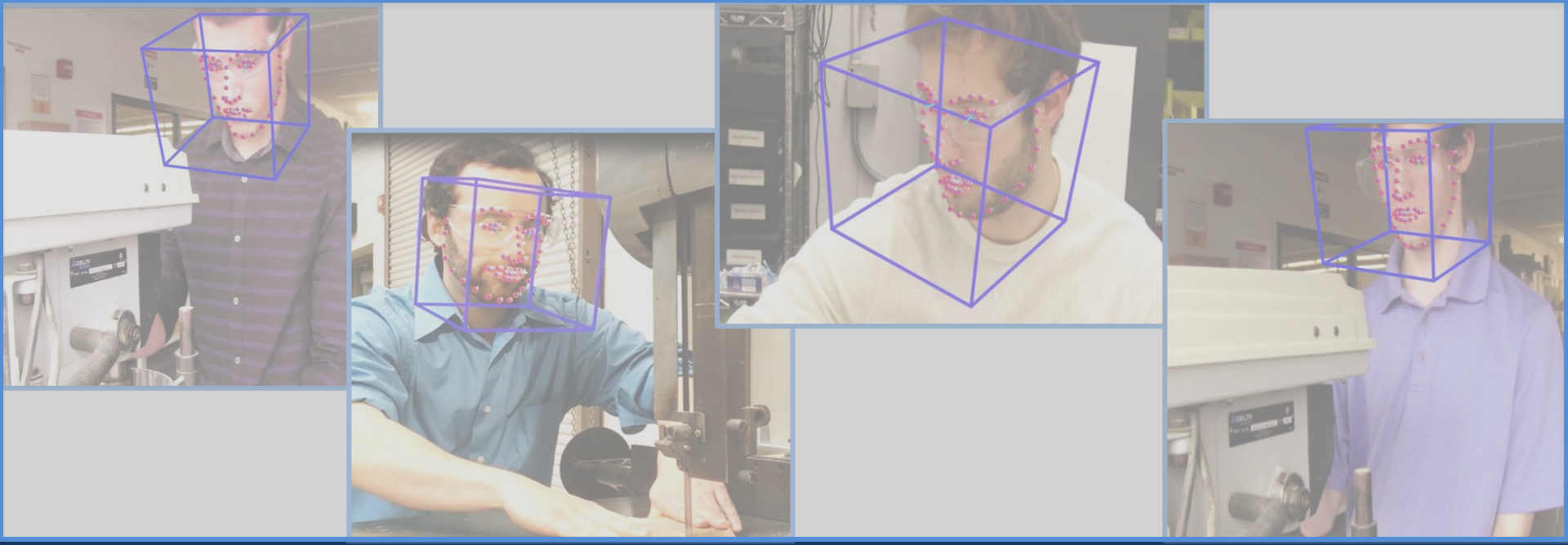

PennState
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'18 ASEE Mid Atlantic Conference

Towards Personalized Performance Feedback:
Mining the Dynamics of Facial Keypoint Data in Engineering Lab Environments

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Grand Engineering Challenges of the 21st century: *Development of Personalized Learning*

[Vest 2008]

