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.

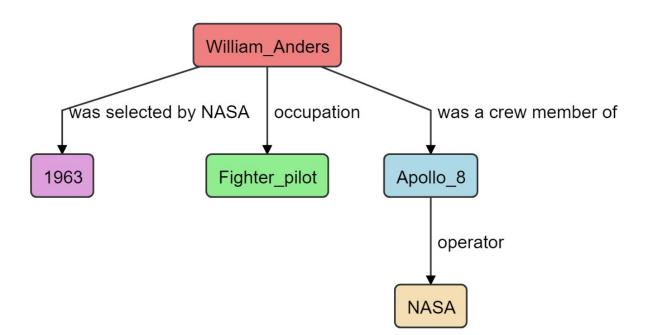


Figure 5: Example of a graph with 4 edges

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

NASA < operator Apollo 8 Fighter pilot < occupation William Anders I Mole 8 < was a crew member of 1 William Anders > was selected by nasa 1963 Fighter pilot < occupation William Anders I Apollo 8 < was a crew member of 1 William Anders I 1963 < was selected by nasa William Anders I 1963 < was selected by nasa William Anders I 1963 < was selected by nasa William Anders I 1963 < was selected by nasa William Anders I 1963 < was a crew member of 1 William Anders I 1963 < was selected by nasa William Anders I 1963 < was a crew member of 1 Apollo 8 < operator Apollo 8 < was a crew member of 1 Apollo 8 < operator Apollo 8 1963 < was selected by nasa William Anders I Fighter pilot < operator Apollo 8 I NASA < operator Apollo 8 < was a crew member of 1 William Anders I NASA < operator Apollo 8 < was a crew member of 1 William Anders I NASA < operator Apollo 8 < was a crew member of 1 William Anders I NASA < operator Apollo 8 < was a cre	Anders > was a crew member of Apollo 8 I NASA < operator 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Figure 7: Realizations of the plans from Figure 6 as produced by the NMT realizer.

Ľ. 3 the Fighter pilot part of NASA , Apollo 8 was selected by William Anders who was a Fighter pilot and was selected by nasa in 1963 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 William Anders was a Fighter pilot William Anders was selected by nasa in 1963 . Apollo 8 was operated by NASA . the Fighter pilot William Anders was selected by nasa in 1963 . Apollo 8 was operated by NASA . William Anders , a crew member of Apollo 8 , served as a Fighter plot 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 NASA operated William Anders was selected by nasa in 1963 Apollo 8 was a crew member on William Anders . the Fighter pilot William Anders was a Fighter pilot . Apollo 8 was operated by NASA . William Anders was selected by nasa in 1963 William Anders was a Fighter pilot William Anders was selected by nasa in 1963 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. Apollo 8 was operated by NASA NASA operated Apollo 8 . William Anders , a crew member of Apollo 8 , served as a Fighter pilot . in William Anders was a Fighter pilot and a crew member of Apollo 8. NASA operated Apollo 8. in 1963, William Anders was selected by nasa 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 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 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 . the book selected by nasa in 1963 , William Anders served as a crew member of Apollo 8 . William Anders was a Fighter pilot 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 Fighter pilot 1963 1963 1963 , William Anders was selected by nasa . Apollo 8 was operated by NASA . 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. NASA operated Apollo 8 . Apollo 8 was a crew member on William Anders William Anders was selected by nasa . the Fighter pilot William Anders was a Fighter pilot . William Anders served as a crew member of Apollo 8 . NASA operated Apollo 8 William Anders was selected by nasa in 1963 and served as a crew member of Apollo 8 . Apollo 8 was operated by NASA William Anders was a Fighter pilot Apollo 8 . the Fighter pilot . NASA operated Apollo 8 . selected by Apollo 8 , William Anders was selected by nasa in 1963 . Apollo 8 was a crew member on William Anders . 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 . the Fighter pilot William Anders was a Fighter pilot . William Anders served as a crew member of Apollo 8 . NASA operated Apollo 8 . Apollo 8 was operated by NASA . Apollo 8 was a crew member on William Anders William Anders was a 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 1963 William Anders was selected by nase . the Fighter pilot William Anders . William Anders was selected by nasa in . in 1963, William Anders was selected by nasa 1963 Apollo 8 . NASA operated Apollo 8 was a Fighter pilot 1963

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.

