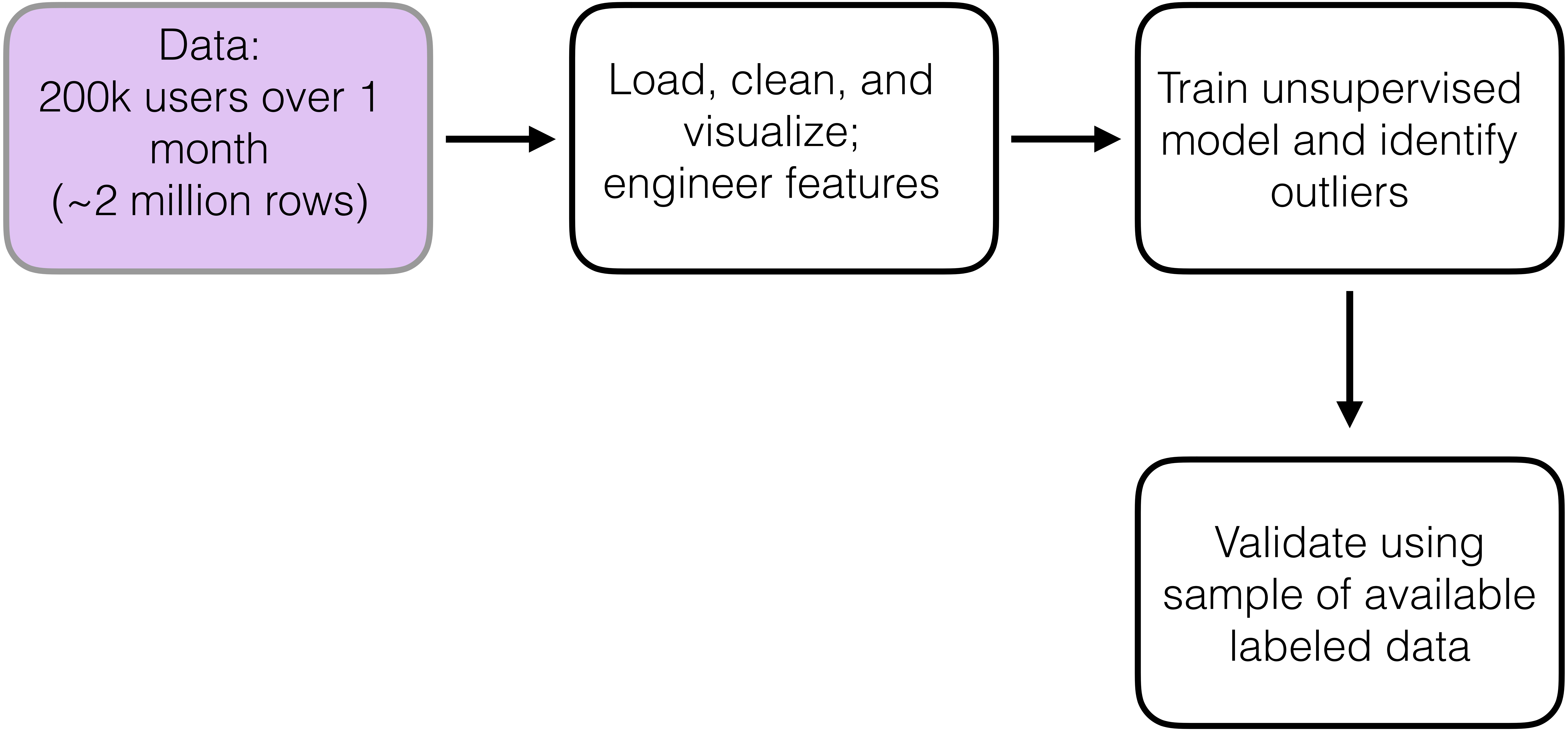
Detection of unusual travel patterns to prevent user account compromise

James Verbus

Collaboration with Castle (castle.io)

- Castle provides automated detection of compromised user accounts & hijack attempts for online businesses
- **Deliverable:** Develop a model to predict the likelihood that a new login belongs to a specific user

