

In the name of the absolute power and the absolute knowledge

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Social and Cognitive Robotics

Alireza Taheri, PhD, Assistant Professor
artaheri@sharif.edu

Head of the Social and Cognitive Robotics Lab.,
Center of Excellence in Design, Robotics, and Automation
School of Mechanical Engineering,
Sharif University of Technology, Tehran, Iran

2023

Preface



Our Research Group



About the course

- ▶ Course Title: **Social and Cognitive Robotics**, Course No.: **28628**
- ▶ Instructor: **Alireza Taheri**, PhD, Assistant Professor
- ▶ Email: artaheri@sharif.edu
- ▶ Website: <http://sharif.ir/~artaheri/>
- ▶ Tel: +98 21 6616 5531
- ▶ Grading:
 - ▶ Homework (30%)
 - ▶ Final Exam (40%)
 - ▶ Final Project (30%)
- ▶ Office Hours by request



About the course

- ▶ References (... but not limited to)
 - ▶ Bartneck, C., Belpaeme, T., Eyssel, F., Kanda, T., Keijsers, M., & Šabanović, S. (2020). **Human-robot interaction: An introduction**. Cambridge University Press.
 - ▶ Matarić M.J., Scassellati B. (2016) **Socially Assistive Robotics**. In: Siciliano B., Khatib O. (eds) Springer Handbook of Robotics. Springer Handbooks. Springer, Cham. https://doi.org/10.1007/978-3-319-32552-1_73
 - ▶ Breazeal, C. (2004). **Designing sociable robots**. MIT press.
 - ▶ Goodfellow, I., Bengio, Y., & Courville, A. (2016). **Deep learning**. MIT press.
 - ▶ Vernon, D. (2014). **Artificial cognitive systems: A primer**. MIT Press.
 - ▶ Samani, H. (Ed.). (2015). **Cognitive robotics**. CRC Press.
 - ▶ Kanda, T., & Ishiguro, H. (2017). **Human-robot interaction in social robotics**. CRC Press.
 - ▶ Nørskov, M. (2017). **Social robots: boundaries, potential, challenges**. Taylor & Francis.
 - ▶ Calinon, S. (2018). **Robot learning with task-parameterized generative models**. In Robotics Research (pp. 111-126). Springer, Cham.



Our Approach in Social Robotics

رویکرد ما (!) در حوزه رباتیک اجتماعی در دانشگاه صنعتی شریف

شناسایی یک نیاز در جامعه (عمدتاً برای کودکان)

انجام مطالعات میدانی و
مداخلات بالینی
در حوزه
بررسی مقبولیت،
آموزش،
توانبخشی و ...

Clinical Interventions

پیاده سازی
الگوریتم های کنترلی و
هوش مصنوعی
جهت توانمندسازی ربات
ها
برای نیل به اهداف تعیین
شده

Control and Machine Learning

خرید،
و یا
طراحی و ساخت
ربات های اجتماعی-
شناختی
با توجه به نیازهای مورد
نظر

Design and Fabrication



Lecture Schedule

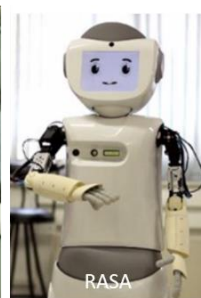
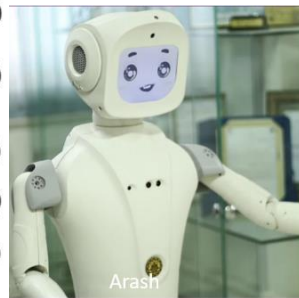
- Introduction, definitions, and basic concepts

*A **Social Robot** is an **Entity** that can, “not only **Sense**, **Think** and **Act**”, “but also must be able to **Communicate** with humans and/or other social robots”.*



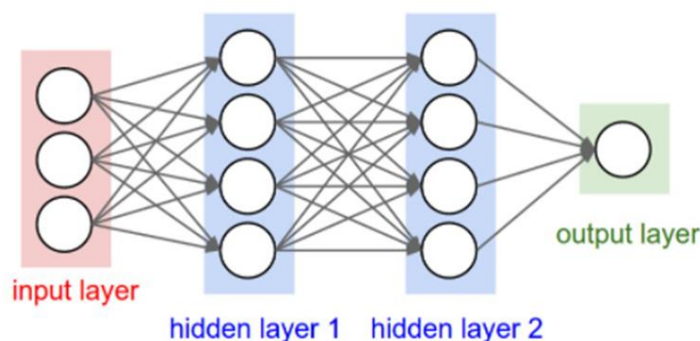
Lecture Schedule

- ▶ Introduction, definitions, and basic concepts
- ▶ Design and interaction of social robots



