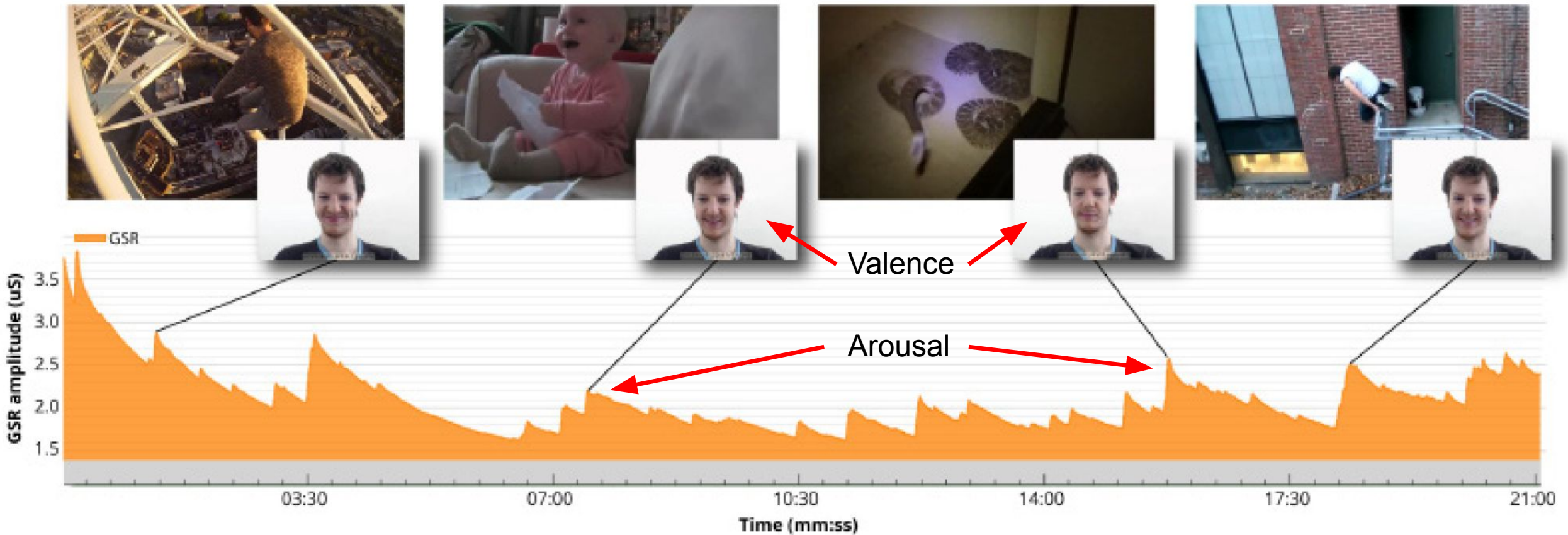
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Combining channels



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What data should I use?



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Method/Tool	Cognition	Metacognition	Affect	Motivation
Screen Recordings (video and audio)	Green	Green	Red	Red
Concurrent Think- Alouds	Green	Green	Yellow	Yellow
Eye Tracking	Green	Green	Red	Red
Log Files	Green	Red	Red	Red
Facial Expressions of Emotions	Red	Red	Green	Red
Physiological Sensors (EDA, EMG, EKG, EEG, fMRI)	Green	Red	Green	Yellow
Pretest-Posttest-Transfer tests	Green	Red	Red	Red
Quizzes	Green	Red	Red	Red
Summaries	Green	Red	Red	Red
Self Report Questionnaires (AEQ, ERQ, MAI, OMQ, EV, Agent Perception Inventory)	Green	Green	Green	Green
Metacognitive Judgements	Red	Green	Red	Red

From Azevedo 2015

Uses of MMLA : Building adaptive interfaces for education



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<https://www.youtube.com/watch?v=RyBEUyEtxQo>

Using Psycho-Physiological Measures to Assess Task Difficulty in Software Development

Thomas Fritz[†], Andrew Begel^{*}, Sebastian C. Müller[†], Serap Yigit-Elliott[°], Manuela Züger[†]