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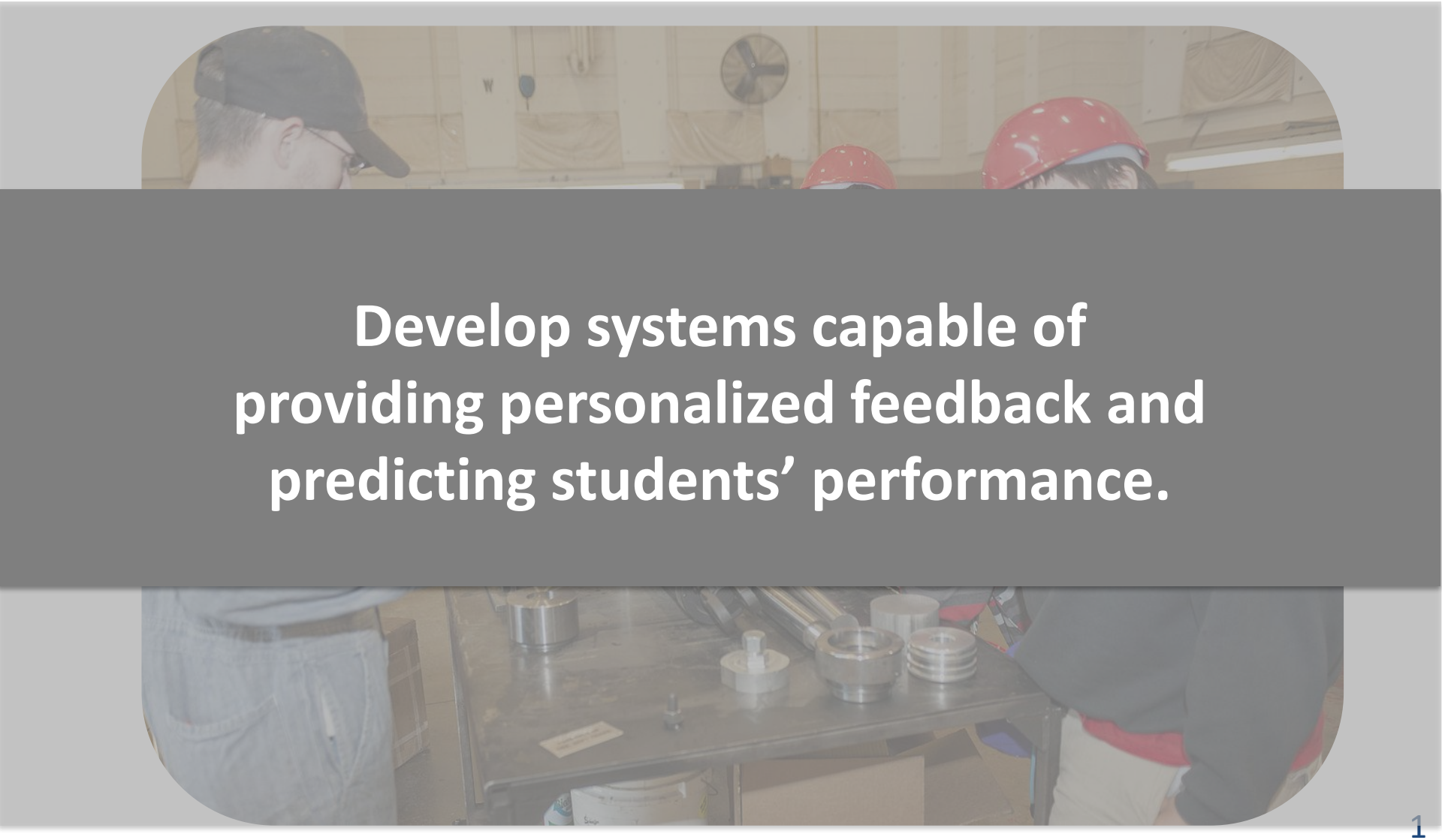