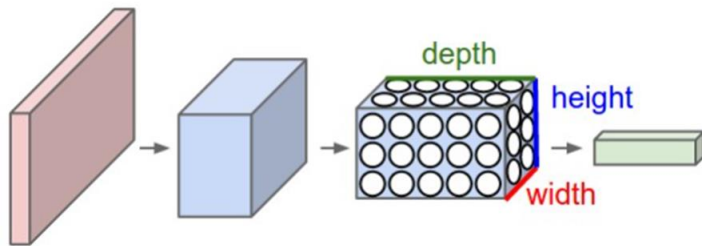
Lecture Schedule

- ▶ Introduction, definitions, and basic concepts
- ▶ Design and interaction perspective of social robots
- ▶ Artificial intelligence: *Towards Deep Learning*
 - ▶ Neural Networks and MLP



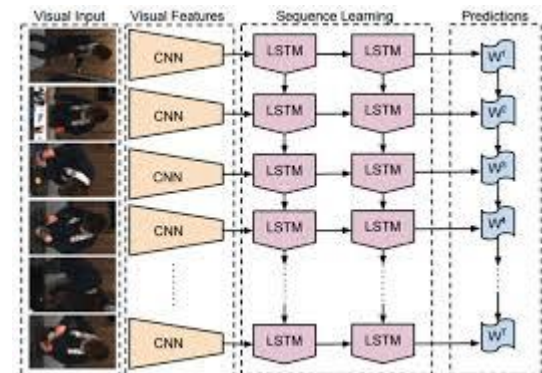
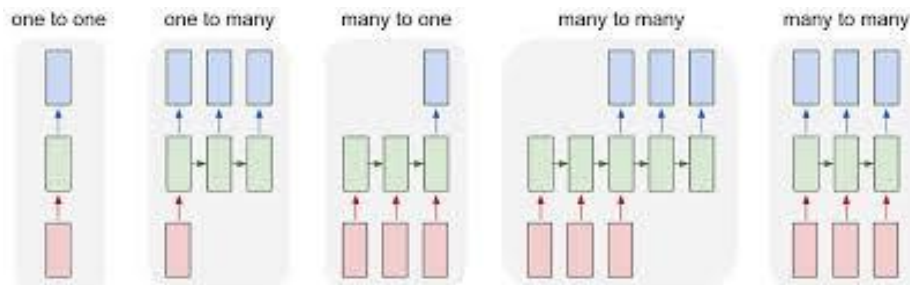
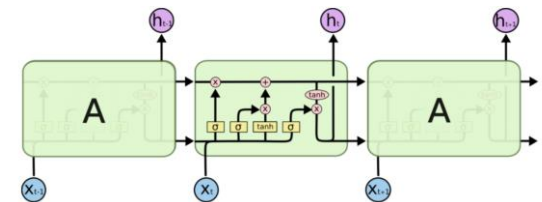
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 - ▶ Neural Networks and MLP
 - ▶ Convolutional Neural Networks (CNN)



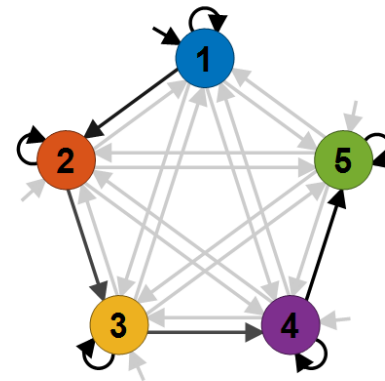
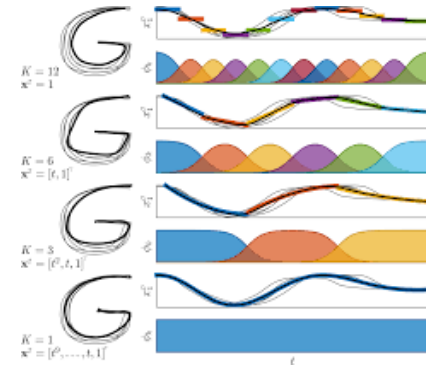
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 - ▶ Recurrent Neural Networks (RNN)



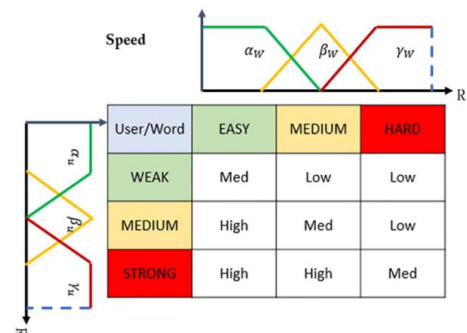
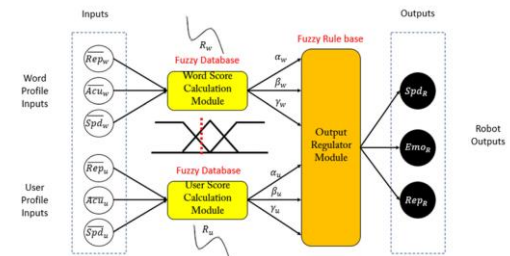
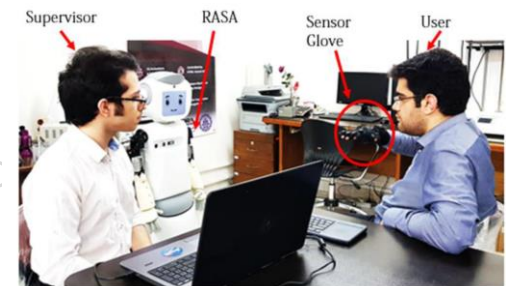
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 - ▶ Convolutional Neural Networks (CNN)
 - ▶ Recurrent Neural Networks (RNN)
 - ▶ Learning from Demonstration (LfD)
 - ▶ Gaussian Mixture Models (GMM)
 - ▶ Hidden Markov Models (HMM)



