Pokémon Trading Card Sequences

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Abstract

In this note, Pokémon trading cards are considered. Evidence is given that certain sequences of these cards are drawn from a larger sequence. We present this sequence and mention several related problems.

1 Introduction

Pokémon are mythical bug-like creatures invented by Satoshi Tajiri [1, 2, 3]. They were originally known as "Poketto Monstaa," Japanese for "Pocket Monster," which was eventually shortened to Pokémon.

Pokémon first appeared in 1996 as characters in a Game Boy game that was available only in Japan. This was followed by Japanese cartoon, or anime, series [1]. The game and television series became world-wide successes.

In 1999 a Pokémon trading card game was introduced, which also became an enormous success. The game is sometimes described as a sophisticated form of rock, paper, scissors. Each Pokémon trainer (i.e., player) has a set of Pokémon cards that are used to battle an opposing trainer's cards. Booster packs of cards are available so that a trainer can create different decks of Pokémon cards with differing characteristics.

The cards themselves became a fad, even for people who had no interest in the game itself. There are several different series of cards, such as "base one," "base two," "fossil," "jungle," etc. Each series had a limited first edition printing, followed by an unlimited printing. Some individual first edition cards were worth hundreds of dollars which, predictably, lead to a significant counterfeit industry [4]. While some first edition cards continue to command substantial prices, the market for cards from unlimited printings has recently collapsed. Booster packs currently sell for as little as 10

The authors had often noticed patterns in the sequences of cards within booster packs. Taking advantage of the recent drop in card prices, we decided to attempt a systematic analysis of the cards that appear in these packs.

[1] See "The Seizure Incident" link from [3] for a bizarre story concerning the original Pokémon anime series.

2 Booster packs

We analyzed 11-card booster packs from the "base one" series, unlimited edition. In this series there are 102 distinct cards, consisting of 32 common cards, 6 common energy cards, 32 uncommon cards, 16 rare cards and 16 rare holofoil cards. The 32 common cards are numbers 43 through 69 (Pokémon cards) and 91 through 95 (trainer cards), the common energy cards are numbers 97 through 102, the uncommon cards are 23 through 42 (Pokémon) and 80 through 90 (trainer) and 96 (uncommon energy), the rare holofoil cards are 1 through 16, and the rare non-holofoil cards are 17 through 22 (Pokémon) and 70 through 79 (trainer).

We have examined 153 of the base one booster packs. Each 11-card pack contains five common cards, two (common) energy cards, three uncommon cards and one rare card. The holofoil cards are the rarest with, on average, one out of three packs containing a holofoil card. Due to their rarity, the holofoil cards are the most valuable. The booster packs are sold wholesale in 36-pack boxes. Each such box contains two stacks of 18 packs. The 153 booster packs that we have examined include three complete 36-pack boxes.

The 11 cards within a booster pack consist of five common cards, two (common) energy cards, one rare card, and three uncommon cards. The order with which these blocks occur varies slightly from box to box.

3 Common card sequence

Due to the larger amount of data available, we concentrated our effort on the nonenergy common cards. One particular pack contained the five common card sequence

$$46, 66, 64, 50, 45$$

while another contained

$$48, 69, 46, 66, 64.$$

Overlapping these we obtain the sequence of length seven

$$48, 69, 46, 66, 64, 50, 45.$$

Further investigation indicated that each card is followed by no more than four other cards. This lead us to adopt the working hypothesis of a sequence of length 128 in which each of the 32 common cards appears exactly four times. We also assumed that no single card could appear twice within a subsequence of length five insuring that no pack would contain two copies of the same common card. Such a sequence would make it easy to generate a "good" set of five common cards by simply generating a single pseudo-random number, taking the seven low-order bits as the starting point to draw five consecutive cards from the sequence of length 128. Among other nice features, this would make it easy to avoid repeating any common card within a pack.

