Digital Data Flows Masterclass on **Machine Learning and Speech**

9 December 2020

FUTURE OF PRIVACY FORUM

Future of Privacy Forum

The Supporters

150+ Companies

25+ Leading Academics

15+ Advocates and Civil Society

5 Foundations

The Mission

Bridging the policymaker-industry-academic gap in privacy policy

Developing privacy protections, ethical norms, & responsible business practices

The Workstreams

AI & Ethics

Student Data

Apps & Ad Tech

Mobility & Location

Privacy Enhancing Tech

Smart Communities

FUTURE OF PRIVACY FORUM

DIGITAL DATA FLOWS

EMERGING TECH MASTERCLASS SERIES

The **Digital Data Flows Masterclass** series is an educational program designed for regulators, policymakers, and staff seeking to better understand the data-driven technologies at the forefront of privacy and data protection law & policy.

Classes	Date	
1. Artificial Intelligence and Machine Learning	25 Oct 2018	Brussels
2. Location Data: GPS, Wi-Fi, &andSpatial Analytics	27 Nov 2018	Brussels
3. De-Identification, Differential Privacy, and Homomorphic Encryption	30 Jan 2019	Brussels
4. Online Advertising, Data Flows, Behavioral Targeting, and Cross-Device Tracking	1 May 2019	Wash. DC
5. Mobile Apps: Operating Systems, Software Development Kits (SDKs), and User Controls	25 Jul 2019	Virtual
6. Facial Recognition and Biometric Data	27 Feb 2020	Wash. DC
7. Connected Cars and Autonomous Vehicles	25 Jun 2020	Virtual
8. Blockchain Technoloties	29 Oct 2020	Virtual
9. Machine Learning and Speech	9 Dec 2020	Virtual

Access recordings and materials for all previous classes at www.fpf.org/classes

Speakers

Professor Marine Carpuat, Associate Professor in Computer Science at the University of Maryland

Dr. Prem Natarajan, VP, Alexa AI-NU

12.09.20
FPF Masterclass on Machine Learning and Speech

Prem Natarajan, Ph.D.
VP, Alexa AI, Natural Understanding
Amazon

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Outline

Evolution of AI
- The Origin Story: Historical development
- Salient science and technology advances

Transformational Advance: Machine-learning powered AI

Human Computer Interaction and Conversational AI
- Case Study: Alexa

Learning with Less Labeled Data

Societal Impact

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AI:
The Origin Story

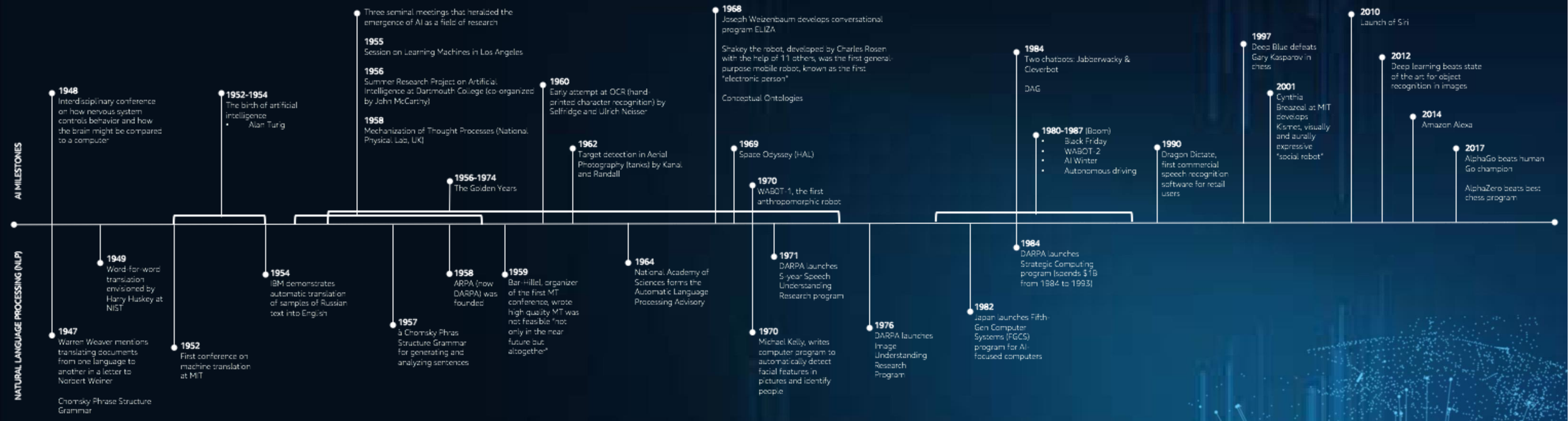
Evolution of AI

Emergence of AI as a Field of Research

Session on Learning Machines in Los Angeles (1955)

“There is considerable promise that systems can be built in the relatively near future which will imitate considerable portions of the activity of the brain and nervous system” - *Willis Ware’s introduction as 1955 session chair*

The AI Journey: Milestones from 1948 - 2017



First AI Winter: 1974 – 1980

Second AI Winter: 1987 – 1993

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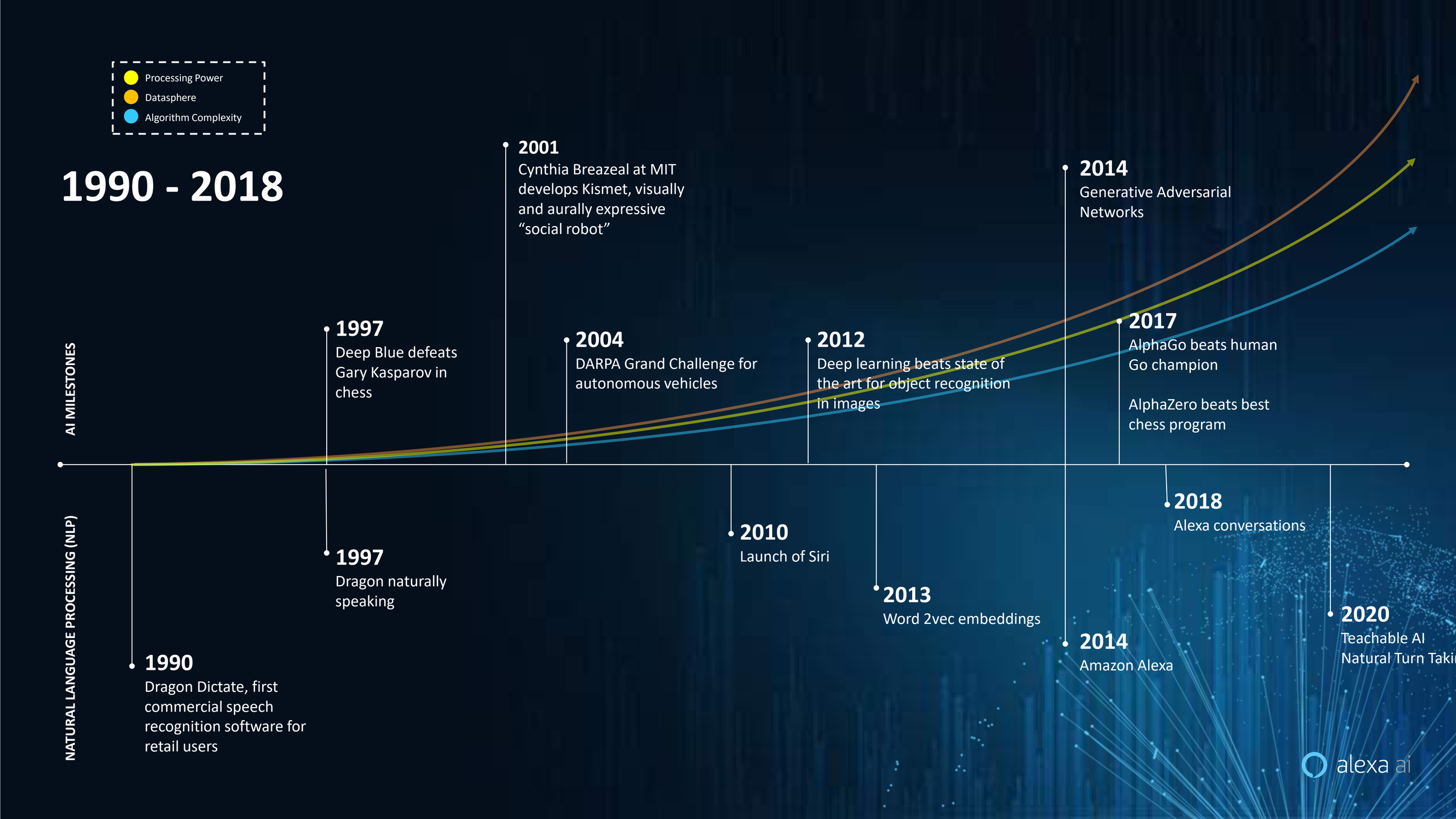
Processing Power
Datasphere
Algorithm Complexity
1990 - 2018
AI MILESTONES
NATURAL LANGUAGE PROCESSING (NLP)
2001
Cynthia Breazeal at MIT develops Kismet, visually and aurally expressive “social robot”
1997
Deep Blue defeats Gary Kasparov in chess
2004
DARPA Grand Challenge for autonomous vehicles
2012
Deep learning beats state of the art for object recognition in images
2014
Generative Adversarial Networks
2017
AlphaGo beats human Go champion
AlphaZero beats best chess program
2018
Alexa conversations
2020
Teachable AI
Natural Turn Taki
1990
Dragon Dictate, first commercial speech recognition software for retail users
1997
Dragon naturally speaking
2010
Launch of Siri
2013
Word 2vec embeddings
2014
Amazon Alexa
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Golden Age of AI Today – Explosion of AI Applications

SELF DRIVING CARS

LANGUAGE

PRECISION MEDICINE

DATING APPS

COMPUTER GRAPHICS

CONVERSATIONAL AI.