Data and Analysis Pipeline



Data:
200k users over 1 month
(~2 million rows)

Load, clean, and visualize; engineer features

Train unsupervised model and identify outliers

Validate using sample of available labeled data

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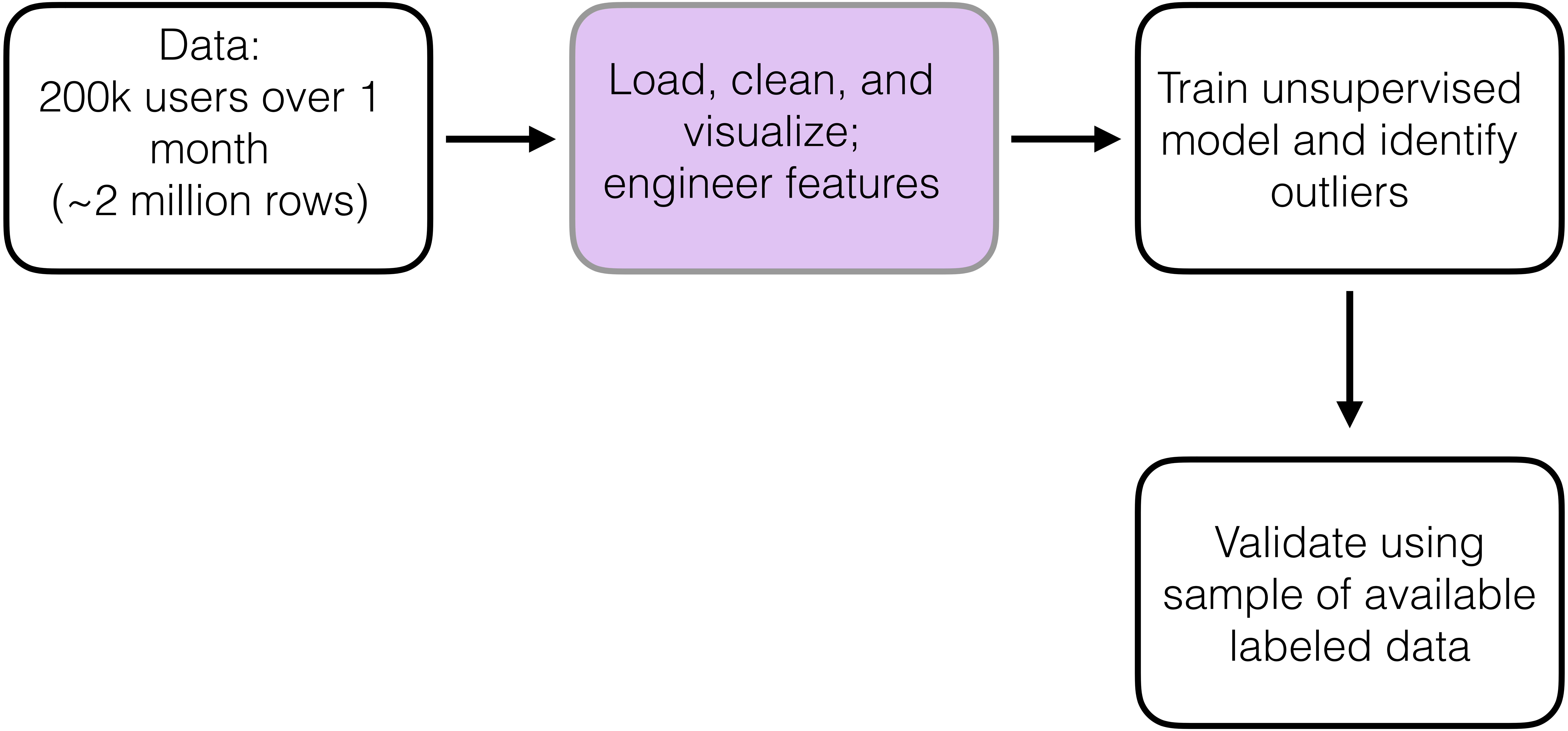

