An Analysis of

Players’ Game Hours

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Game Operators’ Wishes

- MMORPG revenue depending on the number of active subscribers
  - Monthly subscription fees
  - Selling virtual items (through item mall)

- From game operators’ perspective, they are interested to know (predict):
  - How many players will join a game?
  - How long they will stay in the game?
User Population Prediction

- Predicting how many gamers will join?
  - HARD; Too many non-technical issues
    - Release date (whether during long vacation?)
    - Artistic design (comic-like or realistic?)
    - Cultural factors (Western- or Eastern-style?)

- Predicting how long players will continue to stay
  - Should be correlated with the extent of users’ involvement
    - How long they spend in the game each day?
    - How quickly their avatars advance to new levels?
  - That’s what we pursue in this study
User Subscription Time

- User subscription time
  - The length of time since a player joined a game to the time of her last login

- Unsubscription time (= last login time)
  - Can we predict this time point?
Applications of Unsubscription Prediction

- **Game improvement**
  - Players’ unsubscription ➔ low satisfaction
  - Surveys can be conducted to determine the causes of player dissatisfaction and improve the game accordingly
  - More likely to receive useful comments before players quit

- **Prevent VIP players’ quitting (maintain revenue)**
  - For “item mall” model, users’ contribution (of revenue) is heavy-tailed
  - Losing VIP players may significantly harm the revenue

- **Network/system planning and diagnosis**
  - By predicting “which” players tend to leave the game ➔ investigating is there any problem regarding network resource planning, network congestion, or server arrangement
Unsubscription Prediction: Our Proposal

- Rationale: players’ satisfaction / enthusiasm / addiction to a game is embedded in her game play history

![Diagram showing subscription time and login history leading to decision to stay or quit in 30 days.]

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What We Have Done

- Collect players’ game session traces
  
  34,524 WoW players for 2 years

- Analyze the characteristics of the game play time

- Perform predictability study
  
  Short-term prediction is feasible; however, long-term prediction is much more difficult
Talk Progress

- Overview
- Game trace collection
  - How long do gamers play?
  - When do gamers play?
- Predictability analysis
- Future work
World of Warcraft

- The most popular MMOG for now
Data Collection Methodology

- Create a game character
- Use the command ‘\who’
- The command asks the game server to reply with a list of players who are currently online

- Write a specialized data-collection program (using C#, VBScript, and Lua)
The Limitation of WoW API

- WoW returns at most 50 users in one query
- We narrow down our query ranges by dividing all the users into different races, professions, and levels

- Level: 50+
  - 100 users

- Level: 40~49
  - 60 users

- Level: 30~39
  - 45 users

- Monster
  - 45 users

- Human
  - 15 users
## Trace Summary

<table>
<thead>
<tr>
<th>WoW trace</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Start date</td>
<td>2005-12-22</td>
</tr>
<tr>
<td>End date</td>
<td>2007-10-17</td>
</tr>
<tr>
<td>Length</td>
<td>664 days</td>
</tr>
<tr>
<td>Total sessions</td>
<td>1,672,820</td>
</tr>
<tr>
<td>Accounts observed</td>
<td>34,521</td>
</tr>
</tbody>
</table>
Talk Progress

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How Long Do Gamers Play?

- Unsubscription definition: Assume if player has “quitted” a game if she has not shown up for 3 months.
- Analysis in three different time scales:
  - Subscription time
  - Consecutive gameplay days
  - Daily gameplay activity
Subscription Time

60% of users play longer than a year after their first visits
Consecutive Game Play Days

- Consecutive game play days ➔ an indicator of addiction
- An **ON period** as a group of consecutive days during which a player joins the game everyday
- An **OFF period** as the interval between two ON periods.
Cumulative Distribution of ON/OFF Periods

80% of ON and OFF periods are shorter than 5 days

OFF periods are slightly longer than ON periods

Extremely long ON and OFF periods exist

Players tend to alternate between ON and OFF periods within 5 days
Some extremely long OFF periods exist
- 3% OFF periods longer than 1 month
- 1% OFF periods longer than 3 months

Even after a long OFF period, gamers may come back and play game as seriously as before
- What’s the difference between a 3-month OFF period and an “true” unsubscription?

Definitions
- **Vacation**: An OFF period longer than 30 days
- **Season**: An active period between two vacations
Distributions of Seasons and Vacations

Even after a long vacation (> half a year), 20% of gamers still come back.