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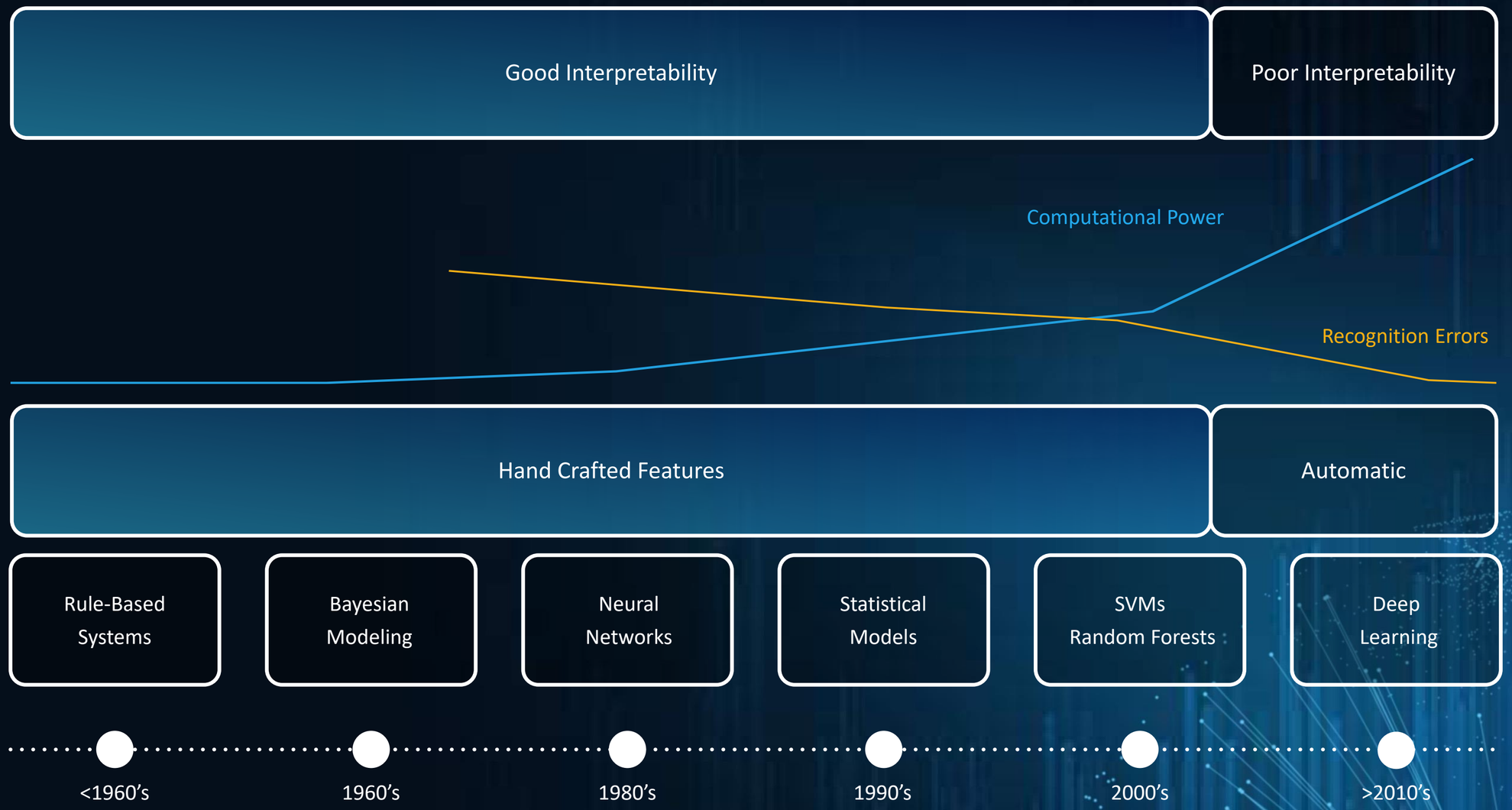
Machine Learning Methodology

Transformational Advance

AI Technological Evolution



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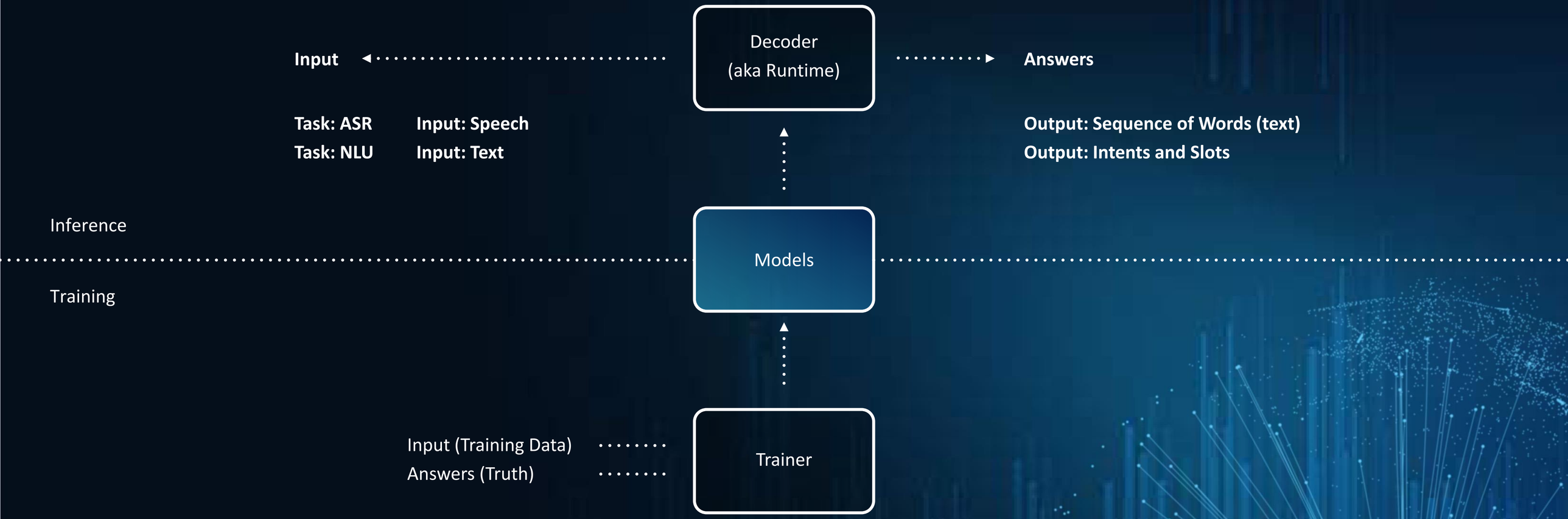
Common Theme: Data Driven Machine Learning