[†]University of Zurich
Zurich, Switzerland

^{*}Microsoft Research
Redmond, WA USA

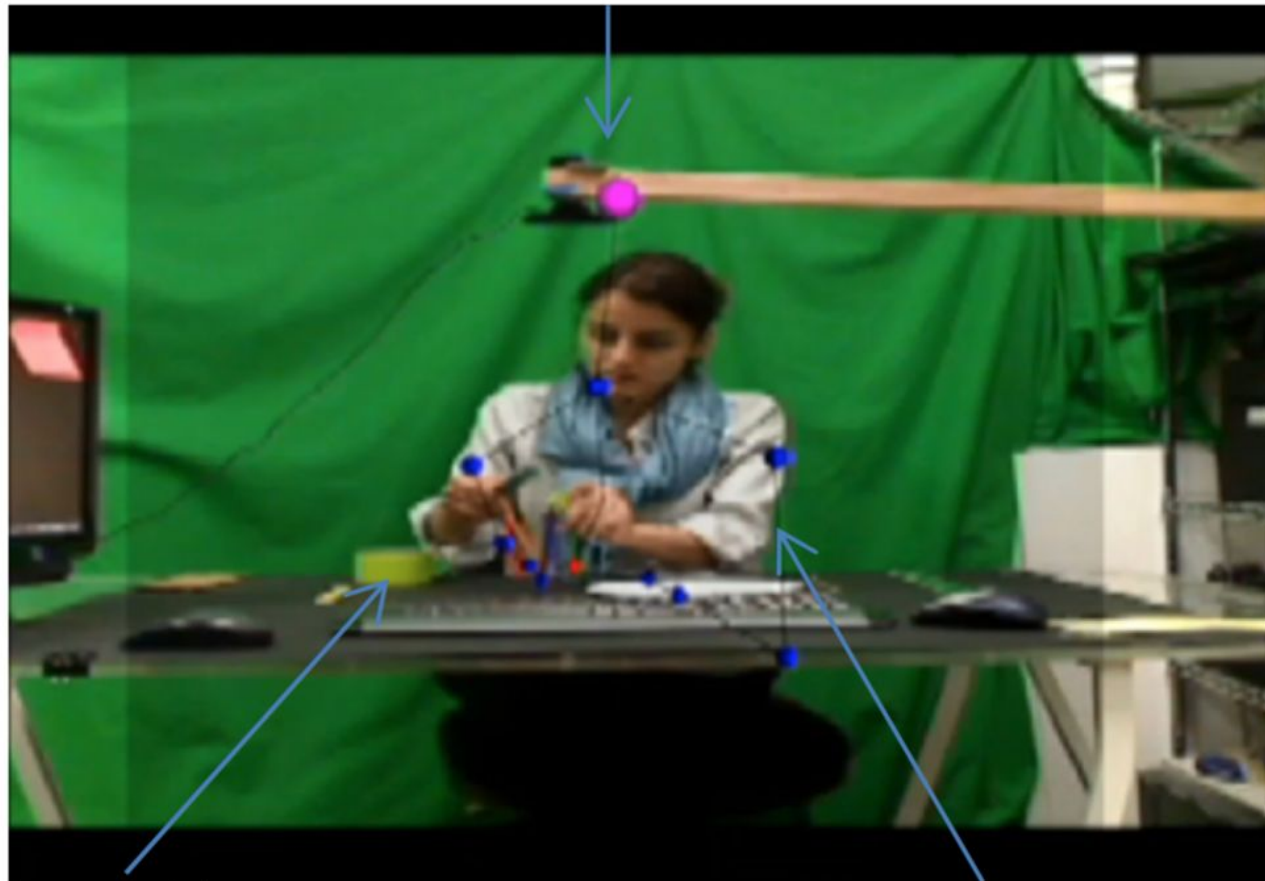
[°]Exponent
Bellevue, WA USA

Prediction	Sensors	Precision	Recall	F-Measure
By Participant	Eye	69.16%	65.83%	65.10%
	EDA	55.18%	55.77%	51.99%
	EEG	53.05%	56.73%	50.82%
	Eye+EDA	68.37%	64.42%	61.92%
	Eye+EEG	68.58%	63.46%	60.89%
	EDA+EEG	68.02%	64.58%	62.01%
	Eye+EDA+EEG	64.99%	64.58%	62.21%
By Task	Eye	79.17%	66.67%	69.65%
	EDA	75.12%	58.65%	63.80%
	EEG	81.97%	59.62%	63.40%
	Eye+EDA	78.59%	66.35%	70.37%
	Eye+EEG	82.42%	66.35%	69.89%
	EDA+EEG	82.79%	65.63%	69.76%
	Eye+EDA+EEG	84.38%	69.79%	73.33%
By Participant-Task	Eye	66.67%	66.67%	66.67%
	EDA	59.62%	59.62%	59.62%
	EEG	56.73%	56.73%	56.73%
	Eye+EDA	68.27%	68.27%	68.27%
	Eye+EEG	62.50%	62.50%	62.50%
	EDA+EEG	62.50%	62.50%	62.50%
	Eye+EDA+EEG	67.71%	67.71%	67.71%

Fritz et al. 2014

Uses of MMLA : Judicious use of one or two sensors with other data

Overhead camera for object tracking



Building materials

Skeletal overlay of gesture capture

- Used video data to understand how children manipulate objects in a building task
- Gesture data measured with Kinect tracked how they moved their hands
- The two together revealed differences between expert and novice builders



Challenges

- Understanding of confounds in each individual channel of data (currently we handle this with use of multiple channels of data hoping that the strength of one channel will offset the weakness of another)
- How data can be linked back to learning theories
- At what resolution data needs to be aggregated



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Thank you

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