Using Learning at the Edge to Deliver Business Value

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AI Product Manager
September 2020

AGENDA:

01 GOALS

02 FIT

03 EXECUTION

DEFINITIONS:

EDGE DEVICE - a device whose compute, memory, and energy resources are constrained and cannot be easily changed.

LEARNING AT THE EDGE - training of a machine learning model on the edge device.


Canon
CANON ZOOM LENS
AF
MF
STABILIZER
ON
OFF
miops
LIGHTNING

01 GOALS

- What is your objective?

01 GOALS

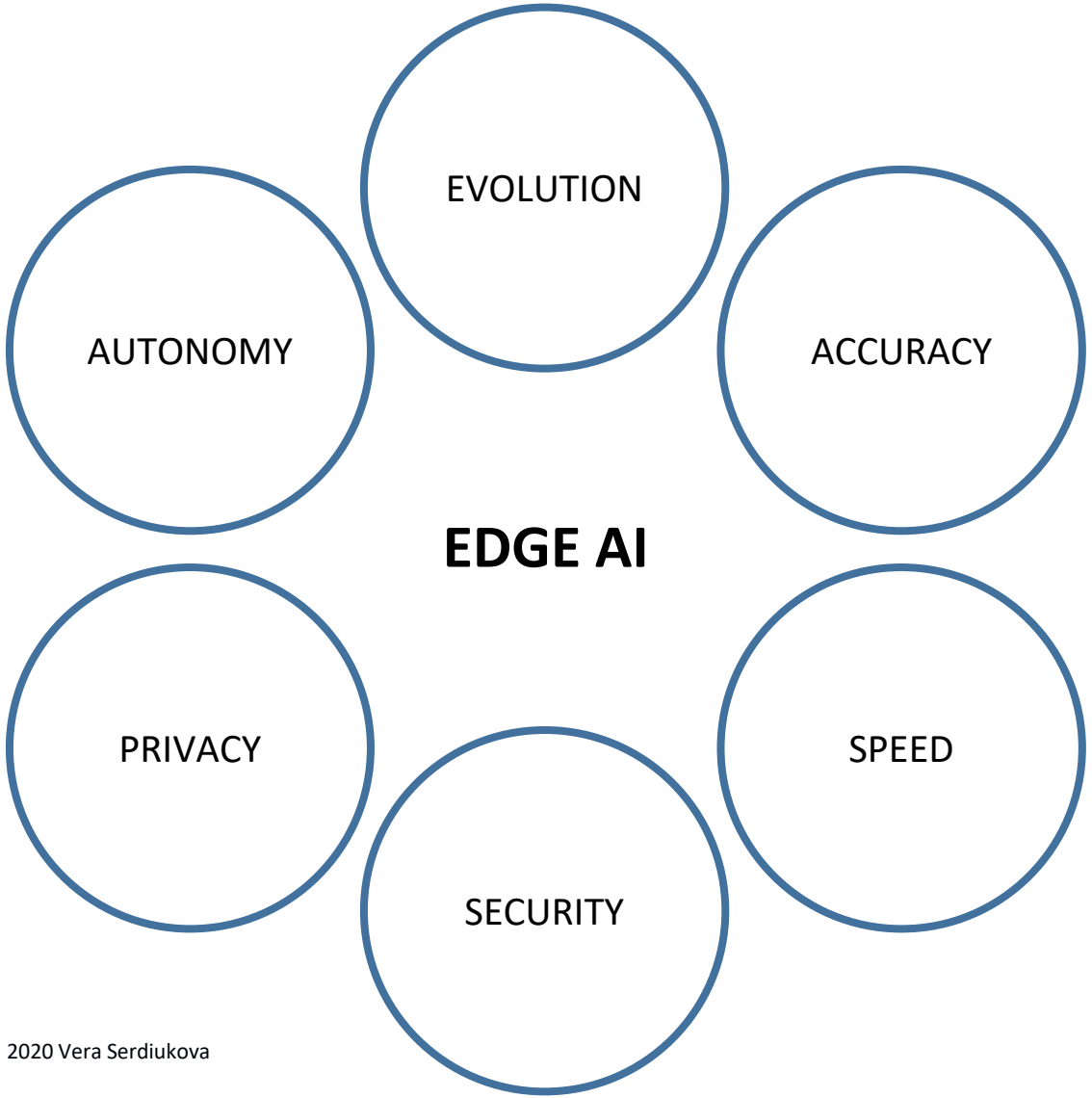
02 FIT

CAN LEARNING AT THE EDGE **HELP**?

01 GOALS

02 FIT

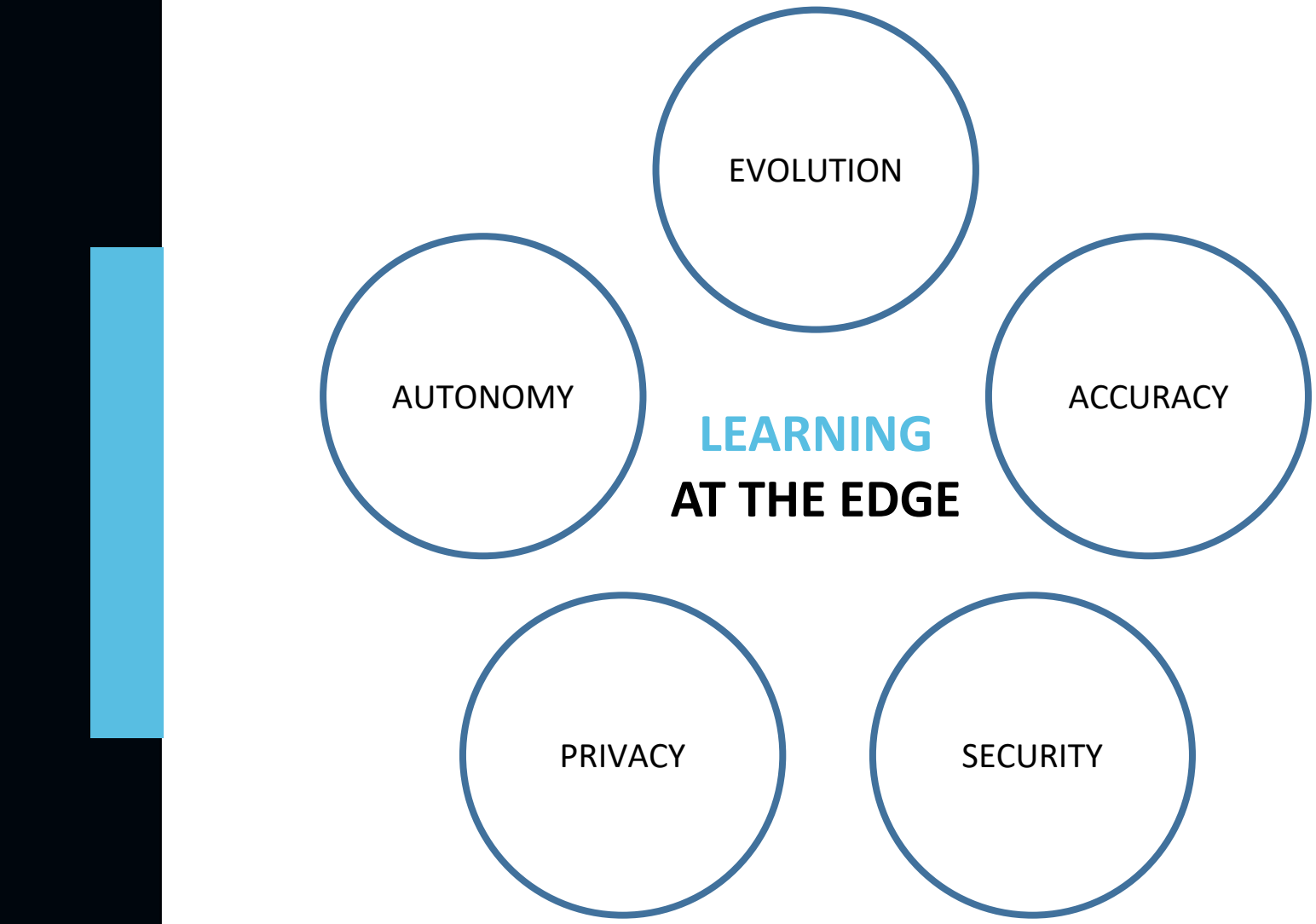
- What are the benefits?



