Deep Learning for Ancillary Pricing

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"Deep Learning is here.
Own what happens next."

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01	Research Objectives
02	Ancillary Pricing Use Case
03	Key Learnings and Next Steps
04	Our broader vision

FROM AVERAGE TO INDIVIDUAL DECISIONS

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Research Objective
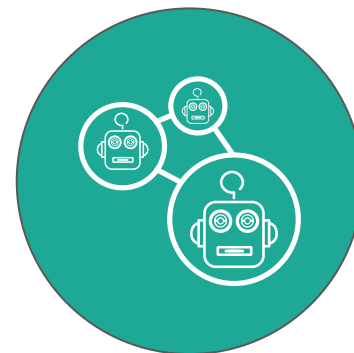
Can deep learning make better predictions at an Individual level

Can those predictions be converted to better Individual decisions

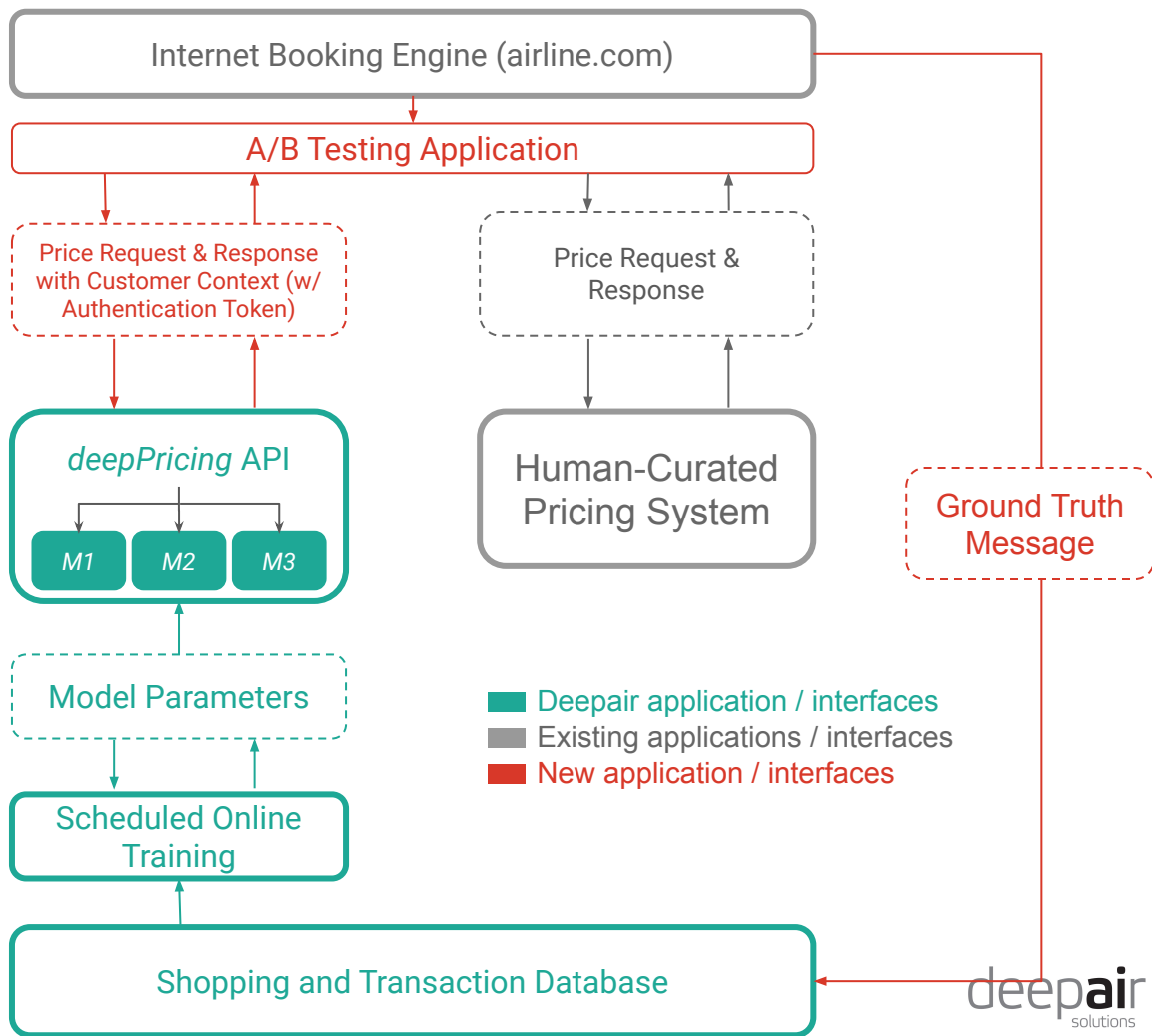What happens when many AI agents make decisions in the same environment

