

Machine Learning: successes, promises and limits

AI Academy Seminar
13 November 2018, Kortrijk
Tom Sercu

Who Am I

- ir. UGent (een burgie)
- Master in Data Science at NYU (New York University)
- Researcher at IBM Research AI
- Published at Speech Recognition and Machine Learning conferences

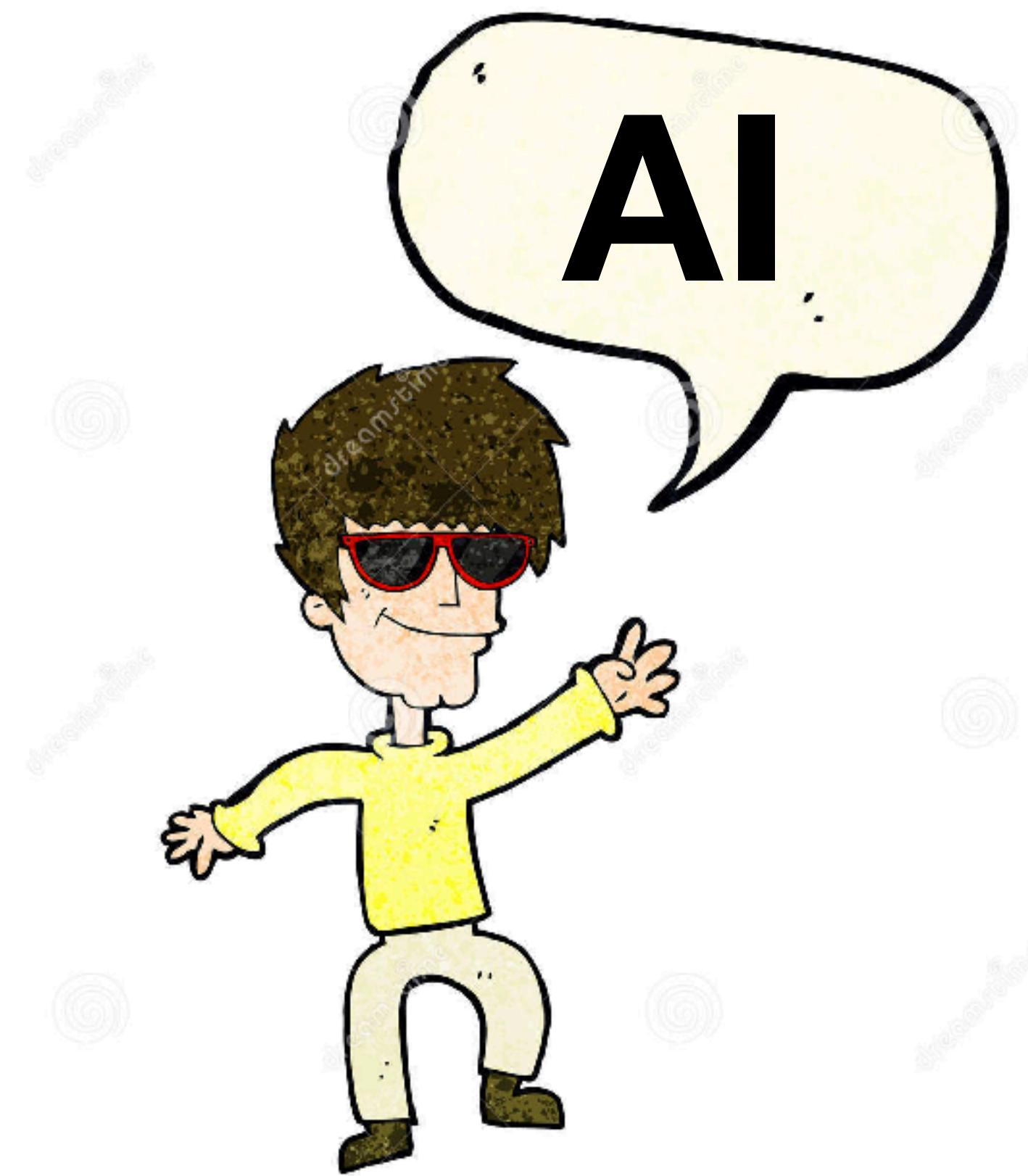


I am NOT

- Representing IBM (opinions are my own)
- Selling you anything
 - Except truth!
- Funny.
 - but I'll try



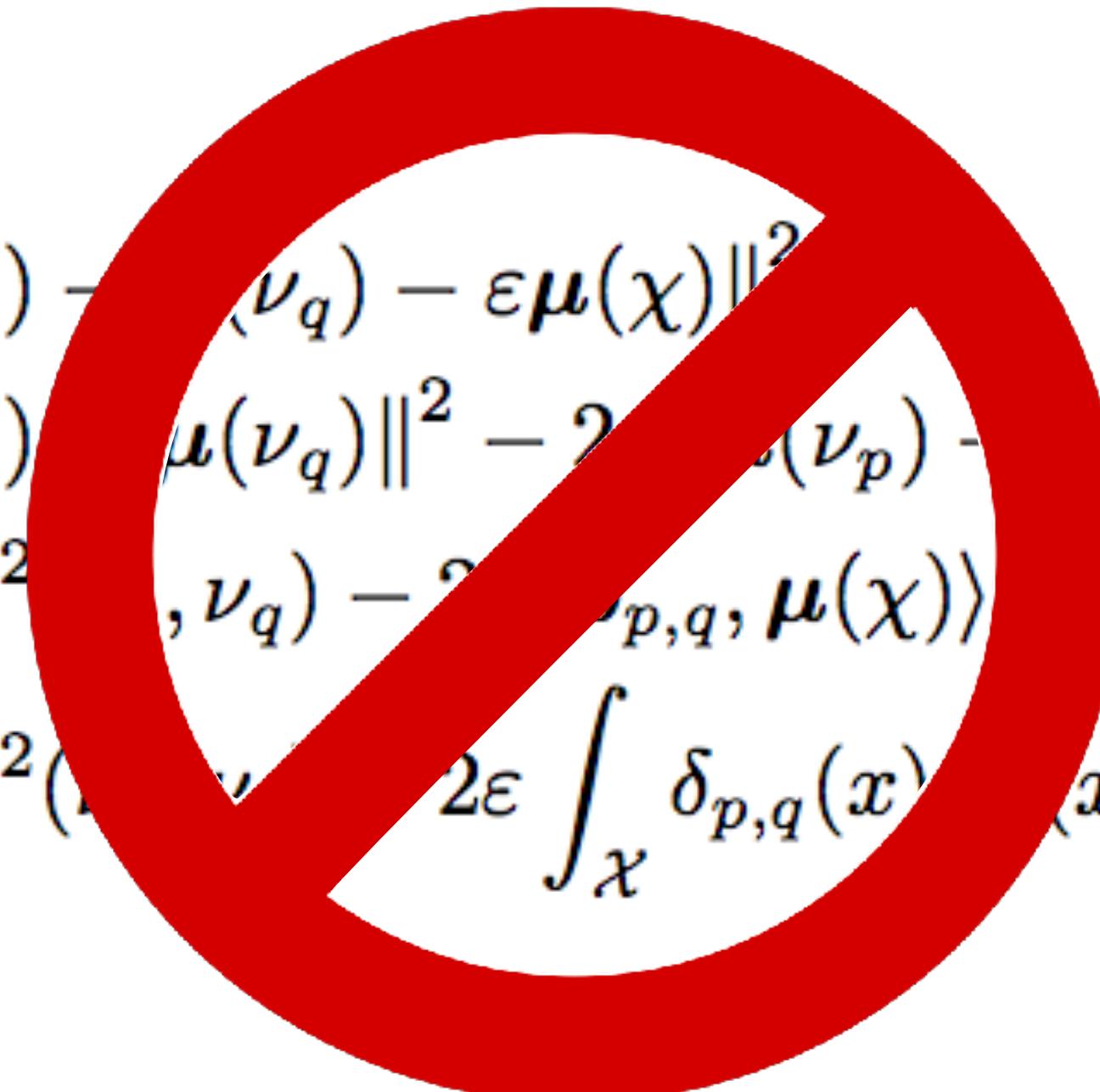
Many companies throw money at AI, but few get real returns.