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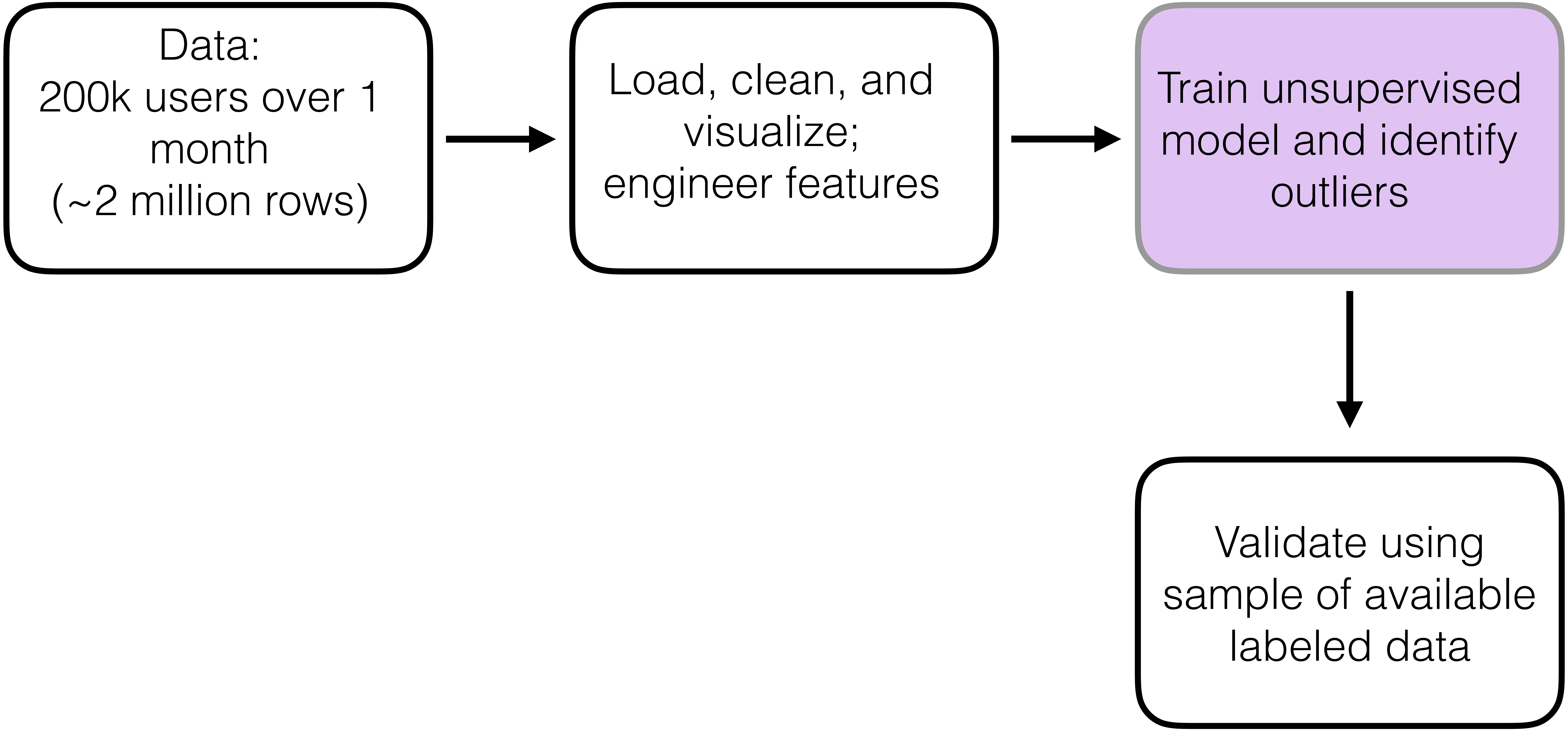

