Factors of the Detective Story and the Extraction of Plot Patterns Based on Japanese Detective Comics

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Abstract
In recent years, there have been attempts to generate stories automatically by utilizing computers and various other kinds of information technology. However, it remains unclear how story sequences can be made to look natural and appear interesting. This study conducted a data description of 134 famous Japanese comic detective stories and listed 37 types of plot elements, 10 types of tricks, 9 types of criminal motives, and 10 types of relationships between victims and criminals, in order to realize a computational narratological analysis. Based on these parameters, eleven factors have been extracted through factor analysis. The structures of the plot transition networks varied according to the factors present in the detective stories. Therefore, an elaborate, human-like, and understandable creation of plot transitions can be enabled based on the detailed differences between plot transition networks.

Keywords: plot, narratology, story structure, detective story

Introduction
In the field of literary studies, research on narrative structures and story patterns is called narratology. Various investigations conducted in the field of narratology have been based on humanities methodologies. For instance, Propp (1968) insisted that the function of character roles in stories can be categorized based on several patterns in specific genres, namely thirty-one story functions and seven character roles in Russian folktales. Greimas (1966) hypothesized that the structures of general stories can be divided into and symbolized by particular elements; additionally, these elements can be classified into symbols. Likewise, Genette (1972) analyzed the stylistic and semantic differences between the sequences in story narration and their chronological order.

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Based on the preceding research, there have been attempts to generate stories automatically by utilizing computers and various other kinds of information technology. To create stories, it is necessary to evaluate the naturalness and creativity of the plot elements’ sequences. To facilitate this, traditional approach is to use cognitive science theory about goals and plans (Schank 1977) to generate the behaviors of each character (Meehan 1977). This type of story generation algorithm is developed based on inference of next action (e.g. assuming Markov chain). As a development of this type, the What-If Machine Project (WHIM) constructed a database of common consequences for numerous situations and produced stories by selecting logically connectable events (Granroth-Wilding, Mark, and Stephen Clark. 2013).

Another traditional approach is to use existing plot structures to create new plot sequences (e.g. Bringsjord and Ferrucci 2000). This type of system is often based on Propp’s thirty-one functions (e.g. Gervás 2014). In another case, the Kimagure AI Project made templates of general story structures to engender various easily understandable stories (Toyosawa et al. 2018). In recent years, the problem of selection from various possible plots has been examined (Amos-Binks 2016). However, there are only a few case studies with empirical data about plot sequences based on existing stories. In sum, it is not scientifically clear how story sequences can be designed to look natural and appear interesting.

In this study, the detective story genre was selected to analyze plot sequences quantitatively. Detective stories are highly patterned, include many short stories, and allow for the collection of many sample works. In addition to that, in the simple typical works of detective comics for beginners that were selected for study, complex discourse transformations such as flashbacks, or parallel narratives rarely appear. Simplicity of plots enables focused quantitative analysis from the viewpoint of fundamental plot structure. In conclusion, detective stories for beginners were deemed to be an appropriate choice for this study.

Some story genres included common elements: a typical plot sequence, a characteristic protagonist, a patterned antagonist, common backgrounds, and frequently used text styles. This study focuses on the most fundamental narratological elements: plot and character patterns. In detective stories, plot patterns include the types of tricks played by criminals, in addition to plot sequences. Moreover, relationships between characters—especially between criminals and victims, which provide the motives for crimes—are
Factors of the Detective Story and the Extraction of Plot Patterns Based on Japanese Detective Comics

critical in detective stories. Therefore, this study analyzes plot sequences, tricks, motives, and the relationships between criminals and victims. These elements were combined to extract distinct categories in detective stories. Based on the extracted categories, characteristic patterns of plot transitions and characters were obtained. By utilizing these quantitative data, it is possible to derive the overarching patterns to compute the probability of any plot element preceding or following another. These computational patterns could serve as the foundation for automatic plot generation by computers in the future.

Target Contents
In this study, the Japanese detective comic series Case Closed (also known as Detective Conan; Japanese title Meitantei Konan) was selected for analysis (Aoyama 1994–). Case Closed is a best-selling detective series and is famous as a successful multimedia property in Japan. Case Closed has been serialized in the comic magazine Weekly Shōnen Sunday since 1994, with more than one thousand episodes. The most recent comic book installment was volume 94, published in December 2017. The total number of copies printed is estimated to be more than one hundred million. This work has been aired as an ongoing TV anime series for more than twenty years, since 1996, and has been investigated in studies of influences of Japanese culture (e.g., Cooper-Chen 2012). Moreover, gender-based character analysis (Unser-Schutz 2015) and case study plot structure analysis (Hatakeyama 2003) have been done for this comic series. However, quantitative plot structure analysis has not yet been attempted.