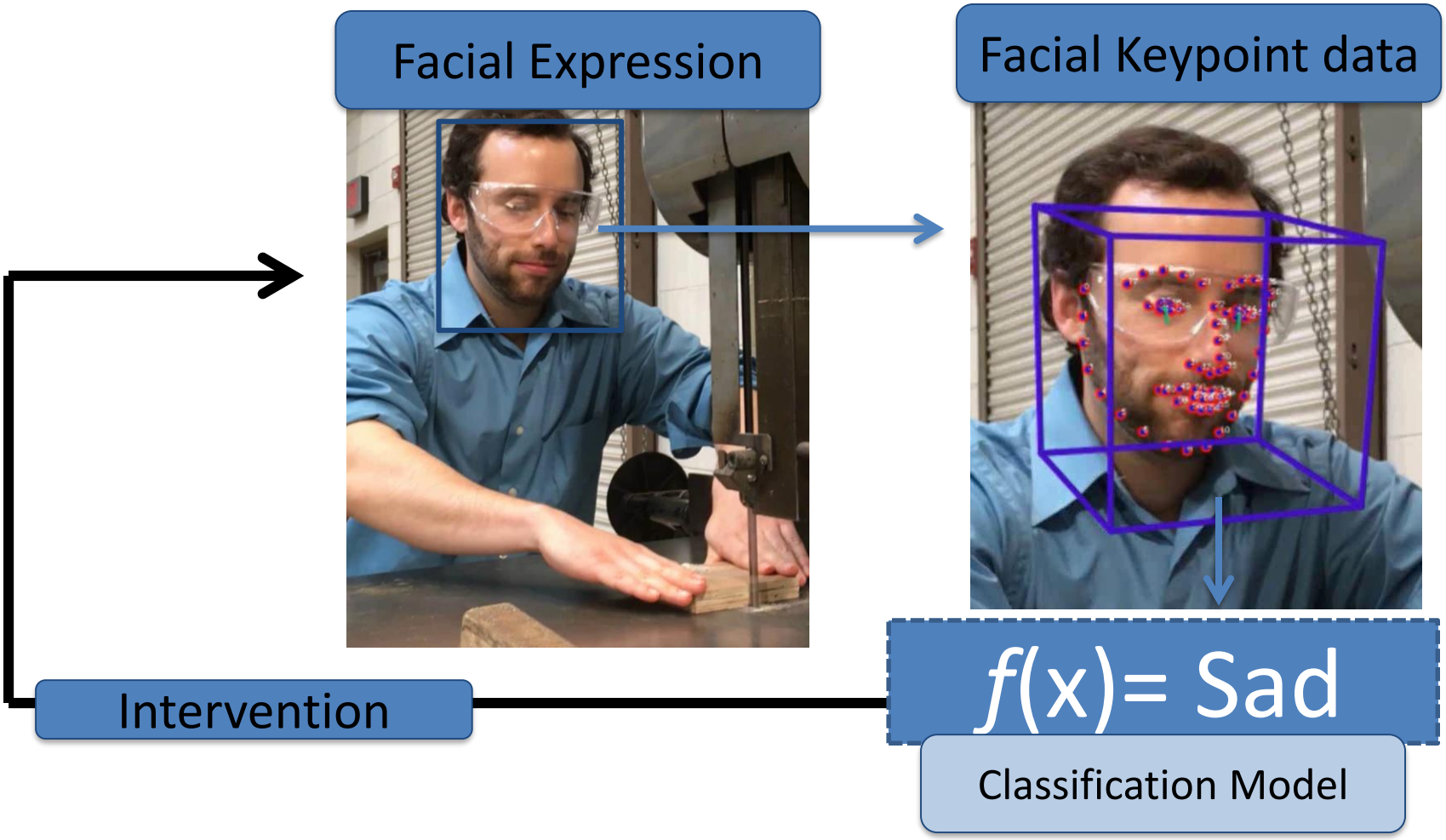
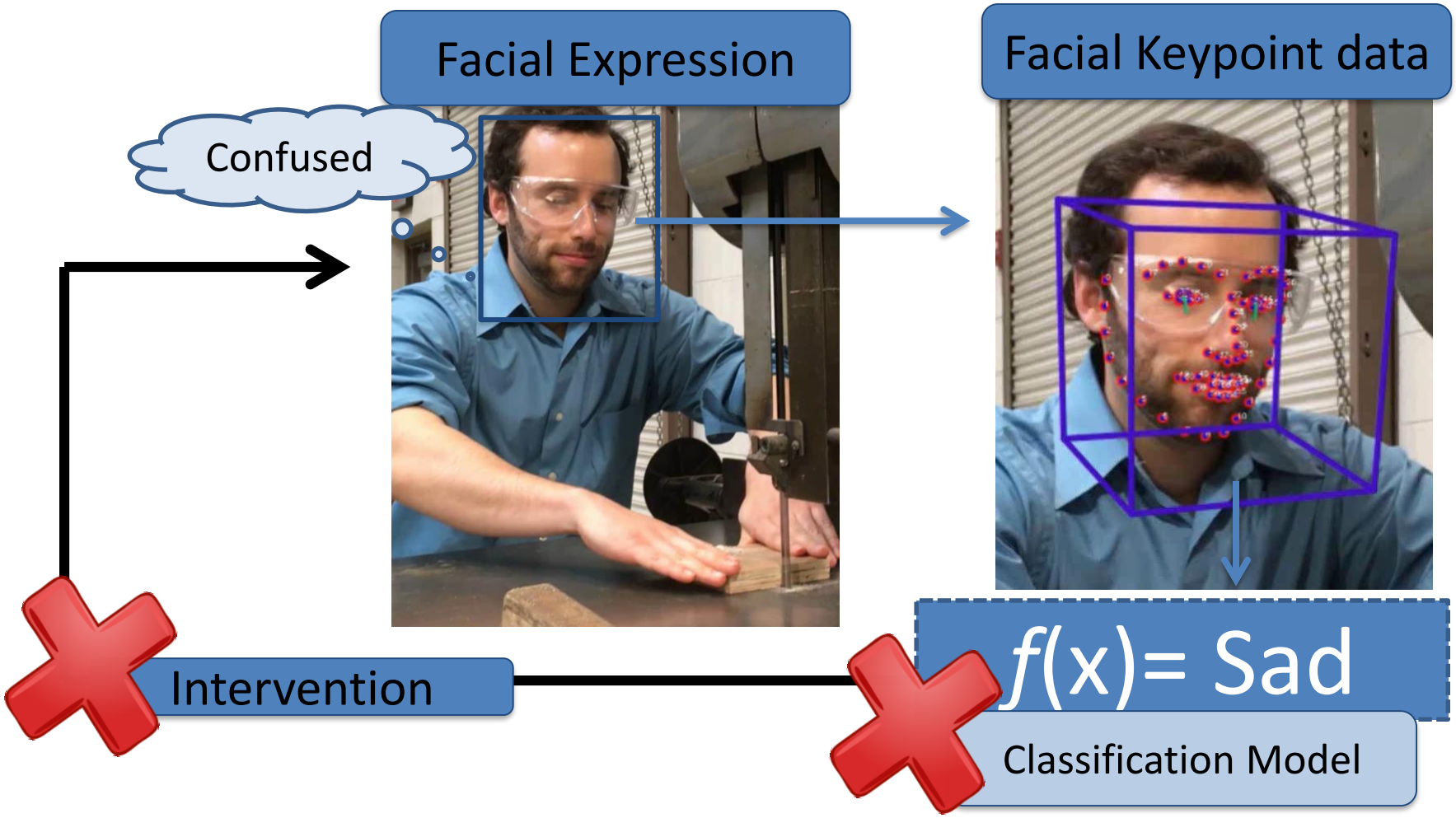