Ancillary Pricing

Ancillaries complement RM and are perfect to measure the revenue opportunity of moving from "Average to Individual"
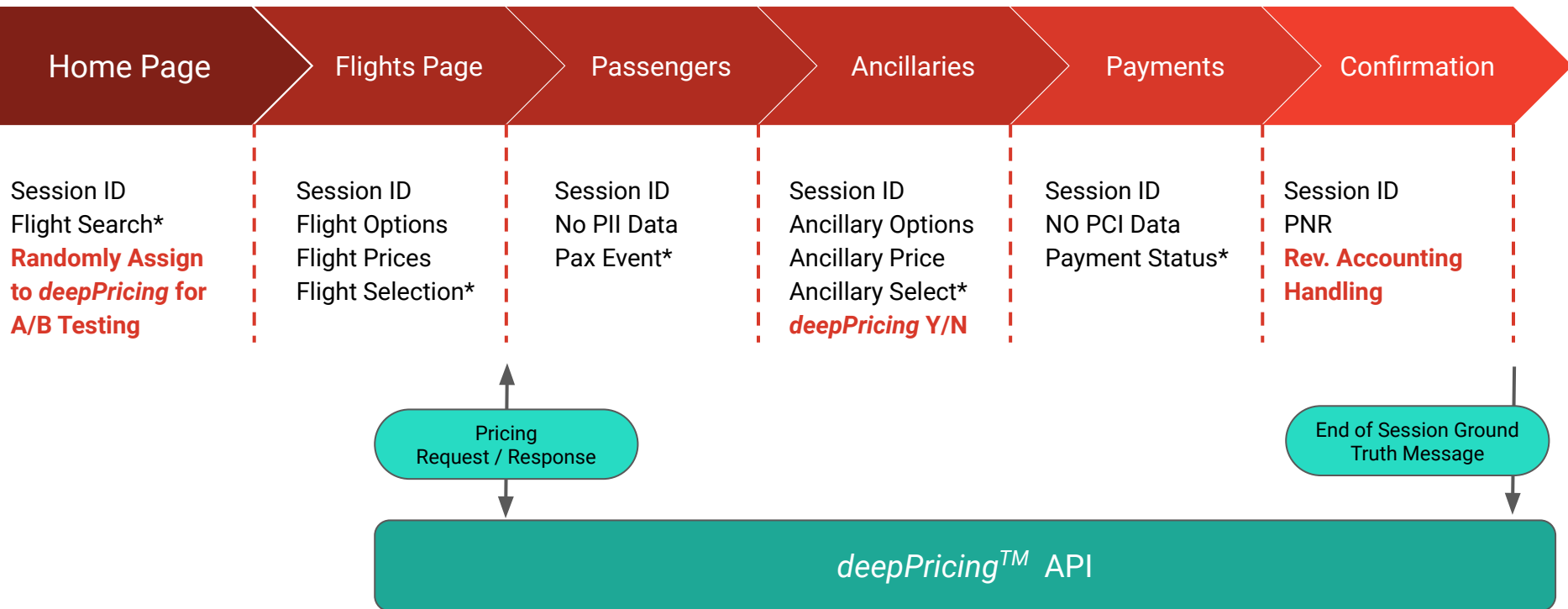
- ✅ Complementary to Right-to-fly