01 GOALS

02 FIT

- What are the benefits?



01 GOALS

02 FIT

- What are the benefits?

01 GOALS

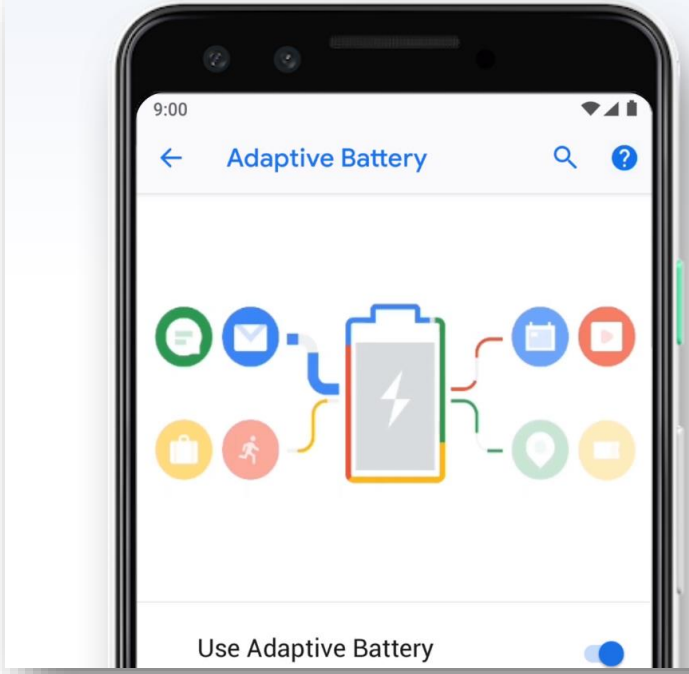
02 FIT

- What are the benefits?

EXAMPLE

android

Android 9 Pie



Adaptive Battery

Go more with a single charge. Adaptive Battery learns how you like to use your phone, so the apps and services you don't use as much aren't a battery drain.

Adaptive Brightness

Don't worry about changing your brightness — your phone learns how you like to set it and automatically adjusts. Easy as pie.

Source: https://www.android.com/versions/pie-9-0/

01 GOALS

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- What are the benefits?
- What are the prerequisites?

FEASIBLE?

01 GOALS

02 FIT

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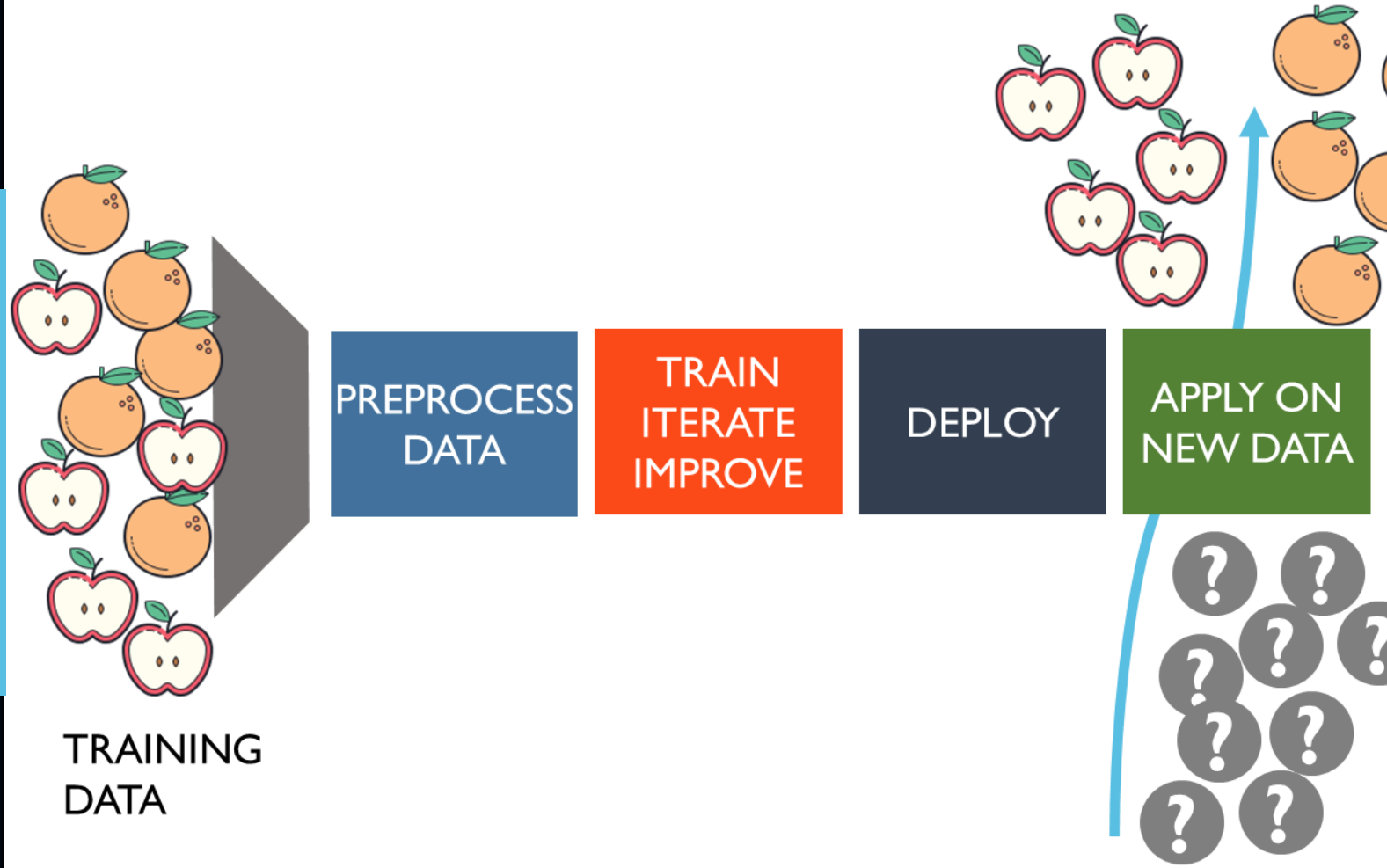