My goal is for you to:

**Build better feeling and understanding of
AI and its limitations!**

$$\begin{aligned} &= \|\mu(\nu_p) - \mu(\nu_q) - \varepsilon\mu(\chi)\|^2 \\ &= \|\mu(\nu_p) - \mu(\nu_q)\|^2 - 2\langle \mu(\nu_p) - \mu(\nu_q), \mu(\chi) \rangle + \varepsilon^2 \|\mu(\chi)\|^2 \\ &= \text{MMD}^2(\nu_p, \nu_q) - 2\varepsilon \langle \delta_{p,q}(x), \mu(\chi) \rangle + \varepsilon^2 \|\mu(\chi)\|^2 \\ &= \text{MMD}^2(\nu_p, \nu_q) + 2\varepsilon \int_{\mathcal{X}} \delta_{p,q}(x) \mu(\chi)(x) + \varepsilon^2 \|\mu(\chi)\|^2 \end{aligned}$$



My goal is for you to:

Build better feeling and understanding of AI and its limitations!

1. Successes: Which problems AI is good at.
2. Limitations part A: Brittleness by cobbling together.
3. Limitations part B: The frontiers. Stuff that's just too difficult for now



1. Successes: Which problems AI (machine learning / deep learning) is good at.



Conclusion:

Simple Input -> Output mappings!

“Learning” in ML/DL: collect many input/output examples,
black box algorithm (Neural Networks!)
will learn to predict the output