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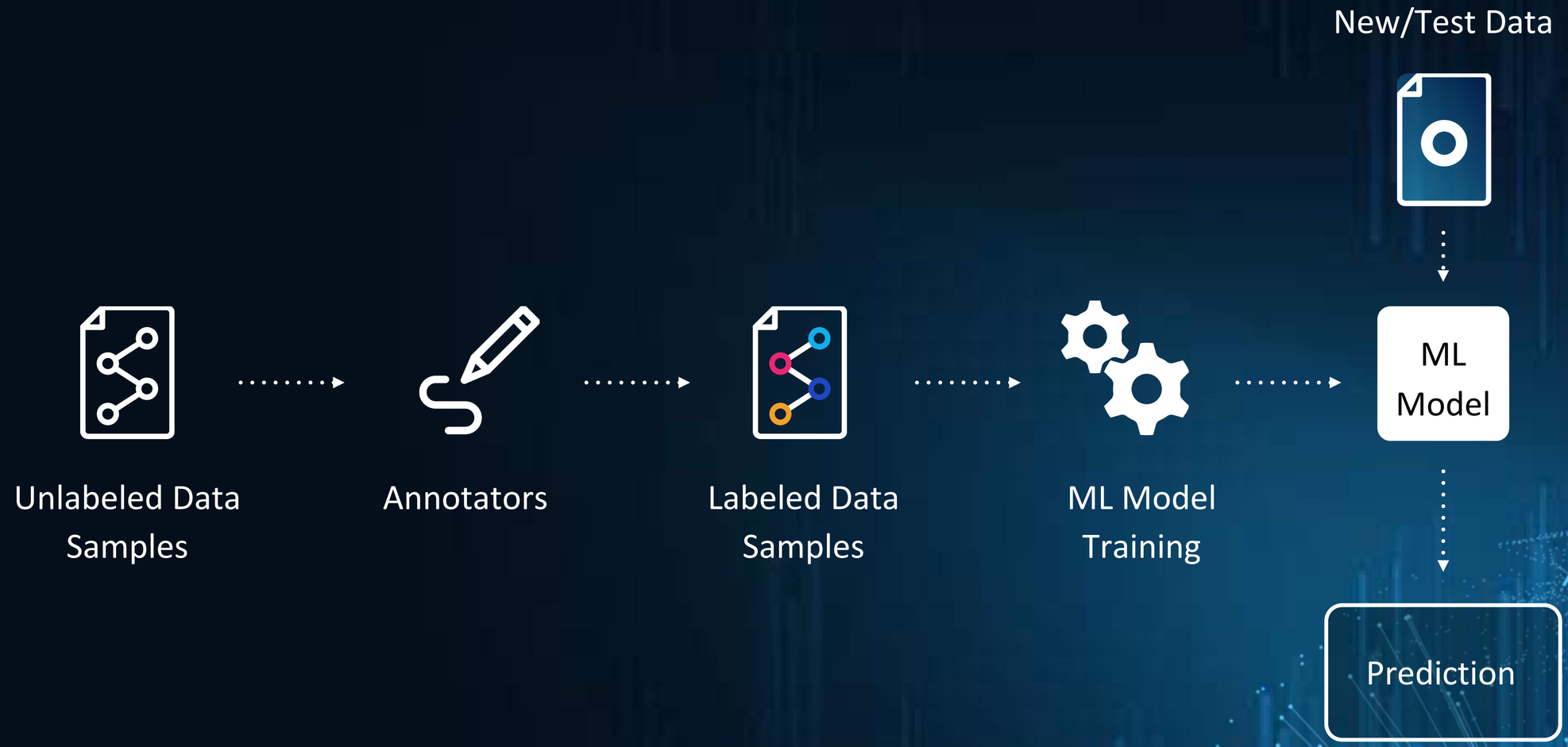
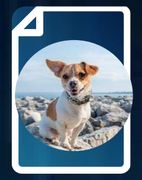
Supervised ML: Most Popular Version of ML

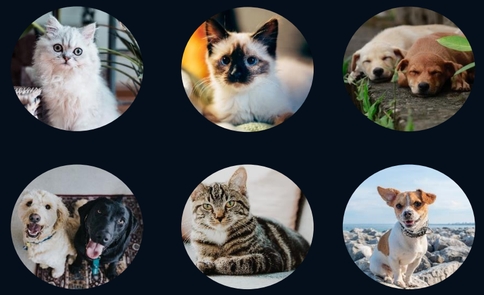


Supervised ML: Example

New/Test Data



Unlabeled Data Samples



Annotators

Labeled Data Samples

ML Model Training

ML Model

Prediction “Dog”

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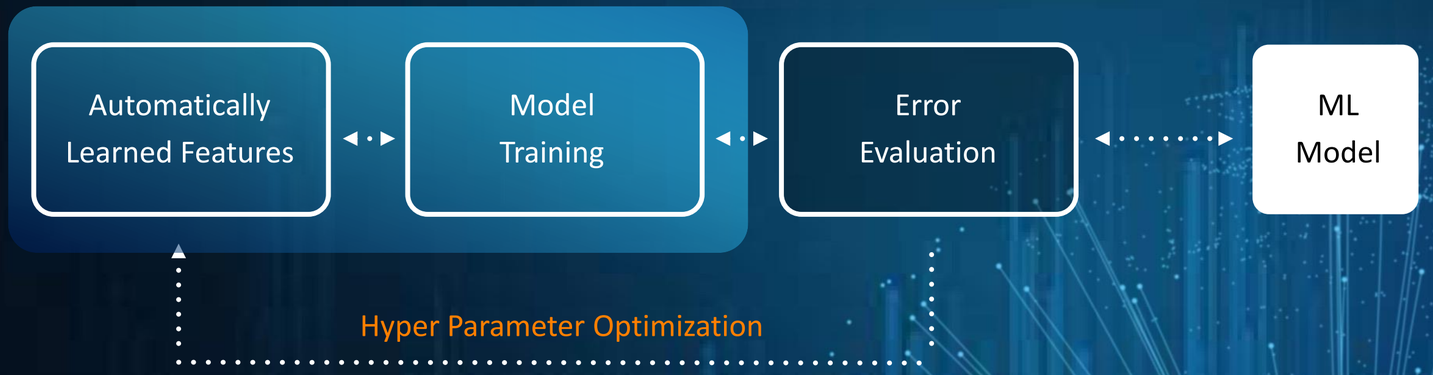
What's Different About Deep Learning

Traditional Machine Learning

Deep Neural Networks



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AI+ML: Powering Our World Today

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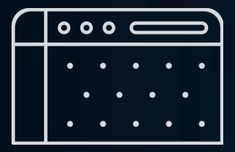
Focus Area: Human-Computer Interaction

A Case Study

Evolution of Human Computer Interfaces

Character Mode

1970s



GUI

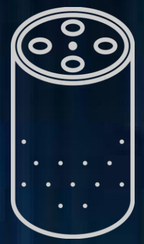
1980s

Web

1990s

Mobile

2000s



VUI

Conversational AI

2014

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Conversational AI Timeline

Era of Hidden Markov Models & Neural Winter

Era of Deep Learning

(D)ARPA Speech Understanding

Small Vocabulary Speech Recognition

Broadcast News
Telephony Speech

Language Translation

Personal Assistants

1970

1980

1990

2000

2010

2020

Voice typewriter

Name Dialing

Call Routing
Directory Assistance
Automotive

Siri
Google Now
Cortana

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Our Mission for Conversational AI

Build world-class AI technologies that make Alexa the most natural, competent, and trusted personal assistant, advisor, and companion for all customers

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Alexa

Wake Word Detection

Automatic Speech Recognition

Alexa Voice Service

Text-to-speech

Natural Language Understanding

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“Alexa, Play Message in a Bottle by Sting.”

Utterance

“Play” directive

Text to Speech (TTS)

Alexa Voice Service

Recognize

Recognition result

Automatic Speech Recognition (ASR)

Recognition result

Intent

Natural Language Understanding (NLU)

