Appendices

A Diverse Outputs

We demonstrate the ability of the model to produce diverse outputs by showing examples of generation from graphs with 4, 5 or 6 edges. For each graph, we show every kth plan, where k is chosen so that our 25 examples cover the top 10% of the plans, and order them by the scores assigned to them by the scoring model (the score is shown to the right of each plan, as well as the rank in the list). Higher scoring plans correspond to more natural plans, according to our model, but all of them are viable options. Then, for each plan we show the corresponding text generated by the NMT model. This provides a glimpse of: (1) the quality of the scoring model; (2) the diversity of the plans; (3) the naturalness of the generation.

For the plans, color boxes indicate entities, and gray boxes around them indicate bracketing. Vertical bars indicate sentence splits. For the generated text, each entity is underlines with the color corresponding to its box.

A.1 Example: Graph with 4 Edges

Figure 5 shows a random 4-edge graph from the seen part of the test set. Figure 6 shows the plans and Figure 7 the corresponding texts.
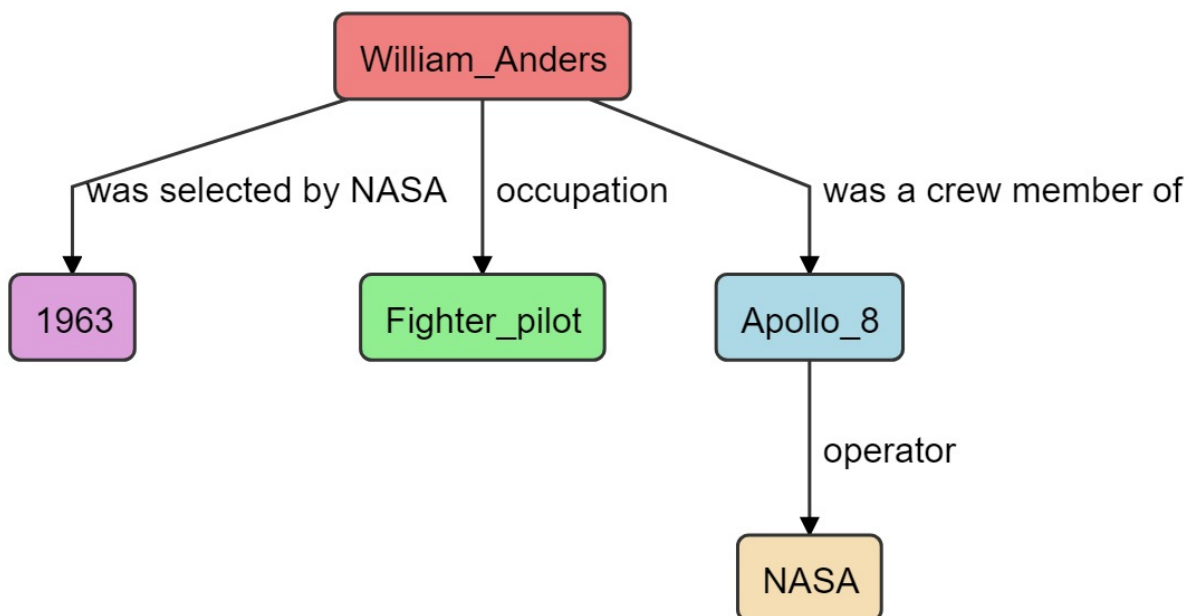