Develop systems capable of providing personalized feedback and predicting students' performance.

Affect-sensitive system can provide personalized feedback based on students' affective state

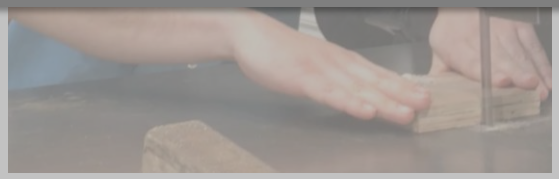


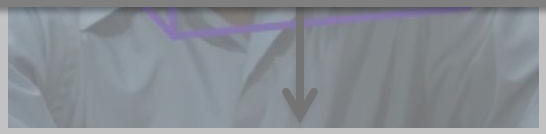
Affect-sensitive system can provide personalized feedback based on students' affective state



Affect-sensitive system can provide personalized intervention based on students' affective state

Due to the limitations of current affect-sensitive systems and the heterogeneity of students, we developed an individual-task model to predict students' performance prior to the start of a task



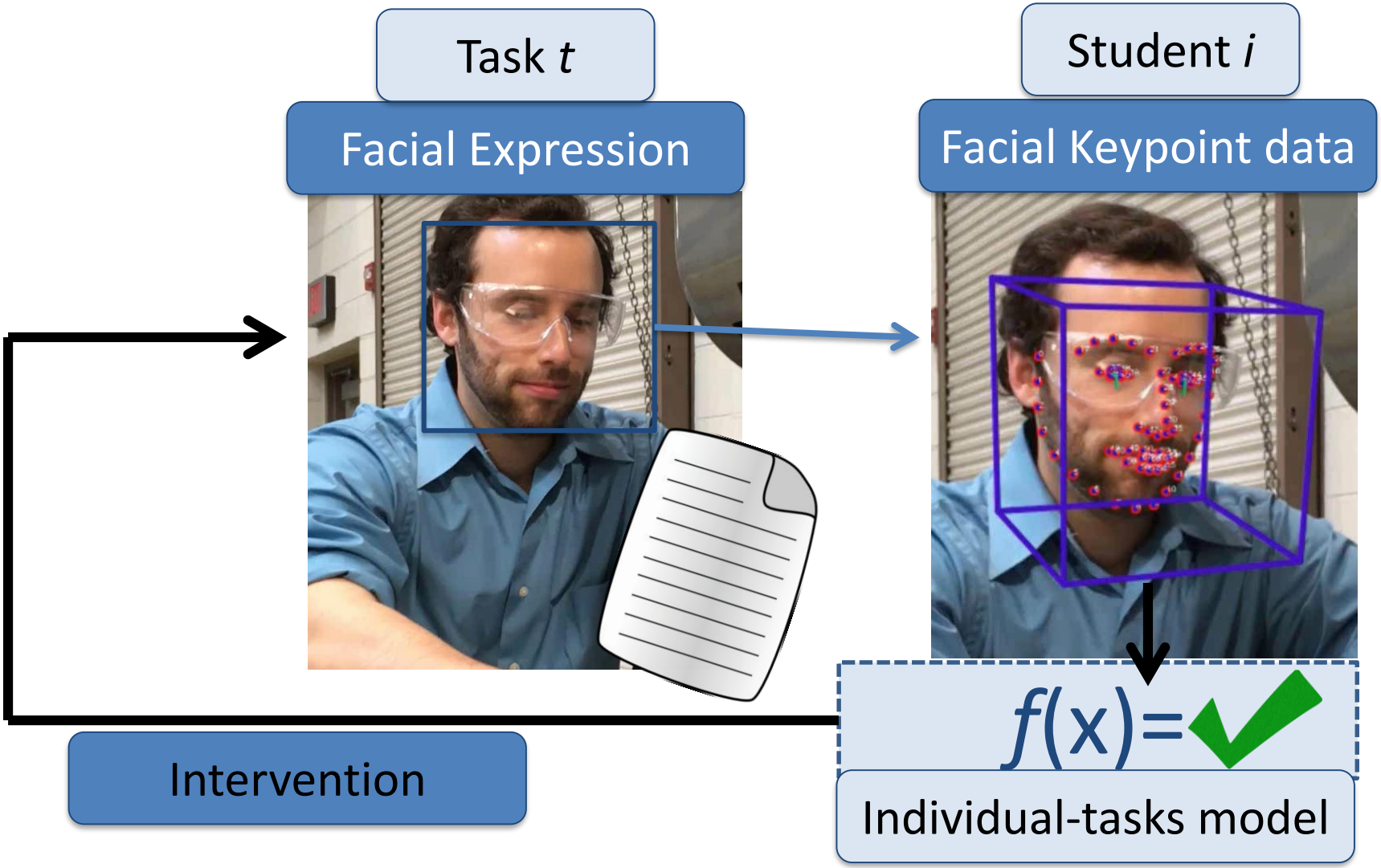


Intervention

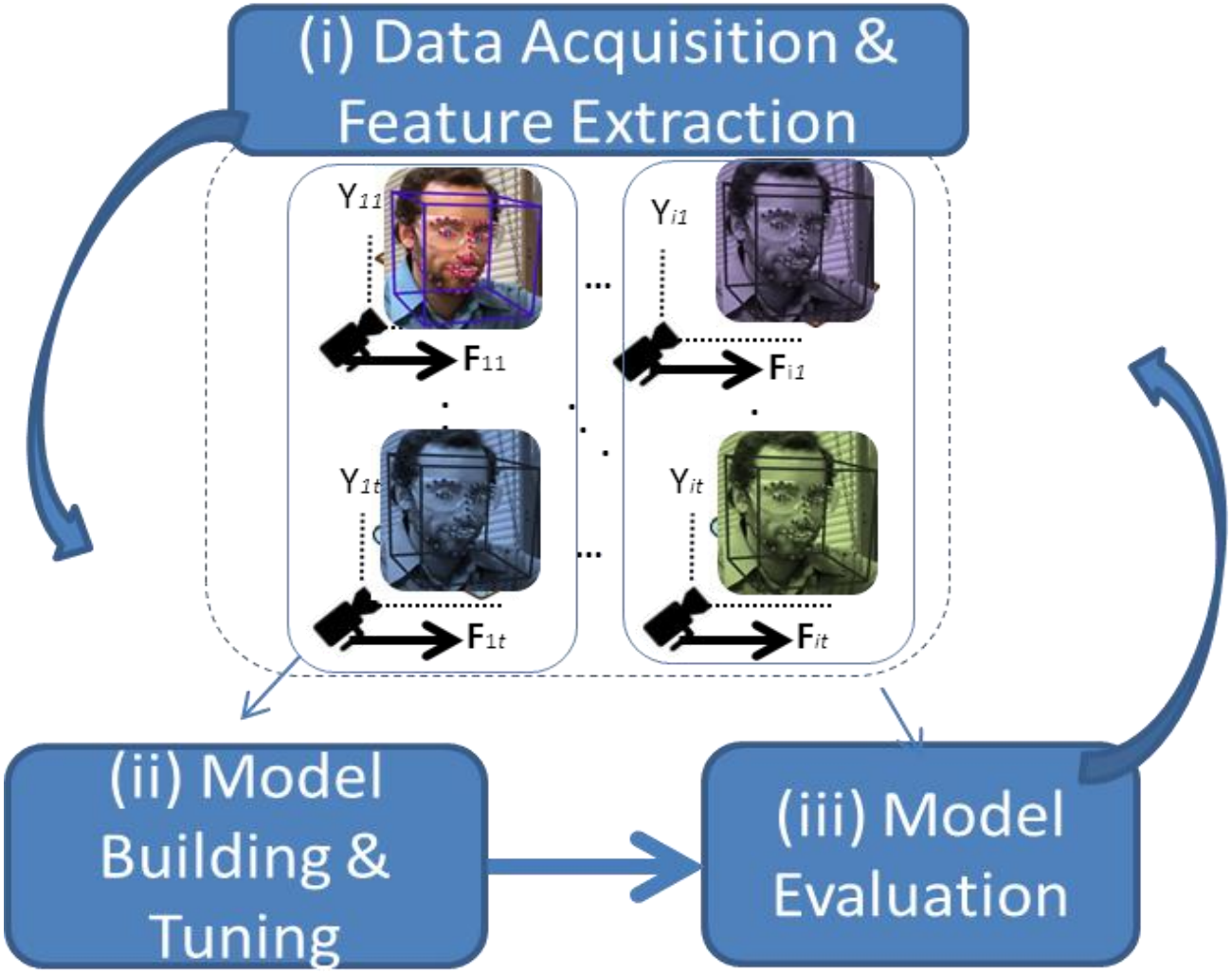
$f(x)$= Sad

Classification Model

The proposed *individual-task* model takes into consideration task and individuals' differences.

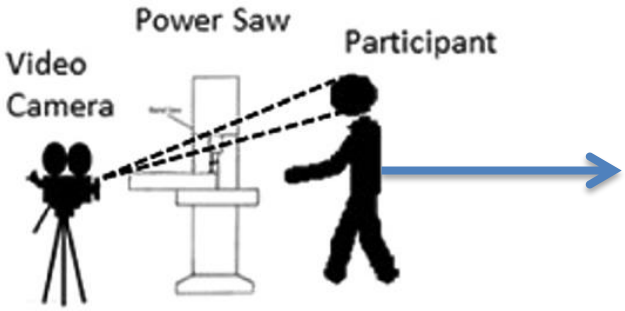


Method to predict students' performance prior to the start of a task by using their facial keypoints

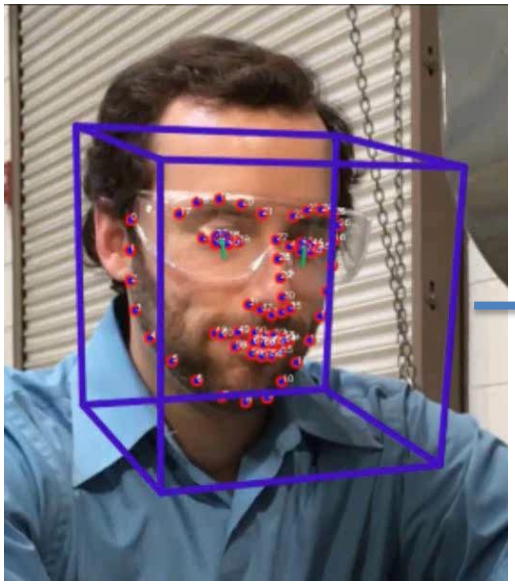


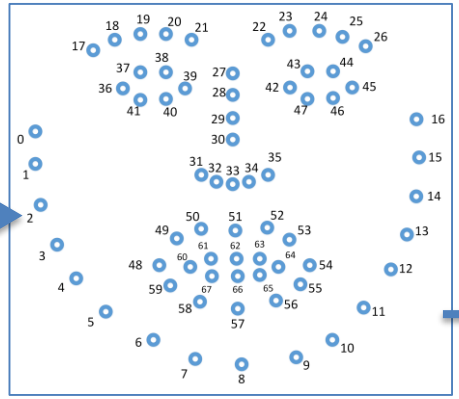
Data Acquisition & Features Extraction:
Facial Keypoint Data and Procrustes Analysis

[640 x 800 pixels]