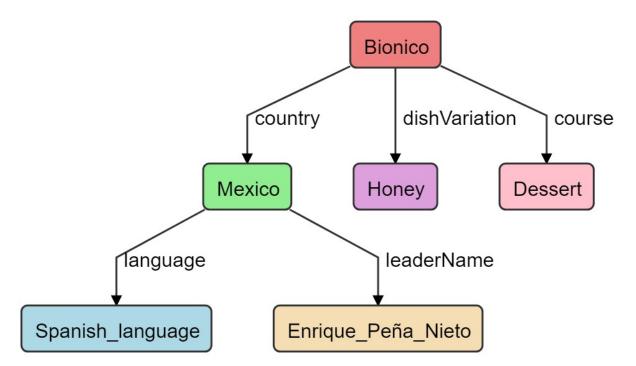


Figure 8: Example of a graph with 5 edges

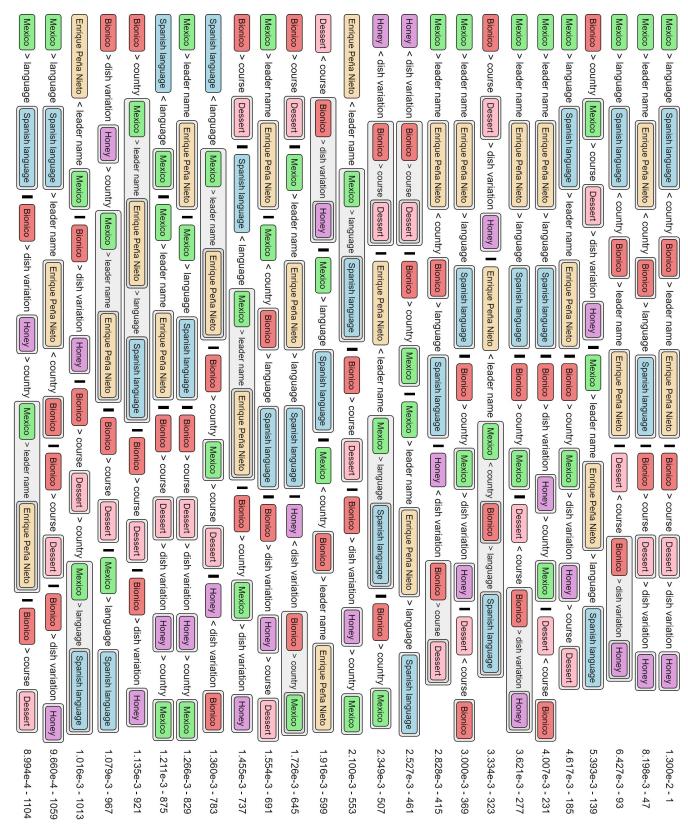


Figure 9: 25 random linearized plans (out of 9,460 possible plans) for the graph in Figure 8, and their ranks and model scores

