



WAYVE

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www.cir-strategy.com/events

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How Can We Build Intelligent Robots?

2017 Robots?



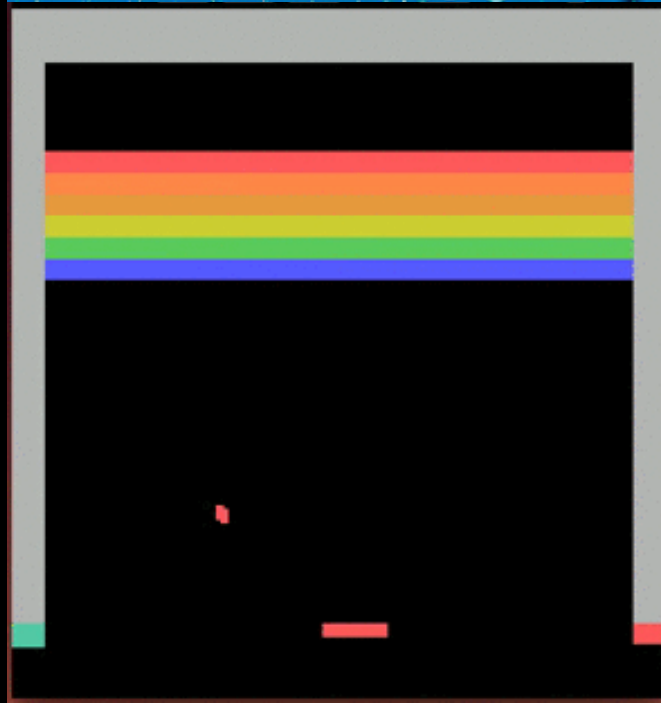


柯洁 KE JIE
00:17:05

ALPHAGO
01:51:38

浙江省体育局

A Go board with black and white stones is shown on the left. On the right, a player (Ke Jie) is seated at a table, looking thoughtful with his hands on his face. The background is blue with white circular patterns.



Why are these algorithms not controlling real world robots??

1. Computer Vision

2. Ethics & Safety

158 087 255 253 251 197 247 157 255 255 255 120 123 146 244 024 249 039 183 085 029 165 255 212

158 059 255 251 114 098 241 255 250 253 097 032 132 038 009 028 075 031 247 089 034 160 088 245

200 051 167

220 111 052

Part I: Computer Vision

167 198 227 075 135 114 021 226 255 255 254 135 255 165 152 017 040 031 131 255 031 022 062 171

050 040 037 149 046 052 108 134 064 051 056 038 024 084 022 021 032 015 023 224 033 052 060 255

054 049 044 052 036 034 057 106 047 044 067 050 062 058 088 022 027 043 015 034 025 026 035 116

050 040 039 052 092 060 117 086 071 072 030 025 047 040 058 032 027 053 028 043 027 057 035 138

055 086 022 069 029 056 103 083 078 080 080 031 048 049 105 057 024 041 035 041 025 030 032 179

048 032 042 060 064 050 089 068 087 055 083 067 084 044 043 073 029 026 045 024 018 037 036 255

047 058 051 043 048 038 067 039 056 056 082 042 042 039 035 038 025 037 035 020 019 024 086 251

088 089 085 082 085 081 085 096 106 114 057 052 036 035 027 036 026 024 032 025 020 021 047 022

039 068 080 089 097 108 095 090 102 094 077 096 102 056 036 029 023 066 026 024 018 112 107 131

054 118 055 074 034 045 055 045 055 054 045 075 033 037 054 045 037 103 054 035 037 104 034 035

We aren't born with the ability to see, We need to learn!