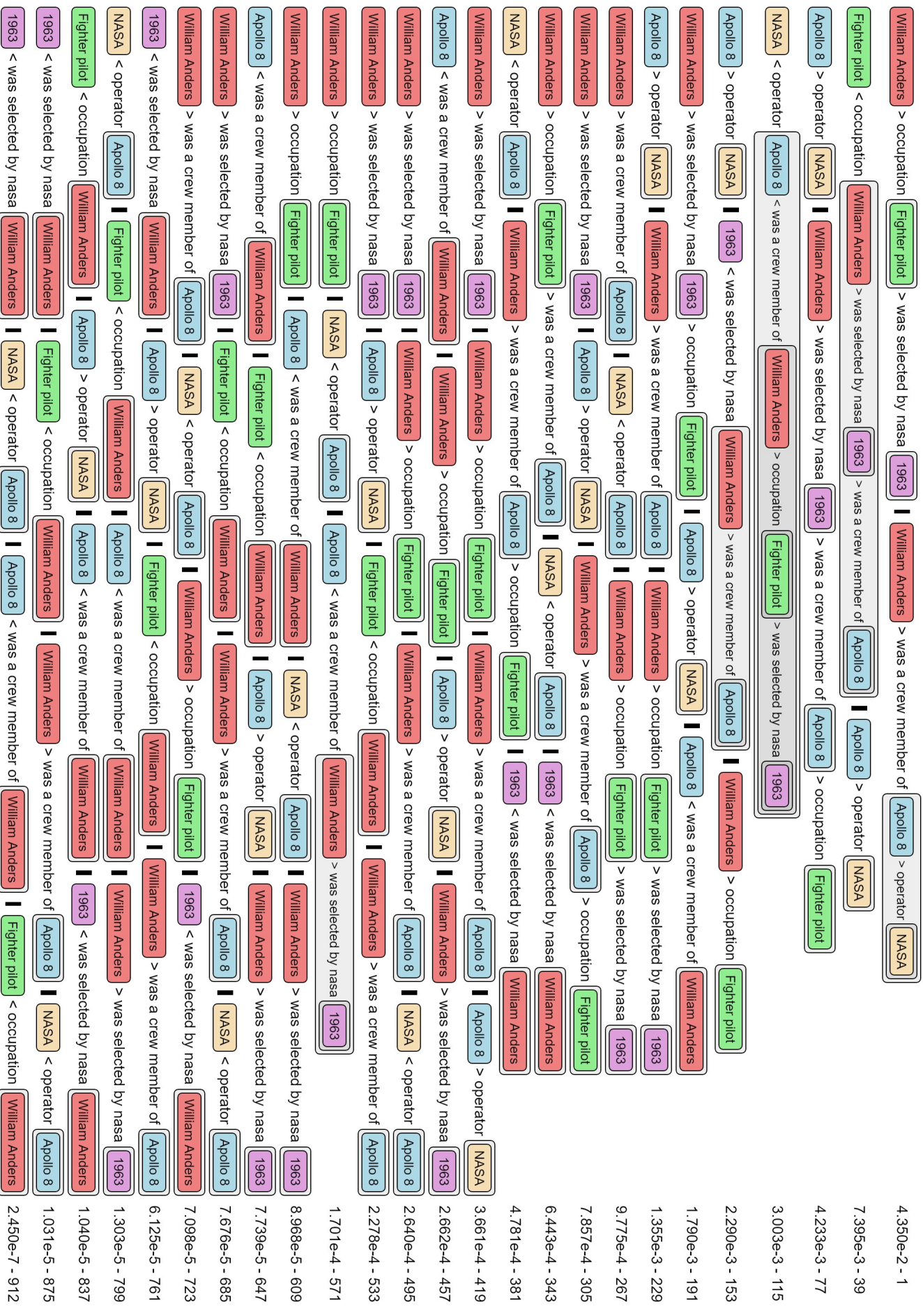Figure 5: Example of a graph with 4 edges

Figure 6: 25 random linearized plans (out of 1,295 possible plans) for the graph in Figure 5, and their ranks and model scores.

William Anders was a Fighter pilot who joined nasa in 1963 . William Anders was a member of the crew of Apollo 8 , operated by NASA .

Fighter pilot William Anders was selected by nasa in 1963 and served as a crew member of Apollo 8 . Apollo 8 was operated by NASA .

Apollo 8 was operated by NASA . William Anders , who was selected by nasa in 1963 , was a crew member of Apollo 8 and was a Fighter pilot .

part of NASA , Apollo 8 was selected by William Anders who was a Fighter pilot and was selected by nasa in 1963 .

Apollo 8 was operated by NASA . the book selected by nasa in 1963 , William Anders served as a crew member of Apollo 8 . William Anders was a Fighter pilot .