Case Closed includes much homage to traditional detective stories like those written by Arthur Conan Doyle and Agatha Christie. The plot style of each episode follows that of traditional detective stories. Moreover, because the main reader demographic of the series is comprised of young boys, the story structure tends to be very simple and easily understood, with explicit explanations of the tricks and mysteries utilized. For this study, the comics of volumes 1–45 were analyzed as the data, with volumes covering a ten-year period (1994–2003). Since the number of episodes differed from the number of actual cases, 134 cases out of 461 episodes were targeted for analysis. On average, three to four episodes were found to correspond per case.

Categorization of Plot Elements

Journal of the Japanese Association for Digital Humanities, vol. 5, No. 1, p. 6
Factors of the Detective Story and the Extraction of Plot Patterns Based on Japanese Detective Comics

Although there are many methods for categorizing story plots based on particular elements, this study focused on the general functions common in detective stories in order to describe plot elements. The macro-level functions of stories were used as a basis for dividing and categorizing plot elements manually. The story functions for 134 cases were then described and synthesized on the basis of the most frequently appearing typical functions of detective stories. As a result, the study depicted 134 cases with 37 types of plot elements. Table 1 displays the 37 types of plot elements. A total of 1,123 plot elements were obtained (Murai 2018). Each case includes an average of 8.4 plot elements.

Table 1. Type and number of appearances per plot element

| Type                                | Number of Appearances | Description                                      |
|-------------------------------------|-----------------------|--------------------------------------------------|
| Investigation                       | 145                   | Abduction (or confinement of detective)            |
| Reasoning                           | 144                   | Explosion/Arson                                   |
| Confession                          | 98                    | Dining                                            |
| Cadaver (appearance of a cadaver)   | 95                    | Death                                             |
| Introduction (of people)            | 67                    | Unaccounted for                                   |
| Arrest (or confinement of suspects) | 58                    | Quarrel                                           |
| Past cases                          | 57                    | Preliminary notice (of a crime)                    |
| Discovery                           | 38                    | Vigilance/Ambush                                  |
| Request (for an investigation)      | 33                    | Surrender                                         |
| Fight                               | 32                    | Intimidation                                      |
| Incursion (of the criminal)         | 32                    | Reinforcement                                     |
| Escape                              | 32                    | Closed circle                                     |
| Visiting (to meet people)           | 30                    | Forgiveness                                       |
| Travel                              | 25                    | Strange incident                                  |
| Outing (for pleasure or shopping)   | 20                    | Theft                                             |
| Murder                              | 18                    | Serious condition                                 |
| Exposed identity                    | 17                    | Suicide                                           |
| Induction                           | 17                    | Concealment                                       |
| Chase                               | 15                    |                                                   |

Categorization of Tricks in the Cases

The tricks in each case were categorized into ten types, as defined below. Some cases include several kinds of tricks. Therefore, the categorization of each case’s trick is a duplicate classification (one case might be categorized in several categories). Table 2 describes the results of manual categorization.
Camouflaging a crime: The crime has not actually happened and the characters pretend that it exists. This includes cases of misunderstanding.

Concealing a crime: The criminal conceals the crime as though it has not happened, to look like suicide, accidental death, or natural death.

Table 2. Type and number of appearances per trick

| Type                                | Number |
|-------------------------------------|--------|
| Camouflaging crimes                 | 12     |
| Concealing crimes                   | 24     |
| Fake criminals                      | 219    |
| Concealing characteristics of criminals | 68    |
| Alibi                               | 42     |
| Camouflaging the purpose            | 23     |
| Camouflaging the means              | 36     |
| Camouflaging the time               | 23     |
| Camouflaging the place              | 28     |
| Camouflaging one’s surroundings and escape route | 34 |

Fake criminals: The true criminal frames innocent individuals. For example, the criminal intentionally places someone else’s lost articles in the possession of the innocent victim, or the criminal disguises the victim’s identity.

Concealing characteristics of criminals: The criminal hides their own characteristics or personality.