- **4 months:** focusing, hand-eye coordination and interest in faces
- **6 months:** depth perception and color vision
- **9 months:** precision grasping and interaction
- **12 months:** object recognition

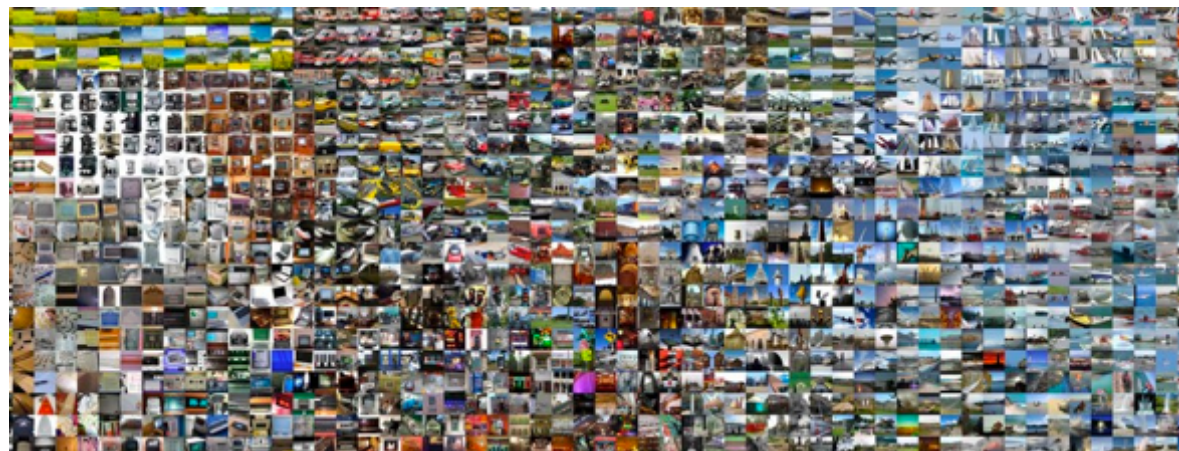


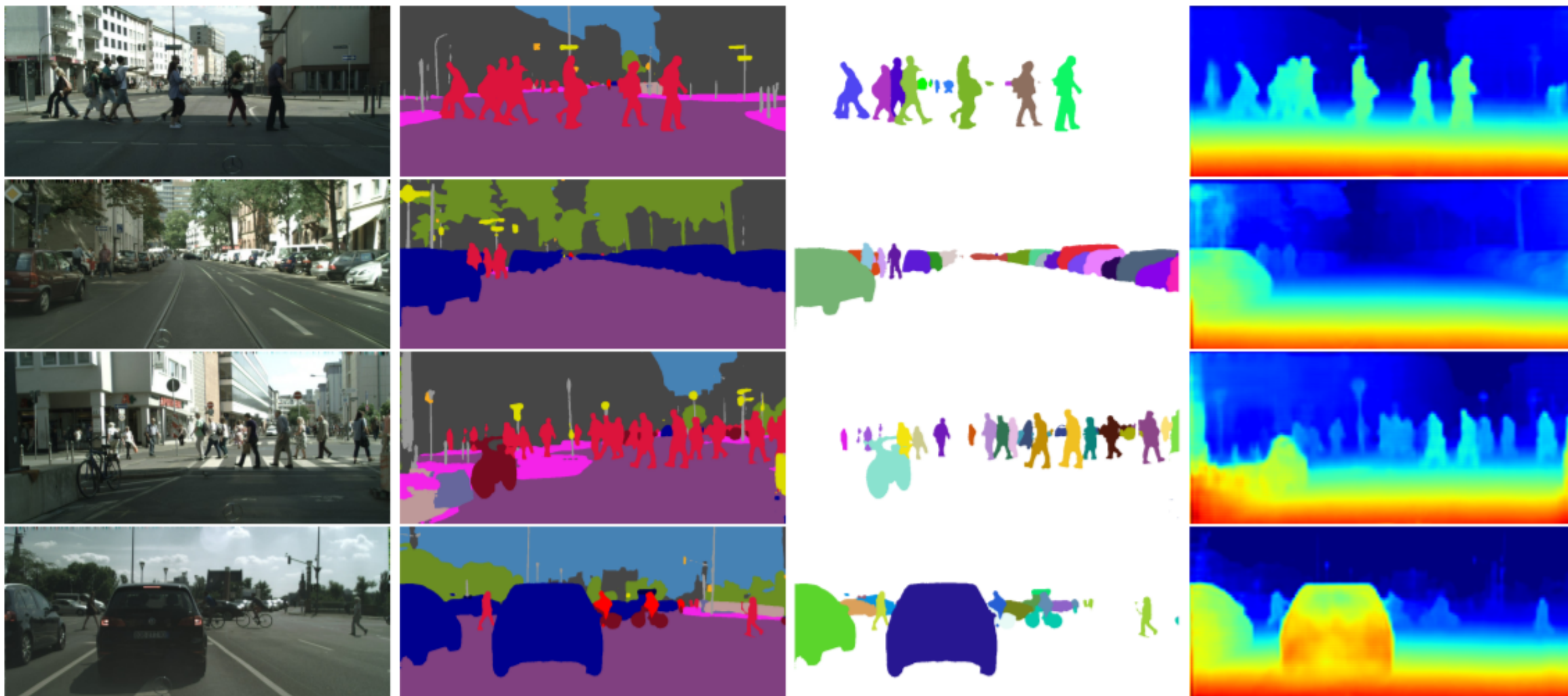
How we learn something as complex as vision?