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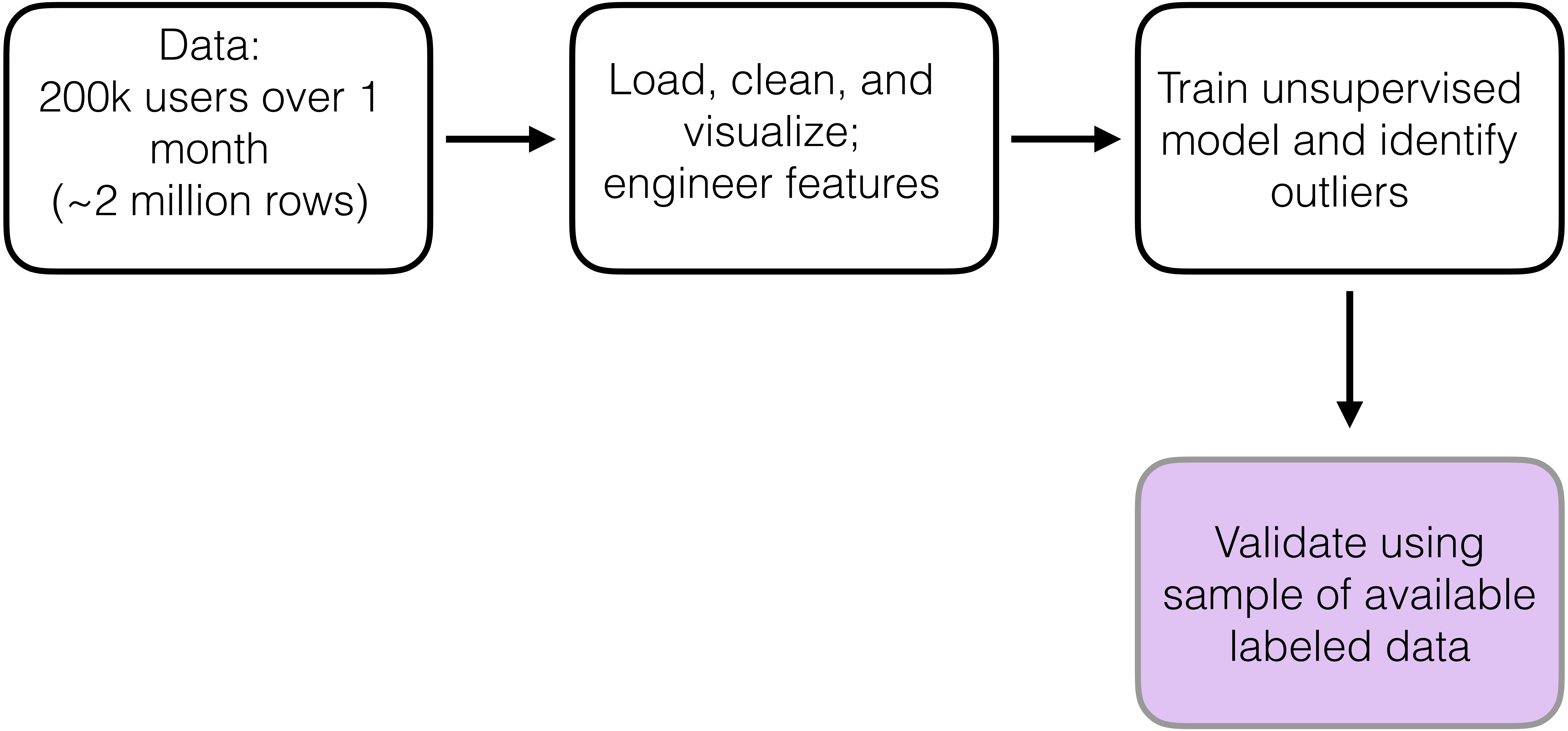