01 GOALS

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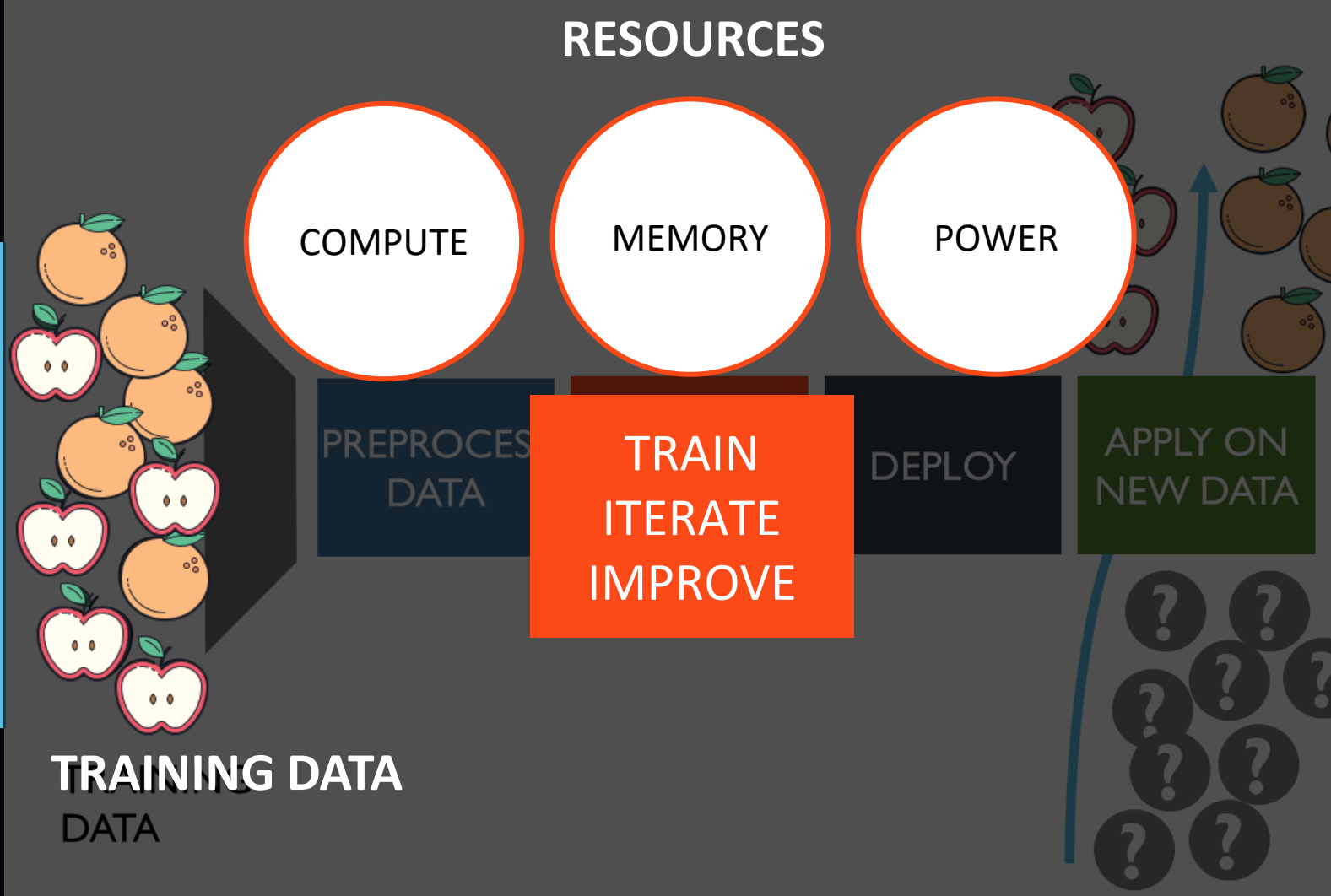

01 GOALS

02 FIT

- What are the benefits?
- What are the prerequisites?

"Model is only as good as the training data

- Anybody who has ever built a ML model

01 GOALS

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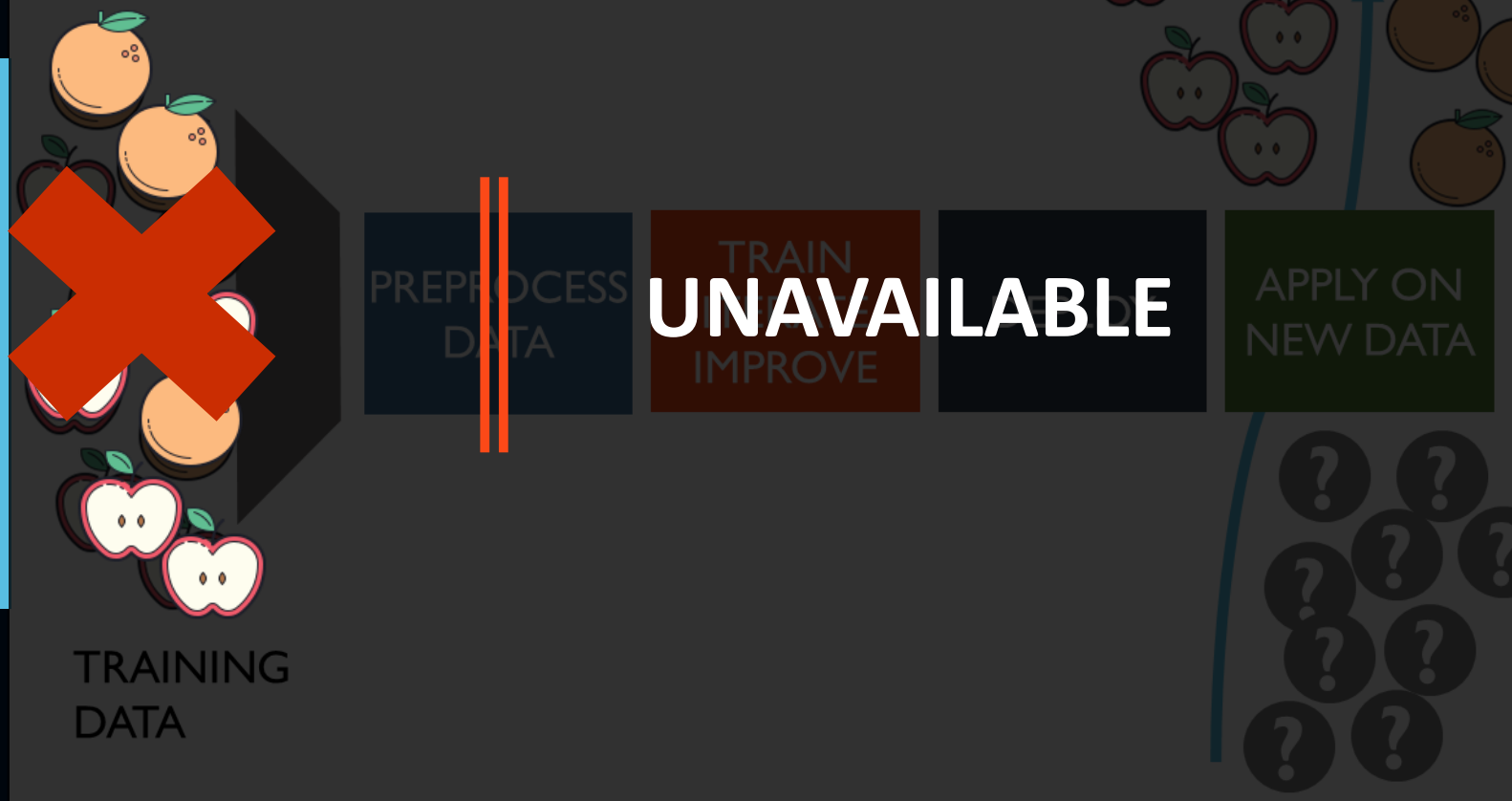
- What are the benefits?
- What are the prerequisites?