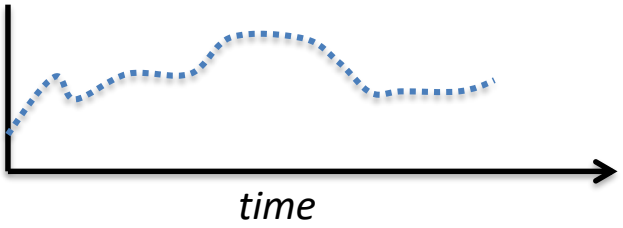


Standard video of students reading the instructions of a task is captured



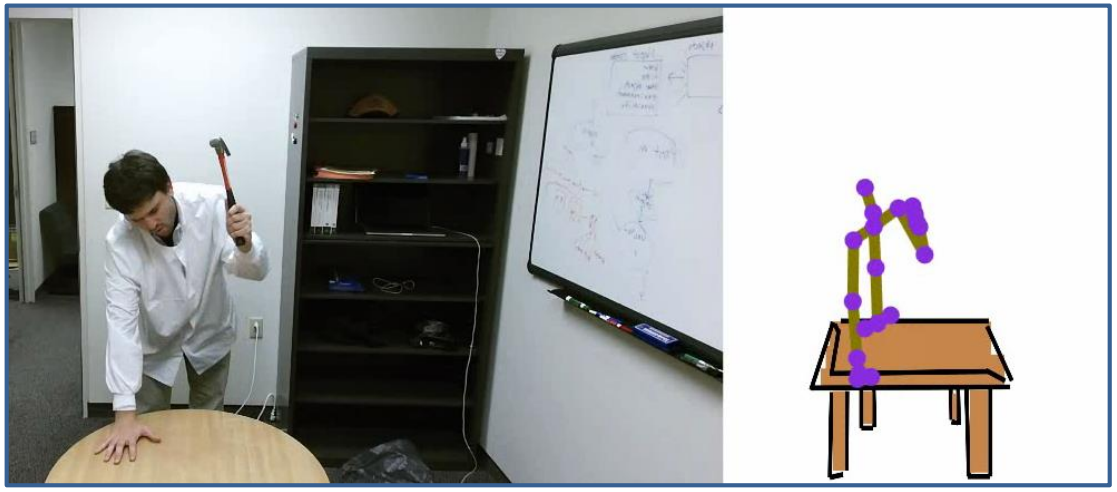


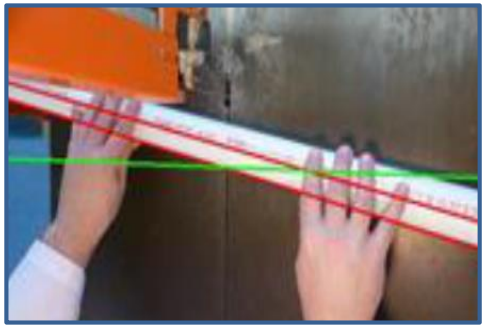
From the videos, facial keypoints are extracted and normalized



$$\boldsymbol{F} = [\mu_1, \sigma_1, \ldots \sigma_{68}, \ldots \theta]$$

Data Acquisition & Features Extraction:
Task performance

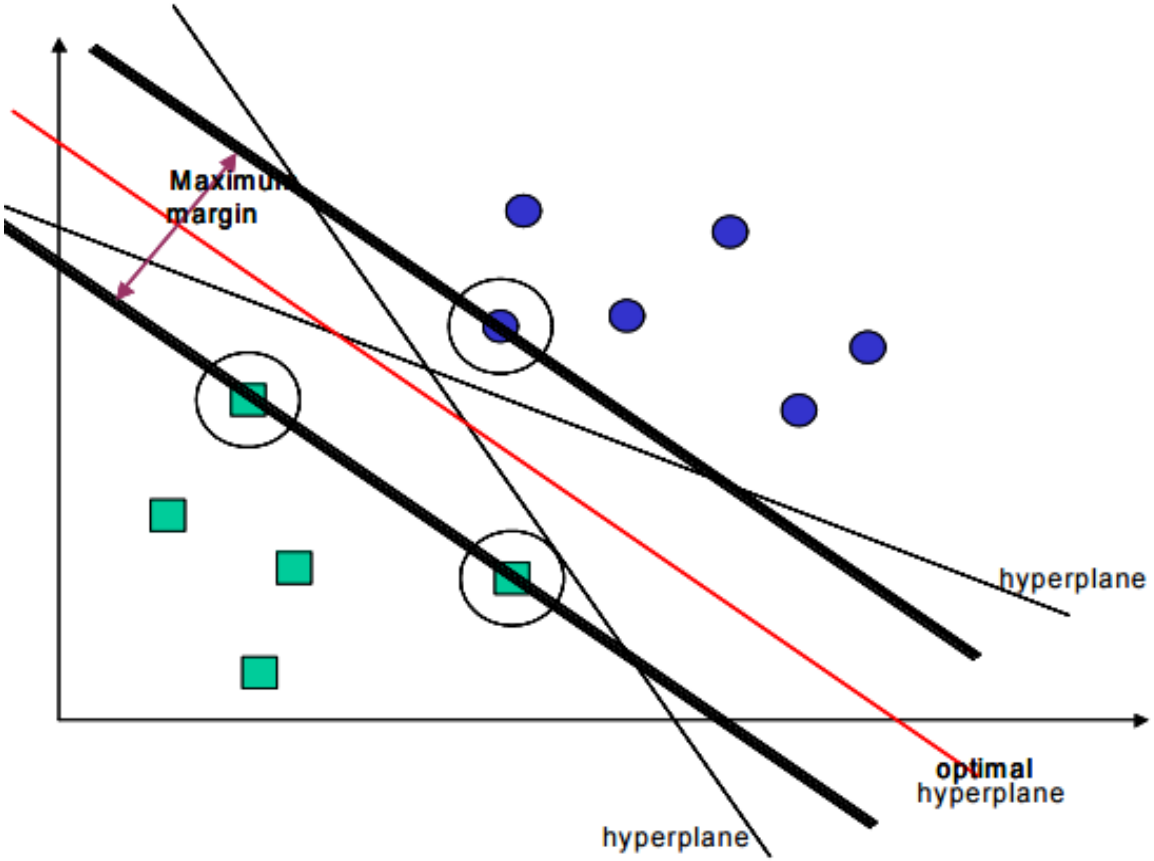




[Dering and Tucker, 2017]

Model Building & Tuning:
Support Vector Machines (SVM) and Grid search

Performance of a student *i* on a given task *t* is assumed to be a binary variable.