- ✅ Not Optimized at Most Airlines

- ✅ Deeply Personal and Attribute Driven Sale

- ✅ Ancillaries Compete for Wallet Share and Shelf-Space

- ✅ Influenced by Price and Placement (start with price)

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High Level Set-up

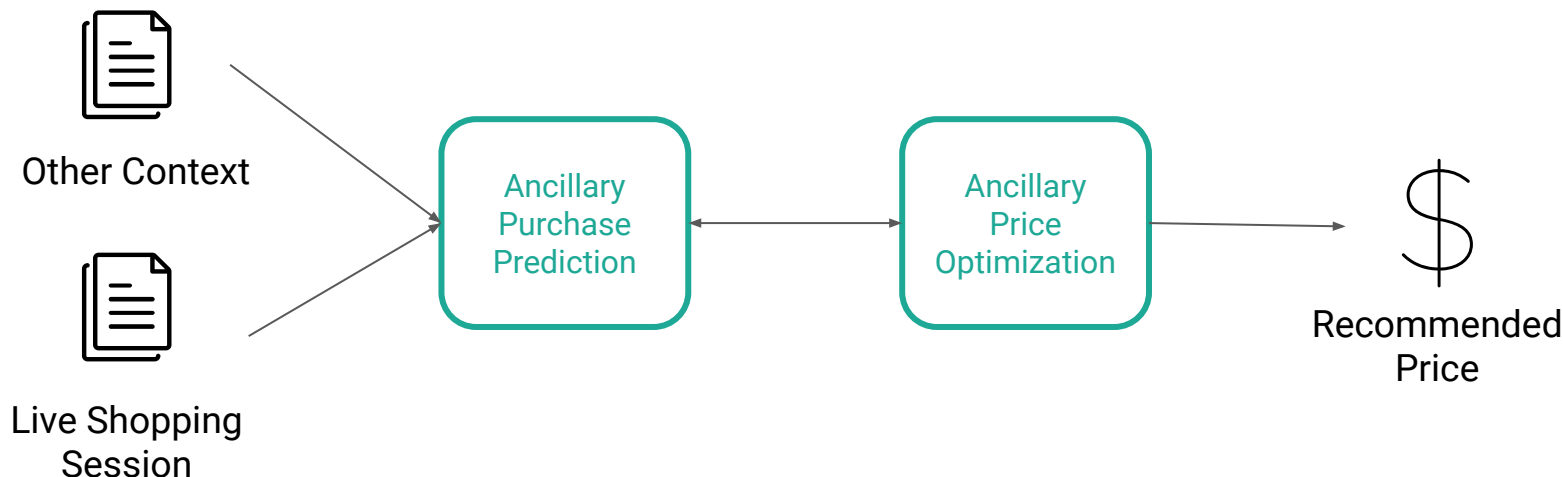Built an ML experimentation platform from the ground up

Internet Booking Engine (airline.com)

A/B Testing Application

Price Request & Response with Customer Context (w/ Authentication Token)

Price Request & Response

deepPricing API

M1 M2 M3

Human-Curated Pricing System

Ground Truth Message

Model Parameters

Scheduled Online Training

Shopping and Transaction Database

■ Deepair application / interfaces
■ Existing applications / interfaces
■ New application / interfaces

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Functional View on airline.com

Home Page	Flights Page	Passengers	Ancillaries	Payments	Confirmation

Home Page
Session ID
Flight Search*
Randomly Assign to *deepPricing* for A/B Testing

Flights Page
Session ID
Flight Options
Flight Prices
Flight Selection*

Passengers
Session ID
No PII Data
Pax Event*

Ancillaries
Session ID
Ancillary Options
Ancillary Price
Ancillary Select*
***deepPricing* Y/N**

Payments
Session ID
NO PCI Data
Payment Status*

Confirmation
Session ID
PNR
Rev. Accounting Handling

Pricing
Request / Response

End of Session Ground Truth Message

deepPricing^TM API

* represents the event that triggers transition
to next step in the booking process

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A Two-Stage Dynamic Pricing Model