Alibi: The criminal camouflages their own alibi. Alibi tricks, which include camouflaging the time of the incident, are categorized as both “alibi” and “camouflaging the time.”

Camouflaging the purpose: The criminal camouflages the purpose and motivations of the crime.

Camouflaging the means: The criminal camouflages the means of the crime. This could include concealing or destroying murder weapons, the placement of fake weapons, and some automatic mechanism for the crime.

Camouflaging the time: The criminal camouflages the time of the crime. This includes operating clocks and changing the estimated time of death by camouflaging cause of death.
Factors of the Detective Story and the Extraction of Plot Patterns Based on Japanese Detective Comics

- **Camouflaging the place**: The criminal takes steps to make it seem as if the crime were committed elsewhere. This includes concealing the location of the crime and secret treasures.

- **Camouflaging surroundings and escape routes**: The criminal camouflages his/her surroundings, escape routes, and intrusion routes. This includes so-called “locked room” tricks.

**Categorization of Motives in the Cases**

Criminals' motives in each case were categorized into nine types, as defined below. Some cases include several types of motives. Therefore, as in the case of tricks, the categorization of each case’s motive is a duplicate classification. Table 3 presents the results of manual categorization.

- **Vengeance**: This is when the criminal’s aim is to exact vengeance on the victim, and includes revenge resulting from misunderstanding. Revenge for past death cases is classified as both “revenge” and a “past death case.”

- **Past death case**: A past death is the motive of a crime; this includes past murders, suicides, and accidental deaths. Past murder is categorized as both a “past death case” and a “past crime.”

- **Past crime**: A past crime is the motive of the current crime. If the concealment of a past crime is the motive, it is categorized as both a “past crime” and “concealment.”

- **Concealment**: The motive is concealment of past crimes or facts that the criminal does not want the public to know. If a serial murder was committed to kill the murderer’s witness, the crime is categorized as “concealment.”

- **Love**: This includes crimes based on feelings related to love. Vengeance for adultery is classified under both “vengeance” and “love.”

- **Wealth**: The crime of obtaining wealth falls under this category. This includes robbery, kidnapping, and obtaining secret treasures.

- **Work**: Profits and promotions related to the criminal’s occupation are categorized as “work.” Motives for past deaths in the workplace are categorized as “past death cases.”

- **Protection**: This includes crimes in which the criminal is trying to protect important things (for instance honor, an aesthetic sense, or animals). Legitimate self-defense is also included.
- **Falsehood, misunderstanding**: The criminal wants to pretend that a crime that is not happening actually exists. This includes cases of detectives misunderstanding.

### Table 3. Type and number of appearances of criminals’ motives

| Motive                  | Number |
|-------------------------|--------|
| Vengeance               | 68     |
| Past death case         | 44     |
| Past crime              | 49     |
| Concealment             | 29     |
| Love                    | 24     |
| Wealth                  | 22     |
| Work                    | 14     |
| Protection              | 6      |
| Falsehood, Misunderstanding | 5      |

### Categorization of the Relationships between Criminals and Victims

The relationships between victims and criminals in each case were categorized into ten types, as outlined below. Some characters have duplicated roles in their respective stories. Therefore, some classifications are duplicated, as in the former tables. Table 4 depicts the outcomes of manual categorization.

### Table 4. Type and number of appearances of relationships between victims and criminals

| Relationship                                | Number |
|---------------------------------------------|--------|
| Responsible person in past death case       | 36     |
| Criminal of past crime                      | 25     |
| Workplace relationship                       | 34     |
| Romantic relationship                        | 22     |
| Witness of a past case                       | 16     |
| Friend                                      | 15     |
| Family                                      | 15     |
| Related occupation                           | 7      |
| Rich person                                 | 7      |
| Irrelevant                                  | 5      |
Factors of the Detective Story and the Extraction of Plot Patterns Based on Japanese Detective Comics