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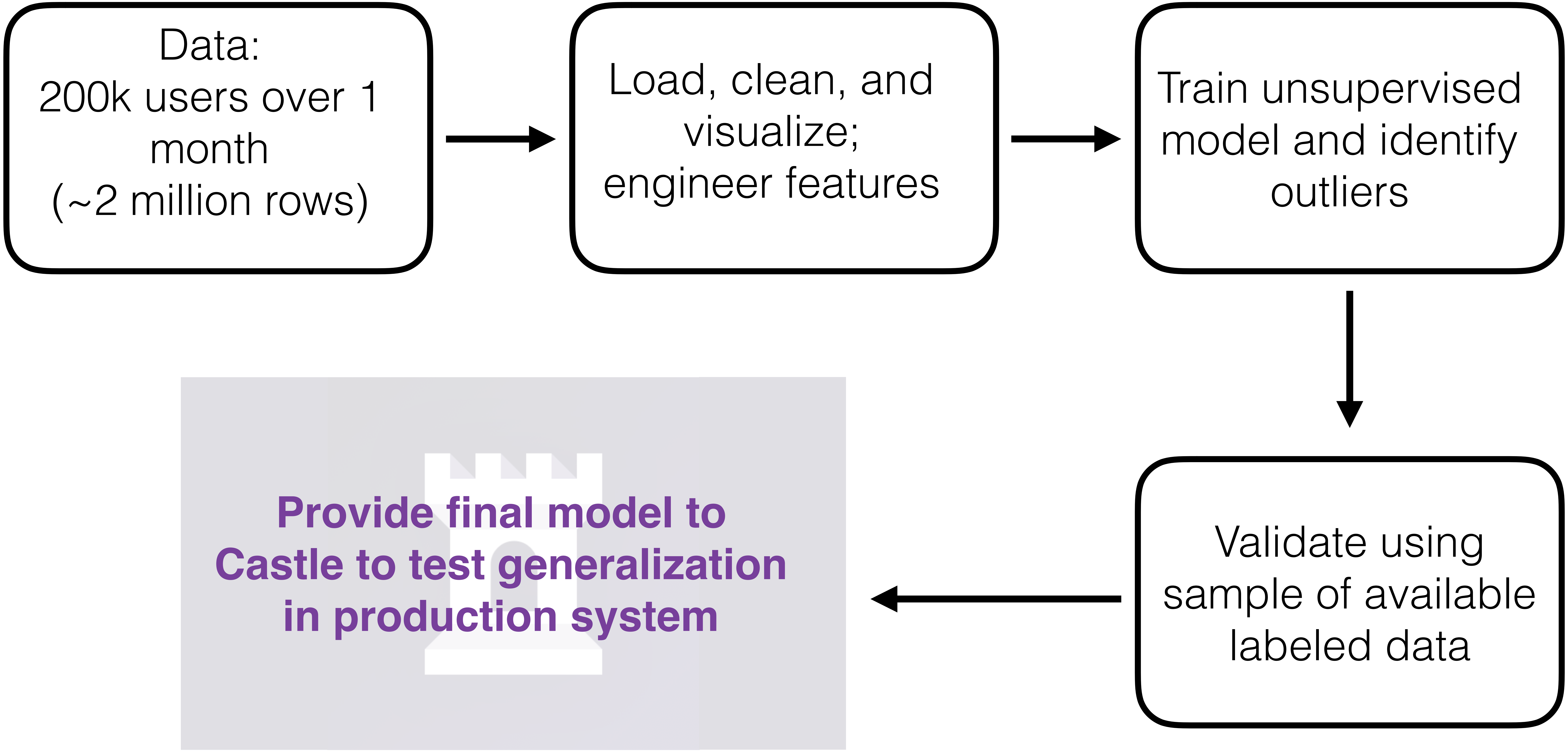

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Provide final model to Castle to test generalization in production system