- Suppose, a baby experiences 1 saccade per second, for 8 hours a day for 365 days
- $1 \times 60 \times 60 \times 8 \times 365 = 10,000,000$ training examples to learn to see

Deep Learning for Computer Vision

- Powerful framework for understanding high dimensional data like images, videos, speech, text
- With enough training data, they outperform human baselines for recognition tasks
- Typically computer vision models contain ~10 million parameters, take 3+ days to train on a GPU



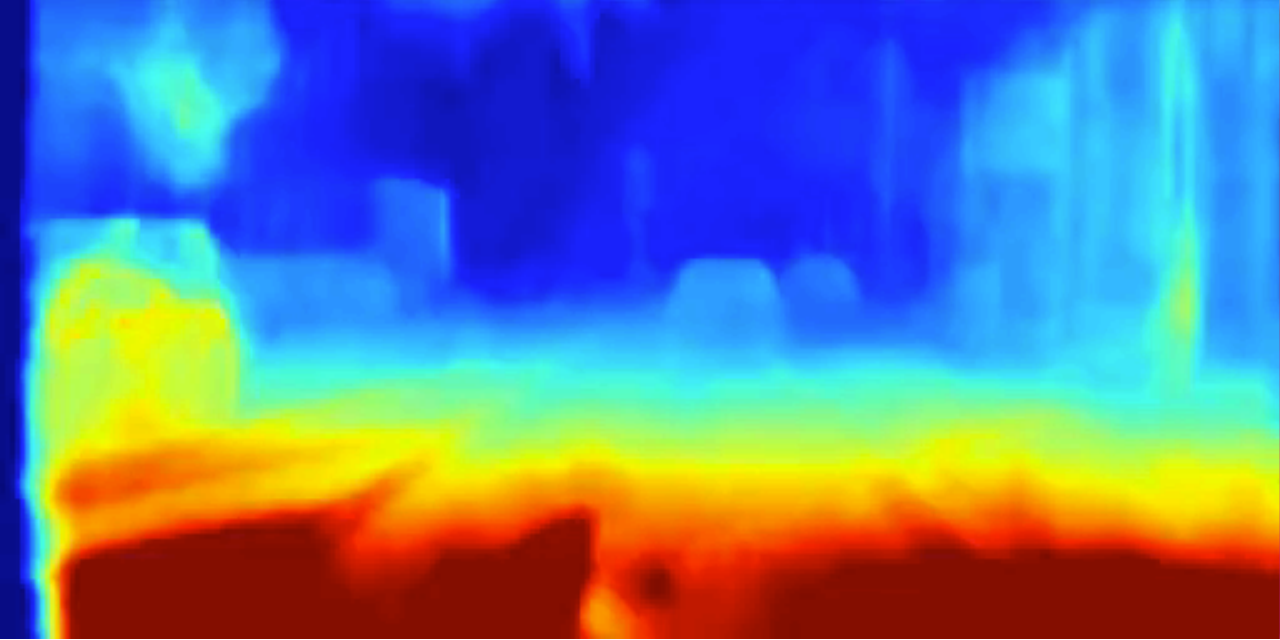


(a) Input image

(b) Segmentation output

(c) Instance output

(d) Depth output

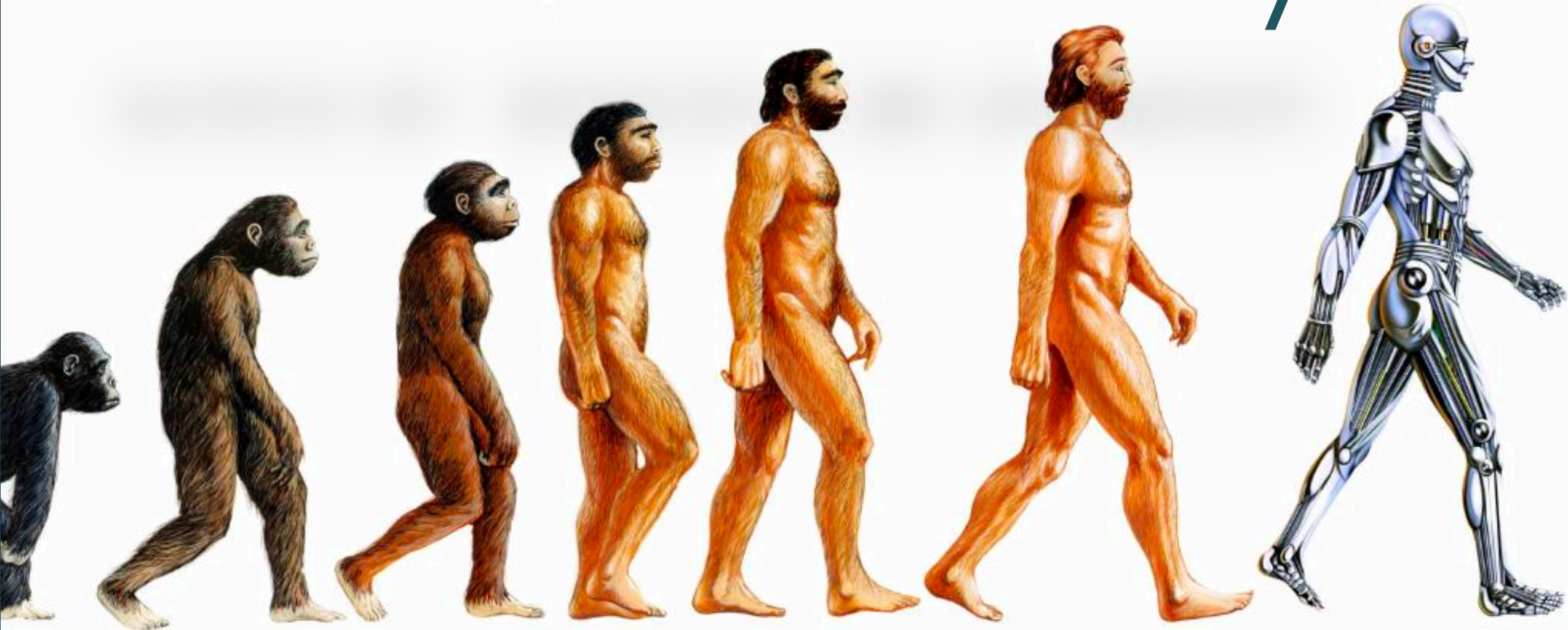


Alex Kendall and Roberto Cipolla. **VideoSegNet: Self-Supervised Motion and Depth for Video Semantic Segmentation.**
In Submission, 2017.