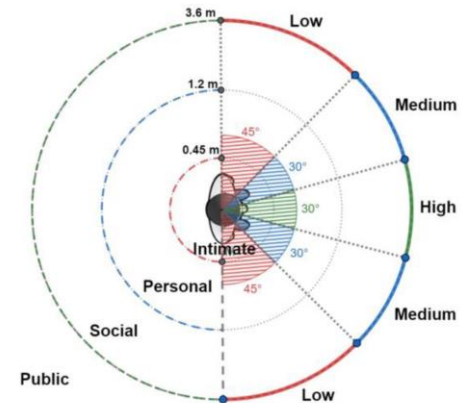
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 - ▶ Learning from Demonstration (LfD)
 - ▶ Adaptive teaching/rehabilitation



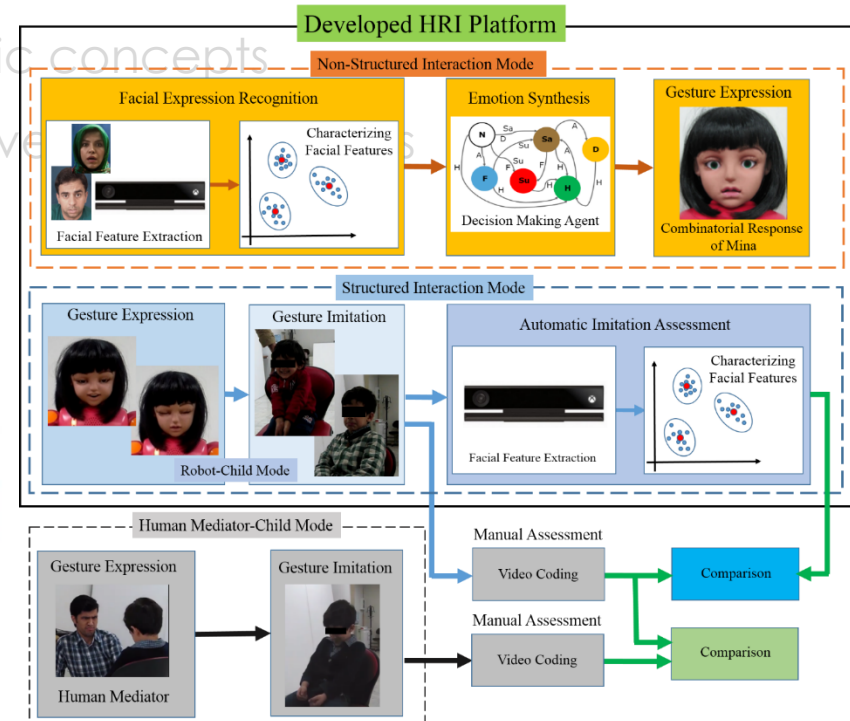
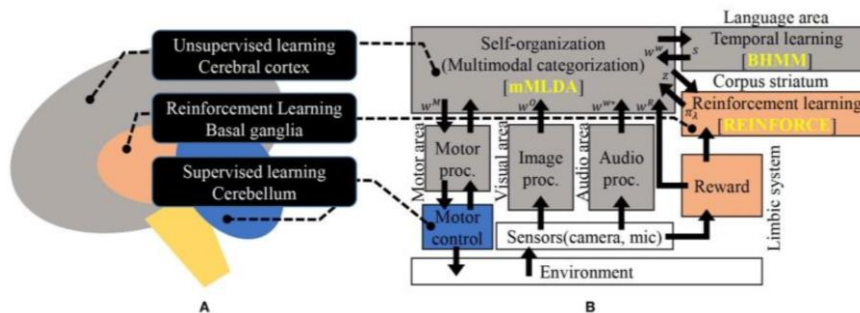
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 - ▶ Adaptive teaching/rehabilitation
 - ▶ Gaze control system



Lecture Schedule

- ▶ Introduction, definitions, and basic concepts
- ▶ Design and interaction perspectives
- ▶ Artificial intelligence
- ▶ Cognitive architectures

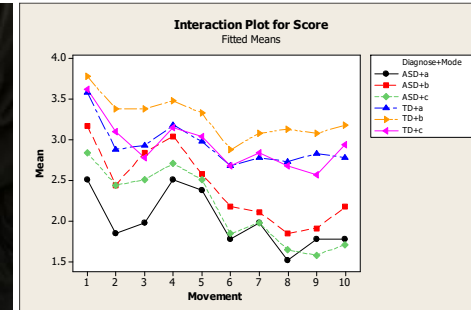


A cognitive architecture is a fixed structure that enables the system to *develop its understanding of the environment and processes by receiving new information and knowledge.*