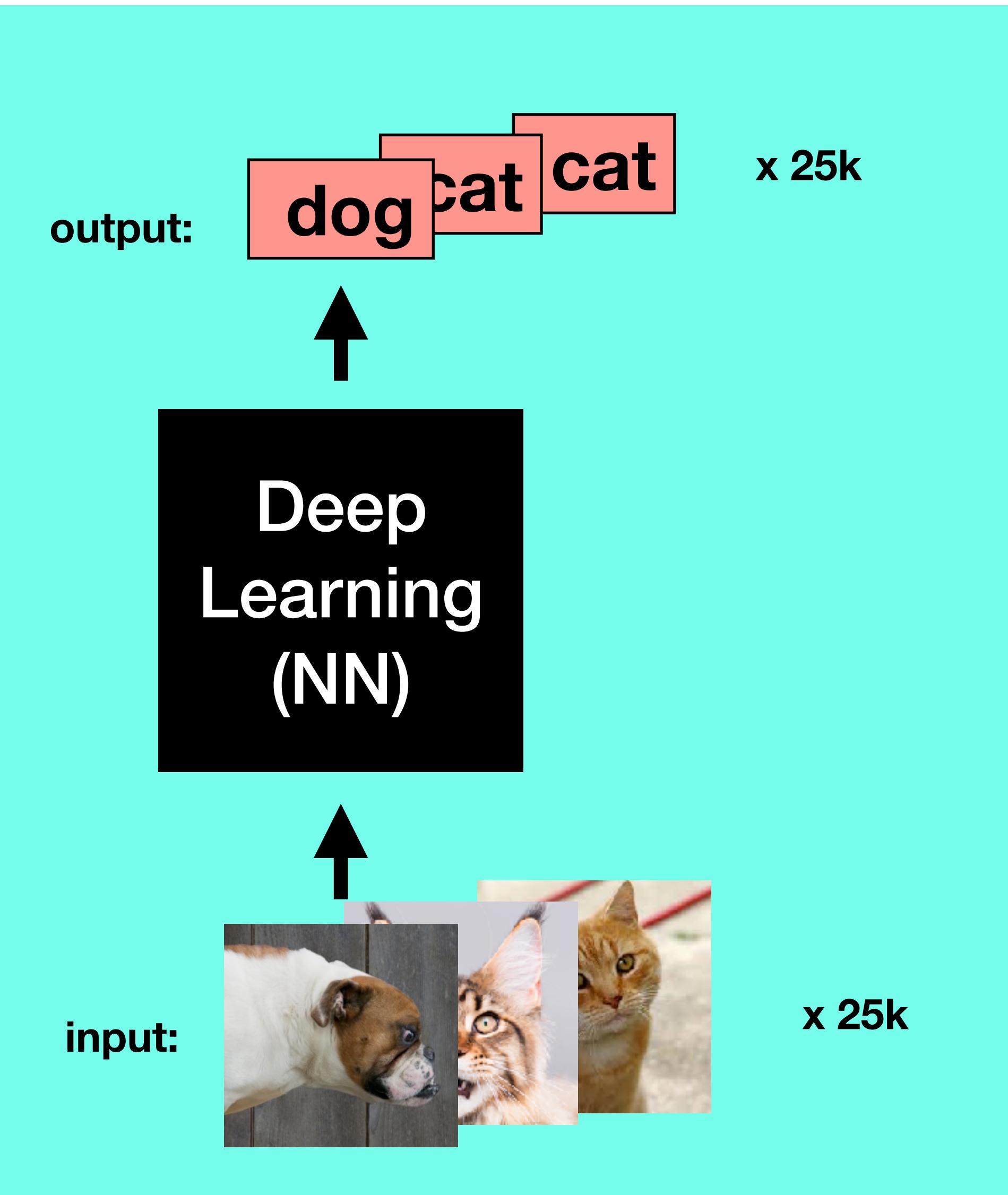
1. Successes

Image Recognition

DOG



CAT

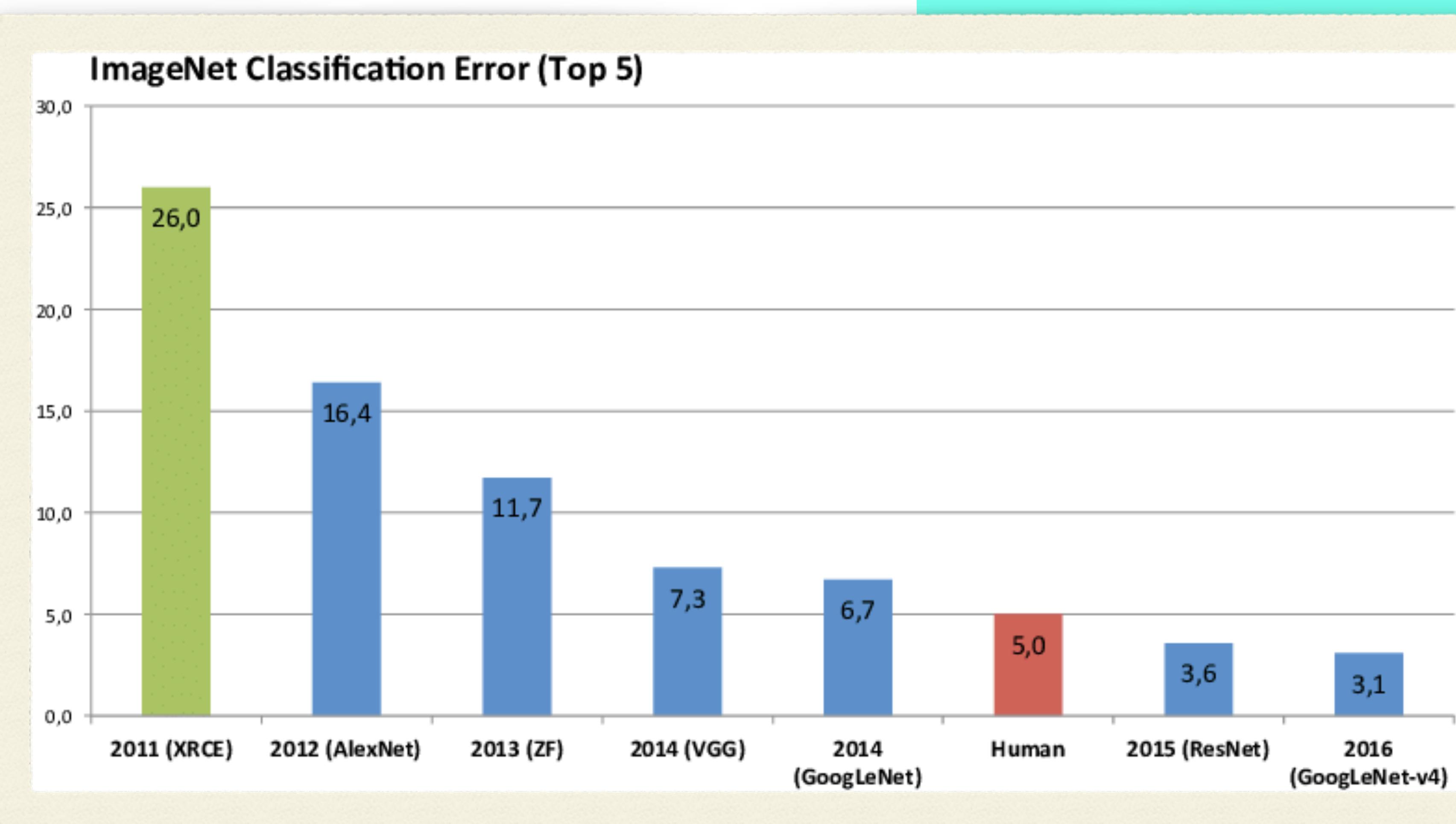


1. Successes

Image Recognition



1000 classes
1M images
Start of Deep Learning



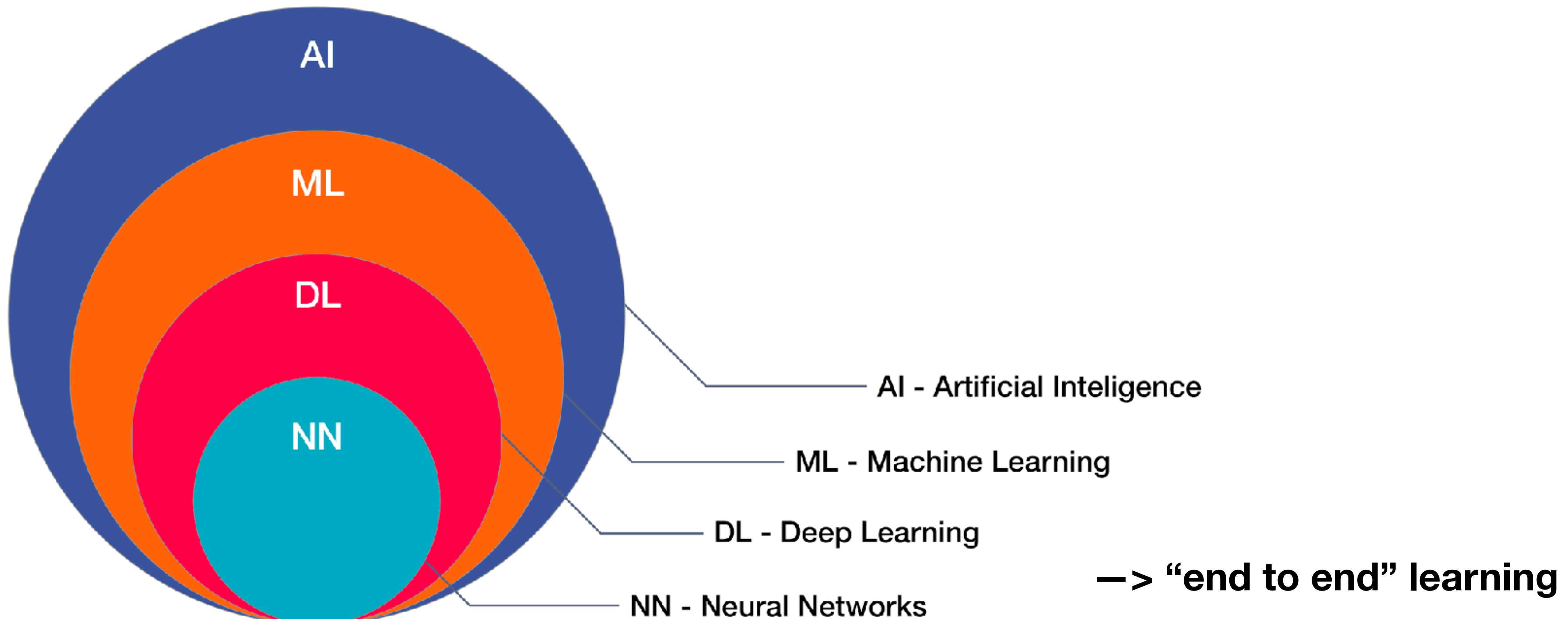
xhound

x 1M



x 1M

Intermezzo: AI > ML > DL



1. Successes

shutterstock

toddler doing crafts

Toddler doing crafts stock photos

505 Toddler doing crafts stock photos, vectors, and illustrations are available royalty-free. See toddler d

Most Relevant

Fresh Content

Image Type ▾

Orientation ▾

Color ▾



output:

image

x millions

Deep
Learning
(NN)

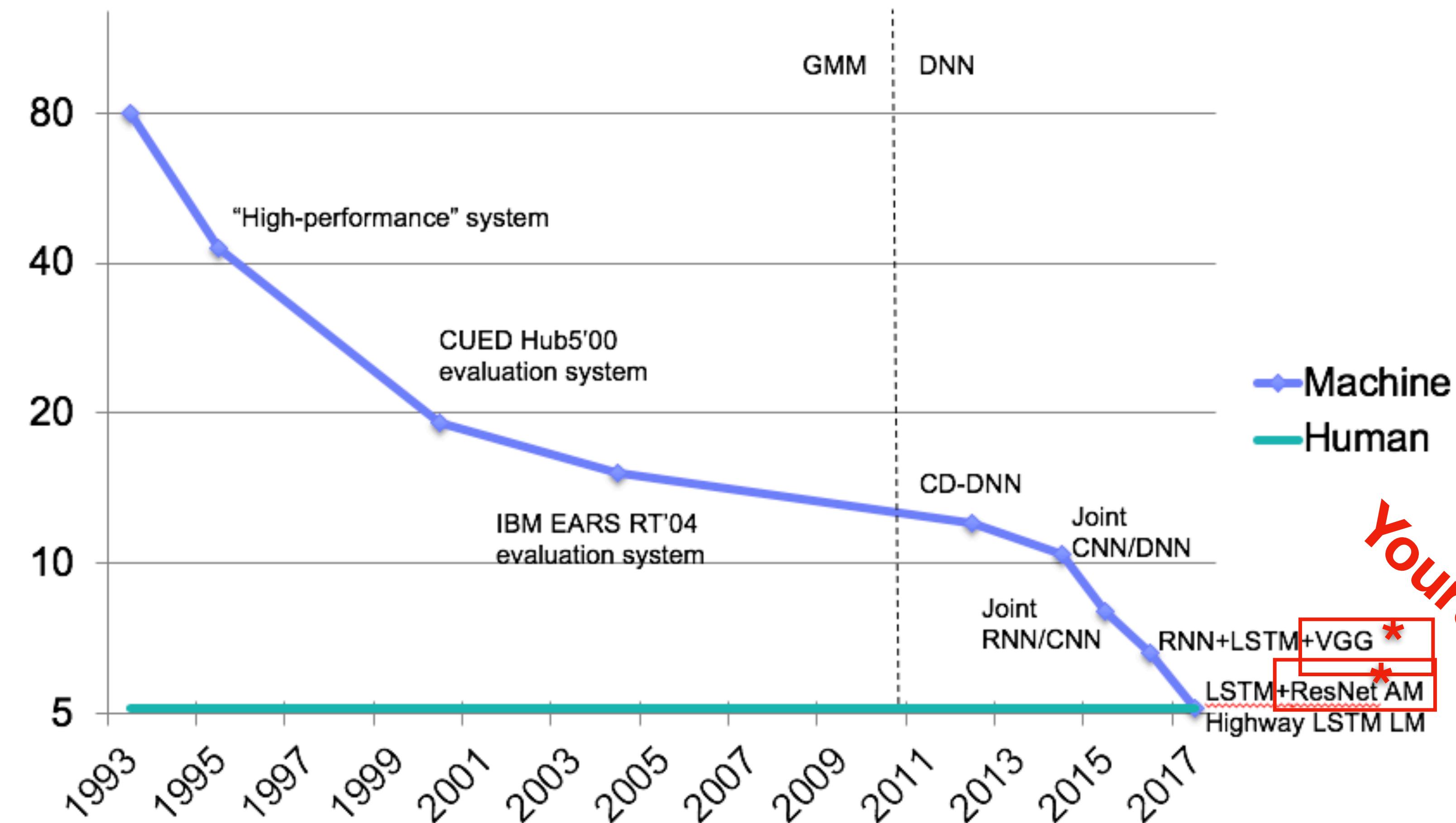
input:

Search Query

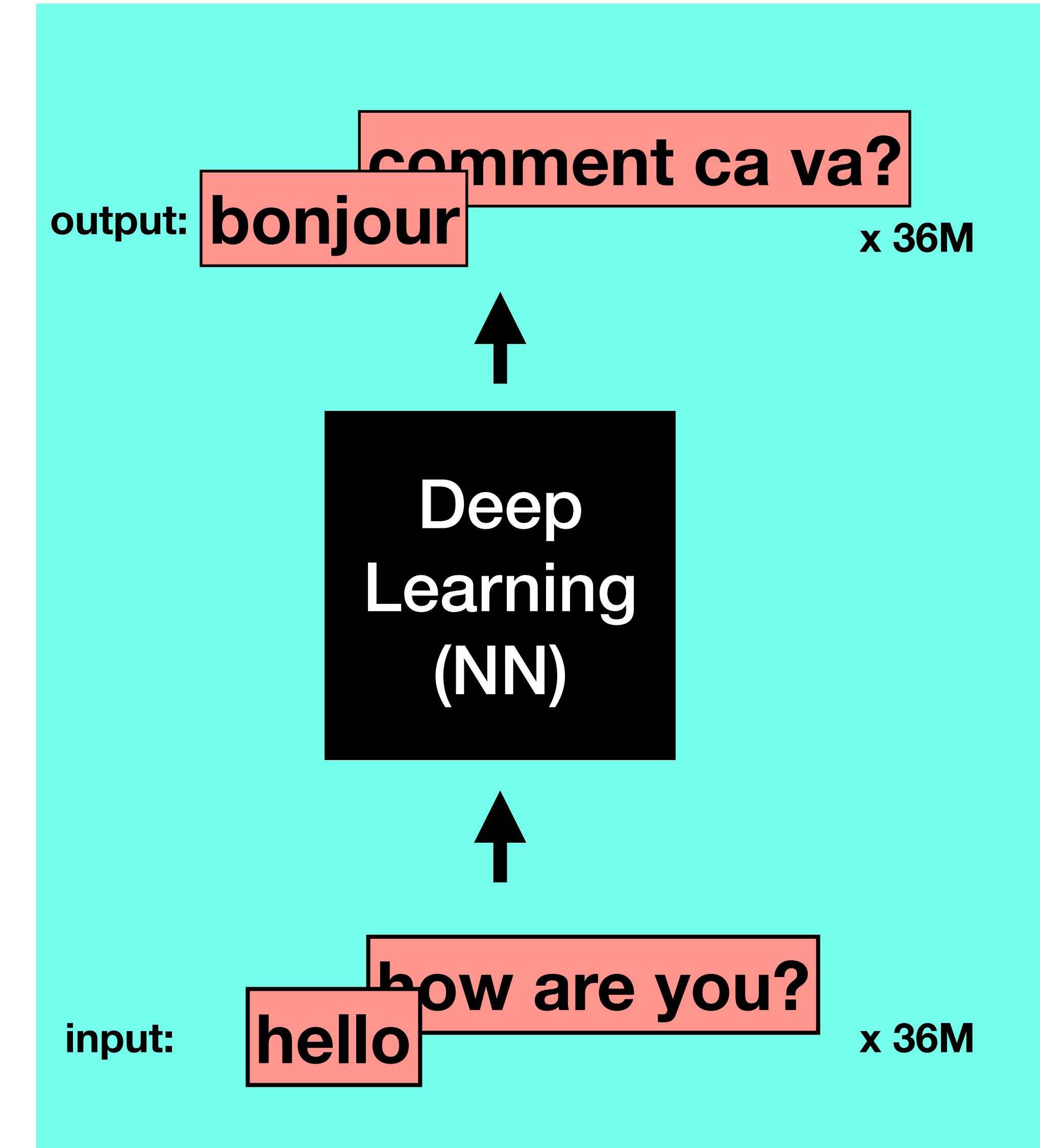
x millions

Speech Recognition

Progress on Switchboard (Hub5'00 SWB testset*)



Machine Translation

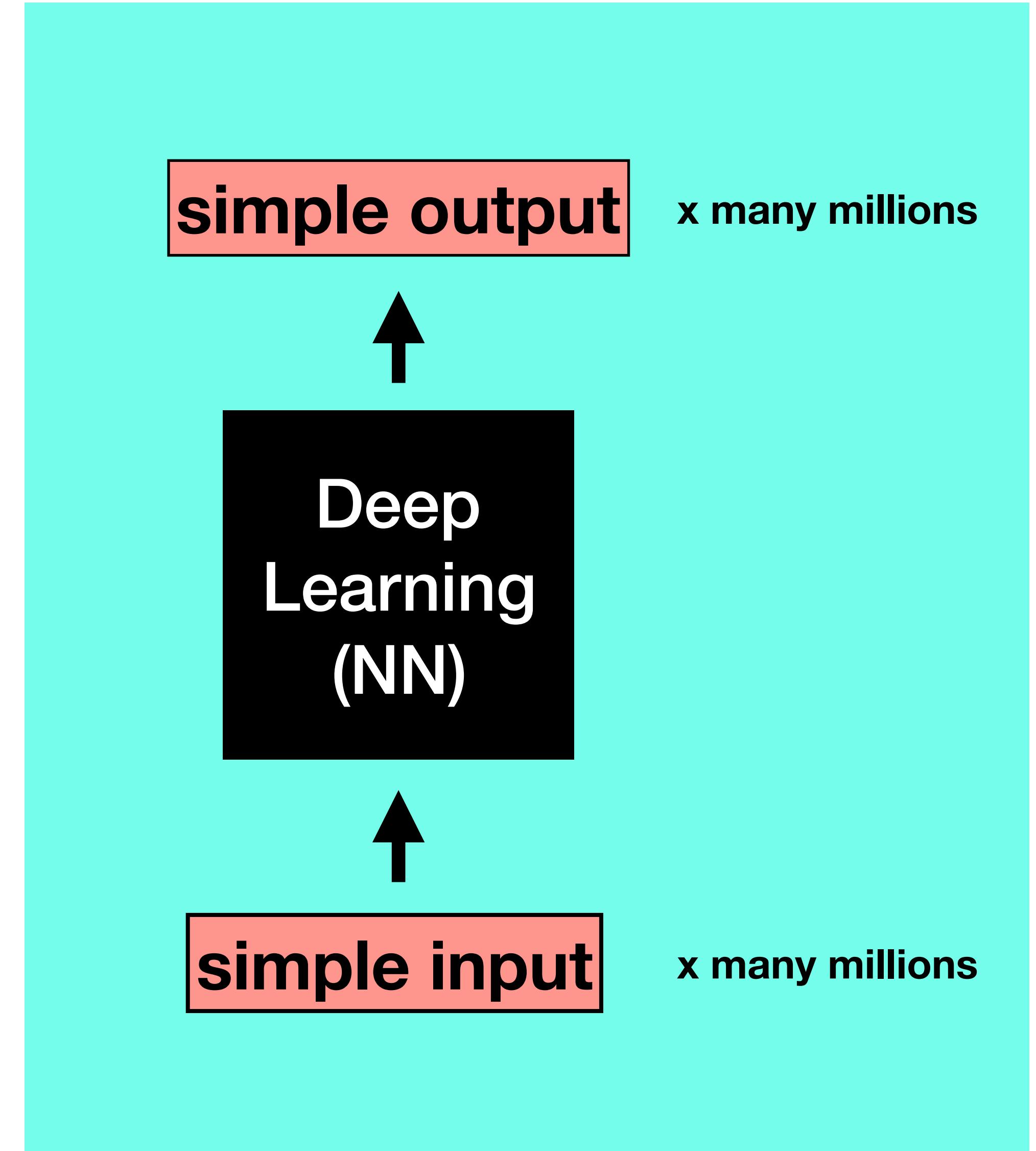


1. Successes

Main drivers:

1. Deep learning.
2. Data. Lots of data.
3. Compute power.
4. Open source software

but also



2. Limitations part A: ML Patchworks, a necessary evil

Conclusion:

Not every problem is this simple!