Intent

“Play” directive

Skills

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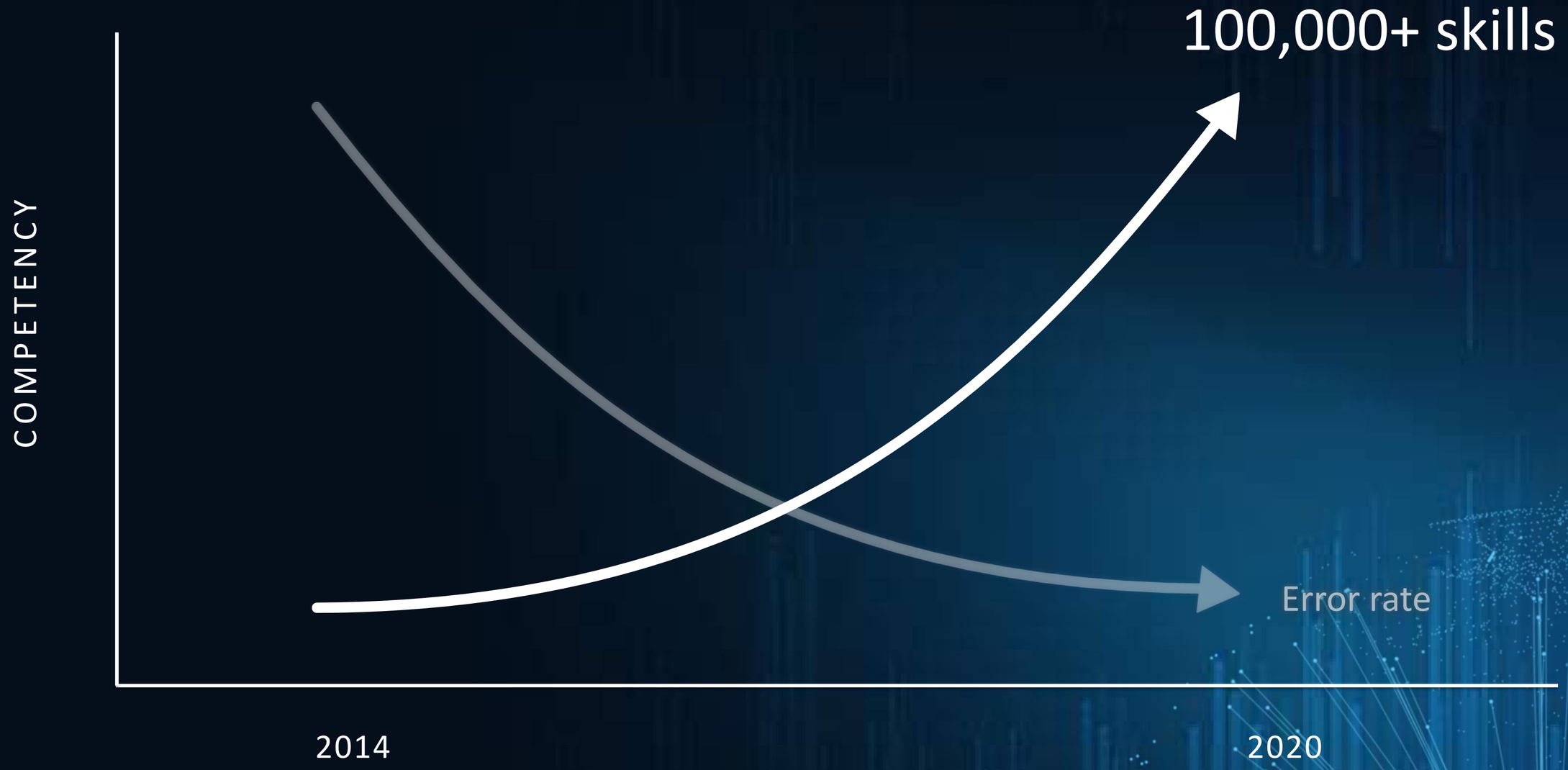

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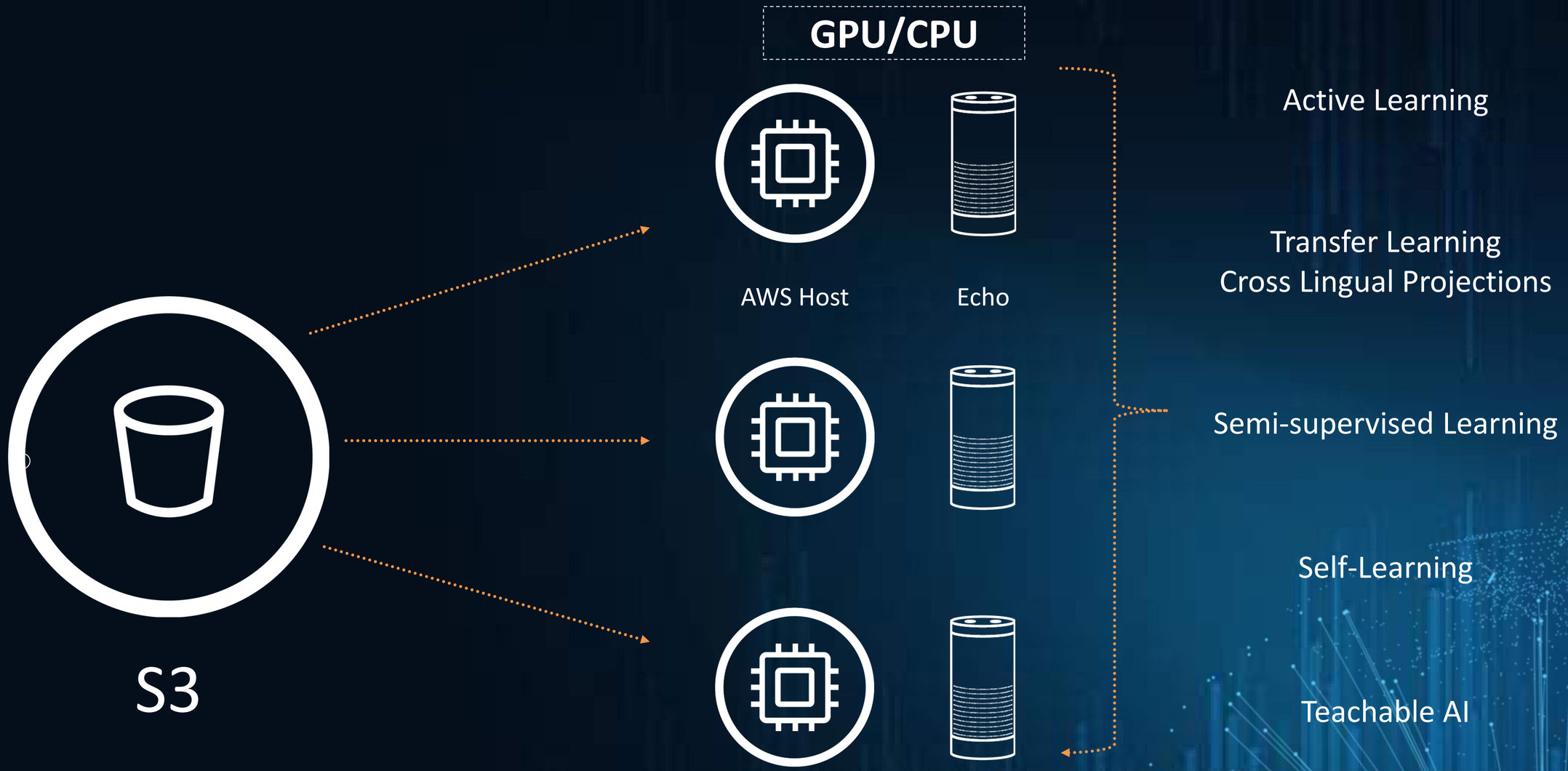
Learning with Less Labeled Data

Going Beyond Supervision

Deep Learning with Less Labeled Data



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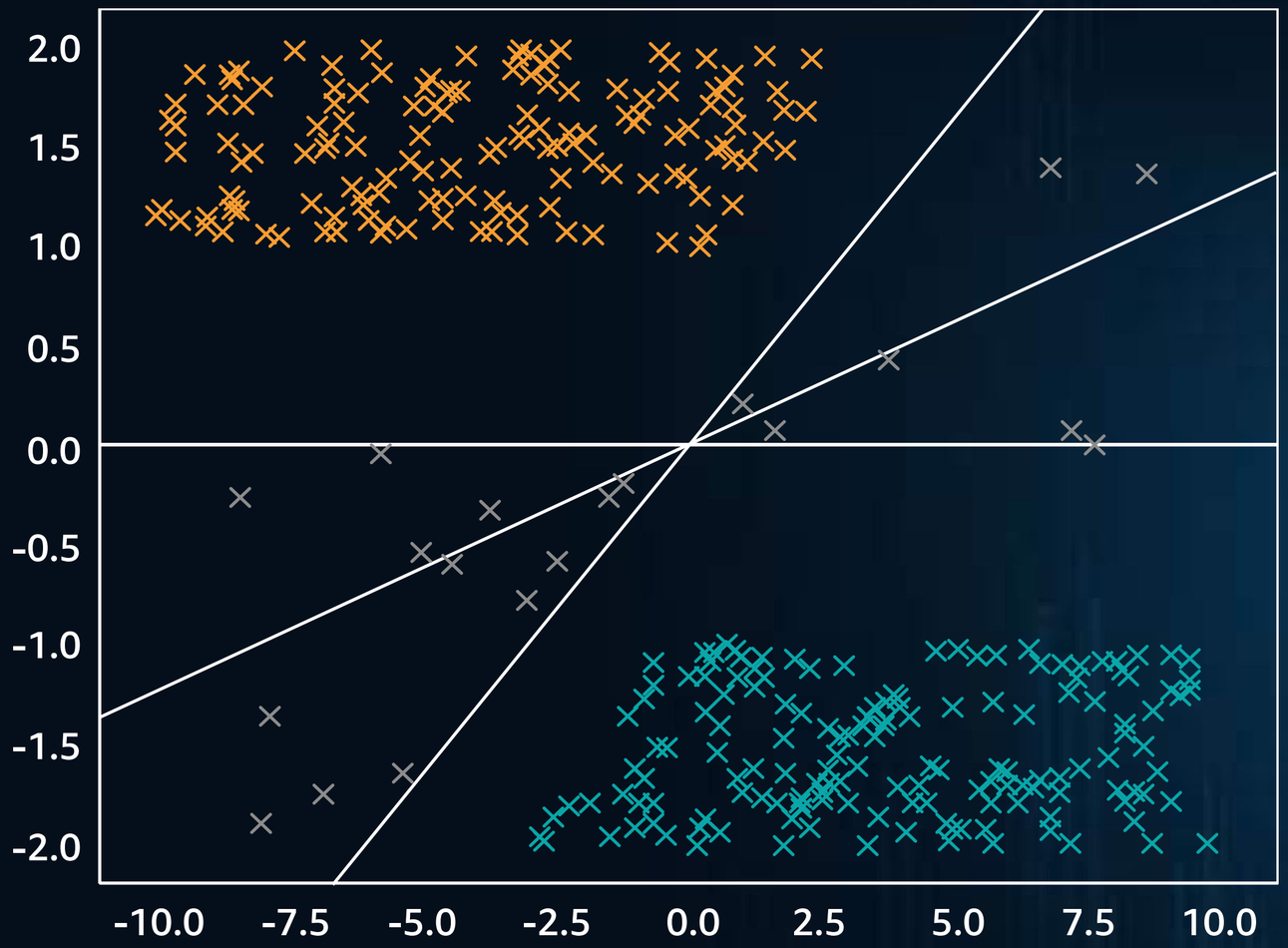
Active Learning