Lecture Schedule

- ▶ Introduction, definitions, and basic concepts
- ▶ Design and interaction perspective of social robots
- ▶ Artificial intelligence
- ▶ Cognitive architectures
- ▶ Design human-robot interactions and evaluation of the interventions



Design of Social Robots

شناسایی یک نیاز در جامعه (عمدتاً برای کودکان)



خرید،

و یا

طراحی و ساخت

ربات های اجتماعی -

شناختی

با توجه به نیازهای مورد

نظر



Machine Learning

شناسایی یک نیاز در جامعه (عمدتاً برای کودکان)

انجام مطالعات میدانی و
مداخلات بالینی
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شده

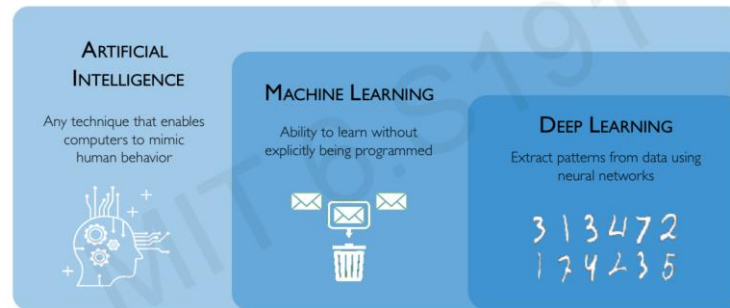
For whom that his/her research
interest lies at the intersection of
control theory and machine learning!

خرید،
و یا
طراحی و ساخت
ربات های اجتماعی-
شناختی
با توجه به نیازهای مورد
نظر



Why Deep Learning?

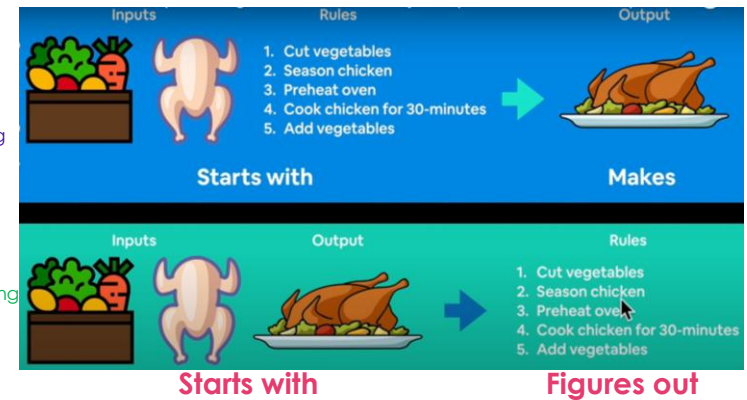
What is Deep Learning?



Traditional Programming

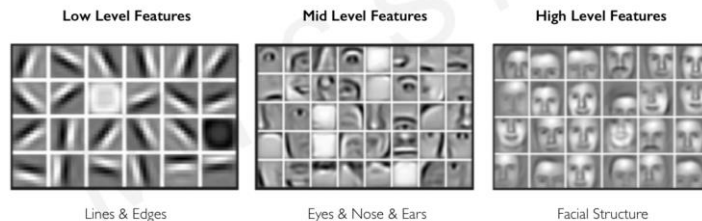
Machine Learning Algorithms

By Daniel Bourke, Learn TensorFlow and Deep Learning



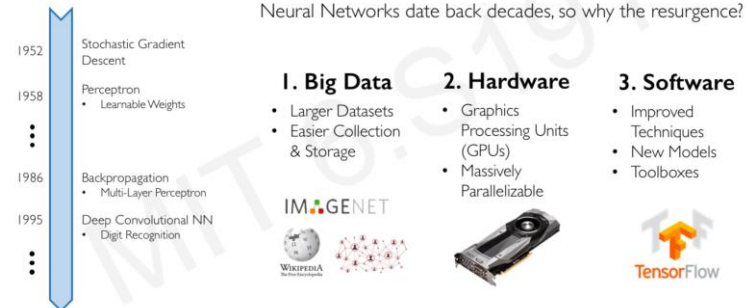
Why Deep Learning?

Hand engineered features are time consuming, brittle, and not scalable in practice
Can we learn the **underlying features** directly from data?



Why Now?