Most real problems require cobbling together AI systems:

- a) makes it work
- b) makes it brittle

2. Limitations A: patchwork ML

Simple I->O problem with lots of examples?



input: front camera
output: steer L/R

yes but..

combination of
many subsystems



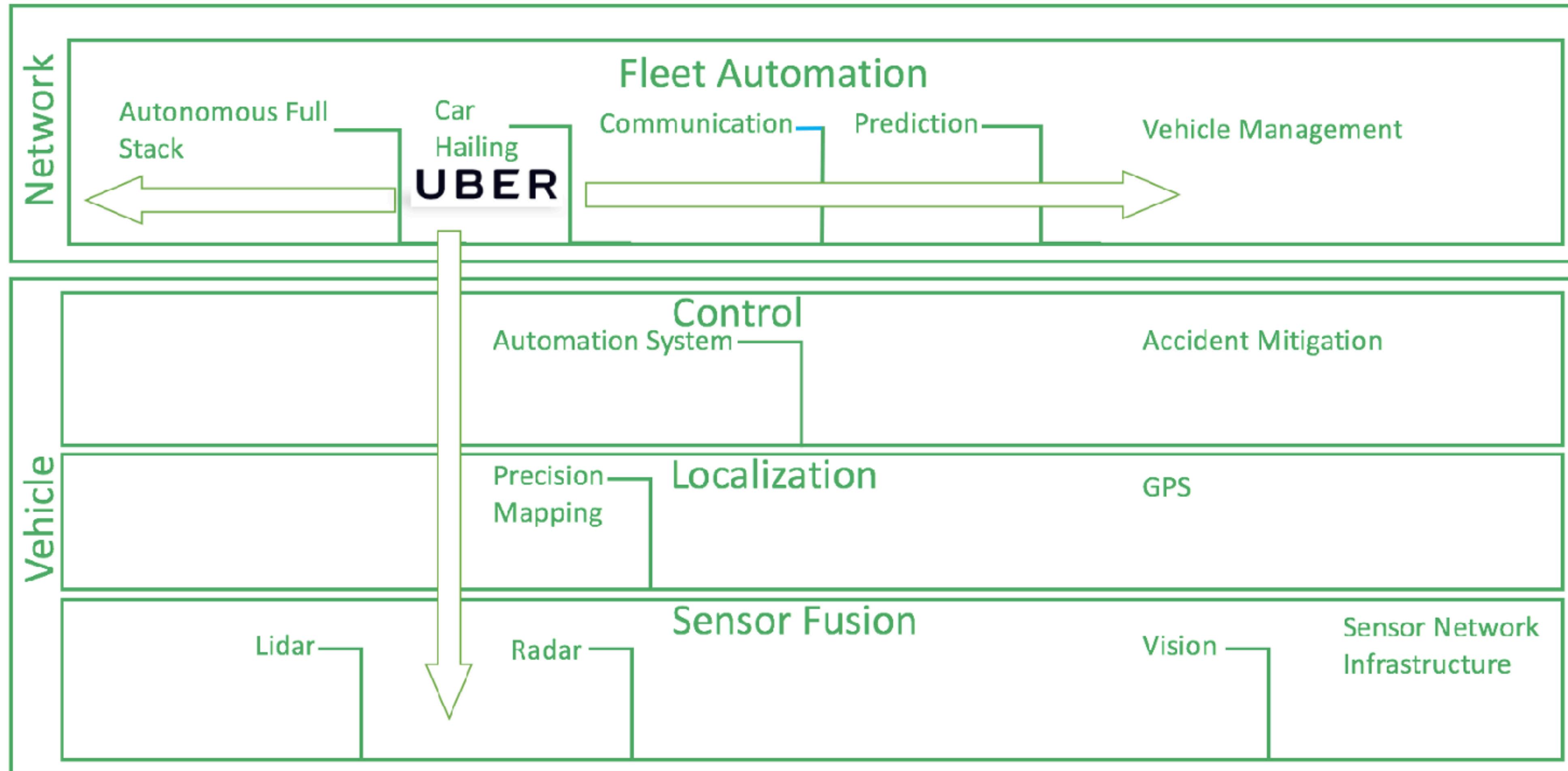
VS



high quality data

2. Limitations A: patchwork ML

Patchwork solution



2. Limitations A: patchwork ML

ML for real estate price prediction



Zestimate ⓘ
\$144,672

ZESTIMATE RANGE ⓘ
\$127,000 - \$158,000 **LAST 30 DAY CHANGE**
-\$4,627 (-3.1%)

Inside the Zestimate

The Zestimate is Zillow's best estimate of a home's value. It is based on a blend of valuation methods, each of which may produce a different estimate depending on the available data.