Canada
Hudson Bay
United States
Mexico
Gulf of Mexico
Cuba
Puerto Rico
Caribbean Sea
North Atlantic Ocean
South Atlantic Ocean
Indian Ocean
Russia
Finland
Norway
Denmark
Ireland
United Kingdom
Poland
Belarus
Germany
Ukraine
France
Austria
Romania
Italy
Spain
Portugal
Greece
Turkey
Kazakhstan
Mongolia
Uzbekistan
Kyrgyzstan
Turkmenistan
China
South Korea
Sea of Japan
East China Sea
Syria
Iraq
Iran
Afghanistan
Pakistan
Nepal
India
Morocco
Algeria
Tunisia
Libya
Egypt
Western Sahara
Saudi Arabia
Oman
Yemen
Mauritania
Mali
Niger
Chad
Sudan
Burkina Faso
Guinea
Ghana
Nigeria
South Sudan
Ethiopia
Somalia
Kenya
Gabon
DR Congo
Tanzania
Angola
Zambia
Mozambique
Namibia
Zimbabwe
Botswana
Madagascar
South Africa
Gulf of Guinea
Gulf of Aden
Arabian Sea
Bay of Bengal
Laccadive Sea
Myanmar (Burma)
Thailand
Vietnam
South China Sea
Philippines
Gulf of Thailand
Malaysia
Indonesia
Banda Sea
Arafura Sea
Australia
Great Australian Bight
Guatemala
Nicaragua
Venezuela
Guyana
Suriname
Colombia
Ecuador
Peru
Brazil
Bolivia
Paraguay
Chile
Argentina
Uruguay

Event details:

- New state
- Same country
- Same device

● Not suspicious

● Suspicious

✸ Very suspicious

Canada
Hudson Bay
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Portugal
Greece
Turkey
Kazakhstan
Mongolia
Uzbekistan
Kyrgyzstan
Turkmenistan
Sea of Japan
South Korea
China
Japan
Syria
Iraq
Iran
Afghanistan
Pakistan
Tunisia
Morocco
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Libya
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Western Sahara
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Event details:

- New country
- IP from data center
- New device
- Unusual event timing

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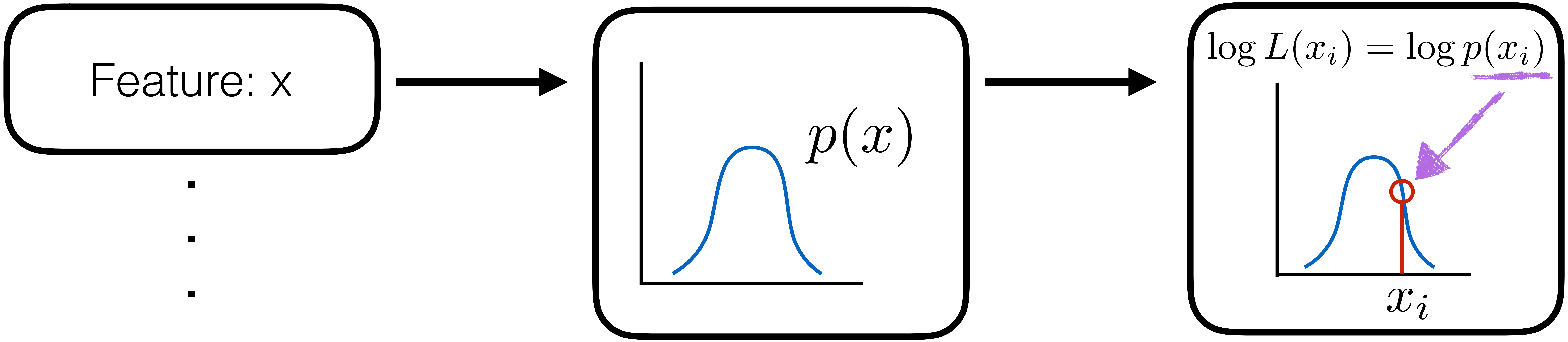
Unsupervised anomaly detection

All features | **Calculate feature distribution** | **Likelihood of observed feature value**