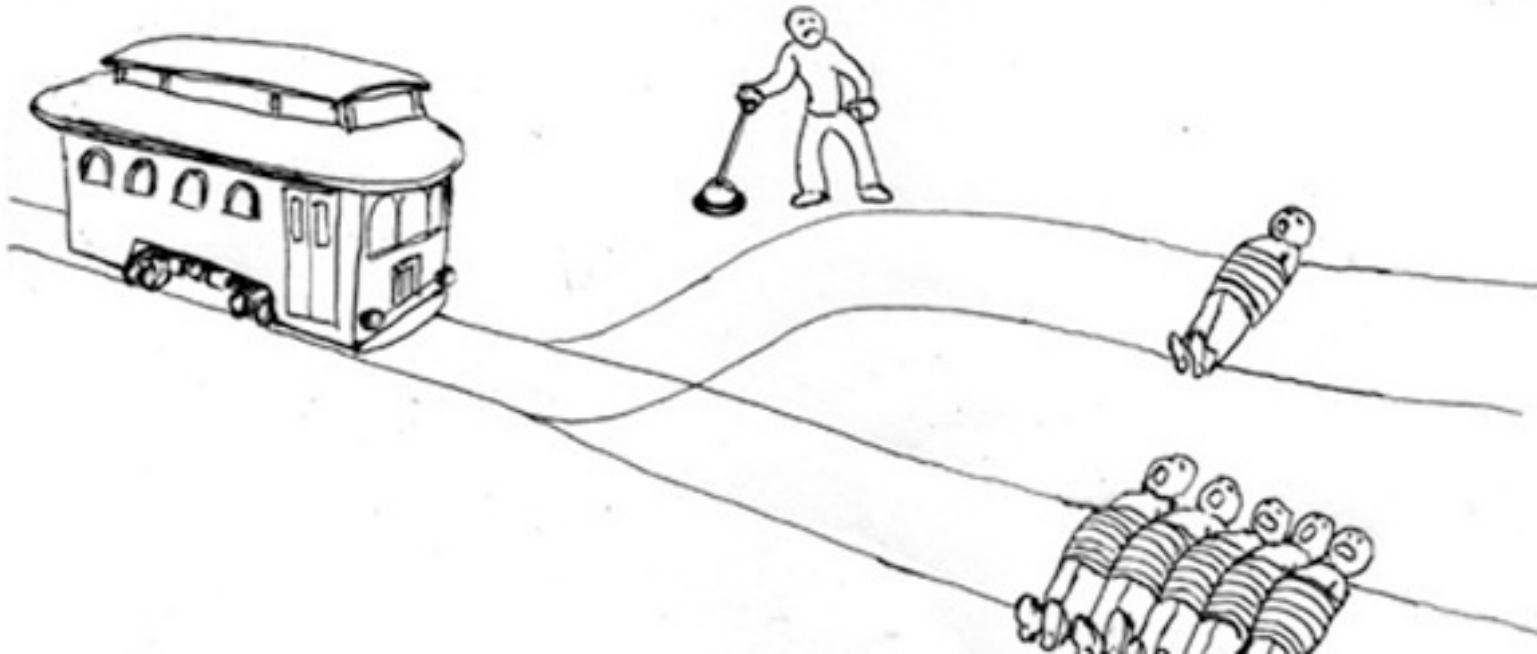


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SKYDIO

Part II: Ethics & Safety



The Trolley Problem



Do you...

1. Do nothing, and the trolley kills the five people on the main track.
2. Pull the lever, diverting the trolley onto the side track where it will kill one person.

Which is the most ethical choice?

1. *The Trolley Problem*, Wikipedia. https://en.wikipedia.org/wiki/Trolley_problem
2. Rowan McAllister, Yarin Gal, Alex Kendall, Mark van der Wilk, Amar Shah, Roberto Cipolla, and Adrian Weller. *Concrete Problems for Autonomous Vehicle Safety: Advantages of Bayesian Deep Learning*. IJCAI, 2017.

Examples of Un-Ethical AI, Today

- US Justice System Re-Offending Rate algorithm.. Biased against minorities

<https://www.propublica.org/article/machine-bias-risk-assessments-in-criminal-sentencing>

- Google's speech recognition system is better at male voices

<https://makingnoiseandhearingthings.com/2016/07/12/googles-speech-recognition-has-a-gender-bias/>