E the the 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 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 the language spoken in Mexico is the Spanish language where 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 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 Mexico where the Spanish language is spoken and the leaders are Enrique Peña Nieto and eat Bionico is a Dessert . a variation of Bionico is Honey Enrique Peña Nieto is a leader in Mexico . a variation of Bionico is Honey . the leader of the Dessert the leader of Mexico is Enrique Peña Nieto where Bionico comes from, where the Spanish language is spoken. Honey can be used as a variation in the dish the leader of Bionico is a food found in Mexico where the leaders are Enrique Peña Nieto and the Spanish language spoken is spanish. Bionico is a Dessert . a variation of Bionico 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 leader of Bionico is a variation of Honey and Mexico (led by Enrique Peña Nieto). Bionico is a Bionico is a 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 Honey can be used as a variation in the dish Bionico is a Mexico is lead by the 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 Spanish language is spoken in 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 is spanish . Bionico is a variation of Mexico is Enrique Peña Nieto . in Mexico the Spanish language spoken is spanish . Bionico is a Dessert and Honey found in Mexico Dessert . the Spanish language is spoken in Mexico where the leader is Enrique Peña Nieto . Bionico is a food found in Mexico and it is a variant of Honey Dessert and can be varied by using Honey . Enrique Peña Nieto is the leader of Mexico where Bionico comes from and where the 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 Bionico, can be varied by using Honey . in Mexico the Spanish language spoken is spanish . the leader of Mexico in Bionico is Enrique Peña Nieto Mexico is Enrique Peña Nieto and the country uses the Spanish language . Bionico is a food found in Mexico and it is a variant of Honey . the Dessert is a Mexico is Spanish language and is lead by Enrique Peña Nieto Enrique Peña Nieto and the country uses the Mexico . the leader of Mexico is Enrique Peña Nieto Bionico which is served as a Dessert Bionico comes from , where the leader is Enrique Peña Nieto Spanish language . Bionico is a dish containing Honey found in Mexico . the Dessert is a Bionico Bionico is a Dessert . in Mexico the Bionico, a food found in Mexico, is a variation of Honey and is served as a Dessert Bionico is a Dessert found in Mexico where the Spanish language is spoken Honey and . Bionico is a food found in Mexico . the leader of Mexico is Enrique Peña Nieto and the country uses the Spanish language Bionico is a Dessert and Mexico (led by Enrique Peña Nieto). Spanish language spoken is spanish Honey found in Mexico the Dessert Bionico is a Bionico, can be varied by using Dessert Spanish language is spoken Bionico which is served as a Dessert Honey S Bionico Honey Honey

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.

