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Scaling geo-temporal ML: How Pokémon GO optimizes global gameplay

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I'm the Director of Machine Learning at Niantic, where I lead efforts to explore machine learning opportunities and integrate AI technologies into location-based mobile gaming. As a full-stack AI leader, I bring deep expertise across the entire ML lifecycle—from research and modeling to deployment and MLOps—to create innovative, scalable solutions that enhance player experiences.

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Niantic – Our Story

Who We Are

We are a San Francisco-based software company recognized for developing augmented reality mobile games.

What We Do

We build real world, AR games and apps that encourage people to explore the world, including top hits like Pokémon GO.

Real-World Social

Our products are centered on encouraging people to explore the world outside, which fosters a sense of community and togetherness.

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Niantic – Play with Purpose

Enhancing Public Space

Healthy communities need public spaces that are accessible to everyone. We're working with our global partners to create, rehabilitate, and protect the public spaces around us, for all of us.

Empowering People

Both through our technology and the initiatives we support, we hope to encourage the explorer and changemaker in all of us.

Creating Community

In partnership with city governments, foundations, and nonprofits, we're seeking to build stronger, more equitable communities.

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Pokémon GO

Pokémon GO is a mobile game developed by Niantic, released in July 2016 for iOS and Android.

It's an augmented reality game that uses your phone's GPS and camera to let you find, catch and interact with Pokémon in the real world.

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A Unique Challenge

Real-world Location Based Gameplay at
Global Scale

- ○ Convenient and Immersive Experience
- ○ Real-world Social
- ○ Safety

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Optimize Real-world Gaming Experience

Showcase

A Better **Raid** Experience Powered by **Geo-temporal Machine Learning**

What are Raid Battles

Raid Battles occur when a Boss Pokémon takes over a Gym. The goal is to defeat this powerful Pokémon. You can't do it alone; you'll need help from fellow Trainers to raid the Gym and prevail.

Raid Battles aren't the typical Gym Battle; your opponent is more difficult to defeat than most other Pokémon.

Raids have several tiers of difficulty. The higher the difficulty, the stronger the Raid Boss and the more players you'll need in order to succeed. There are also several different types of specialty raids.

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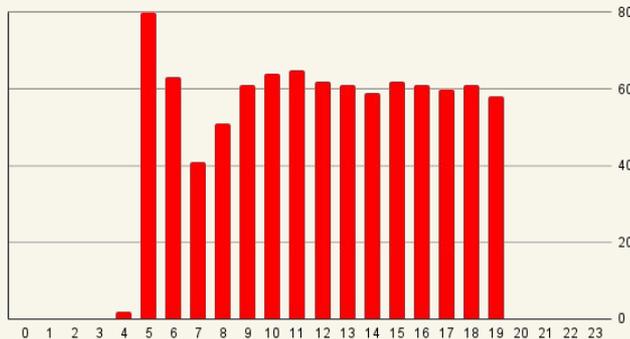# What are Raid Battles

- ○ PvE

- ○ Location-based Appearance

- ○ Group / Social Gameplay

- ○ Multiple Difficulty Levels

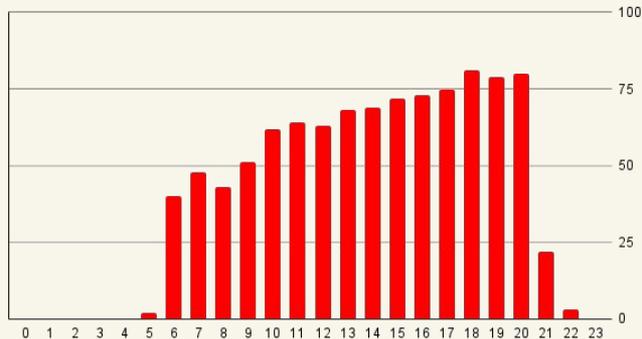- ○ Available Most of The Time

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Player Experience Explained

Raids don't appear at times when players are most engaged

When Do Raids Appear?

