

3.2. Four aspects of the analyses

The basic idea of the analyses is to treat each discourse structure as a set of numerical values which represent structural features corresponding to the ten parameters. We call the values discourse feature values (DFVs). Each DFV is automatically calculated from a generated discourse. For example, “length” and “complexity” are respectively calculated based on the number of terminal nodes in a discourse structure and the number of relations needed for defining temporal order transformation. A set of discourse structures can be treated as a kind of feature space based on their DFVs. The degree of deviation is calculated as the distance between a space of normative discourses and the deviated discourse. The difference between two norms is also calculated as the difference of their spaces.

Based on the above method, we composed a program which consists of the following four analyses.

- (i) *Local generation space*: The role of norm is to restrict the generation space into a certain range. For confirming the behavior of norm-based generation, this analyzes characteristics of the set of normative discourses in each norm.
- (ii) *Degree of deviation*: The deviation is a process to transcend the generation from the local generation space at the time. For clarify the actual action of the deviation, this calculates the distance of the deviated discourse from the local generation space.
- (iii) *Degree of shift in norm*: For clarifying the manner of actual changes in local generation spaces, this calculates the magnitude of difference of each norm from the last norm.
- (iv) *Novelty of norm*: If local generation spaces are always different with all the past local spaces, the

system can continuously produce novel norms and discourses. This analysis calculates the magnitude of difference of each norm from the most similar norm in all the past norms.

4. Results

We executed the system 10000 steps for preparing an experimental data. The input story was same with the story in Ref. 8: A warrior rescues a princess who was abducted by a snake, the plot consisting of 16 total events. The value of n_p , the turning point of the narratee’s satisfaction, was 200.

The DFVs of each discourse were automatically calculated. The program preliminary analyzed the range (the minimum and maximum), average, and standard deviation of each DFV in all the discourses (see Table 1). In total, 8982 patterns of different discourse structures—as combination of the ten DFVs—were counted from the 10000 discourse structures.

Next, the series of discourses was divided into 271 segments (i.e., norms). The average of segment length (i.e., number of discourses) was 36.90 and the minimum and maximum were respectively 17 and 113.

4.1. Local generation space (i)

The program analyzed the normative discourses in each norm by the same manner with the above analysis. Table 2 shows two examples of the results. The ranges of DFVs were restricted from the entire set and each norm has different characteristics.

As an issue to be considered, although each local generation space had different characteristics, the timing in which the narratee’s expectation is saturated was

Table 1. Ranges, averages, and standard deviations of DFVs in all the discourses.

	supplement	complexity	suspense	length	hiding	descriptiveness	repetition	diffuseness	implication	temporal-independency
minimum	0	0	0	11	0	0	0	-9	0	0
maximum	4	50	8	52	10	8	24	20	6	2
average	2.74	8.07	0.69	28.97	3.86	3.44	6.78	2.92	1.90	1.22
SD	1.32	4.48	0.99	6.16	2.34	2.17	3.67	4.21	1.29	0.71

Table 2. The local generation spaces in norm₁ and norm₁₈₁.

Norm ₁ (cycles 1-113)										
	supplement	complexity	suspense	length	hiding	descriptiveness	repetition	diffuseness	implication	temporal-independency
minimum	0	0	0	11	3	0	0	-5	0	0
maximum	0	0	0	13	5	0	0	-3	0	0
average	0.00	0.00	0.00	12.30	3.70	0.00	0.00	-3.70	0.00	0.00
SD	0.00	0.00	0.00	0.65	0.65	0.00	0.00	0.65	0.00	0.00
Norm ₁₈₁ (cycles 6674-6710)										
	supplement	complexity	suspense	length	hiding	descriptiveness	repetition	diffuseness	implication	temporal-independency
minimum	4	8	0	19	5	1	3	-5	1	0
maximum	4	40	5	32	8	3	14	6	3	0
average	4.00	14.94	1.97	25.67	6.72	2.42	6.50	-0.22	2.61	0.00
SD	0.00	7.20	1.26	3.24	0.90	0.72	2.75	2.69	0.54	0.00

arbitrary defined by the value of n_p . On one hand a lot of overlapped discourses with others appeared in generation spaces which have small ranges like $norm_1$. On the other hand, large generation spaces like $norm_{181}$ were shifted to the next norm before the space was not filled sufficiently. A solution is to redefine the saturation as the filling of the local generation space.

4.2. Degree of deviation (ii)

The program calculated the degree of deviation in each norm based on the distance between the local generation space and deviated discourse. As the result, on one hand about 66% of deviated discourses were positioned outside of the space at the time. On the other hand, about 34% of deviated discourses were included in the space—i.e., the narrator failed the deviation in a practical sense. Such failures occurred due to the partial overlapping between the current local generation space and the deviated (subsequent) space. A solution is to use this analyzing method in the narratee mechanism for judging the success or failure of deviation.

4.3. Degree of shift in norm (iii)

The program calculated the degree of shift in each norm based on the difference of each local generation space from the last space. We confirmed that the local generation spaces were gradually shifted. It means that the holistic diversity of discourse structures arose through the restriction of generation space based on the norm and the accumulation of small shifts in the norms.

4.4. Novelty of norm (iv)

The program calculated the novelty of each norm based on the difference of each local generation space from the most similar norm in the past. We clarified that the novelty was gradually decreased through the generation cycle due to the limitation of the possible combinations of parameters in the generative goal and expectation.

5. Conclusion

In this paper, we analyzed a series of discourse structures produced by the narrative discourse system. We used an analyzing program based on a conceptual framework of norm and deviation. The results quantitatively showed that the system can produce diverse discourse structures through the restriction of generation space based on a norm and the accumulation of small shifts in norms.

In addition, mainly the following two issues were clarified: saturation of the narratee's expectation was arbitrary defined regardless the actual reception of generated discourses and the narrator failed the deviation often in a practical sense. A solution is to embed the analyzing program into the narratee mechanism for controlling the generation cycle based on the analyses of actually generated discourses.

The diversity of generable narratives is an important ability for narrative generation systems. The analyzing method proposed in this paper can be applied to other narrative generation systems for clarifying the holistic generation ability.

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