- Many self-driving cars only work in California

<https://www.ft.com/content/4377b4c0-0479-11e7-aa5b-6bb07f5c8e12>

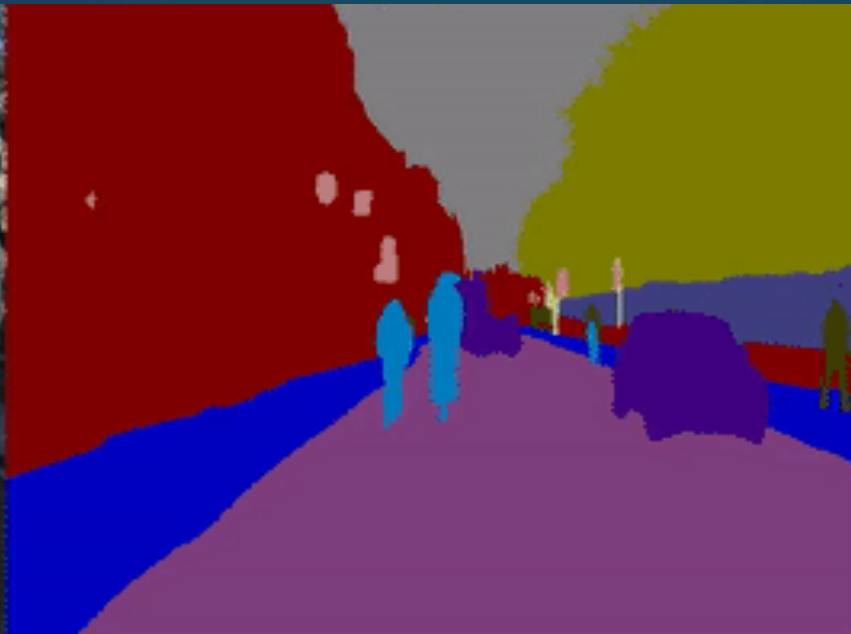
Concrete Problems for AI Safety

- Trust
 - Improve model performance and accuracy
 - Models understanding uncertainty in decisions
- Fairness
 - Improve data efficiency and reduce bias
 - Algorithms which require less training data and generalise better
- Honesty
 - Interpretability of results and model saliency
 - Causal reasoning
 - Avoid reward hacking

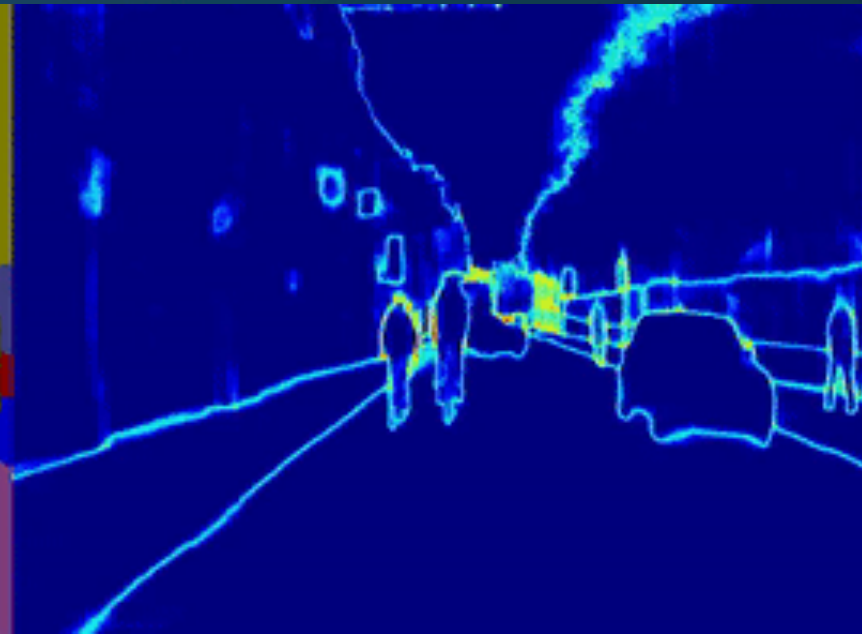
Uncertainty in Deep Learning



Input Video



Semantic Segmentation



Uncertainty

-
1. Alex Kendall and Yarin Gal. *What Uncertainties Do We Need in Bayesian Deep Learning for Computer Vision?* *Advances in Neural Information Processing Systems (NIPS)*, 2017.

Conclusions

- We need **machine learning to scale** to hard problems with intelligent robots – hand engineering isn't good enough
- We can **learning to perceive and act from data** with deep learning
- We cannot explicitly reason about ethical situations on a case-by-case basis – our **models need to understand ethics** themselves
- **Computer vision is holding back robotics** from real-world applications

Questions?



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