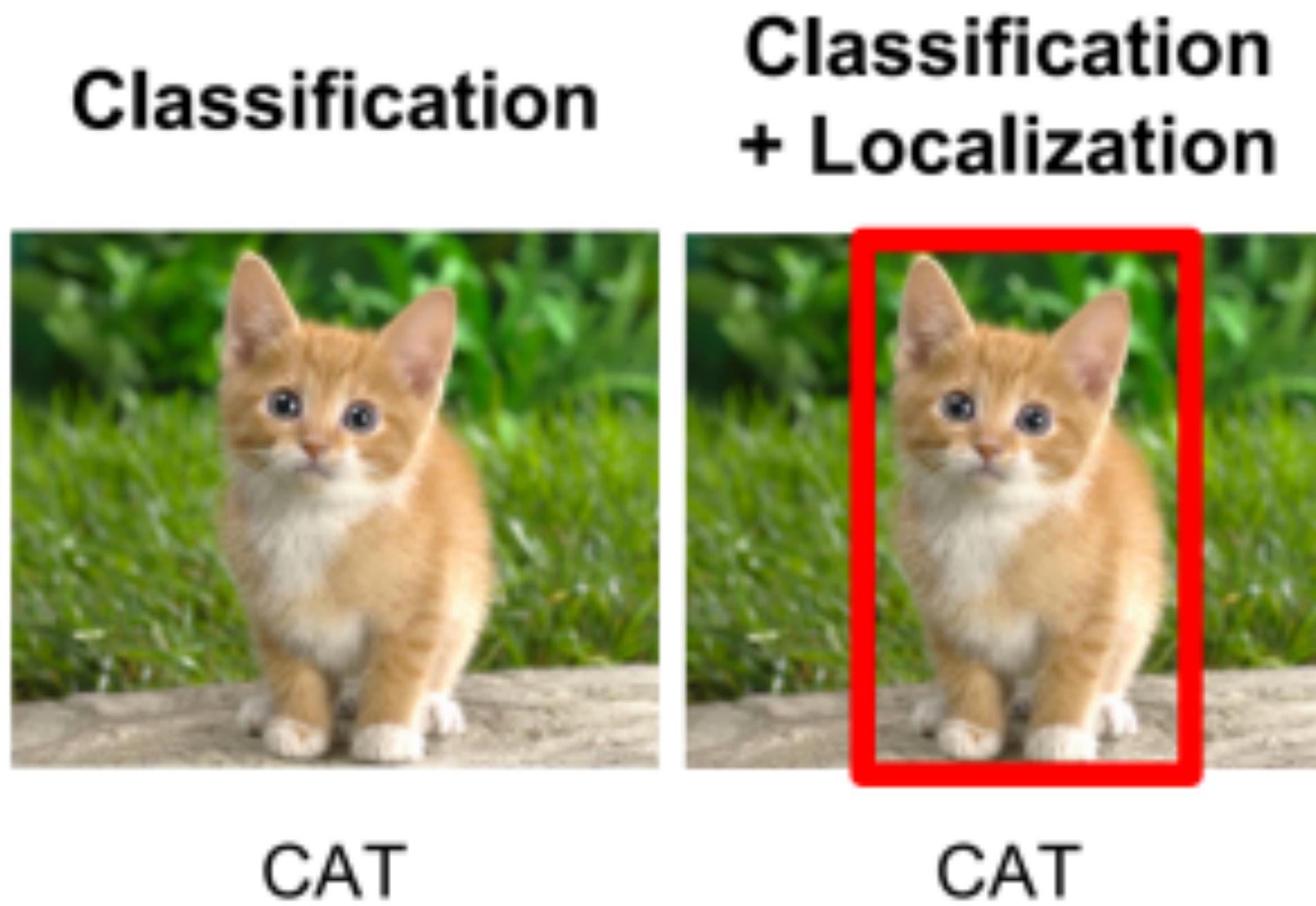
ESTIMATE BASED ON

Comparable homes	\$140,145	▼
Local tax assessments	\$145,039	▼
Market appreciation	\$143,163	▼
Local sale prices	\$135,874	▼

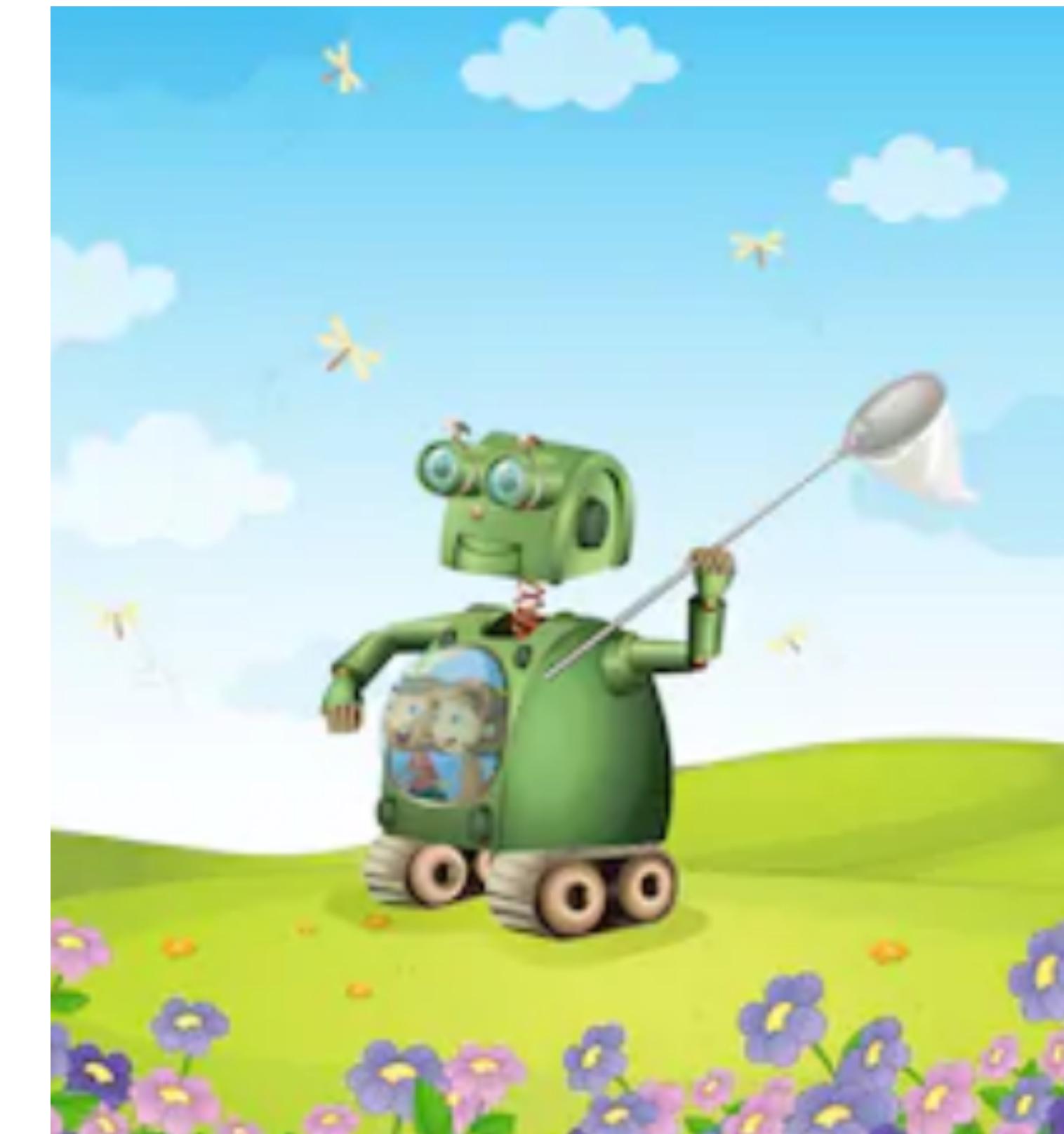
Intermezzo: computer programs

- Sequence of instructions
- Instructions need to be exact, no ambiguity
 - + Correct input: 100% guaranteed output is correct
 - Incorrect input: will freak out and stop
- All ML models live in context of classical computer programs
- Combining ML models happens through classical programming:
set of precise instructions

Dogs and cats revisited



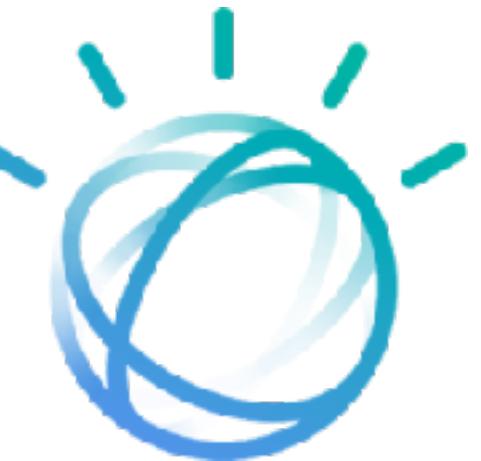
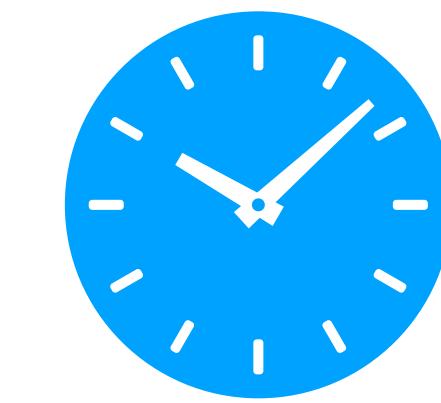
Robot on a mission: catch only cats



Patchwork solution

Pros

- + Get to a solution cheaper & faster
- + Use others' solutions (OS / MLaaS APIs)