William Anders , who was selected by nasa in 1963 , was a Fighter pilot . Apollo 8 was operated by NASA . Apollo 8 was a crew member on William Anders .

Apollo 8 was operated by NASA . William Anders served as a crew member of Apollo 8 . William Anders was a Fighter pilot who joined nasa in 1963 .

William Anders served as a crew member of Apollo 8 . NASA operated Apollo 8 . William Anders was a Fighter pilot who joined nasa in 1963 .

William Anders was selected by nasa in 1963 . Apollo 8 was operated by NASA . William Anders was a Fighter pilot .

William Anders was a Fighter pilot and a crew member of Apollo 8 . NASA operated Apollo 8 , served as a Fighter pilot .

NASA operated Apollo 8 . William Anders , a crew member of Apollo 8 , served as a Fighter pilot . in 1963 , William Anders was selected by nasa .

William Anders was selected by nasa in 1963 . William Anders was a Fighter pilot . William Anders served as a crew member of Apollo 8 . Apollo 8 was operated by NASA .

Apollo 8 was a crew member on William Anders . William Anders was a Fighter pilot . Apollo 8 was operated by NASA . William Anders was selected by nasa in 1963 .

William Anders was selected by nasa in 1963 . William Anders was a Fighter pilot . William Anders served as a crew member of Apollo 8 . William Anders was selected by nasa .

William Anders was a Fighter pilot . NASA operated Apollo 8 . William Anders was selected by nasa in 1963 .

William Anders was a Fighter pilot . Apollo 8 was a crew member on William Anders . NASA operated Apollo 8 . William Anders was selected by nasa in 1963 .

Apollo 8 was a crew member on William Anders . the Fighter pilot . Apollo 8 was operated by NASA . William Anders was selected by nasa in 1963 .

William Anders was selected by nasa in 1963 . the Fighter pilot . William Anders was a Fighter pilot . William Anders served as a crew member of Apollo 8 .

William Anders was selected by nasa in 1963 . the Fighter pilot . William Anders was a Fighter pilot . William Anders served as a crew member of Apollo 8 .

William Anders served as a crew member of Apollo 8 . NASA operated Apollo 8 . William Anders was a Fighter pilot . in 1963 , William Anders was selected by nasa .

in 1963 , William Anders was selected by nasa . Apollo 8 was operated by NASA . the Fighter pilot . William Anders was a Fighter pilot .

NASA operated Apollo 8 . the Fighter pilot . Apollo 8 was a crew member on William Anders . William Anders was selected by nasa in 1963 .

the Fighter pilot . William Anders . Apollo 8 was operated by NASA . Apollo 8 was a crew member on William Anders . in 1963 , William Anders was selected by nasa .

in 1963 , William Anders was selected by nasa . the Fighter pilot . William Anders was a Fighter pilot . William Anders was selected by nasa .

in 1963 , William Anders was selected by nasa . NASA operated Apollo 8 . Apollo 8 was a crew member on William Anders . the Fighter pilot .

Figure 7: Realizations of the plans from Figure 6 as produced by the NMT realizer.