[Kotsiantis 2007]

Model Evaluation:

Leave-one-out Cross Validation

Tuple	Facial Key point 1 μ	Facial Key point 1 σ	…	Rotation x σ	Individual (i)	Task (t)	Y_{it}
1	0.355	0.674	…	0.025	1	1	A
2	0.874	0.234	…	0.332	1	2	B
3	0.365	0.632	…	0.292	1	3	A
…	…	…	…	…	…	…	…
it	0.274	0.193	…	0.05	i	t	B

Testing Set

Training Set

Case Study: Engineering Lab Environment

40 freshmen engineering students enrolled in EDGSN 100 *Introduction to Engineering Design* at the Pennsylvania State University

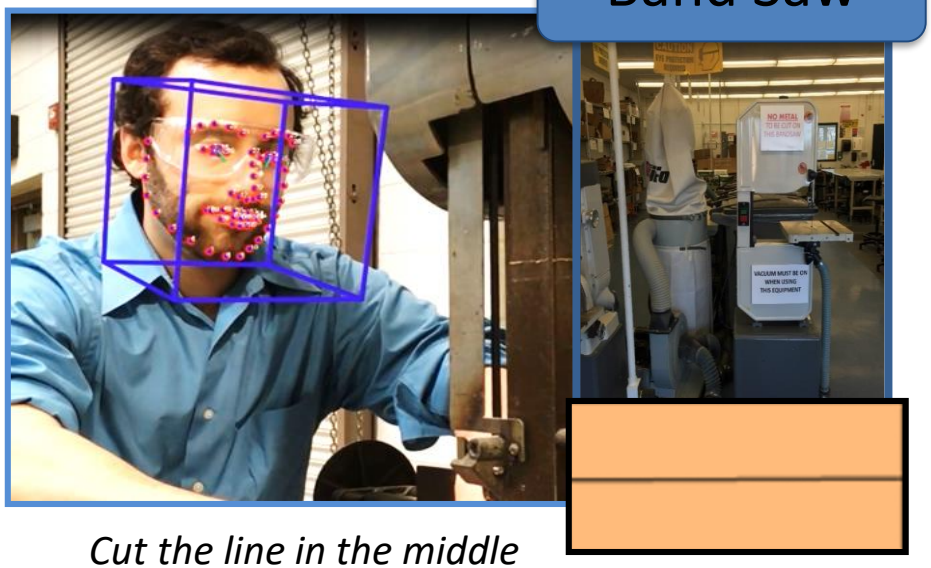
(18 to 19 years of age, 27.5% females)

***OpenFace* facial behavior analysis toolkit**

(68 facial keypoint coordinates)