- **Responsible person in past death case**: The victim is responsible for a past death and the criminal is a related person (e.g., victim, friend of victim, or relative) in the case.
- **Criminal of a past crime**: The victim is the criminal of a past crime, and the criminal is a related person (e.g., victim, friend of victim, or relative) in the case.
- **Workplace relationship**: The victim and the criminal work at the same place, or have relationships related to their work.
- **Romantic relationship**: The victim and the criminal have a romantic relationship with each other. For instance, lovers, ex-lovers, and rivals in love. Married couples are categorized under both “romantic relationships” and “family.”
- **Witness in a past case**: The victim is a witness in a past case (a death or a crime) in which the criminal is involved.
- **Friend**: The victim and criminal are friends or acquaintances.
- **Family**: The victim and criminal are family members or relatives.
- **Related occupation**: The victim works at a job related to the crime in the story; for example, police, detectives, and bank employees in cases of bank robberies, or a kidnapped artist in a case of counterfeit money.
- **Rich person**: A person who became a victim because of his/her wealth. This includes the criminal misunderstanding the case.
- **Irrelevant**: The victim of a phantom killer or indiscriminate terrorism.

**Factor Analysis of Plot and Character Traits**

To categorize and group the features of the plot sequences and character roles in detective stories, all parameters have been analyzed using factor analysis based on each case. Factor analysis statistically extracts groups of given parameters by rotating parameters as vectors in multidimensional space. Those groups are called “factors.” Factor analysis makes it possible to simplify relationships of many variables by grouping. Factor analysis extracts factor loadings between each parameter and factor. Each factor loading signifies the strength of the relationship between a parameter and a factor. Fundamentally, parameters which have large factor loadings in absolute value related to some factor are regarded as included in that factor.

In total, sixty-six parameters (thirty-seven plot elements, ten types of tricks, nine types of criminal motives, and ten types of relationships between victims and criminals)
in 134 cases were analyzed as sixty-six dimensions in 134 vectors for factor analysis. The Promax rotation method was used as a method of matrix rotation in multidimensional space and a parallel analysis was performed to determine the number of factors. After the factor analysis, less significant parameters (with a maximum factor loading of > 0.25) were eliminated, and a subsequent factor analysis was performed repeatedly. Finally, after performing the factor analysis five times, eleven factors were identified.

In total, forty-two parameters (nineteen plot elements, seven types of tricks, nine types of criminal motives, and seven types of relationships between victims and criminals) comprise the eleven factors. Table 5 displays the resultant factor loadings; the bold font signifies cells whose factor scores exceed 0.25. In table 5, the type (in each respective row) indicates the kinds of parameters. Type “P” signals plot elements, “T” represents tricks, “M” describes motives, and “R” signifies relationships between victims and criminals.

Considerations and the naming of the factors are described below:

- **Factor 1**: This factor includes the motive of “concealment” and the victim’s relationship to a “witness in a past case” as the large absolute factor loadings (negative value). On the other hand, large positive factor loadings are the motives of “vengeance,” “work,” and “wealth.” Therefore, this factor signifies that murder for concealing a witness is incompatible with other motives, such as vengeance. This factor was referred to as an “eliminating the witness” pattern.

- **Factor 2**: The parameters with large factor loadings in this factor are the motives of “past death case,” “vengeance,” and the victims of “responsible person in past death case.” This factor clearly indicates the pattern of “vengeance for past death case.”

- **Factor 3**: The largest absolute factor loading is the motive of “wealth.” Moreover, the factor concerning the victim “rich person” and the plot element “request” also have large negative factor loadings. Therefore, this factor would indicate crimes aimed at the property of a rich person. This factor was referred to as the “request for a greedy type of crime” pattern.

- **Factor 4**: The large factor loadings in this factor are the plot elements “vigilance,” “theft,” “escape,” and the victim “rich person.” Although this factor has the common element of the victim with factor 3, the plot elements are different. This factor was referred to as “vigilance against theft.”
• **Factor 5**: This factor includes the category “romantic relationship” and the motive “love.” Therefore, this factor clearly indicates crimes caused by “love.” This factor also includes the plot “serious condition” in the same positive loading. This may suggest that the criminal could sometimes not kill the victim in a romantic relationship.

• **Factor 6**: The largest absolute factor loadings in this factor are the plots “abduction” and “fight.” Moreover, the plot “chase” and the motive “past crime” also have the same large negative factor loadings. This factor indicates that abduction and confinement by the criminal often results in fighting or a chase between criminals and detectives. The factor also suggests that these plots may be caused by a past crime. This factor is referred to as “abduction and fighting.”