A.2 Example: Graph with 5 Edges

Figure 8 shows a random 5-edge graph from the
seen part of the test set. Figure 9 shows the plans
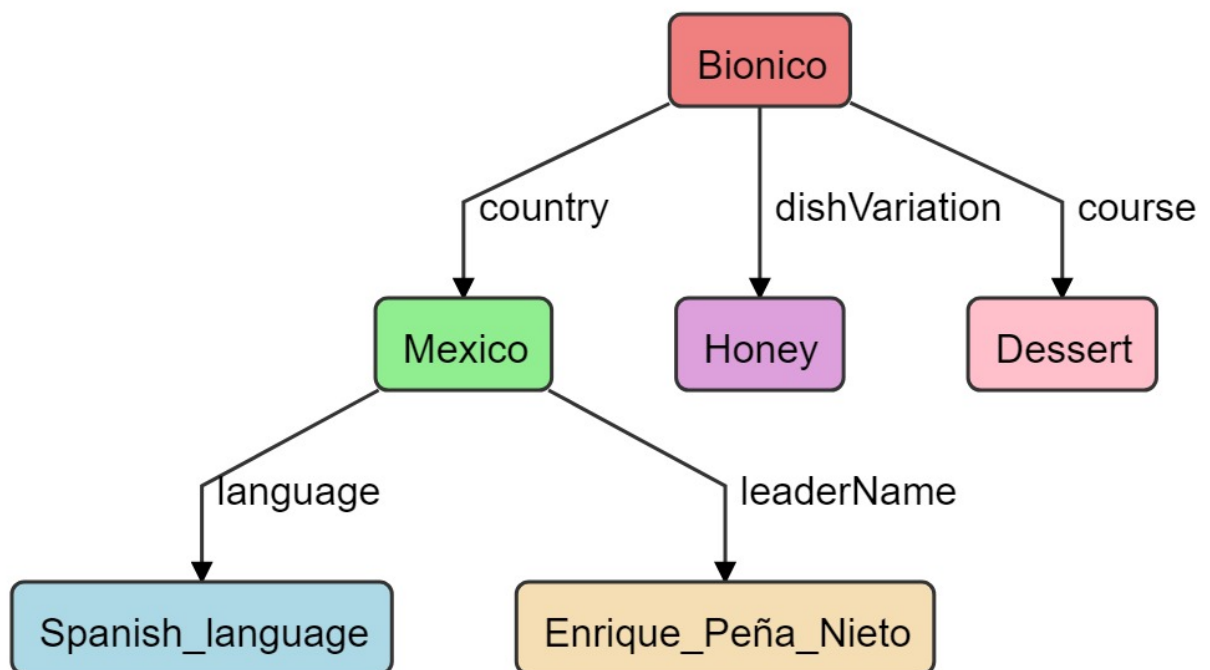and Figure 10 the corresponding texts.

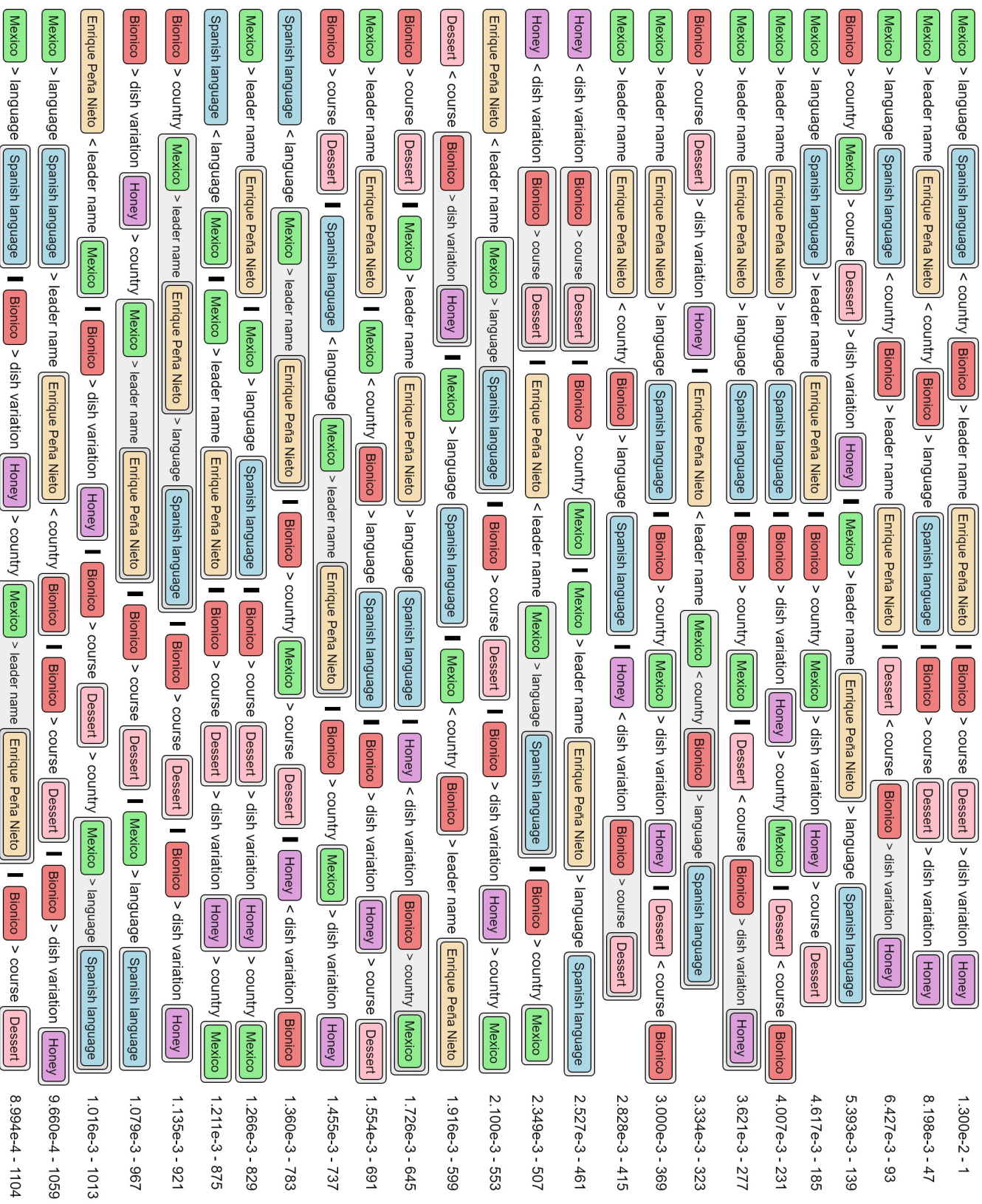Figure 8: Example of a graph with 5 edges