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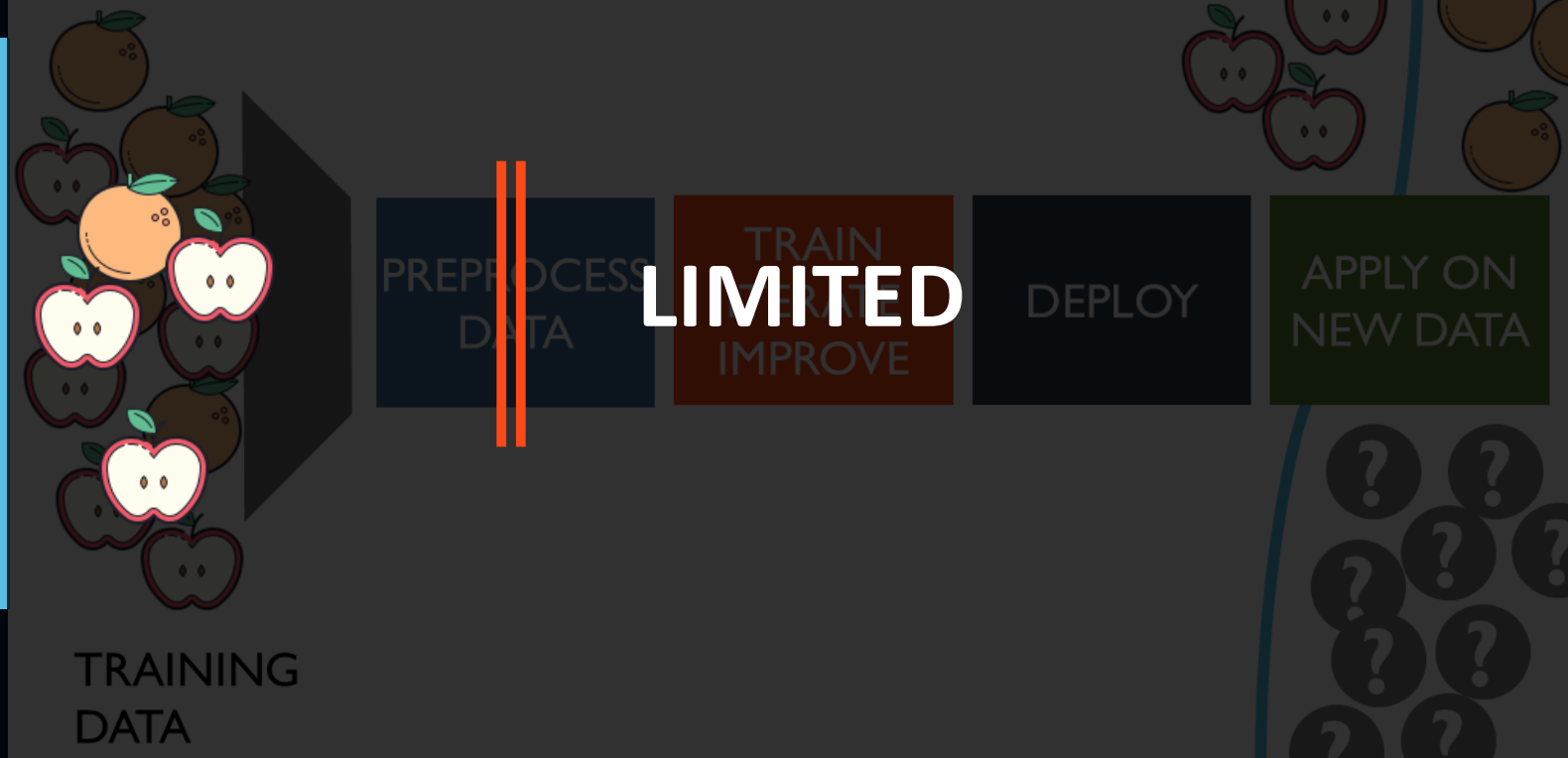

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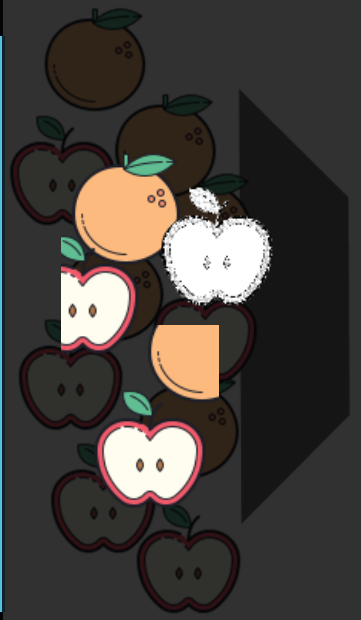


TRAINING DATA

PREPROCESS DATA

TRAIN EVALUATE IMPROVE

DEPLOY

APPLY ON NEW DATA

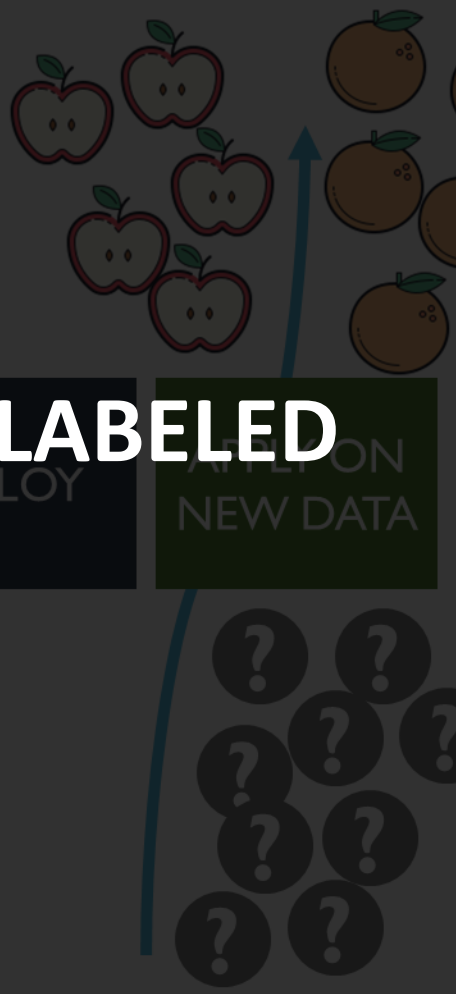
MINIMAL/ NO DATA PREPROCESSING

01 GOALS

02 FIT

- What are the benefits?
- What are the prerequisites?