Using all 153 packs in our sample, we were able to use overlapping subsequences of length two or greater to construct three sequences [2]. One of these sequences was of length 77, one of length 41 and the third of length 6. The first of these begins with card number 57 and ends with 63, while the second ends with 57 and the third begins with 63. Also, cards 57 and 63 each occur five times within the three sequences, while no other card number occurs more than four times. Consequently, we assume that these three sequences can be joined together yielding the sequence of length 122 that appears below

$$
\begin{array}{cccccccccccccccc}
93 & 68 & 51 & 46 & 62 & 95 & 64 & 44 & 53 & 57 & 59 & 91 & 56 & 46 & 45 & 52 \\
49 & 92 & 66 & 65 & 63 & 94 & 50 & 55 & 68 & 48 & 43 & 67 & 69 & 62 & 51 & 54 \\
58 & 47 & 61 & 60 & 64 & 65 & 67 & 68 & 57 & 44 & 62 & 59 & 69 & 52 & 66 & 58 \\
49 & 93 & 43 & 56 & 60 & 53 & 63 & 55 & 45 & 95 & 61 & 92 & 48 & 54 & 50 & 46 \\
47 & 51 & 64 & 59 & 68 & 62 & 57 & 91 & 67 & 51 & 60 & 52 & 65 & 54 & 55 & 95 \\
47 & 53 & 45 & 93 & 44 & 63 & 49 & 43 & 50 & 56 & 61 & 58 & 94 & 48 & 69 & 46 \\
66 & 64 & 50 & 45 & 58 & 59 & 92 & 43 & 52 & 57 & 55 & 49 & 94 & 44 & 56 & 65 \\
48 & 53 & 91 & 61 & 63 & 54 & 47 & 60 & 93 & 66 & & & & & &
\end{array}
\tag{1}
$$

Each card occurs four times in (1), except cards 67,69,91,92,94 and 95, each of which appears three times. It is possible that all of these occur at the beginning or end of (1). But that would be somewhat unusual compared to the recovered part of the sequence, due to the high concentration of trainer cards (91 through 95). Or perhaps some sort of garble has occurred at the beginning of (1) causing an extra card 93 to appear. Then it might be the case that trainer cards (91 through 95) occur only three times each, while the other cards all appear four times, giving a sequence of total length 123.

It could be the case that (1) is not allowed to "wrap," which would explain the apparent diffculty in determining the ends of the sequence using overlapping subsequences. But this would imply that the last four starting positions in the sequence would not be valid. And it would cause the cards at either end of the sequence to be less common than cards that are a distance five or greater from both ends, assuming that the random starting points are generated uniformly.

We noted a few other peculiarities. The common cards from two of the boxes (those from the more recent printing) were often consecutive. For example, if one booster pack held the common cards in positions n through $n+4$ of (1), then the next pack would often contain those cards in positions $n+5$ through $n+9$, though this pattern would eventually be broken.

The box containing cards from the older printing did not contain consecutive common card sequences, but these packs had another strange feature: they contain many repeated common card sequences. All of these repeats occur in adjacent packs, with one exception. This might indicate a flawed method of generating random numbers. Perhaps the manufacturer realized that they were producing a large number of repeats within a box and they attempted to remedy this by selecting cards (more or less) in sequence.

[2] We did find three anomalous cases (out of more than 750) in which a pair of common cards had apparently been transposed. Due to the small number of such cases, we conjecture that this is an artifact of the way that the cards are processed and packaged, instead of an intentional part of the sequence generating process.

4 Questions

The analysis in the previous section raises more questions than it answers. Among the unresolved questions are the following.

1. What is the common card sequence length? Is it 122, 123, or greater? Is there any pattern in the sequence that might allow us to precisely determine the sequence, or do we simply require more data?

2. How are the "random" starting positions generated?

3. Are the uncommon cards selected in a similar manner? We believe the answer is yes, but with the limited data currently available, the longest subsequence we have obtained is of length 37. And there appears to be a slightly higher rate of transpositions in the uncommon sequences as compared to the common cards.

4. How are the energy cards selected?

5. How are the rare and holofoil cards selected? Ideally, a person would like to be able to purchase only those booster packs that contain holofoil cards. Perhaps the position of a pack within a box provides some information on the likelihood of obtaining a holofoil.

6. Does a similar analysis hold for the "fossil" or "jungle" booster packs? There are only 62 different fossil cards and 64 different jungle cards, while there are 102 different base one cards. Consequently, the amount of data required to analyze the fossil and jungle cards might be considerably less than required for the base one cards.

5 Data

The complete set of data used in the analysis presented in this paper is available online at

`http://home.earthlink.net/~mstamp1/pokemon/pokemondata.html`

More data will be added as time and budget permits.

References

[1] `http://www.pokemoncardmanager.fsnet.co.uk/history.html`

[2] `http://www.characterproducts.com/info/character_histories/pokemon_doorway.htm`

[3] `http://members.tripod.com/animefan25/pkmnhistor.htm`

[4] `http://abcnews.go.com/sections/business/TheStreet/pokemon991203.html`