Different loss functions (white lines) divide training data in different ways.

"Active Learning for New Domains in Natural Language Understanding, Stanislav Peshterliev,"
John Kearney, Abhyuday Jagannatha, Imre Kiss, Spyros Matsoukas (Amazon.com)
https://arxiv.org/abs/1810.03450

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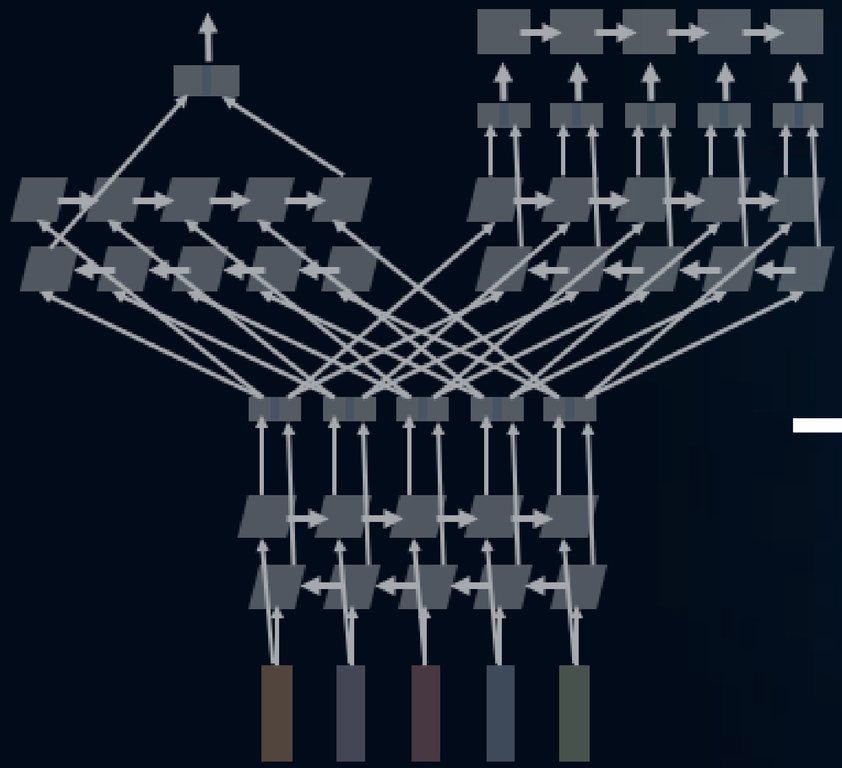
Data Rich

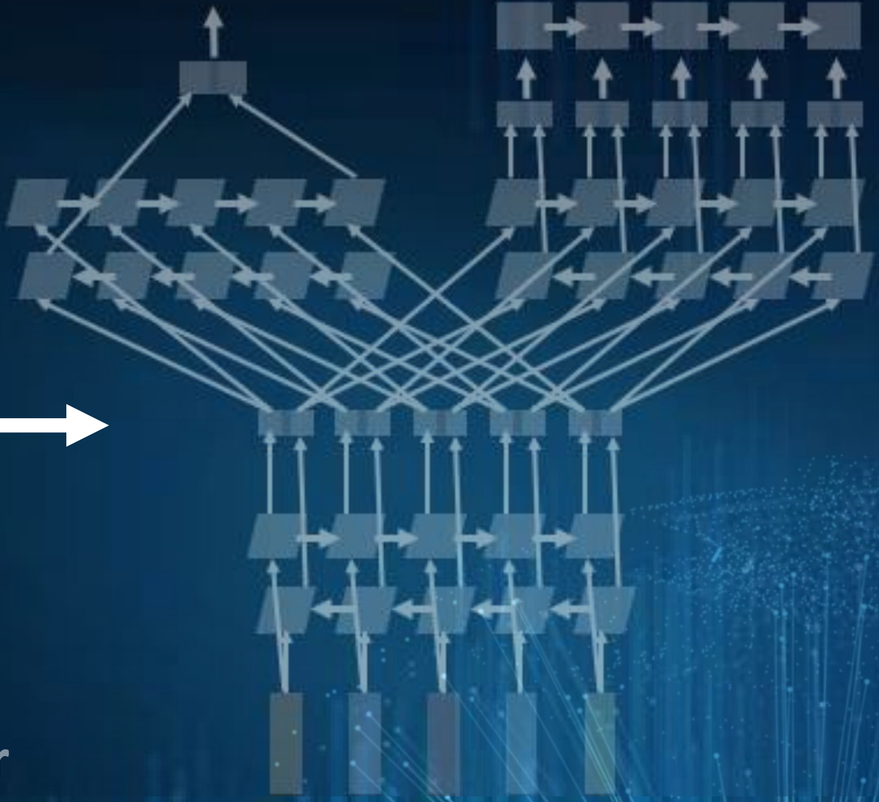
Data Sparse

Weather, Restaurants

Recipes



Transfer Learning



Cross-Lingual Transfer

US English

German

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Transfer Learning: Unsupervised Pre-training + Task-supervised Fine-tuning

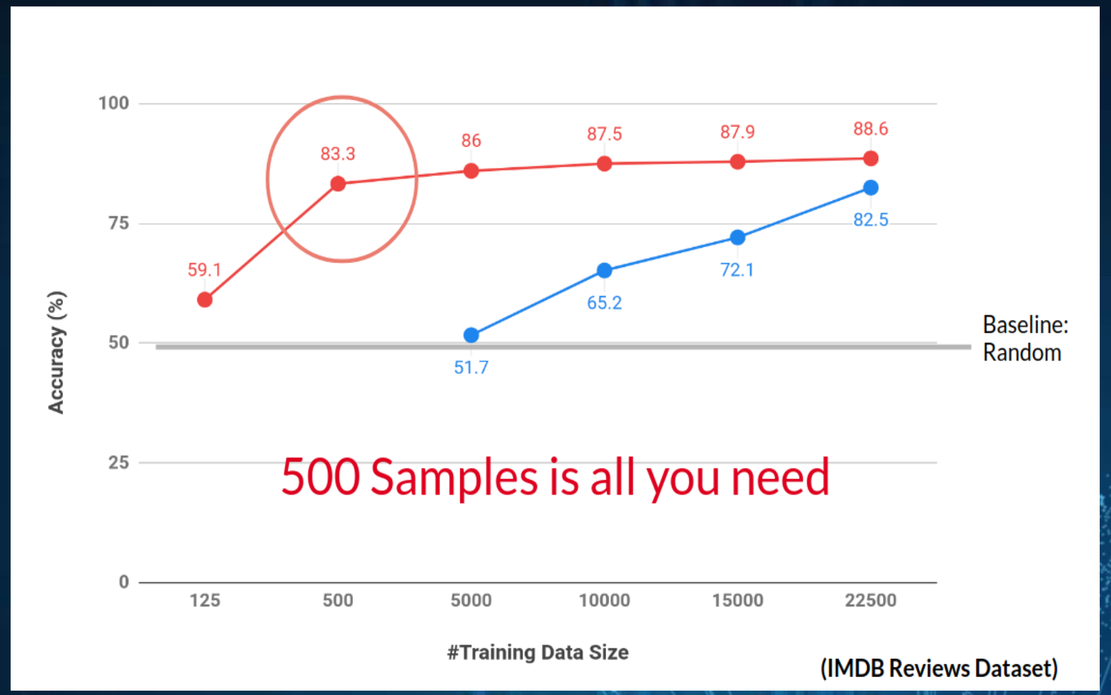
Unlabeled text

Labeled data for each task

Self-supervised Pre-training

Task-specific Fine-tuning

Fine-tuning vs. Training from Scratch



Sample plot from "Insight Data Science" Blog

https://blog.insightdatascience.com/using-transfer-learning-for-nlp-with-small-data-71e10baf99a6