Figure 9: 25 random linearized plans (out of 9,460 possible plans) for the graph in Figure 8, and their ranks and model scores.

the language spoken in Mexico is the Spanish language where Bionico comes from , where the leader is Enrique Peña Nieto . Bionico is a Dessert and can be varied by using Honey .

the leader of Mexico is Enrique Peña Nieto where Bionico comes from , where the Spanish language is spoken . Bionico is a Dessert and can be varied by using Honey .

the language spoken in Mexico is the Spanish language where Bionico comes from , where the leader is Enrique Peña Nieto . the Dessert Bionico , can be varied by using Honey .

Bionico is a food found in Mexico , it is served at the Dessert course and can be varied by adding Honey . the leader of Mexico is Enrique Peña Nieto and the country uses the Spanish language .

Mexico is lead by the Spanish language and is lead by Enrique Peña Nieto . Bionico , a food found in Mexico , is a variation of Honey and is served as a Dessert .

the leader of Mexico is Enrique Peña Nieto and the country uses the Spanish language . Bionico is a dish containing Honey found in Mexico . the Dessert is a Bionico .

the leader of Mexico is Enrique Peña Nieto and the country uses the Spanish language . Bionico is a food found in Mexico . the Dessert Bionico , can be varied by using Honey .

Bionico is a Dessert and can be varied by using Honey . Enrique Peña Nieto is the leader of Mexico where Bionico comes from and where the Spanish language is spoken .

the leader of Mexico is Enrique Peña Nieto . Bionico , a food found in Mexico , is a variation of Honey . the Spanish language is spoken .

the leader of Mexico is Enrique Peña Nieto and the country uses the Spanish language . Bionico is a food found in Mexico and it is served as a variant of Honey . the Dessert is a Bionico .

Honey can be used as a variation in the dish Bionico which is served as a Dessert . the leader of Mexico is Enrique Peña Nieto and the country uses the Spanish language .

Honey can be used as a variation in the dish Bionico which is served as a Dessert . Enrique Peña Nieto is a leader in Mexico where the Spanish language is spoken . Bionico is a food found in Mexico .

Enrique Peña Nieto is a leader in Mexico where the Spanish language is spoken . Bionico is a Dessert . Bionico is a dish containing Honey found in Mexico .

the Dessert Bionico , can be varied by using Honey . in Mexico the Spanish language spoken is spanish . the leader of Mexico is Enrique Peña Nieto .