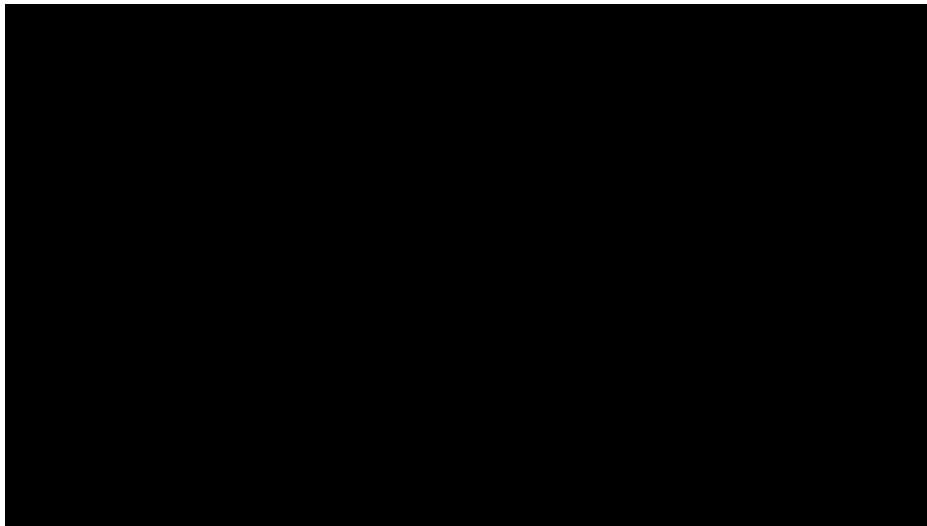
Neural Networks date back decades, so why the resurgence?



Deep Learning Applications

Robotics

Atlas Robot by Boston Dynamics



<https://www.youtube.com/watch?v=EezdinoG4mk>



<https://www.youtube.com/watch?v=fn3KWM1kuAw>



Deep Learning Applications

Autonomous Driving and Self-Driving Cars

Tesla Autopilot



Learning Robust Control Policies for End-to-End Autonomous Driving From Data-Driven Simulation

Alexander Amini, Igor Gilitschenski, Jacob Phillips, Julia Moseyko, Rohan Banerjee, Sertac Karaman, Daniela Rus

Computer Science and Artificial Intelligence Laboratory (CSAIL), MIT
Laboratory for Information Decision Systems (LIDS), MIT



MIT Autonomous Vehicle

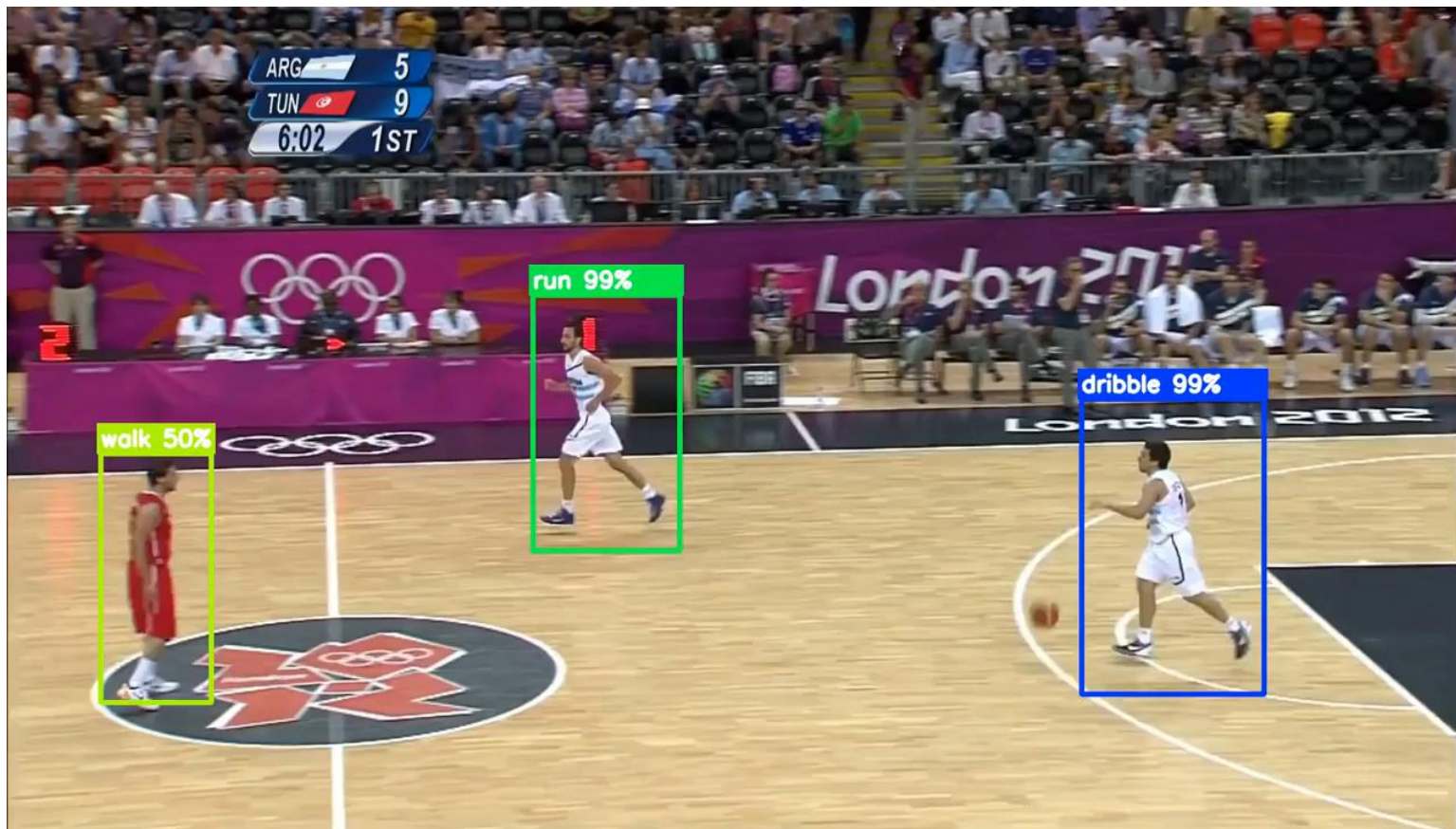
<https://www.youtube.com/watch?v=YgFIMnQmASw>