LIMITED/ NO LABELED DATA



01 GOALS

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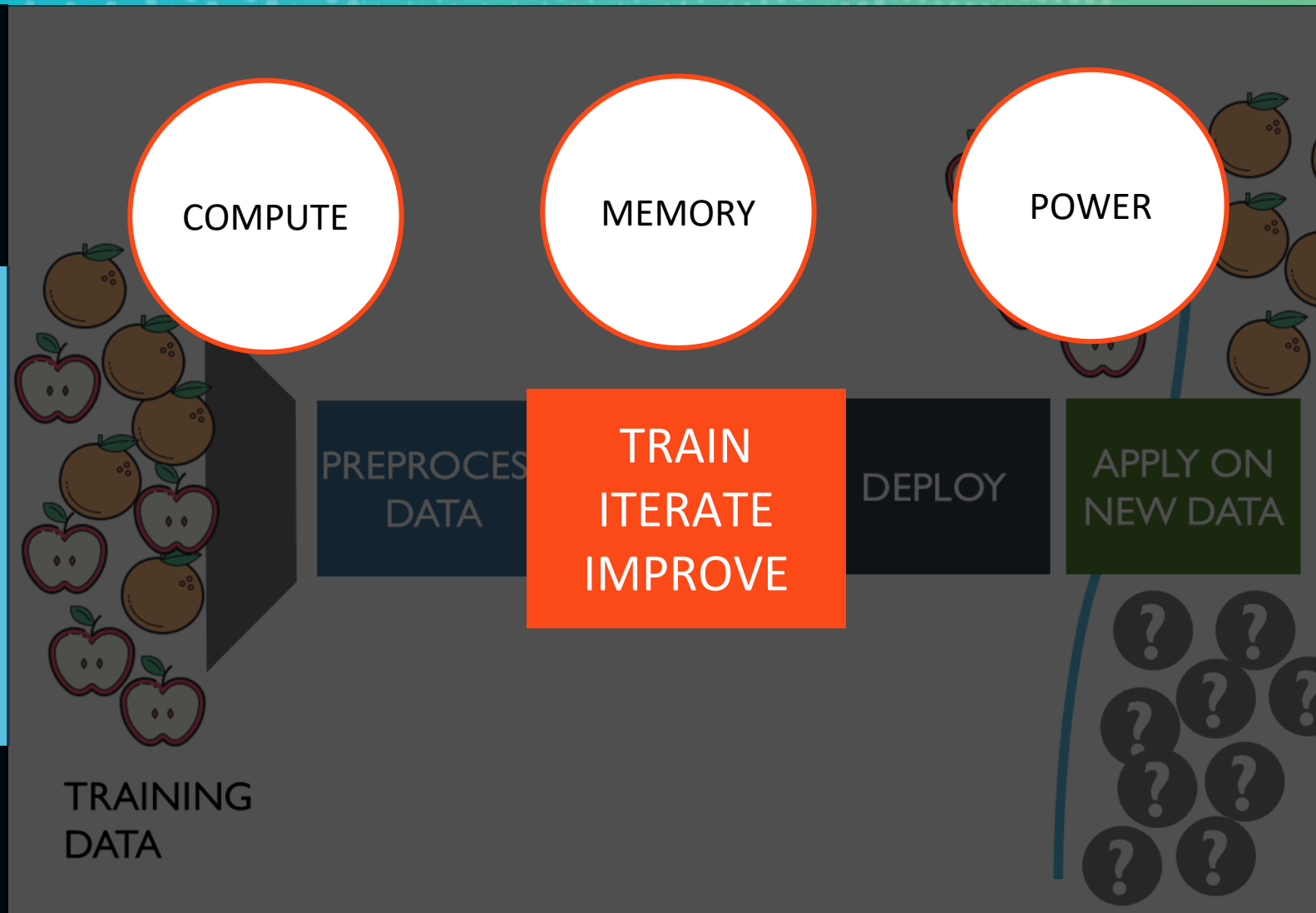

01 GOALS

02 FIT

- What are the benefits?
- What are the prerequisites?

Scenario #1

Build a new product/ device from scratch

01 GOALS

02 FIT

- What are the benefits?
- What are the prerequisites?

Scenario #1

Build a new product/ device from scratch

VS.

Scenario #2

Improve an existing product/ device

01 GOALS

02 FIT

- What are the benefits?
- What are the prerequisites?

Scenario #1

Build a new product/ device from scratch

VS.

Scenario #2

Improve an existing product/ device

YOU ARE SOMEWHERE HERE

01 GOALS

02 FIT

- What are the benefits?
- What are the prerequisites?
- What are the costs?

Scenario #1

Build a new product/ device from scratch

- Bill of materials (BOM)
- Non-recurring engineering (NRE)
- User acquisition and retention, etc.

vs.

Scenario #2

Improve an existing product/ device

01 GOALS

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- What are the benefits?
- What are the prerequisites?
- What are the costs?

Scenario #1

Build a new product/ device from scratch

- Bill of materials (BOM)
- Non-recurring engineering (NRE)
- User acquisition and retention, etc.

vs.

Scenario #2

Improve an existing product/ device

- Non-recurring engineering (NRE)
- Product redesign-related NRE
- Feature introduction, etc.

01 GOALS

02 FIT

- What are the benefits?
- What are the prerequisites?
- What are the costs?
- Does it make sense?

BOTTOM LINE

01 GOALS

02 FIT

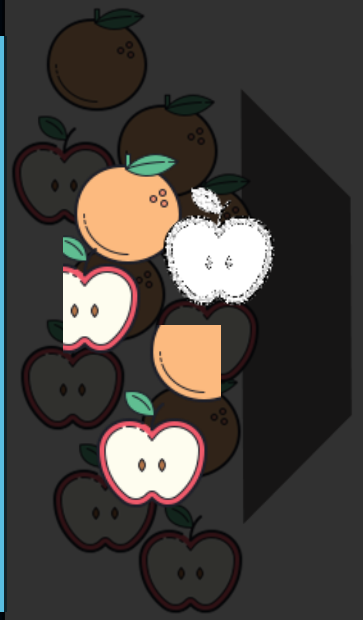
03 EXECUTION

01 GOALS

02 FIT

03 EXECUTION

- Where do I start? Data.



TRAINING DATA

PREPROCESS DATA → ITERATE → DEPLOY → APPLY ON NEW DATA

LIMITED & MINIMALLY PREPROSSED DATA

01 GOALS

02 FIT

03 EXECUTION

- Where do I start? Data.

OBTAIN QUALITY DATA

01 GOALS

02 FIT

03 EXECUTION

- Where do I start? Data.