• **Factor 7**: This factor includes the tricks “fake criminals” and “concealing characteristics of criminals” as large factor loadings. Moreover, the plots “incursion,” “exposed identity,” and “closed circle” are also included. This factor indicates a story pattern about a mysterious criminal. The criminal often achieves “incursion” through a disguise. Additionally, this pattern is frequently used in a “closed circle,” in which the number of characters that appear is limited. Since the criminal’s identity is concealed, the “exposed identity” will be explained later. This factor was referred to as a “mysterious criminal.”

**Table 5.** Factor loadings of plot- and character-related parameters

| Parameter                               | Type | F1   | F2   | F3   | F4   | F5   | F6   | F7   | F8   | F9   | F10  | F11  |
|-----------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|
| Concealment                             | M    | -1.1 | -0.1 | 0.4  | 0.0  | -0.1 | 0.1  | -0.1 | -0.1 | -0.1 | 0.0  | -0.1 |
| Witness in past case                    | R    | -0.7 | -0.1 | 0.3  | -0.1 | 0.0  | -0.1 | 0.2  | -0.1 | -0.1 | -0.1 | -0.1 |
| Vengeance                               | M    | 0.6  | 0.4  | 0.3  | -0.1 | 0.2  | 0.0  | 0.0  | -0.2 | 0.1  | 0.0  | -0.2 |
| Past death case                         | M    | 0.0  | 1.0  | 0.2  | 0.0  | -0.2 | 0.0  | 0.0  | -0.1 | -0.2 | -0.1 | -0.1 |
| Responsible person in past death case   | R    | 0.2  | 1.0  | 0.1  | 0.0  | -0.2 | 0.0  | 0.0  | -0.1 | -0.1 | 0.1  | -0.1 |
| Work                                    | M    | 0.3  | -0.4 | 0.1  | -0.1 | -0.3 | 0.1  | 0.1  | -0.1 | -0.1 | -0.1 | -0.2 |
| Past cases                              | P    | 0.1  | 0.4  | 0.0  | 0.1  | -0.1 | 0.0  | 0.3  | 0.1  | 0.0  | 0.2  | 0.0  |
| Wealth                                  | M    | 0.3  | -0.2 | -1.2 | 0.1  | -0.3 | 0.0  | 0.0  | -0.2 | 0.0  | 0.1  | -0.2 |
| Request                                 | P    | 0.2  | -0.1 | -0.4 | -0.1 | 0.0  | -0.1 | 0.0  | -0.1 | -0.1 | 0.1  | 0.2  |
| Camouflaging the place                  | T    | 0.0  | 0.0  | -0.3 | 0.0  | -0.1 | 0.2  | 0.0  | 0.1  | 0.3  | -0.1 | -0.1 |
| Vigilance/Ambush                        | P    | 0.0  | 0.0  | 0.0  | 1.1  | 0.0  | 0.1  | 0.0  | -0.1 | 0.0  | -0.2 | -0.2 |
| Rich person                             | R    | 0.2  | 0.0  | -0.5 | 0.5  | -0.1 | 0.0  | 0.0  | -0.1 | -0.1 | 0.1  | 0.0  |
| Theft                                   | P    | 0.0  | 0.0  | 0.0  | 0.5  | -0.1 | 0.1  | 0.0  | 0.0  | 0.0  | 0.2  | 0.0  |
|                          | P   | 0.1 | 0.0 | 0.1 | 0.5 | 0.0 | -0.2 | 0.1 | -0.1 | 0.1 | -0.1 | 0.1 | 0.0 |
|--------------------------|-----|-----|-----|-----|-----|-----|------|-----|------|-----|------|-----|-----|
| Escape                   |     |     |     |     |     |     |      |     |      |     |      |     |     |
| Romantic relationship    | R   | 0.0 | -0.2| 0.1 | 0.0 | 0.8 | 0.0  | -0.1| -0.1 | 0.0 | 0.1  | 0.0 | 0.0 |