Ancillary Purchase Prediction
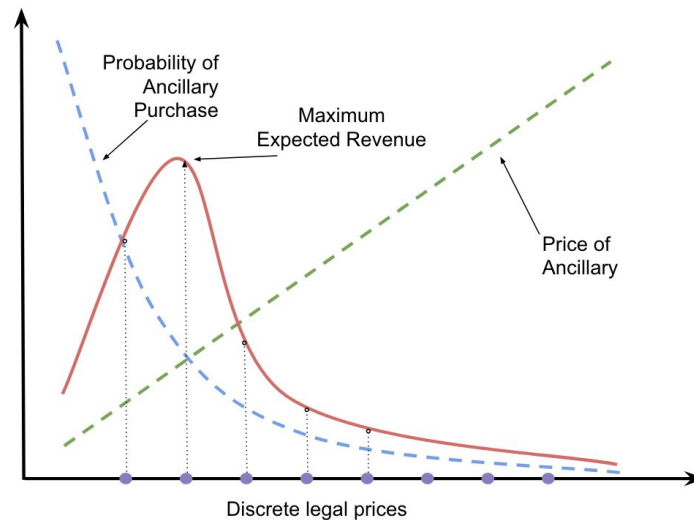
Deep Neural Network
beats traditional models

ROC Curve

Random [AUC: 0.5]
GNBC-4M [AUC : 0.571571]
GNB-4M [AUC : 0.627315]
RF-3M [AUC : 0.677135]
DNN-4M [AUC : 0.723941]
MLP-4MN [AUC : 0.741181]
DNN_4M_FL [AUC : 0.766459]

True Positive Rate

False Positive Rate

relevant elements

false negatives | true negatives

true positives | false positives

selected elements
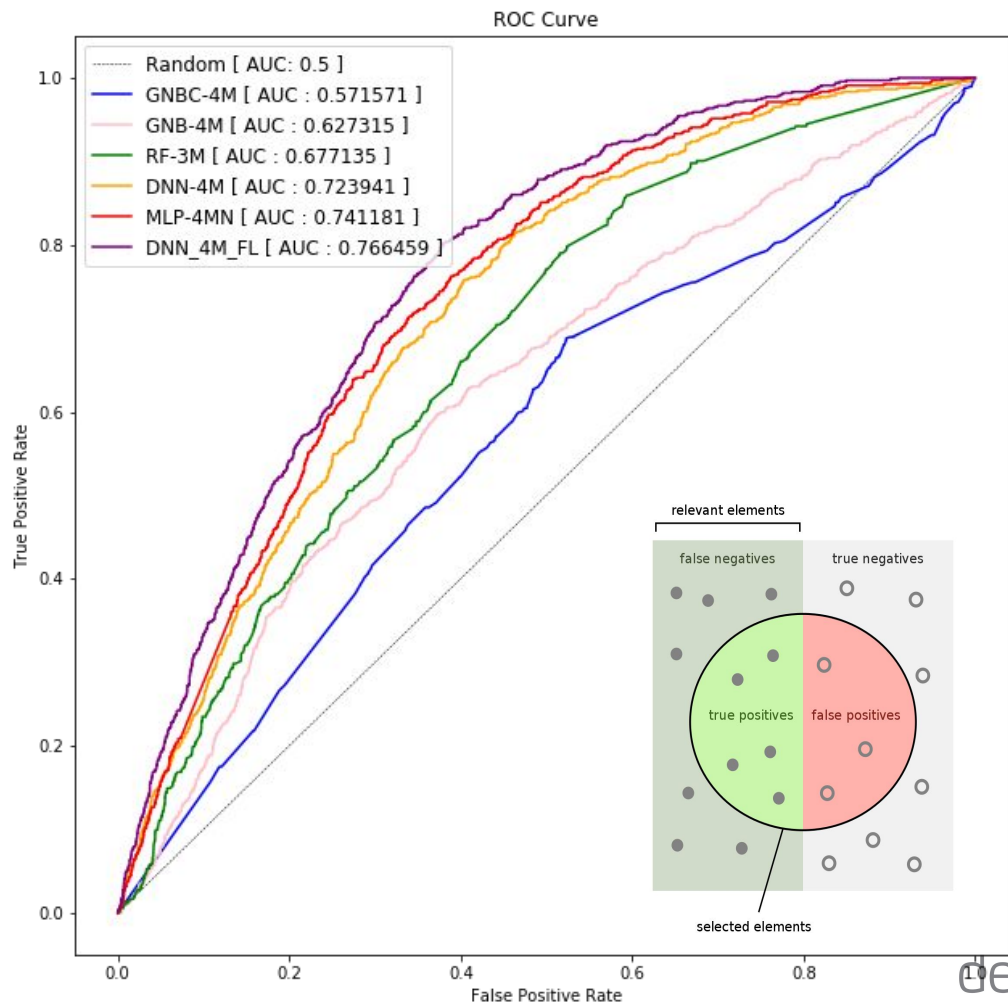
Ancillary Price Optimization