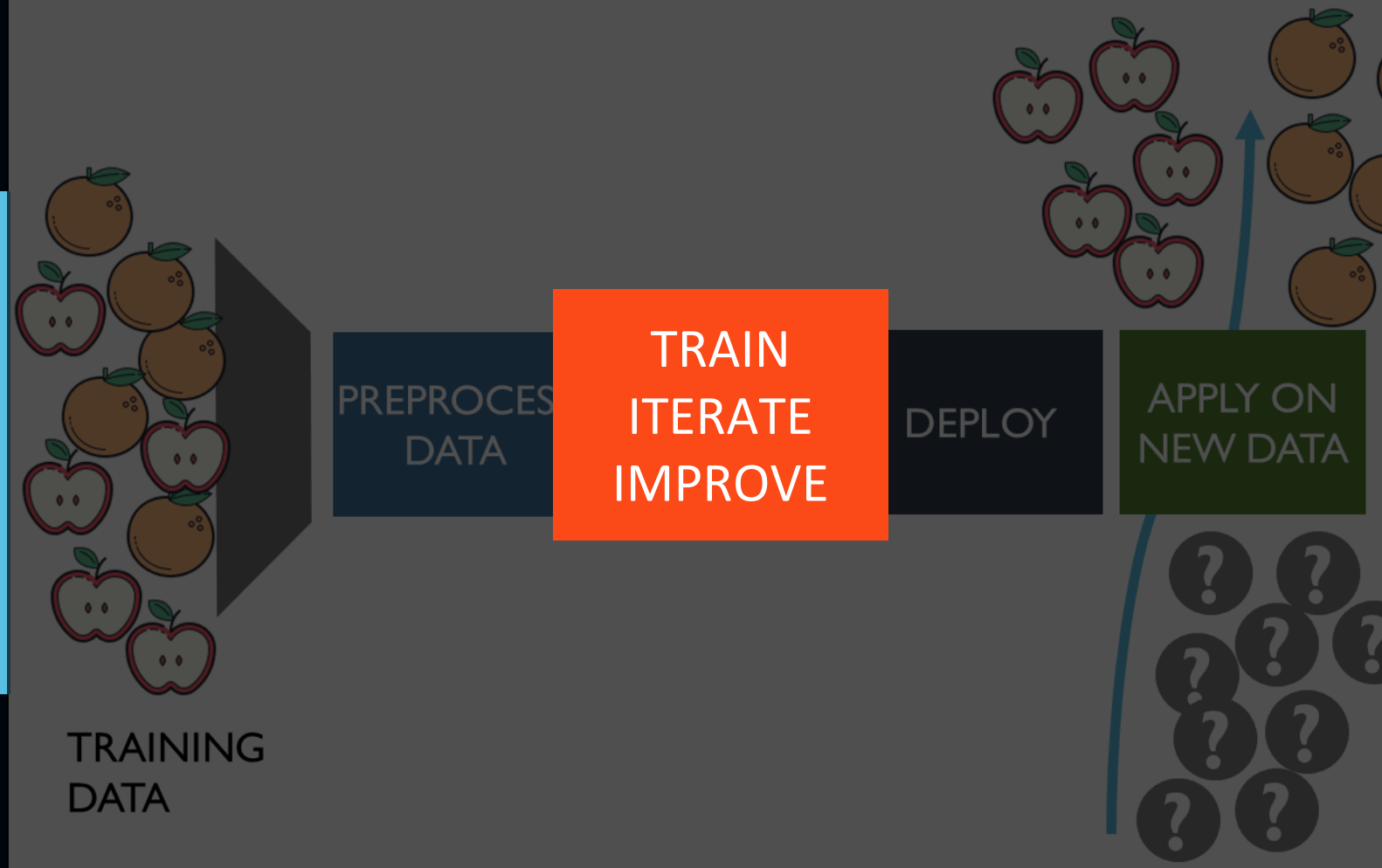
EXAMPLE

01 GOALS

02 FIT

03 EXECUTION

- Where do I start? Data.
- How does learning happen?



01 GOALS

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- Where do I start? Data.
- How does learning happen?

LEARNING AT THE EDGE: **APPROACHES**

GENERIC MODEL TRAINED ON CLOUD/ PREM

+

MODEL REFINED ON-DEVICE

01 GOALS

02 FIT

03 EXECUTION

- Where do I start? Data.
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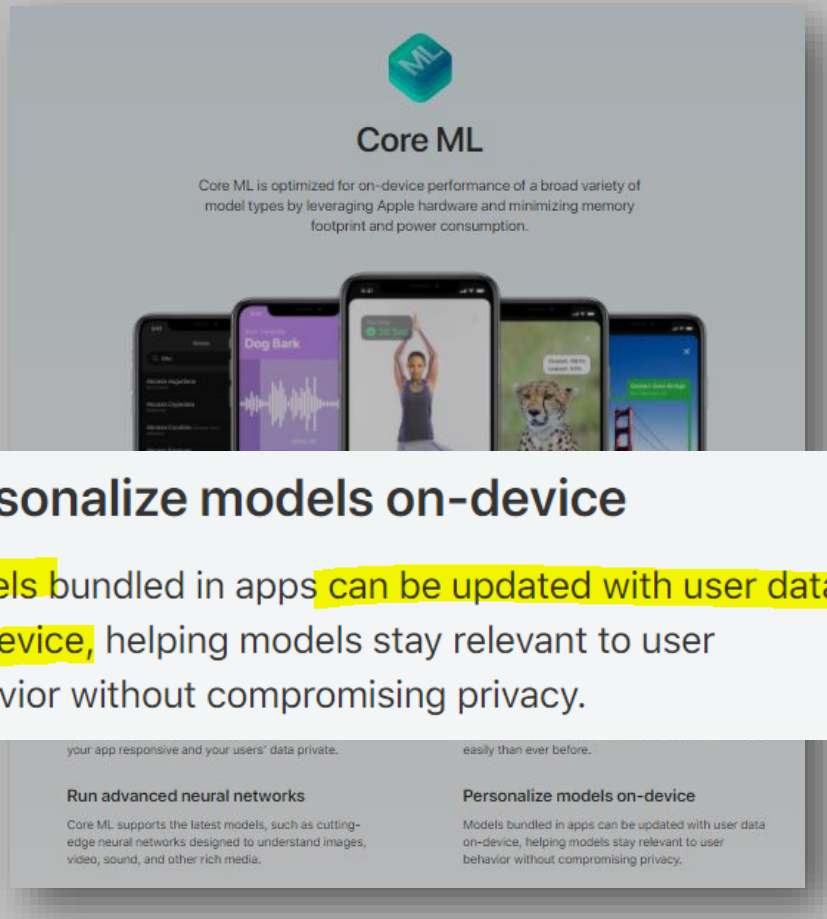
EXAMPLE



Source: https://developer.apple.com/machine-learning/core-ml/

01 GOALS

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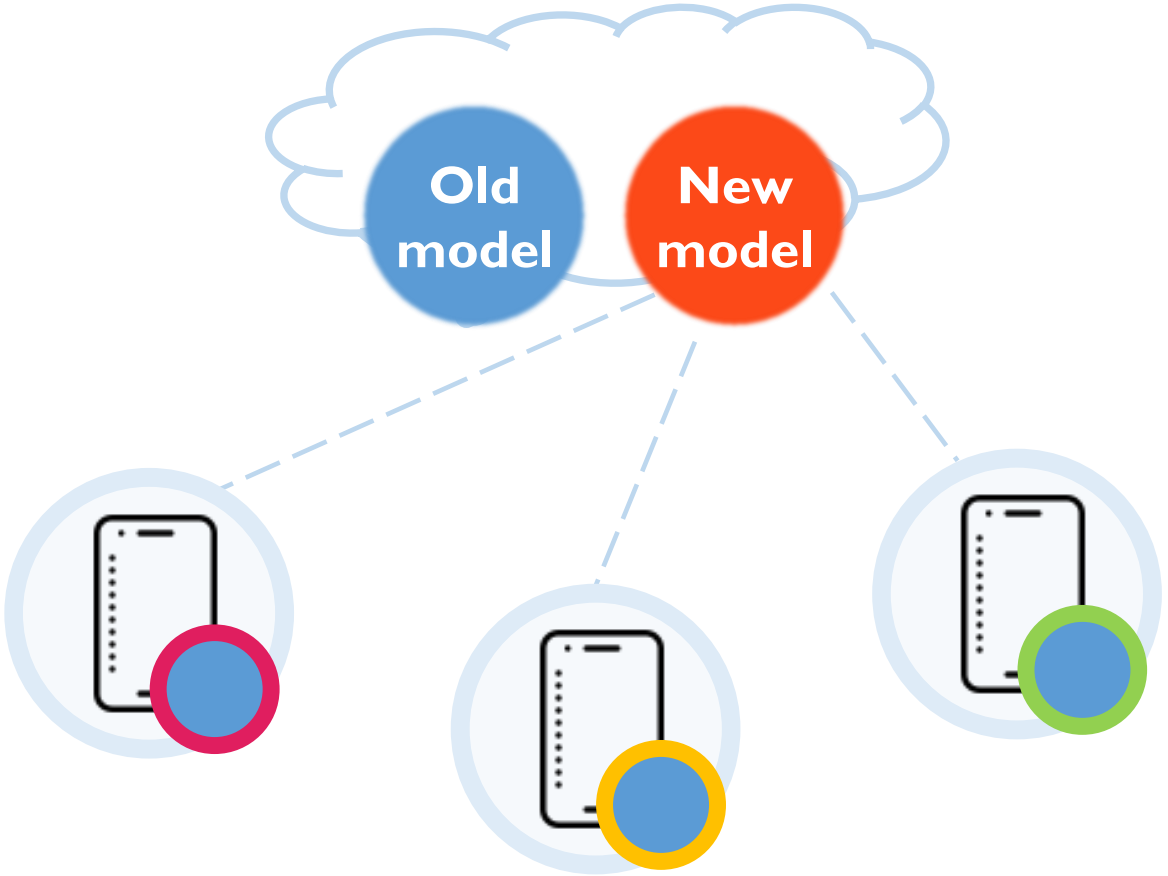
- Where do I start? Data.
- How does learning happen?