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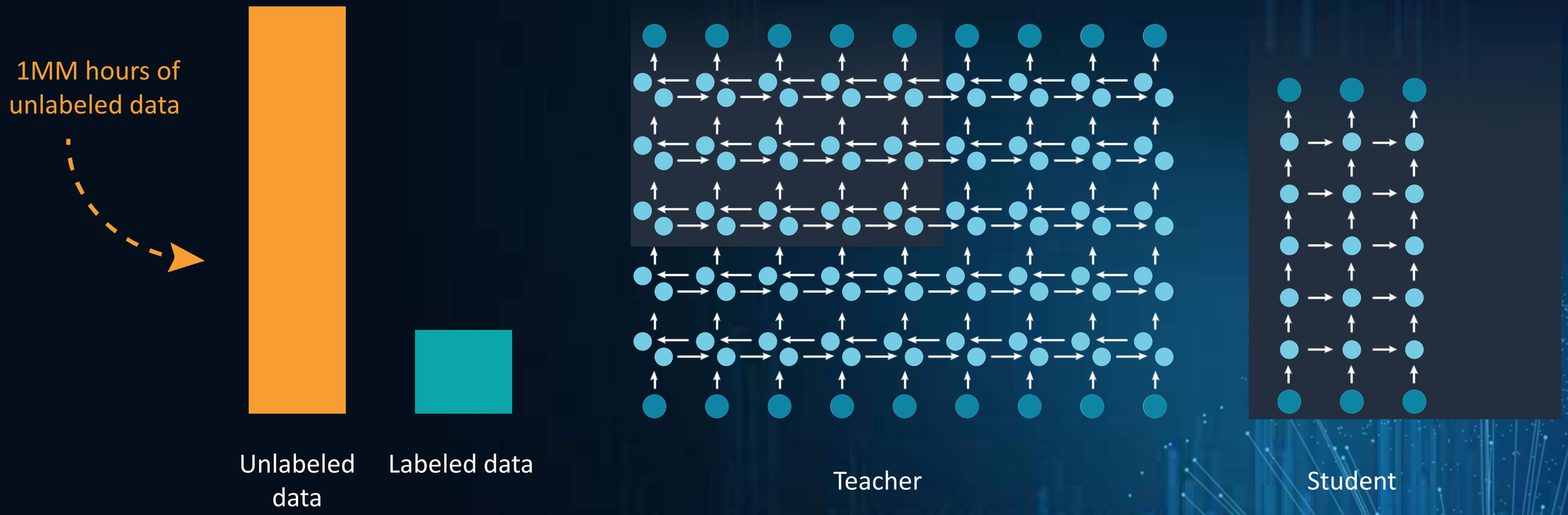
Semi-supervised Speech Recognition Training



"*Lessons from Building Acoustic Models with a Million Hours of Speech,*" Sree Hari Krishnan Parthasarathi, Nikko Strom Amazon.com
https://arxiv.org/abs/1904.01624

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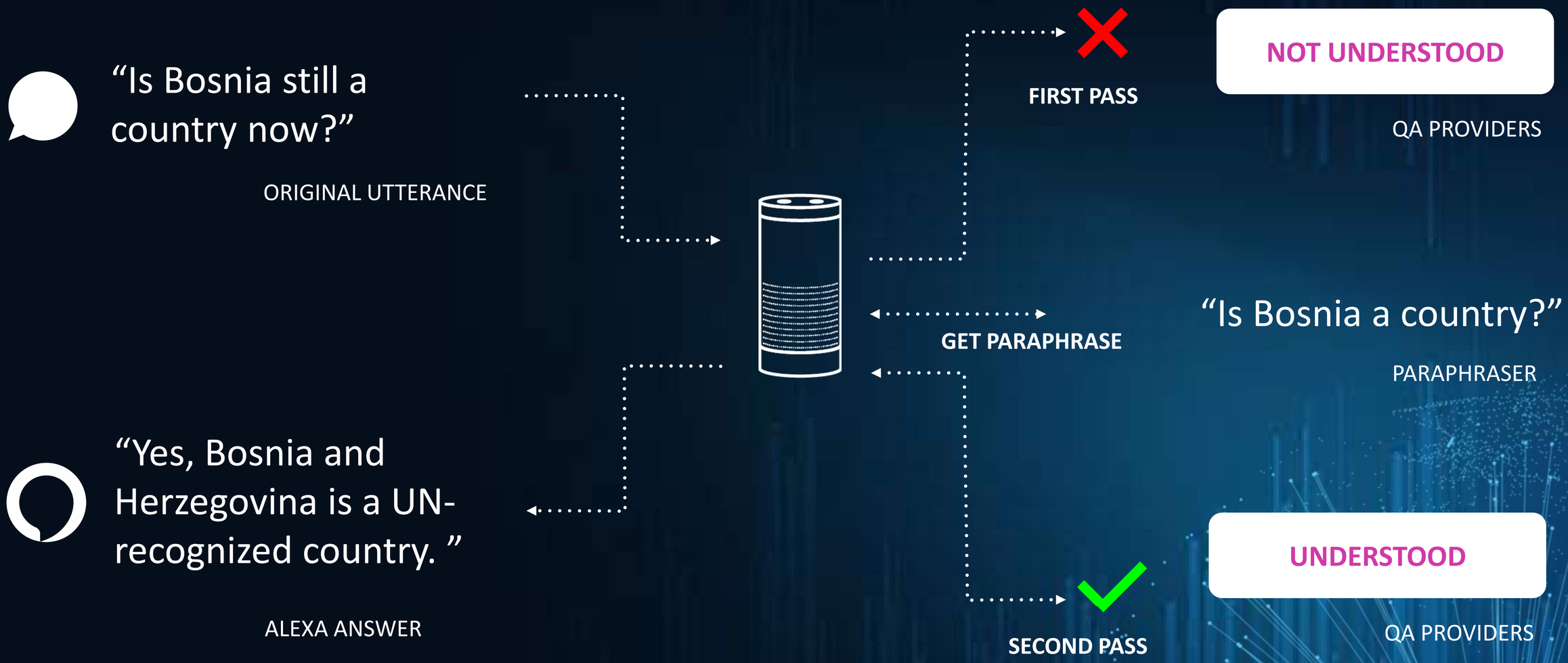
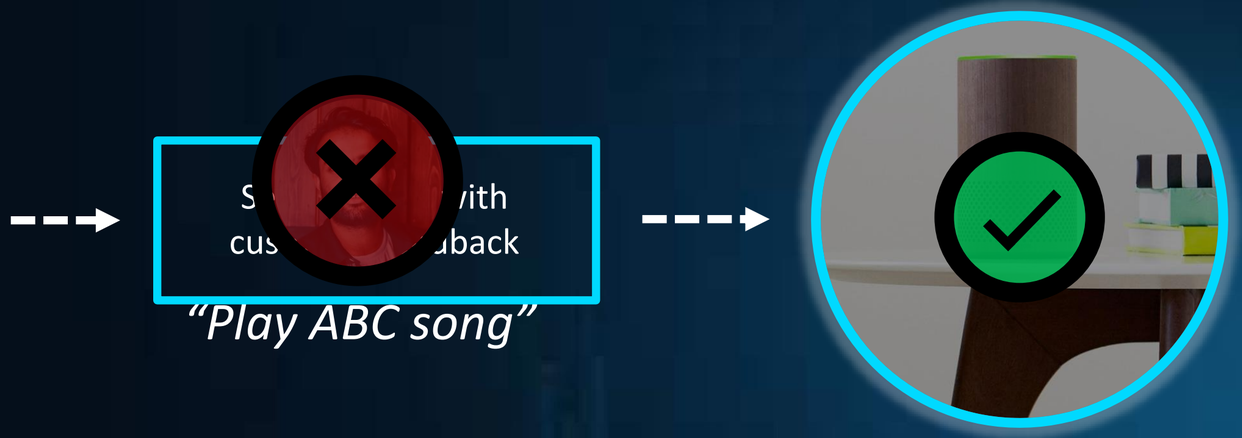
Learning to Paraphrase