| Love                     | M   | 0.2 | -0.1| 0.2 | 0.0 | 0.8 | -0.1 | 0.1 | -0.1 | 0.0 | -0.1 | 0.0 | 0.0 |
| Workplace relationship   | R   | 0.2 | 0.0 | 0.2 | 0.0 | -0.4| 0.2  | 0.0 | -0.1 | -0.1| 0.0  | 0.0 | 0.1 |
| Serious condition        | P   | 0.1 | -0.1| 0.1 | 0.0 | 0.3 | 0.0  | 0.0 | 0.0  | 0.0 | 0.0  | 0.2 | 0.0 |
| Abduction                | P   | 0.0 | 0.0 | 0.0 | -0.1| 0.1 | -0.5 | 0.3 | -0.1 | 0.0 | -0.1 | 0.0 | 0.0 |
| Fight                    | P   | -0.2| 0.1 | -0.1| -0.1| 0.0 | -0.5 | 0.1 | -0.2 | -0.1| 0.0  | 0.0 | 0.0 |
| Introduction             | P   | 0.2 | 0.2 | 0.1 | -0.1| -0.1| 0.4  | 0.1 | -0.1 | 0.0 | 0.0  | 0.0 | 0.2 |
| Alibi                    | T   | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | -0.4 | 0.1 | 0.0  | -0.2| 0.0  | 0.1 | 0.1 |
| Chase                    | P   | 0.1 | 0.1 | -0.1| -0.1| -0.1| -0.4 | 0.0 | 0.3  | 0.0 | 0.1  | 0.0 | 0.1 |
| Visiting                 | P   | -0.1| 0.1 | 0.0 | -0.1| 0.0 | 0.4  | 0.2 | 0.0  | -0.1| -0.1 | 0.0 | 0.1 |
| Camouflaging the time    | T   | 0.0 | 0.0 | -0.1| 0.0 | 0.3 | 0.3  | 0.0 | -0.1 | 0.1 | 0.0  | 0.0 | 0.0 |
| Fake criminals           | T   | 0.0 | -0.2| 0.0 | 0.2 | 0.0 | 0.4  | 0.8 | 0.1  | 0.1 | 0.3  | 0.0 | 0.0 |
| Concealing characteristics of criminals | T | -0.1 | -0.1 | 0.0 | 0.1 | -0.1 | -0.2 | 0.6 | 0.0  | 0.0 | 0.2  | 0.1 | 0.0 |
| Incursion                | P   | 0.0 | 0.1 | -0.1| -0.1| 0.0 | 0.0  | 0.5 | 0.0  | 0.0 | -0.1 | 0.0 | 0.1 |
| Exposed identity         | P   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0  | 0.5 | 0.0  | 0.0 | 0.0  | 0.0 | 0.0 |
| Closed circle            | P   | 0.1 | 0.1 | 0.0 | 0.0 | 0.1 | 0.2  | 0.4 | 0.0  | 0.0 | -0.1 | -0.1| 0.0 |
| Falsehood, misunderstanding | M | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | -0.1 | -0.1| 1.0  | -0.1| -0.1 | 0.0 | 0.0 |
| Camouflaging crimes      | T   | 0.1 | -0.1| 0.0 | 0.0 | 0.1 | -0.1 | 0.1 | 0.5  | -0.1| 0.0  | -0.1| 0.0 |
| Unaccounted for           | P   | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | -0.1 | 0.0 | 0.0  | 0.4 | 0.0  | 0.0 | 0.1 |
| Reasoning                | P   | 0.1 | -0.1| 0.1 | -0.1| 0.0 | 0.0  | 0.1 | -0.2 | 0.9 | 0.1  | 0.0 | 0.0 |
| Preliminary notice       | P   | 0.1 | 0.0 | 0.2 | 0.2 | 0.1 | 0.0  | 0.0 | 0.0  | 0.7 | -0.1 | 0.0 | 0.0 |
| Irrelevant               | R   | 0.1 | -0.1| -0.1| -0.2| 0.0 | 0.0  | 0.0 | 0.0  | 0.5 | 0.0  | 0.0 | 0.1 |
| Criminal in a past crime | R   | 0.1 | 0.1 | -0.1| 0.0 | -0.1| -0.1 | 0.0 | 0.0  | 0.1 | 0.7  | 0.0 | 0.0 |
| Past crime               | M   | -0.4| 0.1 | 0.0 | 0.0 | -0.2| -0.4 | 0.1 | -0.2 | 0.0 | 0.6  | -0.1| 0.0 |
| Investigation            | P   | -0.1| 0.0 | 0.0 | -0.1| 0.0 | 0.4  | 0.0 | -0.1 | 0.0 | 0.4  | 0.0 | 0.0 |
| Suicide                  | P   | 0.0 | -0.1| 0.0 | 0.0 | 0.1 | 0.1  | 0.0 | 0.0  | 0.0 | 0.3  | 0.0 | 0.0 |
| Concealing a crime       | T   | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1  | 0.0 | 0.0  | 0.1 | 0.3  | 0.0 | 0.0 |
| Protection               | M   | 0.1 | -0.1| 0.2 | 0.1 | 0.0 | 0.1  | 0.1 | -0.1 | 0.1 | -0.1 | 1.0 | 0.0 |