Bionico is a Dessert . the leader of Mexico is Enrique Peña Nieto and the country uses the Spanish language . Honey is a variation of Bionico which is a food found in Mexico .

the leader of Mexico is Enrique Peña Nieto . the language spoken in Mexico is Bionico , where the Spanish language is spoken . Bionico has Honey as a variation and is served as a Dessert .

Bionico is a Dessert . the Spanish language is spoken in Mexico where the leaders are Enrique Peña Nieto . Bionico is a food found in Mexico .

the Spanish language is spoken in Mexico where the leader is Enrique Peña Nieto . Bionico is a food found in Mexico and it is served at the Dessert course . Honey can be used by using Bionico .

the Spanish language spoken in Mexico spoken is spanish . Bionico is a Dessert . in Mexico the Spanish language spoken is spanish .

Bionico is a variation of Honey and Mexico (led by Enrique Peña Nieto) . Bionico is a Dessert . in Mexico the Spanish language spoken is spanish .

Bionico is a Dessert found in Mexico where the Spanish language is spoken .

Enrique Peña Nieto is a leader in Mexico . a variation of Bionico is Honey . Bionico is a Dessert found in Mexico where the Spanish language is spoken .

Mexico where the Spanish language is spoken and the leaders are Enrique Peña Nieto and eat Bionico . Bionico is a Dessert . a variation of Bionico is Honey .

in Mexico the Spanish language spoken is spanish . Bionico is a variation of Honey and Mexico (led by Enrique Peña Nieto) . Bionico is a Dessert .

Figure 10: Realizations of the plans from Figure 9 as produced by the NMT realizer.

A.3 Example: Graph with 6 Edges

Figure 11 shows a random 6-edge graph from the seen part of the test set. Figure 12 shows the plans and Figure 13 the corresponding texts.
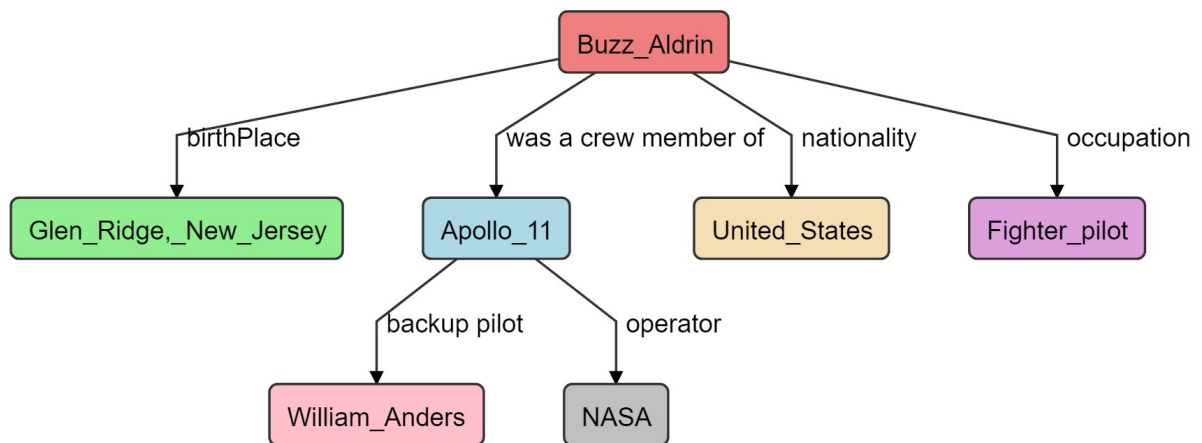
Figure 11: Example of a graph with 6 edges

Figure 12: 25 random linearized plans (out of 171,024 possible plans) for the graph in Figure 11, and their ranks and model scores.

Buzz Aldrin was a Fighter pilot and a crew member of Apollo 11 operated by NASA . United States . Buzz Aldrin was born in Glen Ridge, New Jersey . the backup pilot of Apollo 11 is William Anders .