Logistic Pricing

Aggressive pricing

Conservative pricing

Price of Ancillary

Prior Probability of purchase
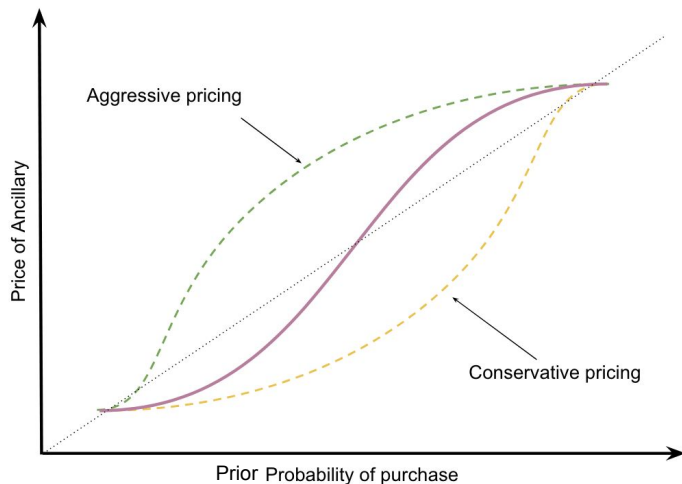
Discrete Exhaustive Search

Probability of Ancillary Purchase

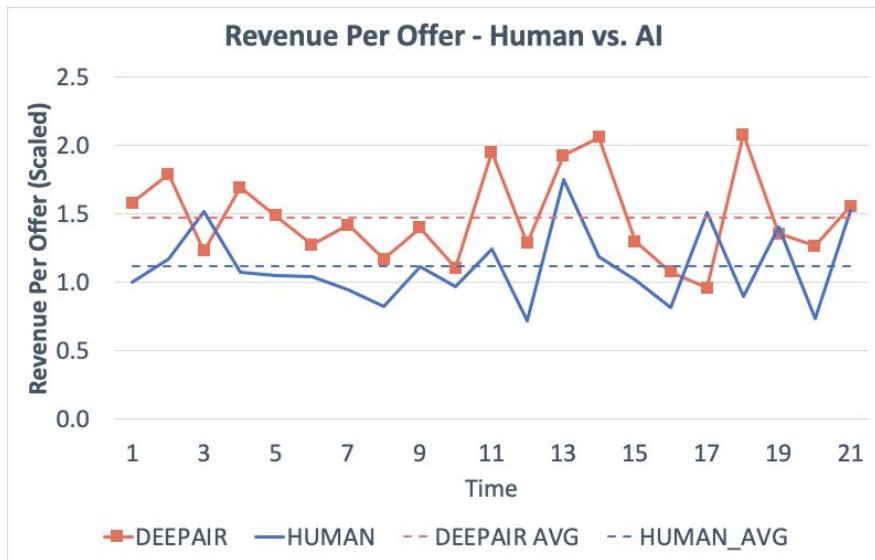Maximum Expected Revenue

Price of Ancillary

Discrete legal prices

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Human vs. AI Performance

Summary: AI driven pricing resulted in 25% incremental Revenue Per Offer (p-value 0.000297) and 17% higher Conversion compared to Human, just with a discounting strategy.