- **Factor 8**: The motive “falsehood, misunderstanding” is the largest factor loading in this factor. The trick “camouflaging a crime” also has a large factor loading. Therefore, this factor is about “a crime that has not happened.” This pattern is often used with the plot “unaccounted for.”
- **Factor 9**: This factor includes the plots “reasoning” and “preliminary notice of a crime.” “Reasoning” is a common plot element in almost every case. Therefore, this factor indicates a story pattern of “preliminary notice of a crime.” This pattern suggests that “irrelevant” victims often get caught up in these types of crimes.

*Journal of the Japanese Association for Digital Humanities, vol. 5, No. 1, p. 14*
**Factor 10:** This factor includes a victim who is a “criminal of a past crime” and the motive “past crime.” Therefore, this factor is about a “past crime.” This factor also indicates that the plot “suicide,” and the tricks “concealing a crime” and “fake criminals,” are often used in this story pattern. This includes the trick of making it seem like a victim who regrets a past crime has committed suicide.

**Factor 11:** This factor seems independent: only the motive “protection” has a large factor loading. Therefore, this factor was named as “protection.”

Table 6 describes the factor correlations of the factor analysis. The bold font signifies the correlation values that exceed 0.25. If correlation value between two factors is large, it signifies that those two factors have a strong influence on each other. Factor 1, “eliminating the witness,” has a weak correlation with factor 3, “request for a greedy type of crime,” and factor 6, “abduction and fighting.” These correlations may indicate that witnesses can be easily killed in connection with violent and selfish crimes. Factor 2, “vengeance for a past death case,” has a weak correlation with factor 5, “love,” and factor 7, “mysterious criminal.” The correlation between factors 2 and 5 may be related to vengeance for a dead lover. Moreover, the correlation between factors 2 and 7 may signal that the avenger would like to hide their identity. Also, factor 4, “vigilance against theft,” and factor 9, “preliminary notice of a crime,” imply the story pattern of a phantom thief who is likely to steal.

**Table 6.** Factor correlations of plot and character-related parameters
Based on these factor loadings, the factor scores of each case can be calculated. The factor score signifies the relationship between factors and each of the original vectors that are composed of parameters. In this paper, the original vector signifies the parameter sets from one detective story. Therefore, the factor score for each detective story signifies the strength of relationship between factors. Table 7 shows the number of stories whose factor scores exceed 1.0 in each category.

|    | F1 | F2 | F3 | F4 | F5 | F6 | F7 | F8 | F9 | F10 | F11 |
|----|----|----|----|----|----|----|----|----|----|-----|-----|
| F1 | 1.0 | -0.1 | **0.4** | -0.1 | -0.1 | **0.4** | -0.2 | -0.1 | -0.2 | 0.0 | -0.1 |
| F2 | -0.1 | 1.0 | -0.2 | 0.0 | **0.3** | 0.2 | **0.3** | 0.1 | 0.1 | 0.2 | 0.0 |
| F3 | **0.4** | -0.2 | 1.0 | -0.2 | -0.3 | 0.2 | -0.1 | -0.3 | -0.2 | 0.0 | -0.2 |
| F4 | -0.1 | 0.0 | -0.2 | 1.0 | -0.1 | -0.2 | 0.0 | 0.0 | **0.4** | 0.0 | -0.2 |
| F5 | -0.1 | **0.3** | -0.3 | -0.1 | 1.0 | 0.2 | 0.0 | 0.1 | 0.0 | 0.1 | -0.1 |
| F6 | **0.4** | 0.2 | 0.2 | -0.2 | 0.2 | 1.0 | 0.1 | -0.1 | -0.1 | 0.1 | -0.1 |
| F7 | -0.2 | **0.3** | -0.1 | 0.0 | 0.0 | 0.1 | 1.0 | 0.0 | -0.1 | 0.1 | 0.0 |
| F8 | -0.1 | 0.1 | -0.3 | 0.0 | 0.1 | -0.1 | 0.0 | 1.0 | 0.1 | -0.1 | 0.0 |
| F9 | -0.2 | 0.1 | -0.2 | **0.4** | 0.0 | -0.1 | -0.1 | 0.1 | 1.0 | -0.1 | 0.0 |
| F10 | 0.0 | 0.2 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | -0.1 | -0.1 | 1.0 | 0.1 |
| F11 | -0.1 | 0.0 | -0.2 | -0.2 | -0.1 | -0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 1.0 |

