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.
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
## 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>
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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

Players tend to alternate between ON and OFF periods within 5 days.

- 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.
Season and Vacation

- 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

CDF

(a) Playtime (hr)
Daily Session Count

The daily playtime is mainly contributed by one or two long sessions rather than a number of short sessions.

More than 80% gamers login less than 2 times per day.
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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)  
ON period length (day)  
cor = 0.47

(b) Daily session count  
ON period length (day)  
cor = 0.46

(c) Daily playtime (hr)  
ON period length (day)  
cor = 0.54

(d) Session time (hr)  
Season length (day)  
cor = -0.11

(e) Daily session count  
Season length (day)  
cor = -0.14

(f) Daily playtime (hr)  
Season length (day)  
cor = 0.13

(g) Session time (hr)  
Subscription time (day)  
cor = -0.17

(h) Daily session count  
Subscription time (day)  
cor = -0.18

(i) Daily playtime (hr)  
Subscription time (day)  
cor = -0.18
ON period length vs. Daily playtime

cor = 0.54
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

(a) Session time (hr)  
Next session time (hr)  
Cor = 0.59

(b) ON period playtime (hr)  
Next ON period playtime (hr)  
Cor = 0.57

(c) Weekly playtime (hr)  
Next weekly playtime (hr)  
Cor = 0.80

(d) Daily playtime (hr)  
Next daily playtime (hr)  
Cor = 0.59

(e) ON period length (day)  
Next ON period length (day)  
Cor = 0.38

(f) Season length (day)  
Next season length (day)  
Cor = 0.02
Players’ Game Hours in Consecutive Periods

Weekly patterns are the most regular for most players
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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Work in Progress

- 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.
Logistic 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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