Revenue Per Offer - Human vs. AI

Conversion Rate - Human vs. AI
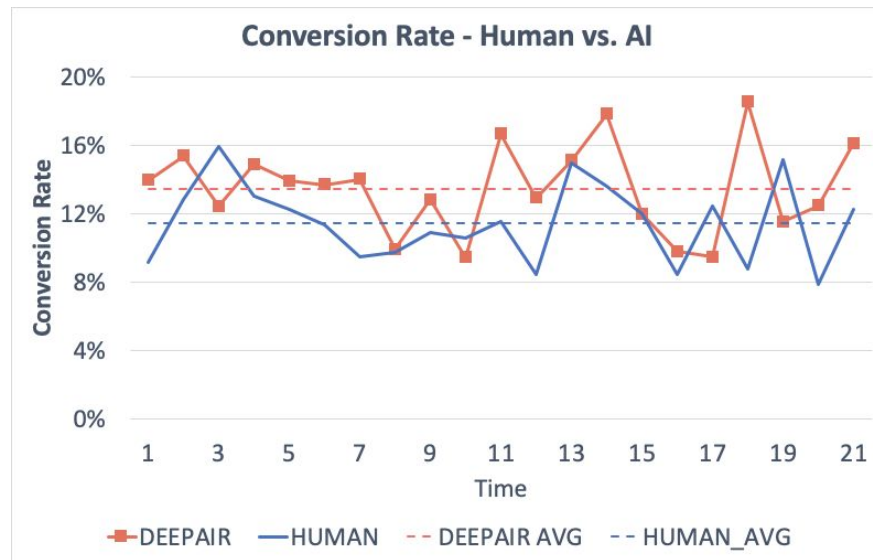
Algorithm Level Performance

Summary: Although deep learning is 35% more accurate in predicting the probability of purchase compared to Traditional ML, this isn't resulting in proportionally better online performance.
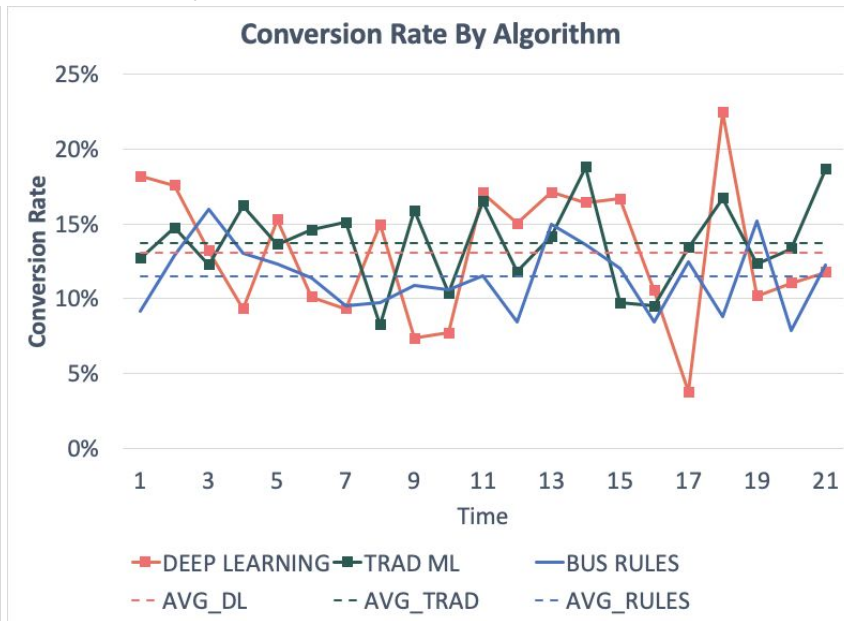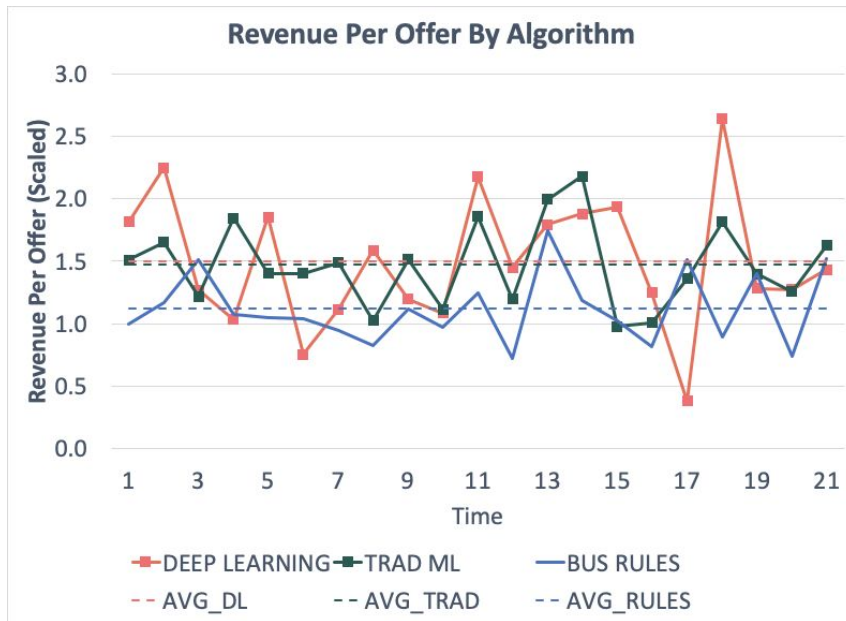
Traditional vs. Rules (p-value): 0.000376; Deep Learning vs. Rules (p-value): 0.00360