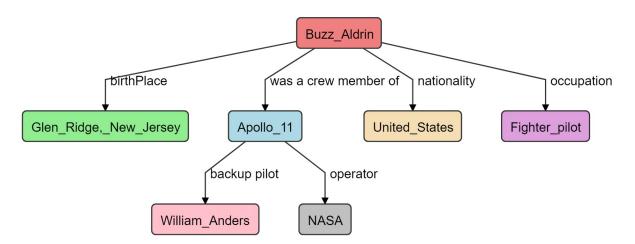


Figure 11: Example of a graph with 6 edges

Buzz Aldrin > nationality United States > birth place Gen Ridge. New Jersey > was a crew member of Apolo 11 > cocupation Fighter pilot Image: New Jersey > was a crew member of Apolo 11 > cocupation > cocupation <t< th=""><th>place Buzz Adrin Buzz Adrin > was a crew member of Apolo 11 > backup pilot (Villiam Anders) > operator (NASA)</th><th></th><th>pilot Apolio 11 Buzz Aldrin > was a crew member of Apolio 11 Buzz Aldrin > nationality (United States)</th><th></th><th>The second secon</th><th>Buzz Addin > vas a crew member of [Apolo 11] + backup pilot [William Anders] Apolo 11 > operator [NASA] Fighter pilot < occupation [Buzz Addin > birth place [Gen Ridge, New Jersey] > was a crew member of [Apolo 11] + backup pilot [William Anders] Apolo 11 > operator [NASA] Fighter pilot < occupation [Buzz Addin > birth place [Gen Ridge, New Jersey] > was a crew member of [Apolo 11] + backup pilot [William Anders] Buzz Addin > occupation [Fighter pilot] + Buzz Addin > birth place [Gen Ridge, New Jersey] + Was a crew member of [Apolo 11] + backup pilot [William Anders] Buzz Addin > occupation [Fighter pilot] + Buzz Addin > birth place [Gen Ridge, New Jersey] + United States < nationality [Buzz Addin]</th><th>Buzz Addrn > nationality United States > was a crew member of Apollo 11 > backup pilot (William Anders) Fighter pilot < occupation Buzz Addrn Buzz Addrn > birth place Gien Ridge, New Jersey Apollo 11 > operator (NAA)</th><th>Apolo 11 > backup pilot William Anders > operator NASA Buzz Addrin > was a crew member of Apolo 11 > nationality United States Fighter pilot < occupation Buzz Addrin Gien Ridge. New Jersey < birth place Buzz Addrin</th><th>United States < nationality Buzz Addrin > birth place Gen Ridge, New Jersey Buzz Addrin > occupation Fighter pilot Apolo 11 < was a crew member of Buzz Addrin > backup pilot (William Anders) > operator (NASA)</th><th>Fighter pilot < occupation Buzz Addin > nationality United States > birth place Glen Ridge, New Jersey > was a crew member of Apollo 11 Apollo 11 > backup pilot William Anders NASA < operator Apollo 11</th><th>Buzz Addn > birth place Glen Ridge, New Jersey > occupation Fighter plot William Anders < backup pilot Apolo 11 < was a crew member of Buzz Addn > operator NASA Buzz Addn > nationality United States</th><th><pre>c backup pilot Apollo 11 > operator NASA)</pre></th><th>NASA < operator Apolo 11 > backup pilot William Anders Buzz Adm > birth place Gen Ridge, New Jersey > occupation Fighter pilot) > was a crew member of Apolo 11 United States < nationality Buzz Adm</th><th>Buzz Addm > nationality United States > occupation (Fighter plot) > was a crew member of Apolo 11) > birth place (Glen Ridge, New Jersey) Apolo 11 > operator (NASA) William Anders < backup pilot (Apolo 11)</th><th>Gen Ridge. 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New Jersey Buzz Adrin > was a crew member of Apole 11 > nationality United States NASA < operator Apole 11 > backup pilot William Anders</th><th>NASA < operator Apollo 11 > backup pilot William Anders Buzz Addin > birth place Glen Ridge, New Jersey > occupation Fighter pilot Buzz Addin > nationality United States Apollo 11 < was a crew member of Buzz Addin</th><th>Gen Ridge, New Jersey < birth place Buzz Aldrin > occupation [Fighter pilot] Apollo 11 > backup pilot [William Anders] > operator [NASA] Buzz Aldrin > was a crew member of [Apollo 11] Buzz Aldrin > nationality [United States]</th><th>Apolo 11 < was a crew member of Buzz Addin > occupation (Fighter pilot) > birth place (Gen Ridge, New Jersey) > nationality (United States) Apolo 11 > operator (NASA) > backup pilot (William Anders)</th><th>Fighter pilot < occupation Buzz Adrin > nationality United States > birth place Gien Ridge. 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New Jersey Buzz Adrin > was a crew member of Apolio 11 > backup pilot William Anders Apolio 11 > operator NASA	Buzz Addin > occupation [Fighter pilot] > was a crew member of Apolo 11 > operator [NASA] United States < nationality Buzz Addin > birth place [Glen Ridge, New Jersey] Apolo 11 > backup pilot [William Anders]
5.200e-4 - 16400 4.966e-4 - 17102	5.427e-4 - 15687	5.675e-4 - 14974	6.011e-4 - 14261	6.304e-4 - 13548	6.613e-4 - 12835	7.393e-4 - 11409 6.930e-4 - 12122	7.909e-4 - 10696	8.426e-4 - 9983	9.139e-4 - 9270	9.936e-4 - 8557	1.073e-3 - 7844	1.200e-3 - 7131	1.329e-3 - 6418	1.508e-3 - 5705	1.751e-3 - 4992	2.037e-3 - 4279	2.337e-3 - 3566	2.788e-3 - 2853	3.481e-3 - 2140	4.515e-3 - 1427	6.172e-3 - 714	1.951e-2 - 1