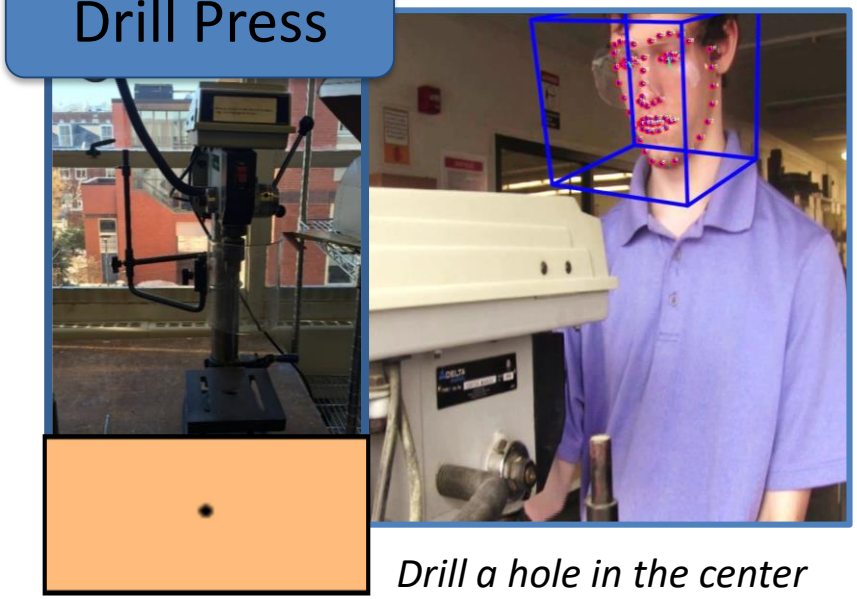
https://cmusatyalab.github.io/openface/

Band Saw



Cut the line in the middle

Drill Press



Drill a hole in the center

40 students x 2 Task =80 videos

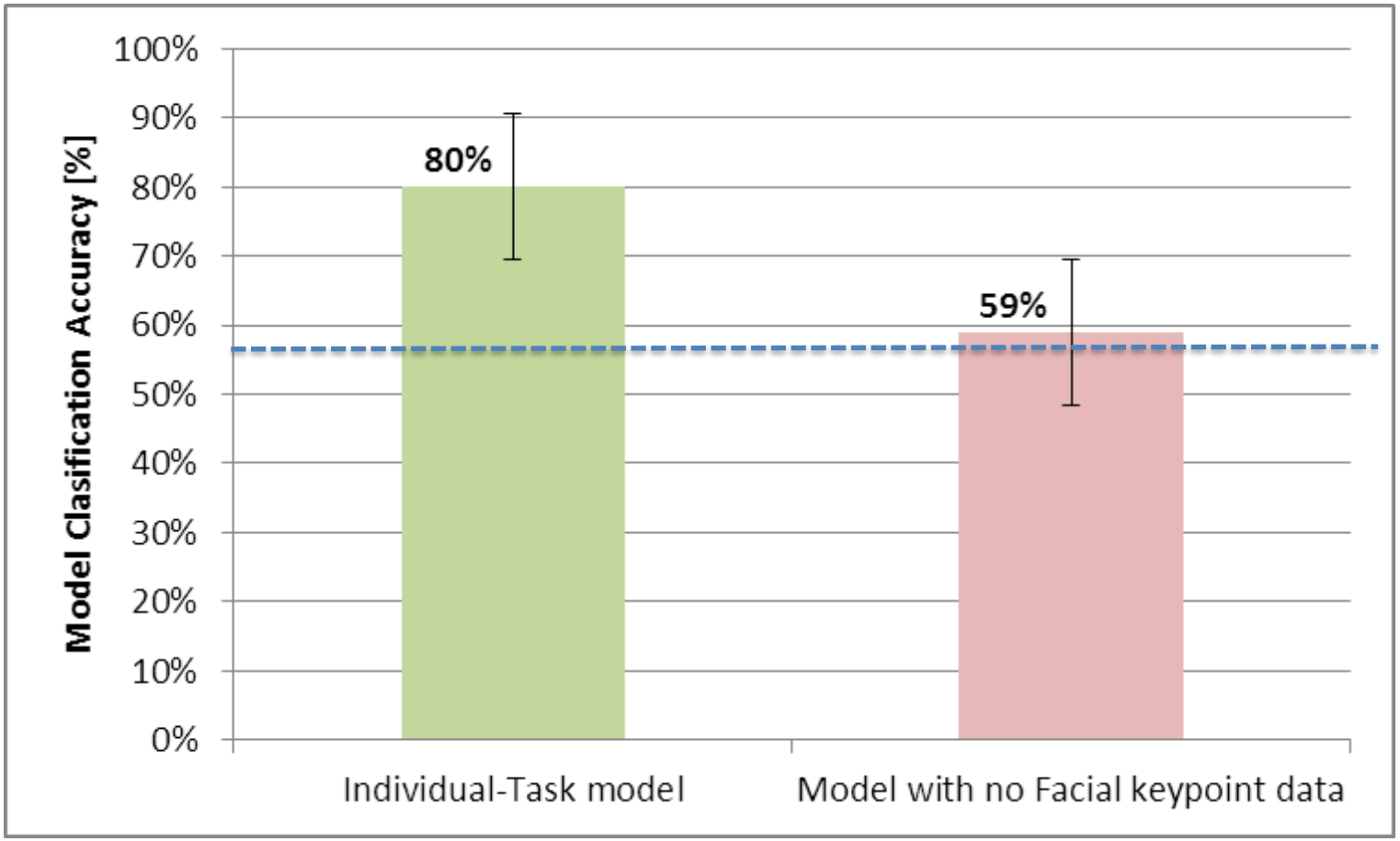
(-5 due to technical difficulties)

Task Performance : ***Below* or *Above* average completion time**

(average of all students given that task)

Results and Discussion

Facial Keypoint data improves model's accuracy



No information rate : ***58.67***%

Limitation and Future Works:
Sample size and diverse number of tasks

This work highlights the potential of using students' unique facial keypoint data to predict their performance prior to the start of task and to advance personalized systems in engineering lab environments

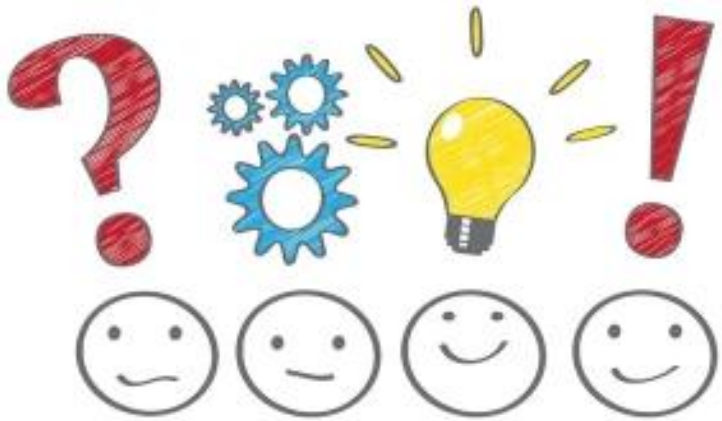
Consider the autocorrelation components of students' facial expression over time

Test for the effects of this systems on students' learning and performance

PennState College of Engineering

D.A.T.A. Design Analysis Technology Advancement Laboratory

Thank you!



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