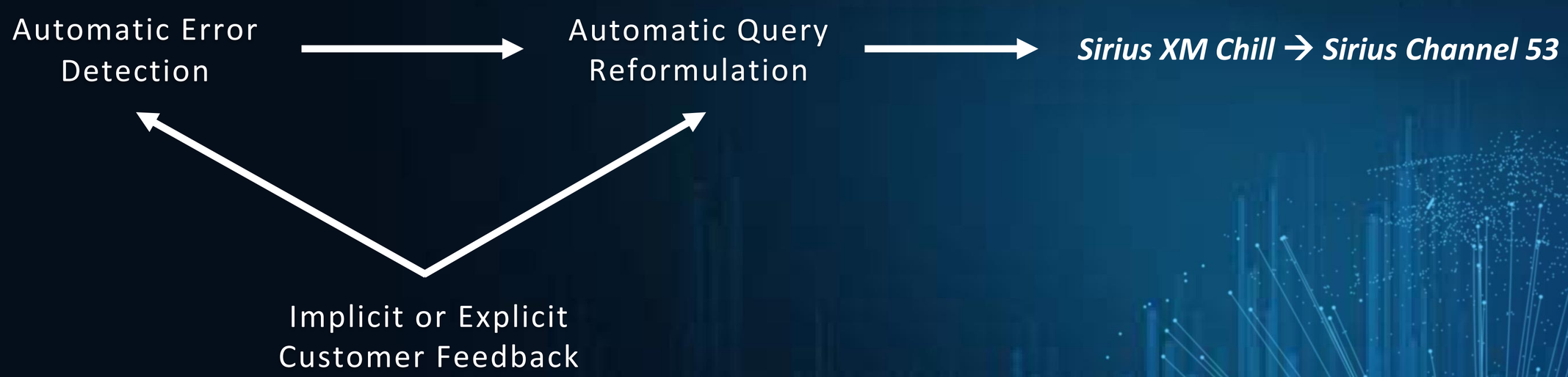
Self-Learning in the Field



Self-Learning in the Field – Modular View

Play Sirius XM Chill ✗

Play Channel 53 on Sirius XM ✓



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Teachable AI

- ***Goal***: Learn new concepts and preferences through direct and interactive teaching by customers
  - Launched in November 2020 in the US

- Example:

  User: Alexa, play this song at full blast
  Alexa: I don't know what full blast means, can you please teach me?
  User: full blast means maximum volume
  Alexa: thank you, playing song at maximum volume

- Integrates natural language understanding with common-sense reasoning

  User: Alexa, it's cold in here
  Alexa: OK, should I increase the temperature of the thermostat?
  ……

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Moving Up the AI Stack

Sensory Data

Phenomena Modeling

Contextual Decisions

Reasoning

Autonomy

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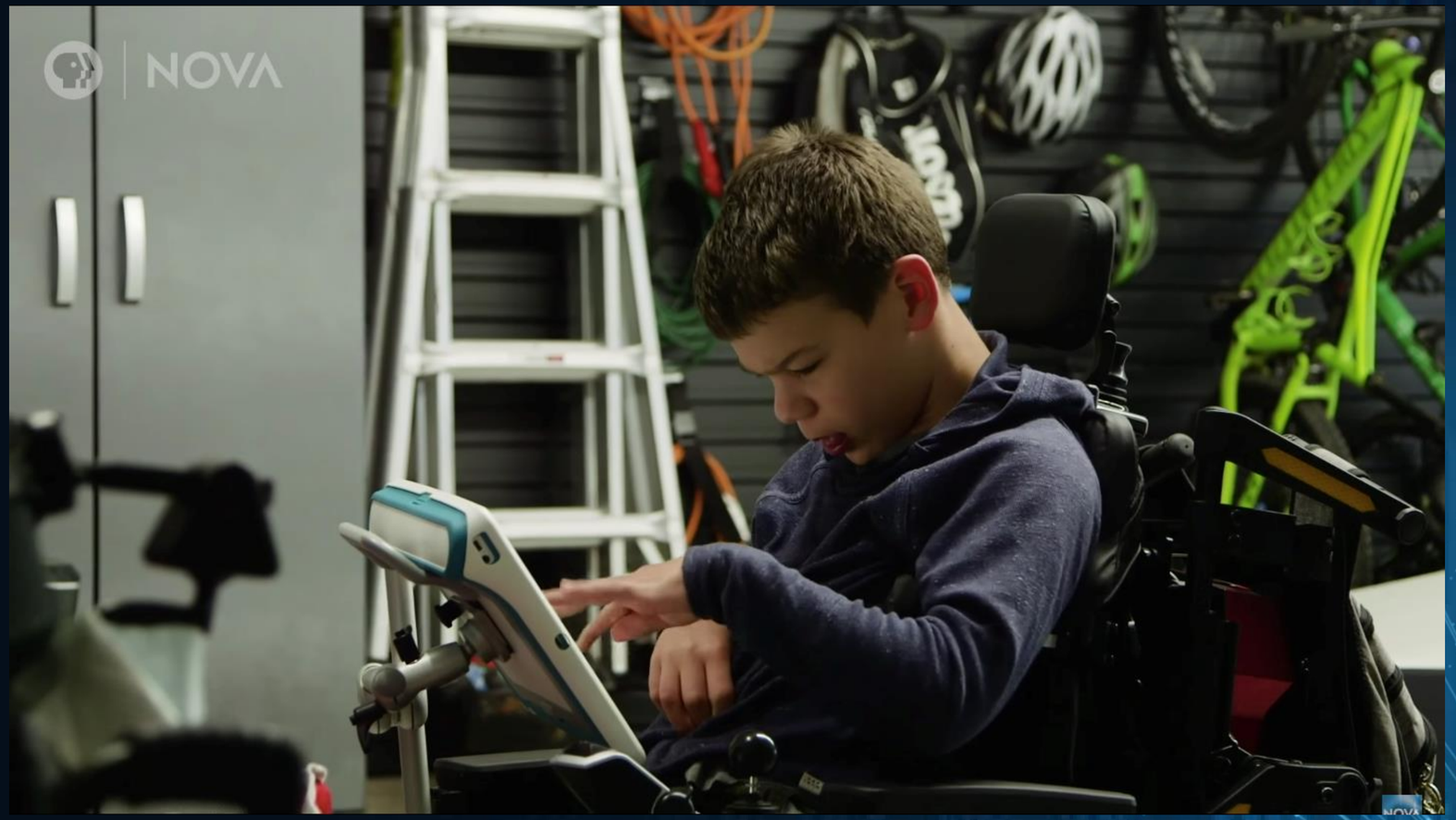
Societal Impact

The Power to Do Good

AI Helps Kaden Find his Voice



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Real World Impact – Teaching English in India