Fighter pilot Buzz Aldrin is a United States national who was born in Glen Ridge, New Jersey . Buzz Aldrin was a crew member of Apollo 11 where William Anders served as backup pilot . the Apollo 11 program was organized by NASA .

the Apollo 11 crew member of Buzz Aldrin , a Fighter pilot , was born in Glen Ridge, New Jersey and was born in the United States . Apollo 11 was operated by NASA and William Anders .

Glen Ridge, New Jersey born Buzz Aldrin served as a Fighter pilot . Apollo 11 's backup pilot was William Anders and he is operated by NASA . Buzz Aldrin is a United States national .

NASA 's Apollo 11 backup pilot is William Anders . Buzz Aldrin (born in Glen Ridge, New Jersey) served as a Fighter pilot . Buzz Aldrin was a member of the crew of Apollo 11 . Buzz Aldrin is a United States national .

Fighter pilot Buzz Aldrin was born in Glen Ridge, New Jersey . Buzz Aldrin , a crew member of Apollo 11 , was born in the United States . NASA 's Apollo 11 backup pilot is William Anders .

NASA 's Apollo 11 backup pilot is William Anders . Buzz Aldrin was a crew member of Apollo 11 . Glen Ridge, New Jersey is the birthplace of Buzz Aldrin . Buzz Aldrin was a Fighter pilot .

born in Glen Ridge, New Jersey , Buzz Aldrin was a crew member of Apollo 11 . NASA 's Apollo 11 backup pilot is William Anders . Buzz Aldrin was a Fighter pilot who was born in the United States .

Buzz Aldrin , a United States Fighter pilot , was a member of the Apollo 11 crew and was born in Glen Ridge, New Jersey . the Apollo 11 program was organized by NASA . William Anders was a backup pilot of Apollo 11 .

NASA 's Apollo 11 backup pilot is William Anders . Buzz Aldrin (born in Glen Ridge, New Jersey) served as a Fighter pilot and was part of the crew of Apollo 11 . United States national Buzz Aldrin .

Buzz Aldrin was a member of the crew of Apollo 11 . Buzz Aldrin was an United States Fighter pilot who was born in Glen Ridge, New Jersey . William Anders was the backup pilot of Apollo 11 , operated by NASA .

Buzz Aldrin (born in Glen Ridge, New Jersey) served as a Fighter pilot . William Anders was the backup pilot of the Apollo 11 , which was part of Buzz Aldrin and operated by NASA . Buzz Aldrin is a United States national .

the Fighter pilot Buzz Aldrin is a Buzz Aldrin , a United States national . was born in Glen Ridge, New Jersey and serving the crew member of Apollo 11 . the backup pilot of Apollo 11 is William Anders . NASA operated the Apollo 11 mission .

United States Buzz Aldrin was born in Glen Ridge, New Jersey . Buzz Aldrin was a Fighter pilot . the Apollo 11 crew member Buzz Aldrin . William Anders was operated by NASA and operated by NASA .

Apollo 11 's backup pilot was William Anders and he is operated by NASA . Buzz Aldrin , a crew member of Apollo 11 , was born in the United States . the Fighter pilot Buzz Aldrin is a Buzz Aldrin . Glen Ridge, New Jersey is the birthplace of Buzz Aldrin .

Buzz Aldrin is a United States national and a member of the Apollo 11 crew where William Anders was a backup pilot . the Fighter pilot Buzz Aldrin . Buzz Aldrin was born in Glen Ridge, New Jersey . the Apollo 11 program was organized by NASA .

Buzz Aldrin is a United States national . the backup pilot of Apollo 11 is William Anders . the Apollo 11 program was organized by NASA . Buzz Aldrin was born in Glen Ridge, New Jersey . and served as a crew member of Apollo 11 .

Buzz Aldrin was a member of the crew of Apollo 11 was operated by NASA and William Anders . Buzz Aldrin was a Fighter pilot . United States national Buzz Aldrin . William Anders was a backup pilot of Apollo 11 . Buzz Aldrin is a United States national .