Price Sensitivity

Neural Network did not learn the monotonic relationship between price and probability
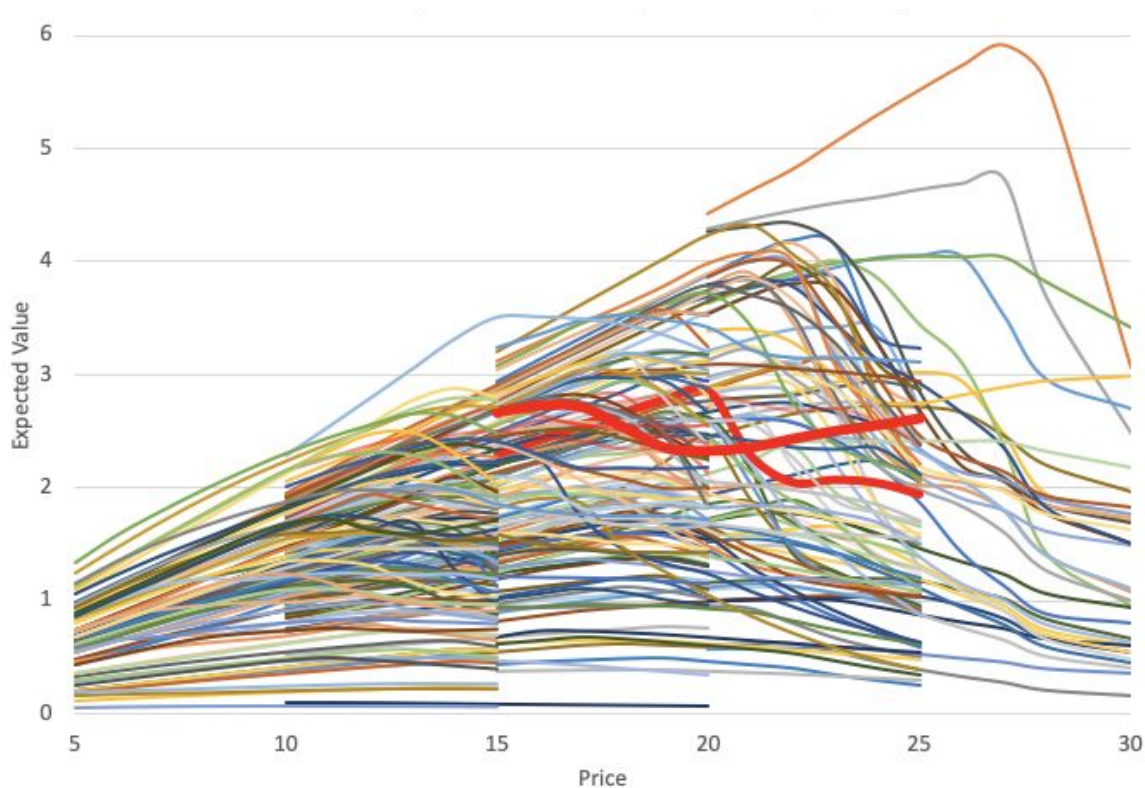
Next Steps