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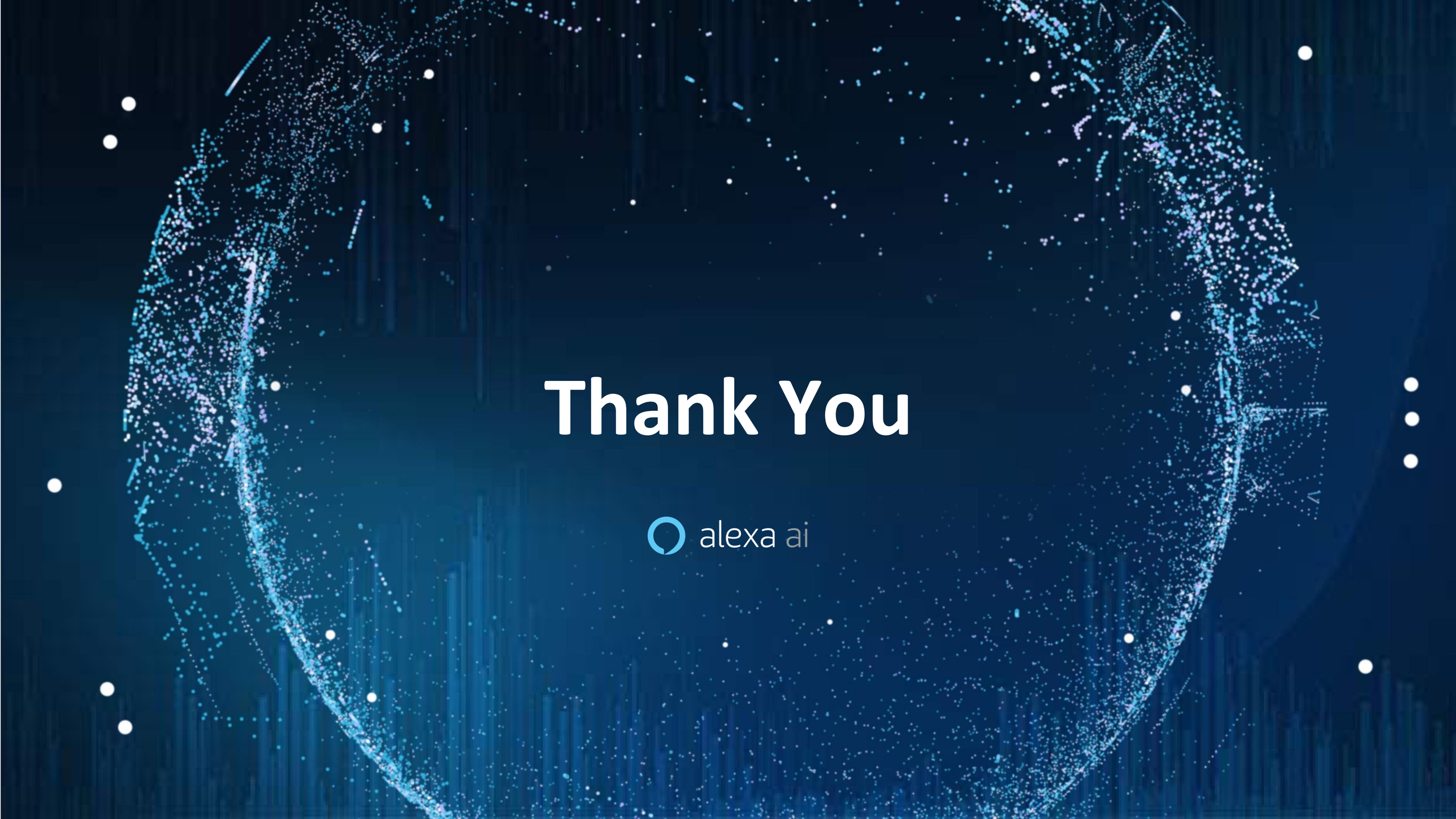
Thank You



1940-1959

AI MILESTONES

1948
Interdisciplinary conference on how nervous system controls behavior and how the brain might be compared to a computer

1950
Alan Turing's paper "Computing Machinery and Intelligence"

1952-1954
The birth of artificial intelligence

Three seminal meetings that heralded the emergence of AI as a field of research

1955
Session on Learning Machines in Los Angeles

1956
Summer Research Project on Artificial Intelligence at Dartmouth College (co-organized by John McCarthy)

1958
Mechanization of Thought Processes (National Physical Lab, UK)

1956-1974
The Golden Years

NATURAL LANGUAGE PROCESSING (NLP)

1947
Warren Weaver mentions translating documents from one language to another in a letter to Norbert Weiner

1949
Word-for-word translation envisioned by Harry Huskey at NIST

1952
First conference on machine translation at MIT

1954
IBM demonstrates automatic translation of samples of Russian text into English

1957
Chomsky Phrase Structure Grammar for generating and analyzing sentences

1958
ARPA (now DARPA) was founded

1959
Bar-Hillel, organizer of the first MT conference, wrote high quality MT was not feasible "not only in the near future but altogether"

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1960 - 1990

AI MILESTONES

1960
Early attempt at OCR (hand-printed character recognition) by Selfridge and Ulrich Neisser

1962
Target detection in Aerial Photography (tanks) by Kanal and Randall

1968
Shakey the robot, developed by Charles Rosen with the help of 11 others, was the first general-purpose mobile robot, known as the first "electronic person"

Conceptual Ontologies

1969
Space Odyssey (HAL)

1970
WAB0T-1, the first anthropomorphic robot

Michael Kelly writes computer program to automatically detect facial features and identify people

1976
DARPA launches Image Understanding Research Program

1980-1987 (Boom)
- WABOT-2
- Expert Systems introduced by Ed Feigenbaum
- CMU demon-strates Navlab, the first autonomous car (1986)
- Black Friday

NATURAL LANGUAGE PROCESSING (NLP)

1964
National Academy of Sciences forms the Automatic Language Processing Advisory

1968
Joseph Weizenbaum develops conversational program ELIZA

1971
DARPA launches 5-year Speech Understanding Research program

1982
Japan launches Fifth-Gen Computer Systems (FGCS) program for AI-focused computers

1984
DARPA launches Strategic Computing program

Two chatbots: Jabberwacky & Cleverbot

1988-1990
DARPA ends Strategic Computing
Japan ends FGCS

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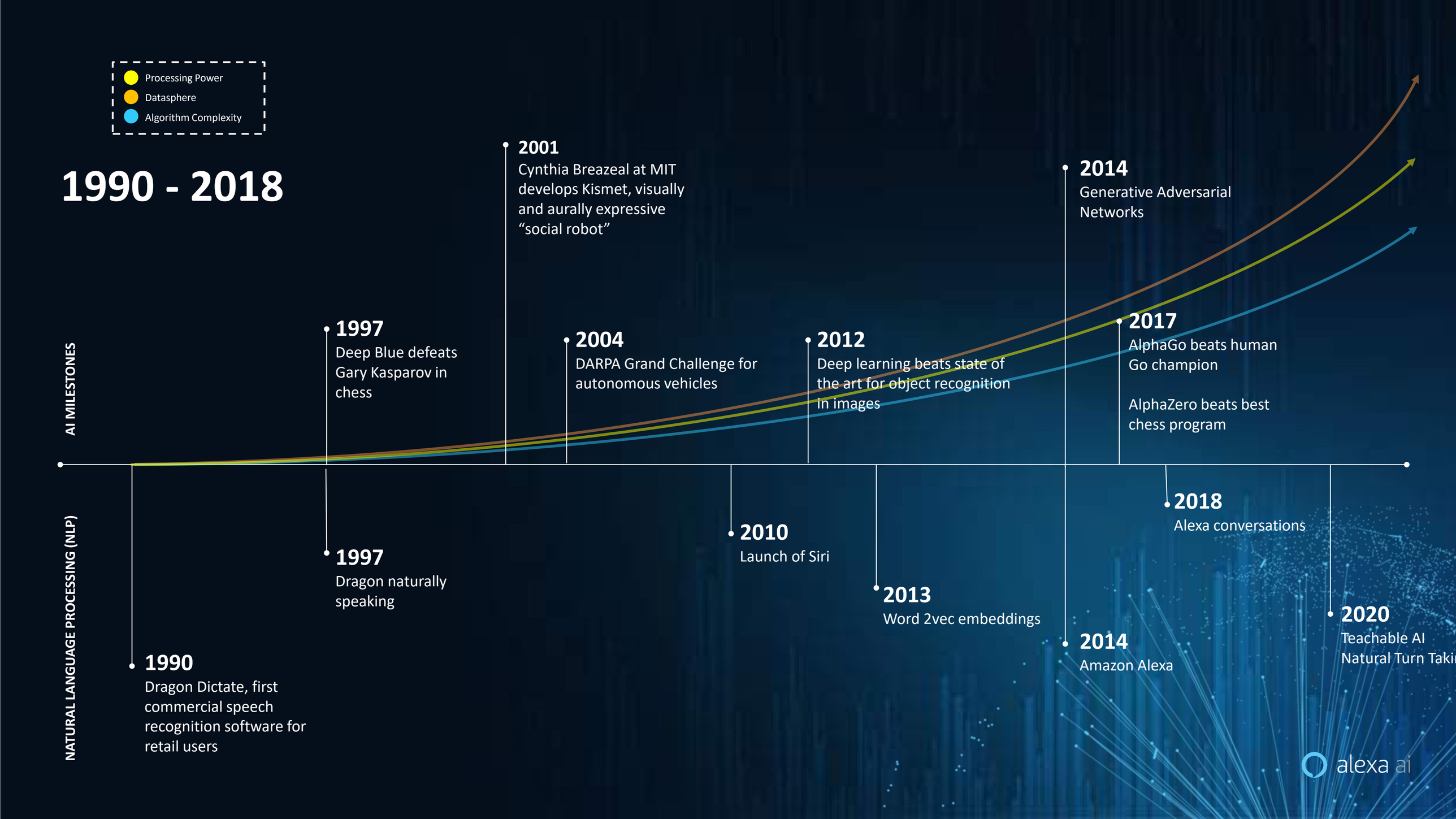
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Thank you!

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