Apollo 11 's backup pilot is William Anders . the Apollo 11 program was organized by NASA . Buzz Aldrin was a Fighter pilot . Buzz Aldrin was born in Glen Ridge, New Jersey . Buzz Aldrin was a member of the crew of Apollo 11 .

Buzz Aldrin , a United States Fighter pilot , was a member of the Apollo 11 crew . the Apollo 11 program was organized by NASA . Buzz Aldrin was born in Glen Ridge, New Jersey . Buzz Aldrin is a United States national .

the Apollo 11 program was organized by NASA . Buzz Aldrin (born in Glen Ridge, New Jersey) served as a Fighter pilot . William Anders was a backup pilot of Apollo 11 . Buzz Aldrin was a member of the crew of Apollo 11 .

Buzz Aldrin was born in Glen Ridge, New Jersey . Buzz Aldrin was a member of the crew of Apollo 11 operated by NASA and is United States . William Anders was a backup pilot of Apollo 11 . the Fighter pilot Buzz Aldrin is a Buzz Aldrin .

Buzz Aldrin , a United States national , was born in Glen Ridge, New Jersey is the birthplace of Buzz Aldrin . Buzz Aldrin was a Fighter pilot . the Apollo 11 program was organized by NASA . the backup pilot of Apollo 11 is William Anders .

Buzz Aldrin was a Fighter pilot . Buzz Aldrin is a United States national . Buzz Aldrin was a crew member of Apollo 11 . Buzz Aldrin was born in Glen Ridge, New Jersey . the Fighter pilot Buzz Aldrin is a Buzz Aldrin .

Buzz Aldrin , a United States national , was born in Glen Ridge, New Jersey and serving the crew member of Apollo 11 . Buzz Aldrin was a Fighter pilot . the Apollo 11 program was organized by NASA , the backup pilot of Apollo 11 is William Anders .

William Anders was the backup pilot of Apollo 11 , operated by NASA . Buzz Aldrin , a United States national , was a crew member of Apollo 11 and served as a Fighter pilot . Glen Ridge, New Jersey is the birthplace of Buzz Aldrin .

Figure 13: Realizations of the plans from Figure 12 as produced by the NMT realizer.

B Manual Evaluation Setup

When performing pairwise system comparisons, we show the user, for each set of RDFs, the two texts produced by the compared systems in random order, along with the RDF triplets in textual and image forms as a reference. For consistency, both texts are normalized by lower-casing and splitting tokens on punctuation. The same interface is used for turkers (for the fluency task) and local annotators (for the faithfulness task).

B.1 Fluency Evaluation by Crowd

We evaluate on the RDF sets in the original WebNLG manual evaluation setup. The task is performed by mechanical-turk workers. The workers are presented with the question:

"Which text reads more fluently?"
which can be answered by either *Text 1*, *Text 2* or *Both are equally good or bad*.

We paid 0.08\$ per hit, employing three workers on each. For qualification, workers were required to have over 98% hit approval rate, and over 1000 approved hits.

B.2 Faithfulness Evaluation by Expert

To obtain reliable fine-grained evaluation of semantic faithfulness, the first author annotated the system outputs of **StrongNeural** and **BestPlan**.

For each text, we present all the RDF input triplets, and ask the annotator to choose for each triplet one of three options: (1) This triplet is *expressed* in the text; (2) This triplet is not expressed in the text (*ommitted*); (3) The text expresses a relation between the two entities that is different than the one specified for them in the RDF triplet (*wrong lexicalization*). Also, for each text, we ask the annotator to count the number of facts that were wrongly *over generated*, counting both repeated facts and hallucinated ones.

C Training Parameters

For the realization model we use the Open-NMT toolkit (Klein et al., 2017) with pre-trained GloVe.6B word embeddings (Pennington et al., 2014), downloaded from `http://nlp.stanford.edu/data/glove.6B.zip`. We used the default parameters (except for the `-copy_attn` flag). This corresponds to the following values:

- train_steps = 40000
- save_checkpoint_steps = 2000
- batch_size = 16
- word_vec_size = 300
- layers = 3
- copy_attn
- position_encoding