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



Deep Learning Applications

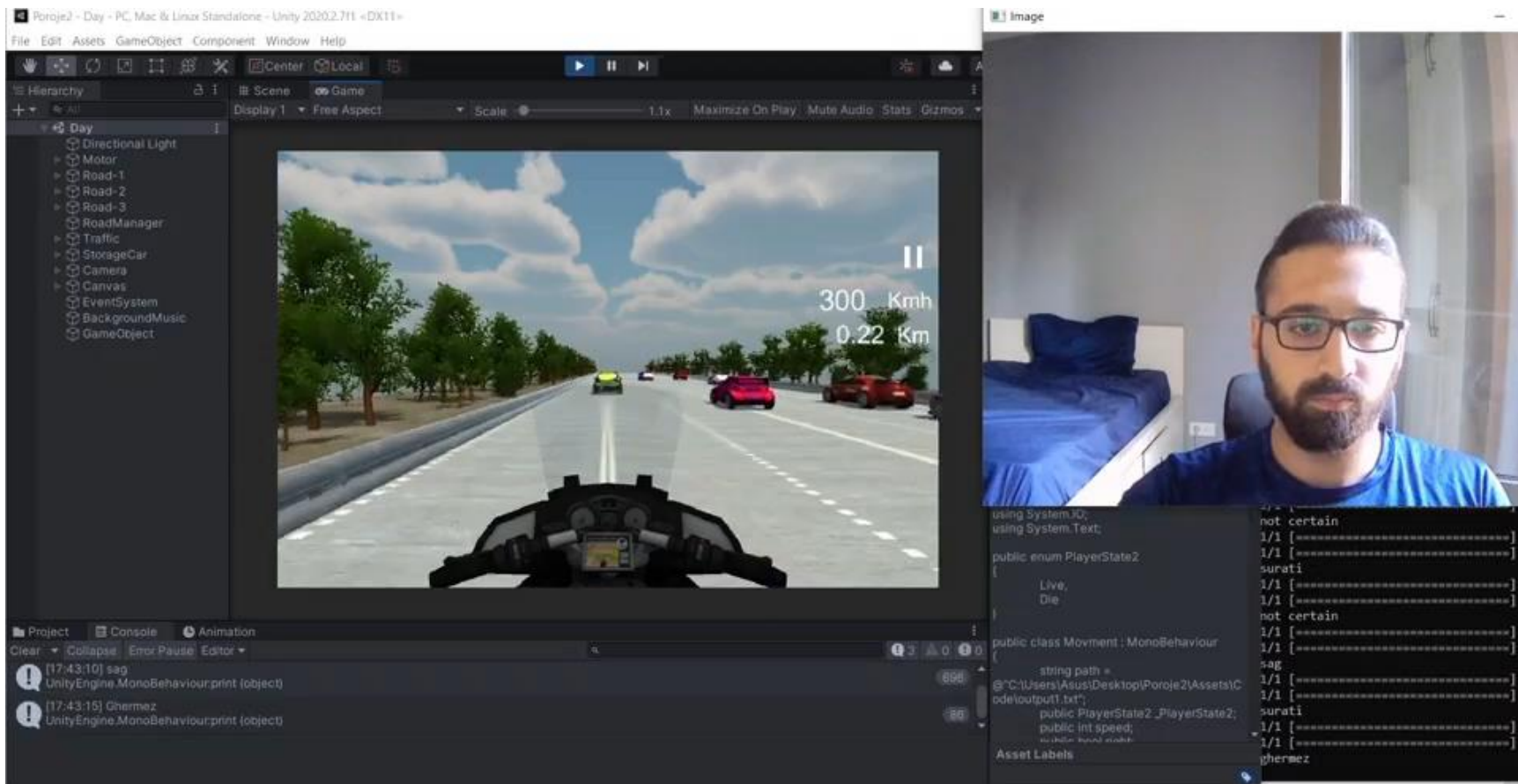
Action Recognition



<https://www.youtube.com/watch?v=PEziTgHx4cA>

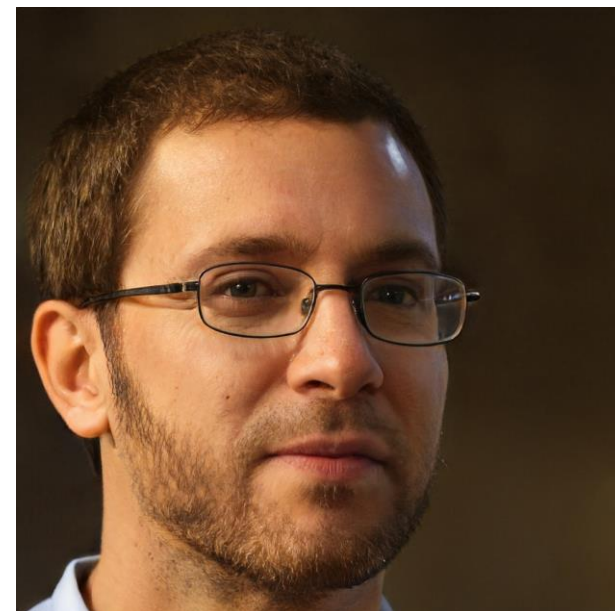