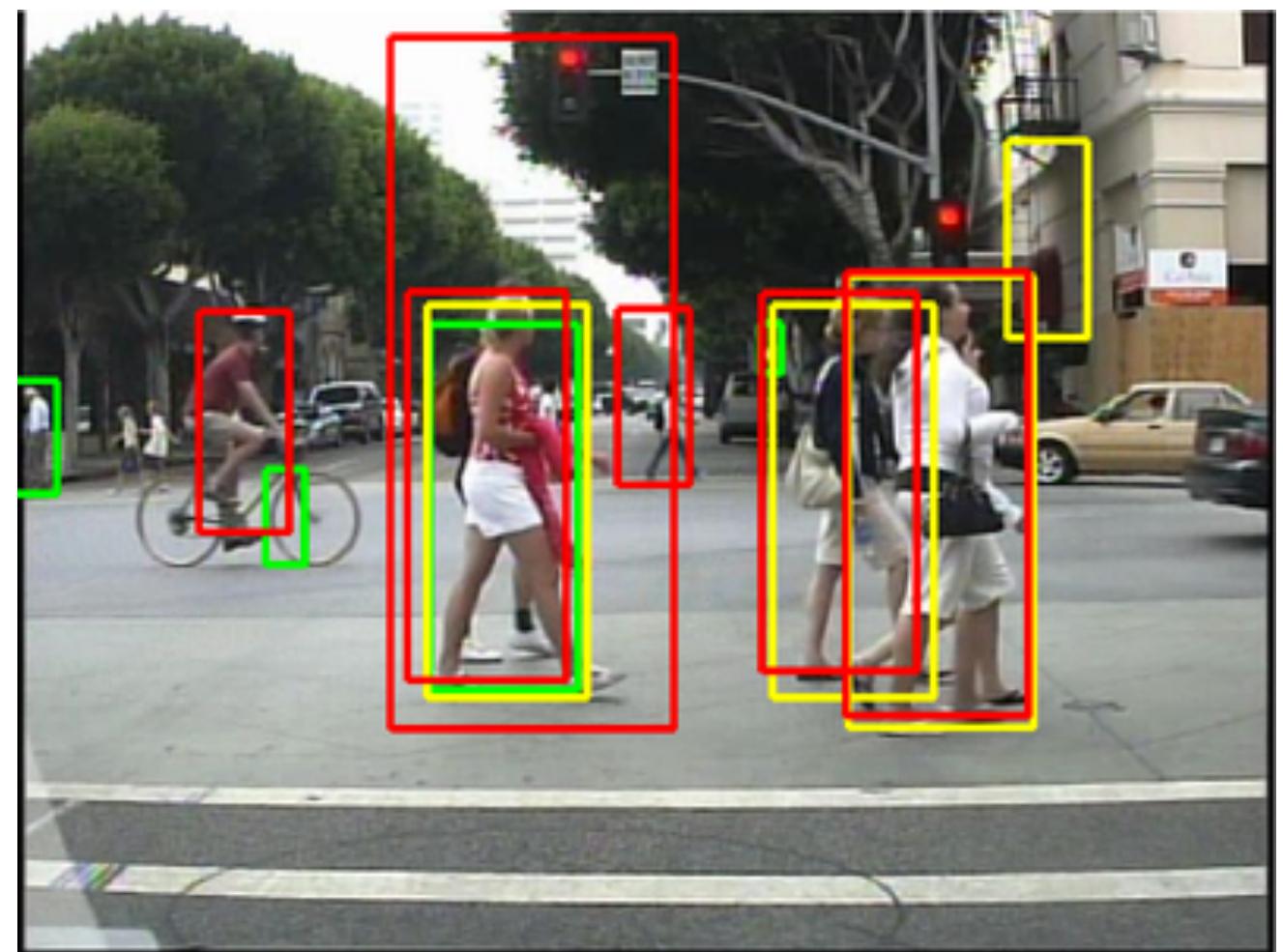
Cons

- More engineering to get good performance
& you may never get there
- More cost to maintain
- No easy way to generalize
vs end to end machine learning: just collect new data



Patchwork solution: Reasons Why

- Not enough data for the whole
 - but data for the sub problems!
- Need for “guarantees” or explainability
- Legacy and history
- Spread of teams / skills
- No need for DL expertise



Tough decision

Patchwork solution

- make it work fast
- need to fix it forever

End to end ML solution

- spend more time and money upfront
- more expertise needed to “design it right”
- better performance
- more robust

Why a patchwork is more brittle

than end to end ML solution

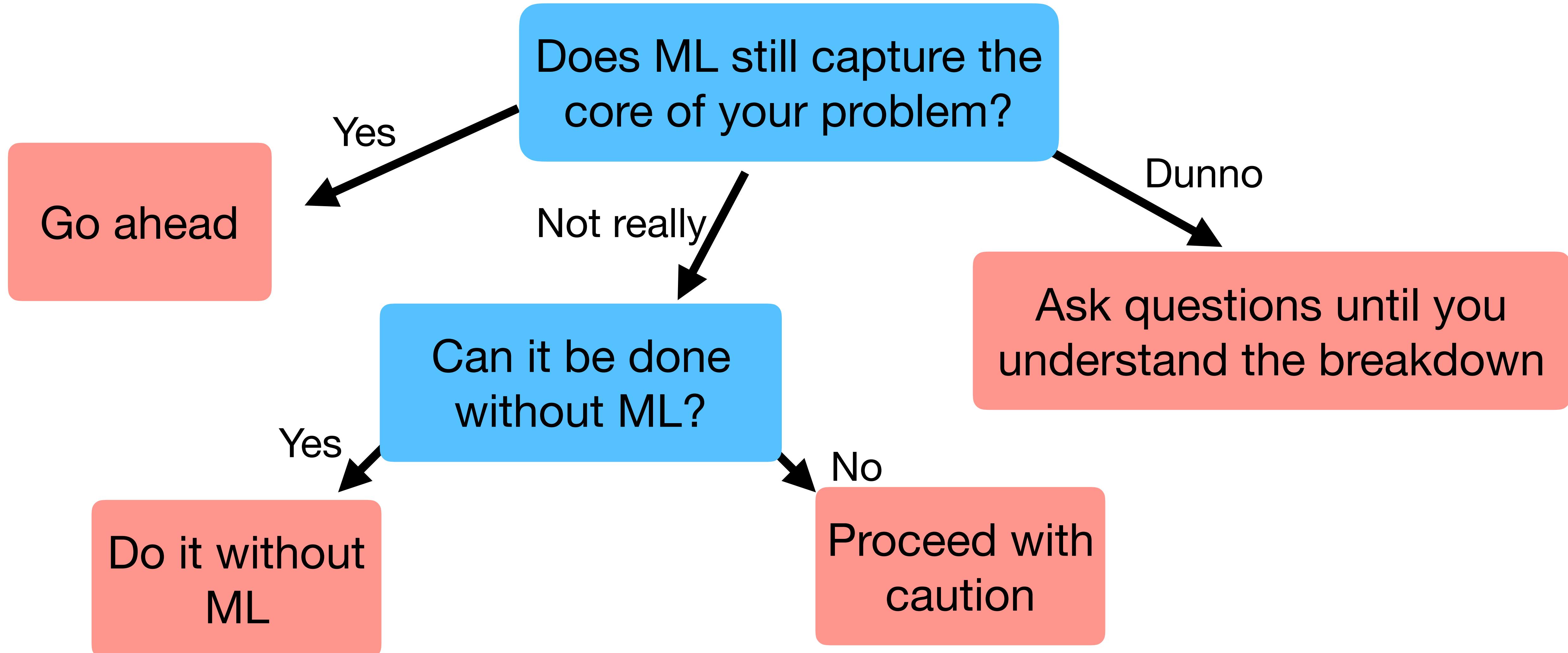
- Often subsystem data doesn't exactly match the actual problem
- Errors accumulate
- Model + heuristics combination Limited by engineers' imagination
- Needs active human intervention
- More places for bugs to hide