KEEPING MODELS UP-TO-DATE



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- Where do I start? Data.
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LEARNING AT THE EDGE: **APPROACHES**

GENERIC MODEL TRAINED ON CLOUD/ PREM
+
MODEL REFINED ON-DEVICE

COLLABORATIVE LEARNING (E.G. FEDERATED LEARNING)

01 GOALS

02 FIT

03 EXECUTION

- Where do I start? Data.
- How does learning happen?

EXAMPLE

Gboard

Google AI Blog

The latest news from Google AI

mobile devices (like the Mobile Vision API and On-Device Smart Reply) by bringing model *training* to the device as well.

It works like this: your device downloads the current model, improves it by learning from data on your phone, and then summarizes the changes as a small focused update. Only this update to the model is sent to the cloud, using encrypted communication, where it is immediately averaged with other user updates to improve the shared model. All the training data remains on your device, and no individual updates are stored in the cloud.

Federated Learning enables mobile phones to collaboratively learn a shared prediction model while keeping all the training data on device, decoupling the ability to do machine learning from the need to store the data in the cloud. This goes beyond the use of local models that make predictions on mobile devices (like the Mobile Vision API and On-Device Smart Reply) by bringing model *training* to the device as well.

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Source: https://ai.googleblog.com/2017/04/federated-learning-collaborative.html

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- Where do I start? Data.
- How does learning happen?

LEARNING AT THE EDGE: **APPROACHES**

GENERIC MODEL TRAINED ON CLOUD/ PREM
+
MODEL REFINED ON-DEVICE

COLLABORATIVE LEARNING (E.G. FEDERATED LEARNING)

MODEL TRAINED FROM SCRATCH
+
POTENTIALLY RETRAINED

ON-DEVICE ONLY

01 GOALS

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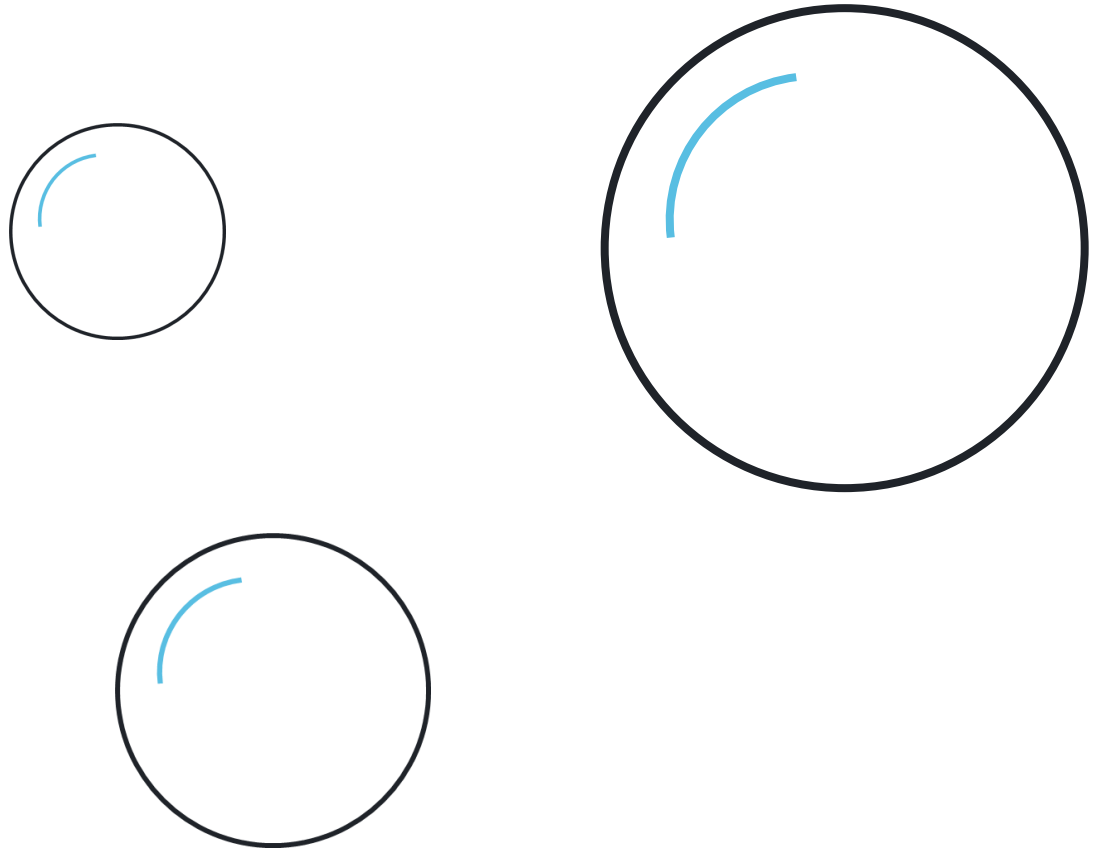
- Where do I start? Data.
- How does learning happen?

KNOWLEDGE SILOS



01 GOALS

02 FIT

03 EXECUTION

- Where do I start? Data.
- How does learning happen?
- What else shall I take into account?

A FEW ADDITIONAL CONSIDERATIONS

01 GOALS

02 FIT

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- Where do I start? Data.
- How does learning happen?
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MODEL LOSS

01 GOALS

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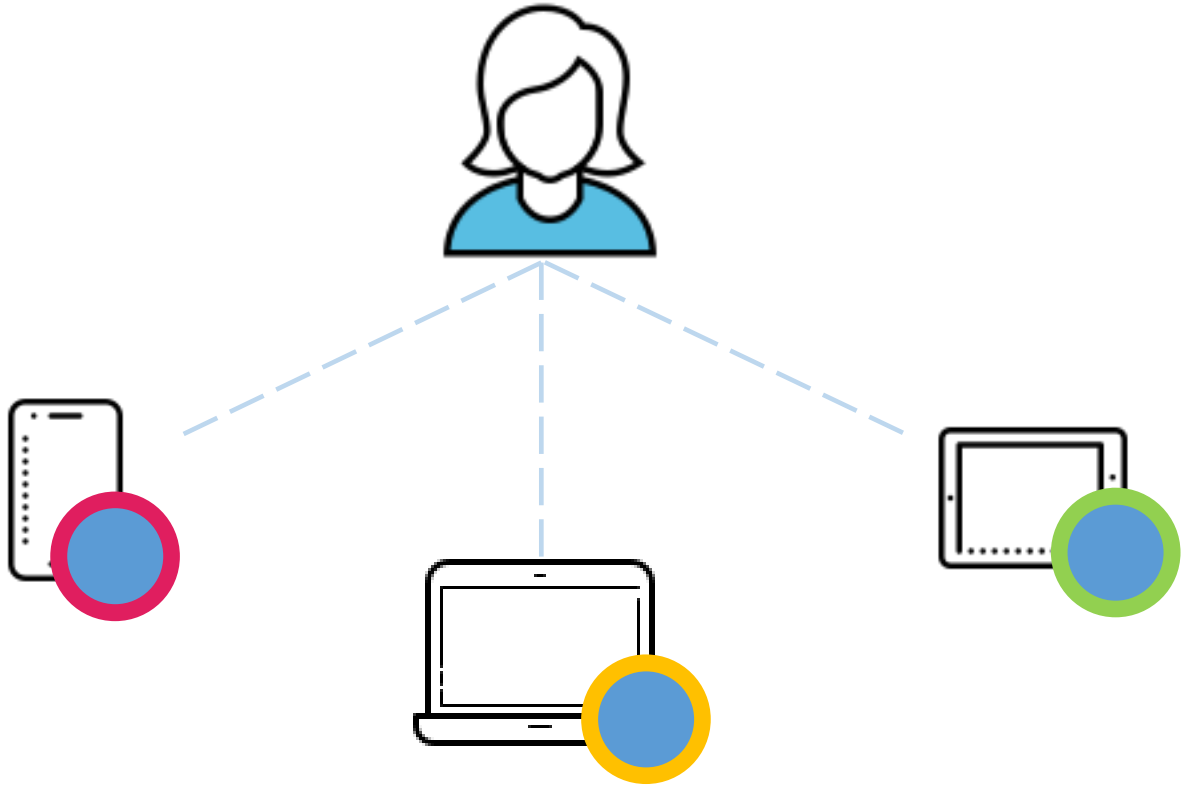
EXPERIENCE CONSISTENCY