Deep Learning Applications

Action Recognition; Sign Language Detection



Deep Learning Applications

Fake Images!



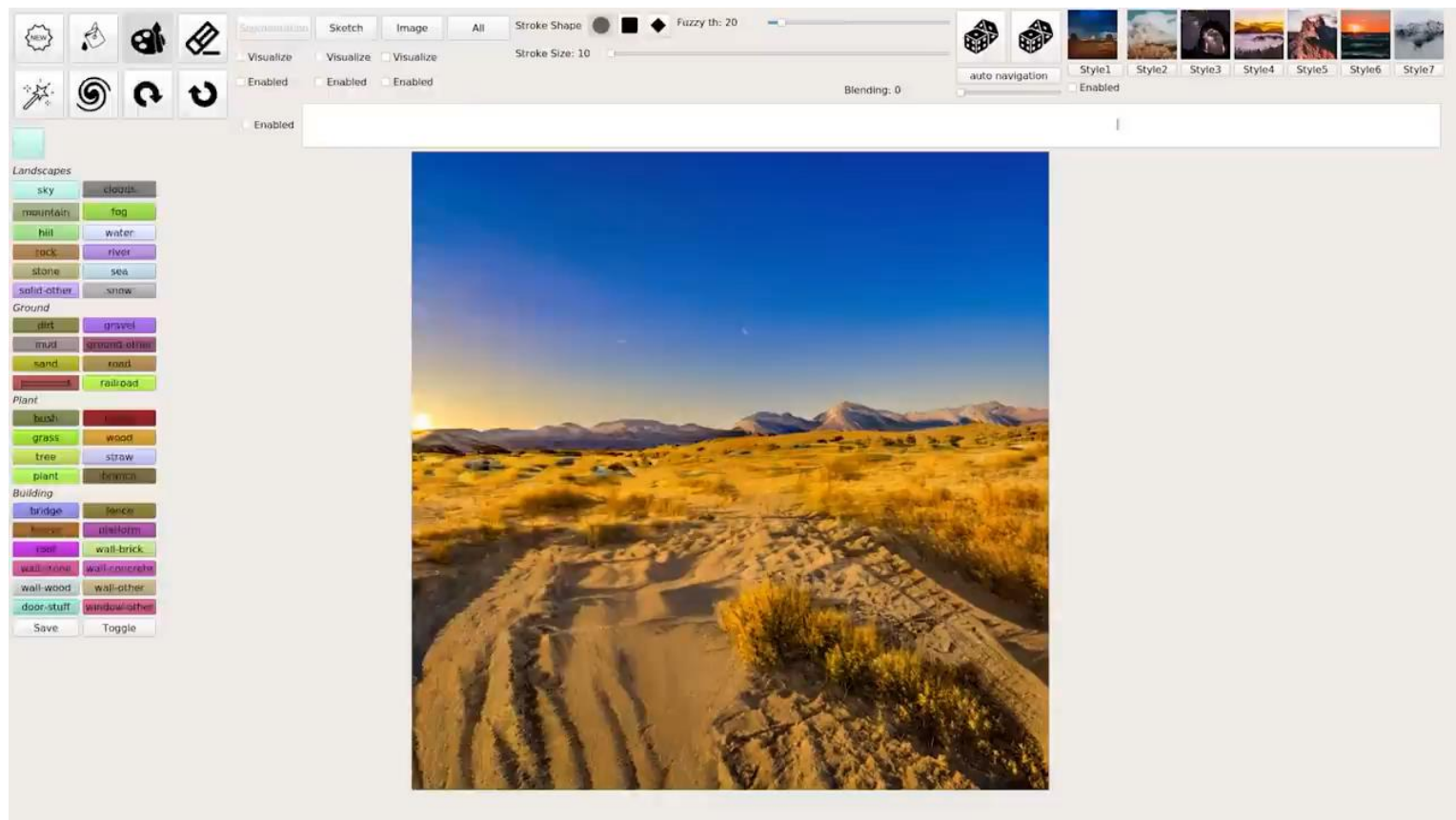
<https://thispersondoesnotexist.com/>

Take a look and enjoy!