- 20% of vacations are longer than 180 days.
- 50% of seasons are longer than 60 days.
Daily Activities

- Daily playtime
- Daily session count
- Session playtime
Daily Playtime and Session Time

- 25% gamers play longer than 5 hours per day.
- 75% gamers play longer than 2 hours per day.
- Significant knees around 1 and 5 hours.
Daily Session Count

More than 80% gamers login less than 2 times per day

The daily playtime is mainly contributed by one or two long sessions rather than a number of short sessions
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When Do Gamers Play?

- Average daily playtime on each day of a week
- Average number of gamers in each hour of a day

- Our Conjectures
  - Much longer playtime on weekends
  - Much more gamers at night
Avg. Daily Playtime in a Week

The difference between weekends and weekdays is not large
Average Number of Gamers at Different Time

Peak hours are from 9pm to 1am
Cold hours are from 4am to 10am
Keep increasing quickly even in office hours
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Predictability

- Can we predict players’ future gameplay time based on their game play history?

- Two aspects
  - Predicting long-term behavior based on daily activities
  - Temporal dependence in multiple time scales
Correlations between Daily and Long-Term Factors

- Daily activities
  - Session time
  - Daily session count
  - Daily playtime

- Long-term behavior
  - ON period length
  - Season length
  - Subscription length

Strong correlation exists?
Correlation between Daily and Long-term Factors

(a) Session time (hr)  
(b) Daily session count  
(c) Daily playtime (hr)  
(d) Session time (hr)  
(e) Daily session count  
(f) Daily playtime (hr)  
(g) Session time (hr)  
(h) Daily session count  
(i) Daily playtime (hr)
ON period length vs. Daily playtime

![Graph showing the relationship between ON period length and daily playtime with a correlation coefficient of 0.54.](image)
Correlation between Daily and Long-term Factors

No significant correlations for season length and subscription period
Autocorrelations of Players’ Game Hours

- This session’s length vs. next session’s
- Today’s playtime vs. tomorrow’s
- This week’s playtime vs. next week’s
- This ON period’s playtime vs. next ON period’s
- This ON period’s length vs. next ON period’s
- This season’s length vs next season’s
Players’ Game Hours in Consecutive Periods

- Correlation between Next session time (hr) and Session time (hr): \( r = 0.59 \)
- Correlation between Next daily playtime (hr) and Daily playtime (hr): \( r = 0.50 \)
- Correlation between Next weekly playtime (hr) and Weekly playtime (hr): \( r = 0.80 \)
- Correlation between Next ON period playtime (hr) and ON period playtime (hr): \( r = 0.57 \)
- Correlation between Next ON period length (day) and ON period length (day): \( r = 0.38 \)
- Correlation between Next season length (day) and Season length (day): \( r = 0.02 \)

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Players’ Game Hours in Consecutive Periods

Weekly patterns are the most regular for most players

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### Game Play Time Predictability: Summary

<table>
<thead>
<tr>
<th></th>
<th>Daily playtime</th>
<th>Session time</th>
<th>Session count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subscription time</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>Season length</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>ON period length</td>
<td>★★★</td>
<td>★</td>
<td>★</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Session</th>
<th>Day</th>
<th>Week</th>
<th>ON period</th>
<th>Season</th>
</tr>
</thead>
<tbody>
<tr>
<td>Playtime Length</td>
<td>★★★</td>
<td>★★</td>
<td>★★★★</td>
<td>★★★</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>★</td>
<td>×</td>
</tr>
</tbody>
</table>

★★★★: strong correlation \( (\text{cor} \geq 0.8) \)
★★★: medium correlation \( (0.8 > \text{cor} \geq 0.5) \)
★★: weak correlation \( (0.5 > \text{cor} \geq 0.3) \)
★: no correlation \( (0.3 > \text{cor}) \)
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Our results indicate that although short-term prediction is feasible, long-term prediction will be more difficult.

We are developing a model that can predict whether a player will leave a game.
Logisitic Regression Model for Unsubscription Prediction

- Significant features (out of > 20 features)
  - Avg. session time
  - Daily session count
  - Variation of the login hour (when the player starts playing a game each day)
  - Variation of daily play time (number of hours)
- A naive logistic regression model achieves approximately 75% prediction accuracy (whether a player quits in one month)
Thank You!

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