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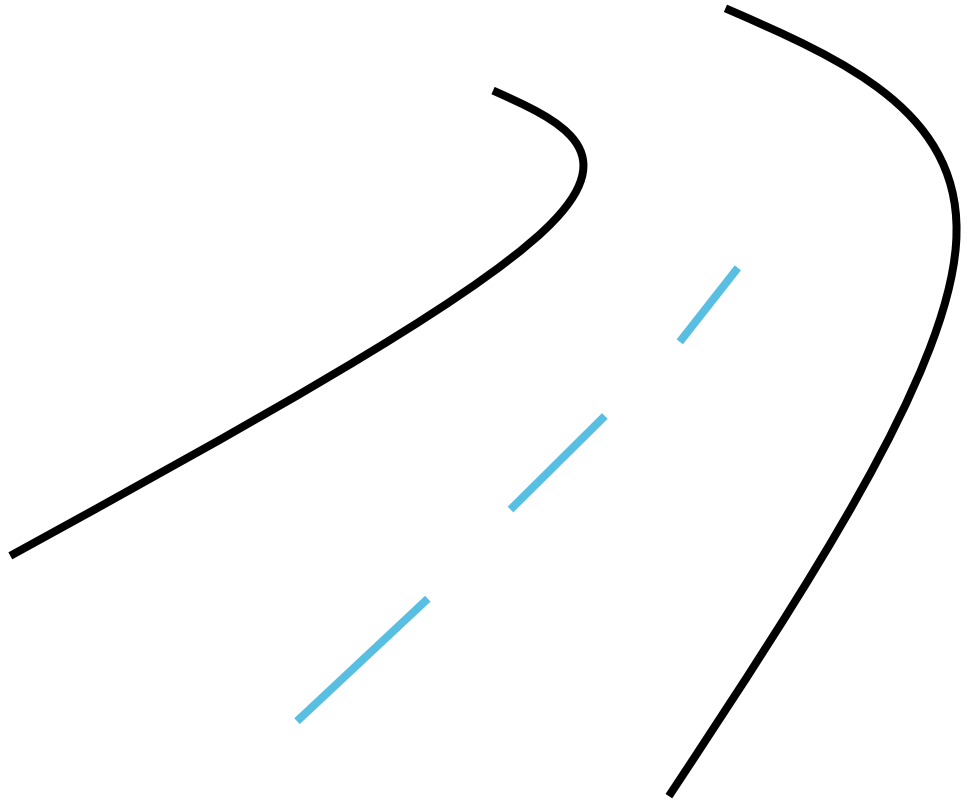
MODEL EVOLUTION TRACKABILITY



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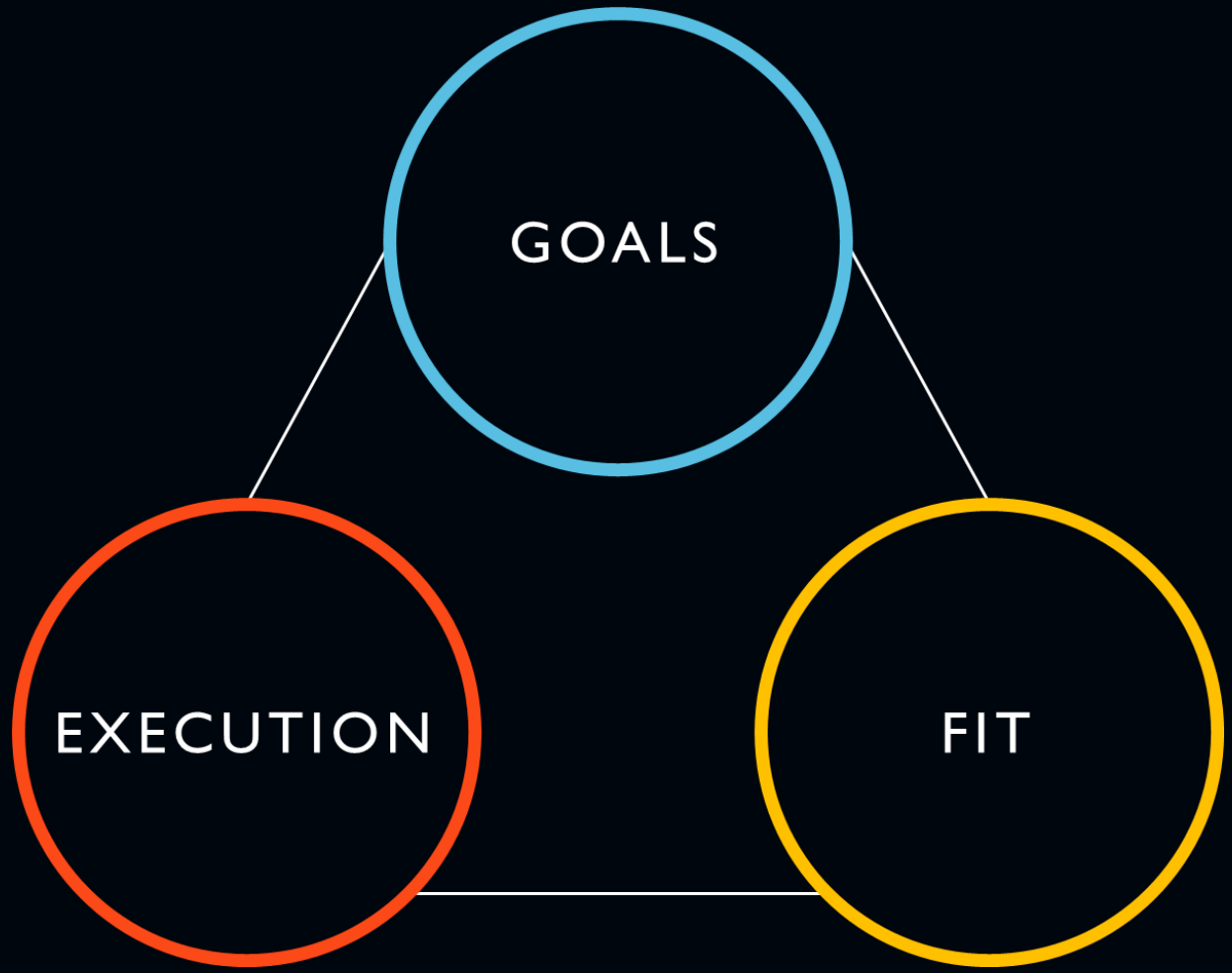
FUN? YES!
TRIVIAL? NO!


GOALS
EXECUTION
FIT

RESOURCES:

Publications

On-Device Machine Learning: An Algorithms and Learning Theory Perspective

https://arxiv.org/abs/1911.00623

On-device Learning: Examples

Android 9 Pie, Adaptive Battery and Brightness

https://www.android.com/versions/pie-9-0/

Core ML 3, On-device Training

https://developer.apple.com/machine-learning/core-ml/

Federated Learning: Collaborative Machine Learning without Centralized Training Data

https://ai.googleblog.com/2017/04/federated-learning-collaborative.html

THANK YOU

Vera Serdiukova

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