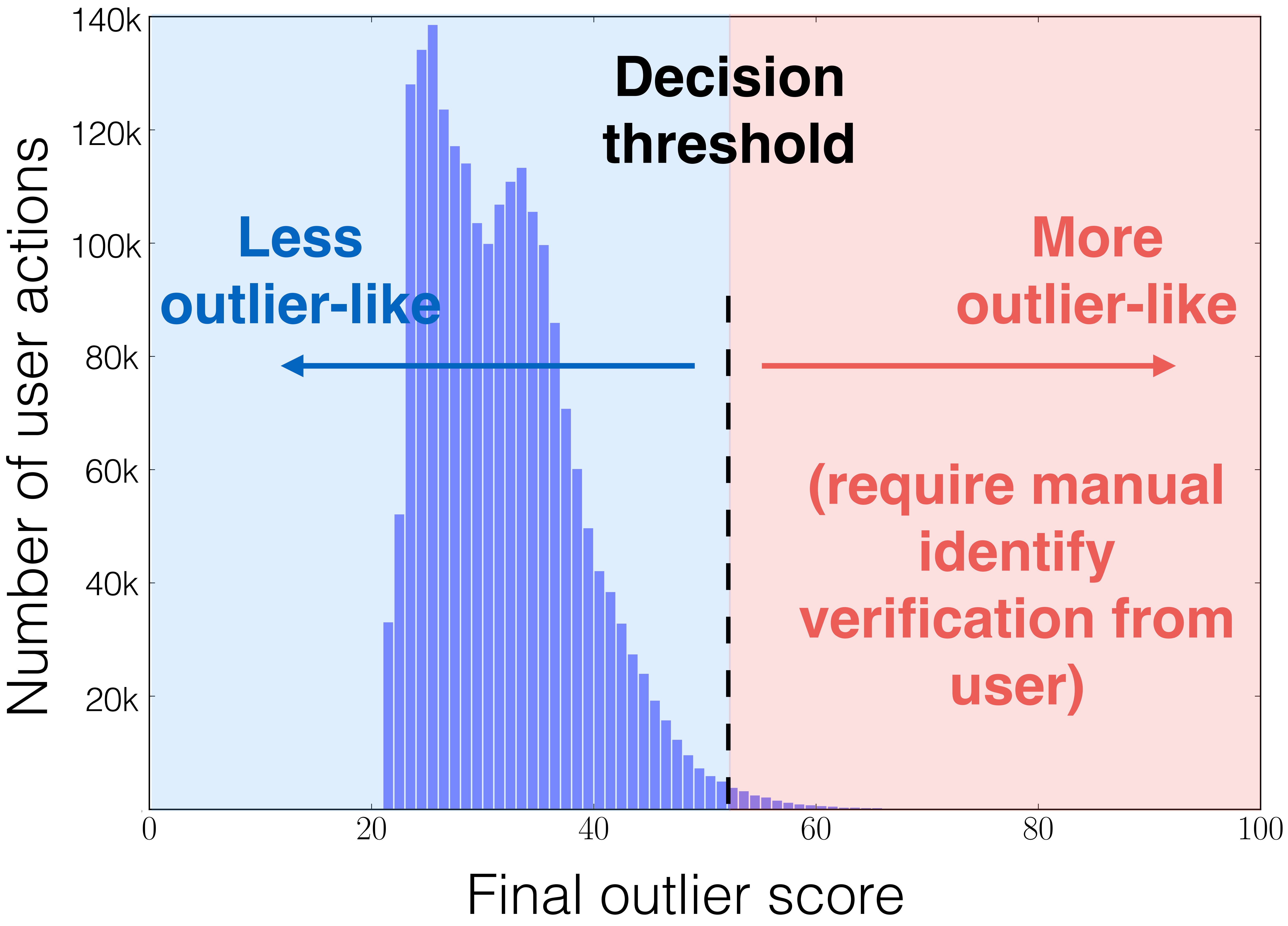
For event i, combine log-likelihood over all features:

$$\log L_i = \log L(x_i) + \log L(y_i) + \ldots$$

Single final score for outlier detection

Tune decision threshold

- Can **validate** using list of known compromised accounts
- Area under ROC curve = **0.95**
- For this choice of threshold: **79% recall** with **5% false positive rate**



Product delivers measurable improvement

- **Improved** the recall of compromised accounts by >2x compared to the baseline model with the same false positive rate
- **Fast** to train and use
- **Interpretable** feature importance
- **Extendable** to include new features
- **More details** available at jverbus.github.io

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