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

the the backup pilot of Apollo 11 is William Anders . Buzz Aldrin was born in Gien Ridge. New Jersey . United States . Buzz Aldrin was a Fighter pilot . Buzz Aldrin was a member of the crew of Apollo 11 . NASA operated the Apollo 11 mission the Fighter pilot Buzz Aldrin is a Buzz Aldrin , Buzz Aldrin , a United States national, was born in Gien 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 born in Glen Ridge, New Jersey Buzz Aldrin William Anders Buzz Aldrin Buzz Aldrin Buzz Adrin was a member of the crew of Apollo 11 . Apollo 11 was operated by NASA and William Anders . Buzz Adrin was a Fighter pilot . Buzz Adrin was born in Glen Ridge, New Jersey . United States national Buzz Adrin Buzz Aldrin is a United States national . the backup pilot of Apollo 11 is William Anders . the Apollo 11 program was organized by NASA . the Fighter pilot Buzz Aldrin is a United States national and a member of the Apolo 11 crew where William Anders was a backup pilot. the Fighter pilot Buzz Aldrin is a Buzz Aldrin . Buzz Aldrin was born in Gien Ridge, New Jersey . the Apollo 11 program was organized 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 . Gen Ridge. New Jersey is the birthplace of Buzz Aldrin and the state of Buzz Al United States 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 was a member of the crew of Apollo 11 NASA 's Apolio 11 backup pilot is William Anders . Buzz Adrin (born in Glen Ridge, New Jersey) served as a Fighter pilot and was part of the crew of Apolo 11 . United States national Buzz Adrin Buzz Adrin , a United States Figher pilot , was a member of the Apolo 11 crew and was born in Glen Ridge, New Jersey . the Apolo 11 program was organized by NASA . William Anders was a backup pilot of Apolo 11 NASA 's Apolio 11 backup pilot is William Anders . Buzz Aldrin , a United States national , was a crew member of Apolio 11 . Glen Ridge, New Jersey is the birthplace of Buzz Aldrin . Buzz Aldrin was a Fighter pilot Fighter pilot NASA 's Apollo 11 backup pilot is William Anders Glen Ridge, New Jersey born Fighter pilot Buzz Adrin is a United States national who was born in Glen Ridge, New Jersey . Buzz Adrin was a crew member of Apollo 11 where William Anders served as backup pilot. the Apollo 11 program was organized by NASA Buzz Aldrin was a Fighter pilot and a crew member of Apollo 11 operated by NASA . United States Apollo 11 Apollo 11 crew member of ي ھ was born in , a United States was a Buzz Aldrin was born in Glen Ridge, New Jersey . program was organized by NASA 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 was the backup pilot of United States Fighter pilot Glen Ridge, New Jersey Buzz Aldrin served as a Fighter pilot Fighter pilot, was a member of the Apollo 11 crew. the Apollo 11 program was organized by NASA. Glen Ridge, New Jersey is the birthplace of Buzz Aldrin. William Anders was a backup pilot of Apollo 11 national Buzz Aldrin , a Fighter pilot , was born in Gien Ridge. New Jersey and was born in the United States . Apollo 11 was operated by NASA and William Anders Buzz Aldrin was a crew member of Apollo 11 . NASA 's Apollo 11 backup pilot is William Anders Buzz Aldrin is a , was born in Apollo 11 , operated by NASA United States Buzz Aldrin Buzz Aldrin (born in Glen Ridge, New Jersey) served as a Glen Ridge, New Jersey and serving the crew member of Buzz Aldrin (born in Glen Ridge, New Jersey) served as a Fighter pilot . Buzz Aldrin was an United States was a member of the crew of Apollo 11 operated by NASA and is United States Buzz Aldrin , a crew member of Apollo 11 , was born in the United States . NASA 's Apollo 11 backup pilot is William Anders national . Apollo 11 's backup pilot was William Anders and he is operated by NASA Buzz Aldrin Glen Ridge, New Jersey is the birthplace of ي. ھ Fighter pilot who was born in Gien Ridge, New Jersey . William Anders was the backup pilot 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 national Apollo 11 Fighter pilot , was a crew member of Buzz Aldrin Buzz Aldrin William Anders was a backup pilot of Buzz Aldrin is a United States national Buzz Aldrin was a crew member of . Buzz Aldrin was a Fighter pilot who was born in the United States was a Apollo 11 and served as a Fighter pilot . Buzz Aldrin was a member of the crew of Apollo 11 . Buzz Aldrin is a . William Anders . the Buzz Aldrin was born in Glen Ridge, New Jersey and served as a crew member of Apollo 11 Apollo 11 program was organized by was a backup pilot of Apollo 11 . the Apollo 11 Fighter pilot Apollo 11 was a crew member of Buzz Aldrin Apollo 11 where William Anders Buzz Aldrin was a member of the crew of Glen Ridge, New Jersey . Buzz Aldrin is a United States nationa NASA was a backup pilot and operated by NASA Fighter pilot is the birthplace of . the backup pilot of Apollo 11 is William Anders Buzz Aldrin is a Buzz Aldrin Apollo 11 United States national Buzz Aldrin Buzz Aldrin is a United States national

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 pretrained 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