AI Driven Pricing show
revenue potential

- ✓ Explicitly "Teach" the Neural Network Price-Demand Relationship

- ✓ Single Stage Optimization To Reduce Error

- ✓ Meta Learning AI that explores and exploits various AI algorithms

- ✓ More ancillaries and more touch points to research multi-agent environments

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The Big Picture

———————•

Delighting travelers at scale by moving from average to individual
Decisions

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"In an Experience Economy, businesses will find that the next competitive battleground lies in staging experiences."
- HBR

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Revenue Optimization Redefined

Imagine 100s of services and revenue sources to choose from, to curate a truly individualized experience

Traveller Experience

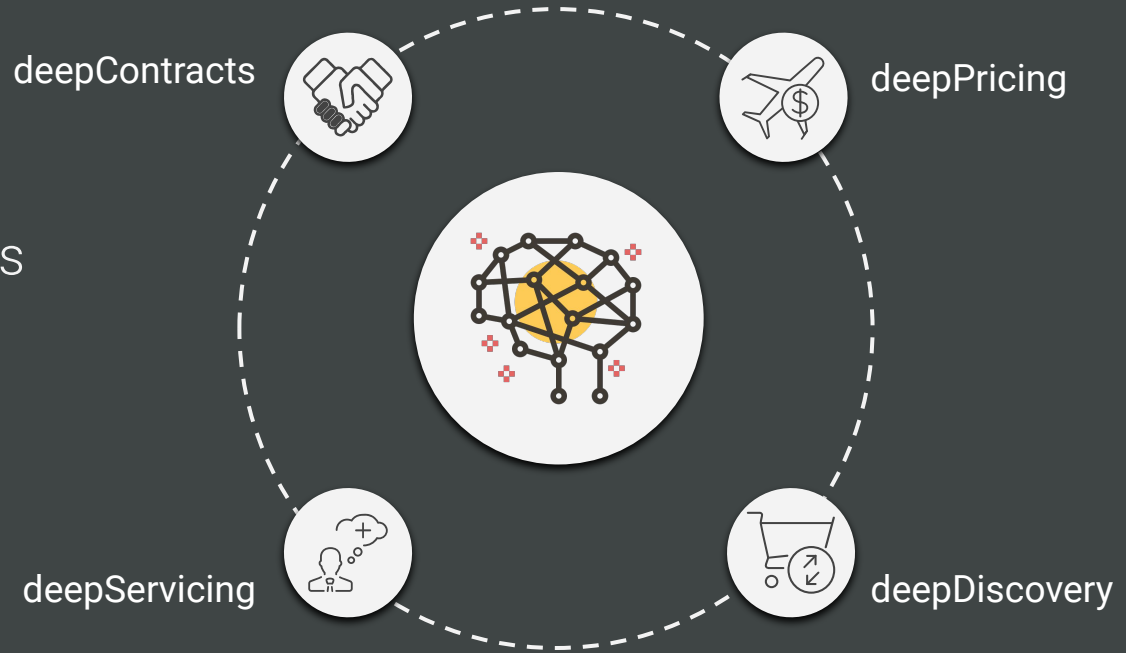## AI Driven Retailing

Pricing

Content Discovery

Contracts

Service

CIRRAVIA   Settlement and Distribution Platform

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Four Deep Learning Agents
Working in Harmony

deepContracts

deepPricing

deepServicing

deepDiscovery

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Join us at KDD 2019
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