vs



Decision: investing in a patchwork ML solution



3. Limitations part B: Frontiers. Stuff that's just too hard

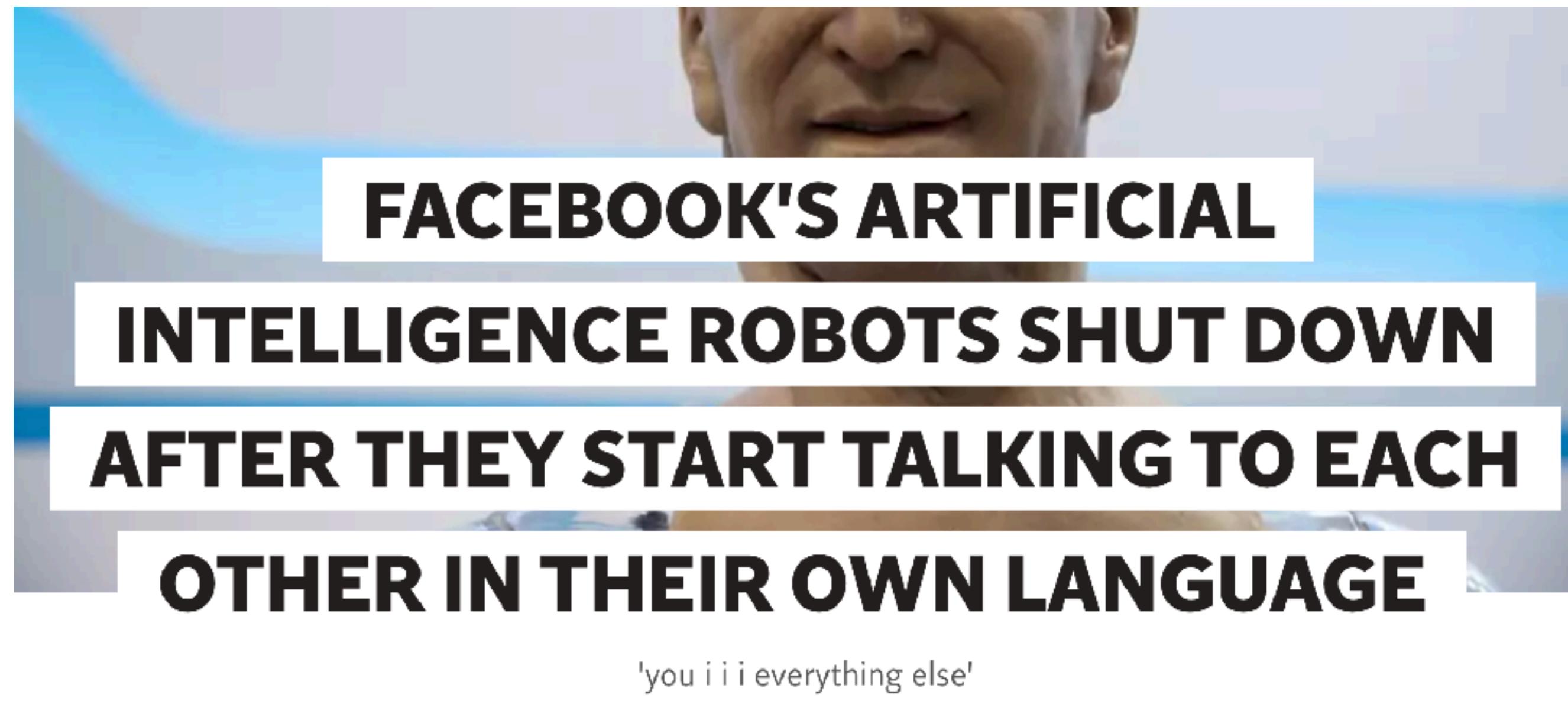
Conclusion:

**Don't believe anyone who sells you “an AI that
understands language and reasons about a problem
from common sense”**

Will consist of simpler components cobbled together
or just won't deliver on the promise.



3. Limitations B: Frontiers



Dan Joyce @dan_w_joyce · Sep 10
Replying to @zacharylipton @elonmusk
Doctors become irrelevant in a crumbling health service... But AI can save us

Computers could replace doctors, Jeremy Hunt says
At the Expo conference in Manchester, Mr Hunt said: 'The changes in medical innovation are likely to transform humanity by as much in the next

dailymail.co.uk

Elon Musk @elonmusk
This is nothing. In a few years, that bot will move so fast you'll need a strobe light to see it. Sweet dreams...

alex medina @mrmedina
we dead

PM - Nov 26, 2017

Natural Language Understanding

disambiguation:



(EN: bank)



(NL: bank)

dialogue



winograd schemes:

The trophy doesn't fit into the brown suitcase because it's too [small/large].

What is too [small/large]?

3. Limitations B: Frontiers

Reasoning



How many slices of pizza are there?
Is this a vegetarian pizza?



Does it appear to be rainy?
Does this person have 20/20 vision?

**Visual
Question
Answering
VQA**



Multi agent games

**Set of simple
reasoning tasks**

Task 15: Basic Deduction
Sheep are afraid of wolves.
Cats are afraid of dogs.
Mice are afraid of cats.
Gertrude is a sheep.
What is Gertrude afraid of? **A:wolves**

Task 16: Basic Induction
Lily is a swan.
Lily is white.
Bernhard is green.
Greg is a swan.
What color is Greg? **A:white**

**Only limited scope!
Requires heavy engineering**

Learning from less (labeled) data



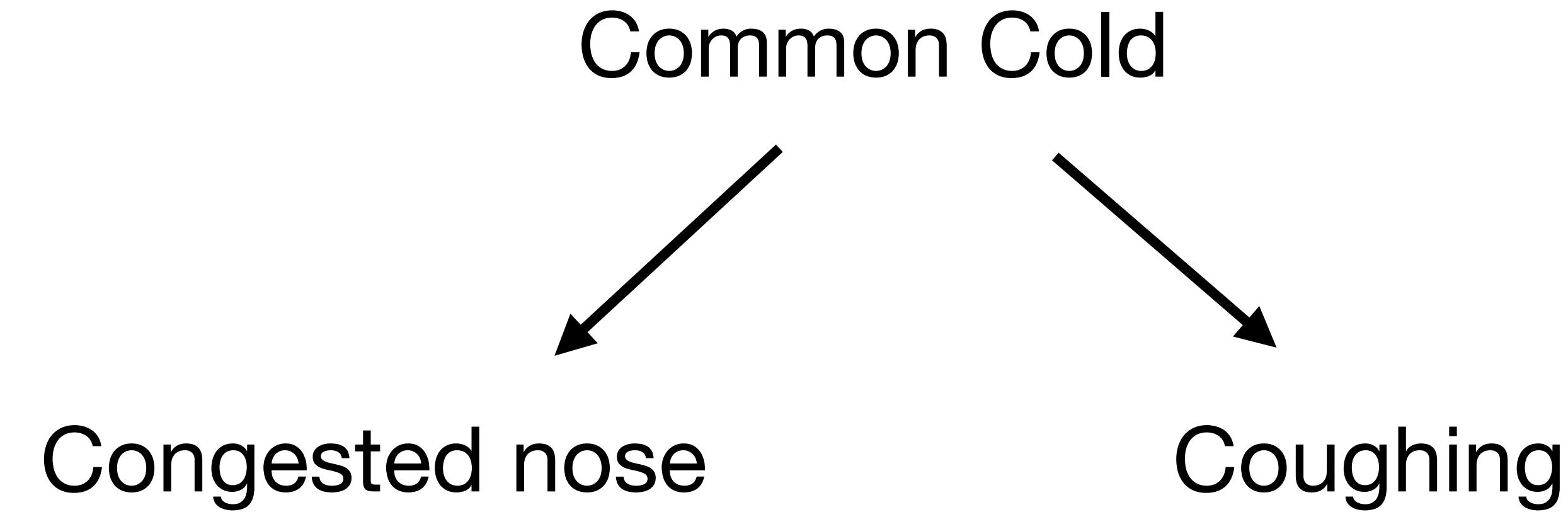
1M labeled images

vs



**continuous visual stream, mostly UNLABELED
cuddles as reward signal for recognizing papa**

Causality



Common Sense aka gezond verstand

Imagine what happens if you open your hand:



vs



Common Sense

aka gezond verstand

- Remembering and accessing knowledge
- Provides prior knowledge in new problem
- Intuitive reasoning (by analogy)
- Easily infer causal direction
- Reduces data hungriness

The holy grail



I hope now you have a
**better feeling and understanding of
AI and its limitations!**

1. Successes: Which problems AI / ML / DL is good at:
simple Input -> Output problems!
2. Limitations part A: Brittleness by cobbling together.
3. Limitations part B: The frontiers. Stuff that's just too difficult for now





you

Thank you

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