Deep Learning Applications

Art; Painting



<https://www.youtube.com/watch?v=5Qdr8AUNYqU>

By Nvidia



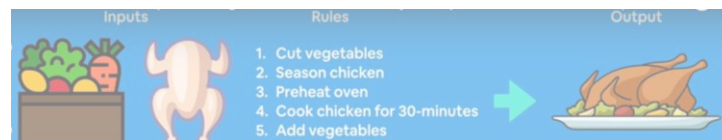
Why Deep Learning?

Let's come back to slide #19

What is Deep Learning?



Traditional Programming



فوب، حالا بازم «چرا یادگیری عمیق؟»

۱- چرا که نه؟!

۲- داریم به نقطه ای می رسیم (تازه آگه نرسیده باشیم) که

ندونستش زشته! ... زشت ... می فهمین؟!



Lines & Edges

Eyes & Nose & Ears

Facial Structure



Why Deep Learning?

Let's come back to slide #19

What is Deep Learning?

By Daniel Bourke, Learn TensorFlow and Deep Learning

یعنی بدون هیچ پیشینه ای و با موارد مورد نظر در این درس، می شه زد تو گوش دیپ لرنینگ؟!

۱- اول توکل به خدا ... حالا شاید تهشو نون نگیریم، اما تلاش می کنیم لنگان خدک
فویش به منزل برسانیم!



۲- «... بابا فکر کن، خک کردن که عیب نداره!!»

۳- تصور کن تو می تونی، ... بشی تعبیر این رویا!!!



Lines & Edges



Eyes & Nose & Ears



Facial Structure

1986
backpropagation
• Multi-Layer Perceptron
1995
Deep Convolutional NN
• Digit Recognition



Learning Outcomes

... and in the end, hopefully, you can

- ▶ Understand the definitions and principles of human-robot interaction
- ▶ Learn required components in social and cognitive robots
- ▶ Build your own Deep Neural Networks (from scratch)
- ▶ Carry out user requirement analysis and design of human-robot interaction
- ▶ Use quantitative and qualitative approaches for evaluation and analysis of human-robot interaction data
- ▶ Know applications of social robots to improve the quality of life of the users (specially children with special needs)

تلاش بر این است تا در درس رباتیک اجتماعی و شناختی، بستری غنی (و تا حد امکان جذاب) جهت فراگیری موارد ضروری در طراحی ربات های اجتماعی، تعاملات انسان-ربات، یادگیری عمیق به صورت کاربردی، و طراحی و ارزیابی مداخلات بالینی و مطالعات میدانی برای شما به وجود آید.

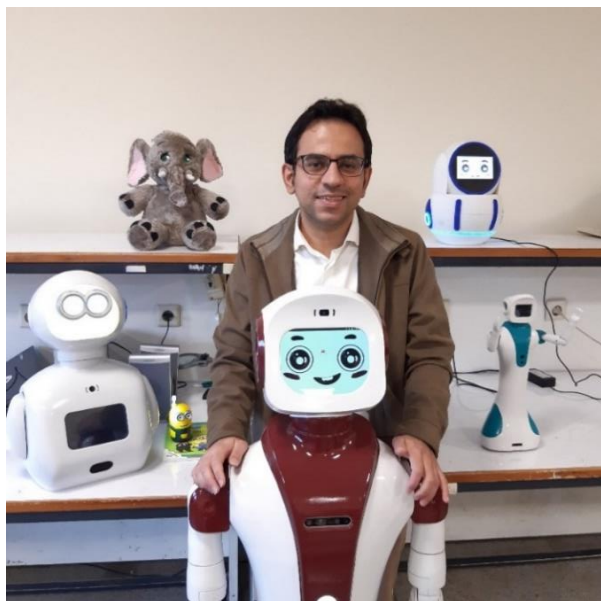


Social Robot Definition

Next Session ...

and roles attached to its role ([Wikipedia](#)).

- ▶ A **Social Robot** is an **Entity** that can “not only **Sense**, **Think** and **Act**”, “but also must be able to **Communicate** with humans and/or other social robots”.



- رباتیک اجتماعی، به عنوان یک مفهوم جوان در ادبیات پژوهشی رباتیک، صحبت از ربات هایی دارد که با انسان ها (و یا با یکدیگر)، تعاملات عاطفی، کلامی و غیر کلامی، شنیداری/دیداری (نیمه/تمام هوشمند) و ... داشته و به عنوان دوست، همدم، دستیار معلم و یا کمک درمانگر وارد زندگی افراد (به خصوص کودکان با نیازهای ویژه و یا سالمندان) می شوند.





CEJRA
Center of Excellence In Design, Robotics & Automation

Thanks for your attention