When Do Players Join Raids?

Player Experience Explained

Raids don't appear at difficulty levels proportionate to the engagement in the area

User 1 - Raid Tiers Too High

Who I am: I am level 20-35 and live in a suburban area, where there's only one gym within walking distance of my house.
Problem: I only get the opportunity to see 1 or 2 raids per day, but since there are very few PGO players in the area if it's anything other than a 1* or 3* regular pokemon, I don't have a shot at defeating it and catching it.

User 2 - Raid Tiers Too Low

Who I am: I am level 35-45 and work in an urban environment where I can access 1-2 gyms while I'm at work (roughly 9-5pm). There are a decent number of players in the area who can coordinate or ambiently work together to raid.
Problem: Whenever there are 1* pokemon (regular or shadow), I'm not interested in wasting a raid pass since I can catch those pokemon anyways.

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Why Machine Learning Helps

Attribute	Heuristic	Machine Learning
Core Logic	Static, hard-coded rules	Dynamic, data-driven algorithms
Scalability & Maintenance	Manual tuning, hard to maintain at scale	Automated and self-optimizing
Local Context	One-size-fits-all approach	Adapts to hyper-local conditions
Adaptability	Struggles with complex interactions	Continuously improves with new data
Ability to Learn	Cannot learn or improve	Learns autonomously

A Complex Machine Learning Problem

Multidimensional

Raid Optimization is an optimization problem across dimensions of location, time, and difficulty.

"Feels Natural"

Optimized raid appearance should still feel diverse enough and less predictable to players around the world.

Coordination

The AI solution is not the only party manages the raid feature, it needs to closely "coordinate" with the Live Game Operation teams who proactively manage the feature on a daily basis.

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Multidimensional - Data

- **Feature Engineering on Geo-temporal Data**
  Geo-based Feature Aggregation
  Event Features and Seasonality

- **Geo-based Experimentation Framework**
  Spillover Effect
  Clustering and Matching

Multidimensional - Modeling

- ○ **Combine Predictive Modelling and Geo-based Scheduling**

- ○ **Predictive Modelling**
  Gym (location) Centered with Unique Grain
  Granularity Adjustment

- ○ **Geo-based Scheduling**
  "Local" Optimization
  Extensible Scheduler Implementation

"Feels Natural" - Diversity

- ○ **Data Driven – Diversity Metrics**
  Define the Problem Before Everything Else

- ○ **Data Visualization for Better Visibility**
  Tooling Matters

- ○ **Efficiency Trade-off**

"Feels Natural" - Scheduling

- ○ **Mix-and-match of Different Scheduling Algorithms at Local Level**

- ○ **Tune the Level of Randomness**

- ○ **Various Scheduler Plugins**
  Configurable "Noise"
  Pair-swap and Shuffle

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"Feels Natural" - Experimentation

- ○ **Listen to the Players**

- ○ **Try it Out and Trust the Data**

- ○ **Continuous Improvement**

Coordination - Engineering

- Modeling the Problem

- Simplify and Streamline the Operation

- Testing and Simulation

- Pay Attention to the Nuance

Coordination - People

- ○ **Cross-functional Communication**
  Speak the Same Language
  "Putting yourself in other people's shoes"

- ○ **Demythify AI**
  It shouldn't be Just A "Black Box"

- ○ **Planning is the Key**
  Streamline the Process

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Priority

Questions to Ourselves

What comes as priorities when applying AI to gaming experience?

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Player First

- ○ **Meaningful Engagement**

- ○ **Sustainable Gameplay**

- ○ **Listen to The Players**
  Feedback-driven Development
  Agile Response

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Responsible AI

- ○ **Player Safety**

- ○ **Data Privacy and Security**

- ○ **Accessibility and Fairness**

- ○ **Consistency and Reliability**

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The Real World Matters