Table 7. Number of categorized stories based on factor scores

|    | F1 | F2 | F3 | F4 | F5 | F6 | F7 | F8 | F9 | F10 | F11 |
|----|----|----|----|----|----|----|----|----|----|-----|-----|
| 15 | 36 | 15 | 6  | 21 | 12 | 14 | 5  | 8  | 21  | 6   |

Patterns of Plot Transitions

In order to investigate the sequential relationships between each pair of plot elements, the transitions between those plot elements were visualized as a direct network (fig. 1) by utilizing the software Graphviz (Ellson et al. 2003). For visualization purposes, the numbers of sequential transitions for two different plot elements were aggregated in 134...
cases (stories), and frequent transitions (more than 3) were employed as edges in the network. Each plot element was a node for the network. The nodes’ font sizes represent the frequency of each plot element.

Figure 1 shows that fundamental narrative patterns can be symbolized as transitions between typical functions in detective stories. Based on frequently appearing plot elements, the common story pattern in the series Case Closed can be described as a sequence of an “introduction,” the appearance of a “cadaver,” the “investigation,” the “past case,” “reasoning,” “confession,” and “arrest.”

Although figure 1 describes the average plot transition in all cases, each typical plot transition, according to the extracted factors, can be obtained based on factor scores. For instance, figure 2 describes the plot transitions of six cases whose factor scores of factor 4, “vigilance against theft,” exceed 1.0 (in table 7) based on frequent transitions (> 2).

Figure 2 shows that the plot transitions of the story pattern “vigilance against theft” are completely different from the average detective story pattern in figure 1. Although not as extreme as in figure 2, figure 3 presents an example of a slightly different pattern of plot transition. Figure 3 portrays the plot transitions of fourteen cases, whose factor scores of factor 7, “mysterious criminal,” exceed 1.0 (in table 7) based on frequent transitions (> 2).
Factors of the Detective Story and the Extraction of Plot Patterns Based on Japanese Detective Comics

Figure 1. The transition network of all plot elements in the detective stories

![Transition Network of All Plot Elements](image)

Figure 2. The transition network of factor 4–based plot elements

Although figure 3 is like figure 1, the plot element “incursion” and “exposed identity” are characteristics of the story pattern “mysterious criminal.”

Both the average plot transition pattern (fig. 1) and the individual plot transition patterns (based on minor story types) embody the typical structures of detective stories. In the future, based on the quantitative structure of these transitional networks, human-like plot sequence generation could be enabled by utilizing mathematical methodologies, such as the random walks in the Markov chain model.
Conclusions and Future Work

This study utilized a data description of 134 famous Japanese comic detective stories and listed thirty-seven types of plot elements, ten types of tricks, nine types of criminal motives, and ten types of relationships between victims and criminals to realize a computational narratological analysis. By utilizing factor analysis, eleven factors — “eliminating the witness,” “vengeance for a past death case,” “a request for a greedy type of crime,” “vigilance against theft,” “love,” “abduction and fighting,” “a mysterious criminal,” “a crime that has not happened,” “preliminary notice of a crime,” “past crime,” and “protection”—have been extracted. These factors related to the fundamental story patterns within the detective story genre.

The transition patterns between the various plot elements were visualized as networks. The structures of the plot transition networks changed according to the factors present in the detective stories. Because this paper targeted one of the most famous Japanese detective comics, the resultant factors and networks represent that work’s characteristics. However, by analyzing other detective stories using this methodology,
human-like elaborate and understandable creation of plot transitions in general detective stories would be enabled based on those detailed difference of plot transitional networks. Although another coder needs to verify the objectivity of the coding, this computational narratological outcome could be one of the foundations of automatic story generation by AI in the future.

Just as Propp’s results are limited to Russian fairy tales, the results of this analysis of detective stories are also limited to a single story genre. However, by accumulating analytic results from several genres, the whole shape of story plots may emerge in the future. Knowledge about story structures based on quantitative analyses could enable not only automatic story generation but also more objective and precise scientific interpretation of stories.
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