

Gradual Language Model Adaptation Using Fine-Grained Typology

Marcell Richard Fekete
Aalborg University
Copenhagen, Denmark
mrfe@cs.aau.dk

Johannes Bjerva
Aalborg University
Copenhagen, Denmark
jbjerva@cs.aau.dk

Transformer-based language models (LMs) offer superior performance in a wide range of NLP tasks compared to previous paradigms. However, the vast majority of the world’s languages do not have adequate training data available for monolingual LMs (Joshi et al., 2020). Multilingual LMs like mBERT (Devlin et al., 2019) and XLM-RoBERTa (Conneau et al., 2020) offer a solution to this state of affairs, and their joint pretraining on data taken from a large set of languages results in surprisingly robust cross-lingual representations (Pires et al., 2019; Wu and Dredze, 2019, 2020). This lends them the ability to also carry out zero-shot transfer, solving tasks in a target language without language-specific supervision (Wu and Dredze, 2019; Üstün et al., 2020, 2022).

However, multilingual LMs may struggle when it comes to adapting to additional languages (Conneau et al., 2020; Pfeiffer et al., 2020; de Vries et al., 2021). This is especially true if these languages are resource-poor (Wu and Dredze, 2020; Rust et al., 2021; Pfeiffer et al., 2020, 2021), or have typological characteristics unseen by the LM during its pretraining (Üstün et al., 2020, 2022). The performance of multilingual LMs might suffer even on resource-rich languages due to the lack of model capacity to adequately incorporate language-specific parameters and vocabulary (Conneau et al., 2020; Pfeiffer et al., 2020; Üstün et al., 2020, 2022), although some success has been achieved with model adaptation techniques that add extra language-specific parameters to multilingual LMs (Houlsby et al., 2019; Pfeiffer et al., 2020; Üstün et al., 2020, 2022).

Beyond standard training methods for multilingual LMs, monolingual model adaptation techniques may help to overcome the relatively low adaptability for resource-poor languages (de Vries et al., 2021), by adapting monolingual LMs to closely related target languages. Ács et al. (2021) do not find that language-relatedness is a significant

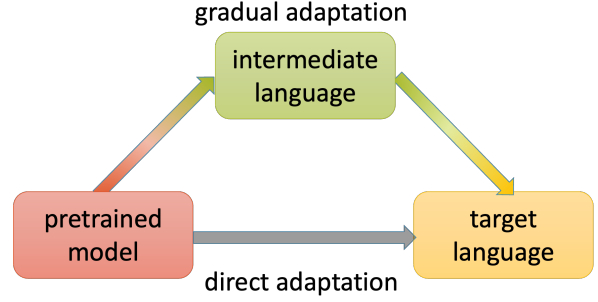


Figure 1: Gradual adaptation proceeds from the source language to the target language through an intermediate language in order to maximise cross-lingual transfer to the benefit of the target language.

indicator in determining whether transfer would work best for various Uralic languages using various monolingual and multilingual LMs. In contrast, de Vries et al. (2021) observe a positive correlation between the typological similarity of the LM and target languages and the success of transfer when looking at Gronings and West Frisian. While these studies reach conflicting conclusions, it is possible that differences in specific model adaptation techniques may explain the discrepancies in their findings; the former study fine-tunes LM weights using training data from target languages, while the latter retrains the lexical layer while freezing all LM weights.

In this paper, we build upon previous work on monolingual model adaptation, extending it in a new, flexible, typologically-informed framework of *gradual* model adaptation. Instead of directly adapting a monolingual LM to a target language, we propose that adaptation should take place in multiple stages (see Figure 1), based on the insight that cross-lingual transfer is enhanced by typological similarity (Pires et al., 2019; Üstün et al., 2020, 2022; de Vries et al., 2021). We hypothesise that by ensuring high typological similarity between the languages involved throughout the gradual adapta-

tion process, we can facilitate this transfer. Gradual model adaptation is also informed by principles of curriculum learning, which aims to find an ideal ordering of training instances in order to enhance LM learning (Bengio et al., 2009). In this case, the instances are in fact languages, while the ordering is based on typological similarity.

The explicit consideration of typology sets our work apart from a majority of model adaptation approaches that either do not consider the individual properties of languages (Pfeiffer et al., 2020, 2021; Artetxe et al., 2020; Rust et al., 2021; Bapna and Firat, 2019), or consider solely their genealogical relations (Wu and Dredze, 2020; Ács et al., 2021; Faisal and Anastasopoulos, 2022). When it comes to typologically informed approaches such as Üstün et al. (2020, 2022), they typically use features extracted from hand-crafted typological resources such as WALS WALS (Dryer and Haspelmath, 2013) and URIEL (Littell et al., 2017).

However, such hand-crafted typological resources are typically quite coarse-grained, and fail to represent the in-language variation in terms of features such as word order (Ponti et al., 2019). German, for instance, has verb-second word order except for in subordinate clauses, while Hungarian subjects may precede or follow their verbs depending on topicalization. While de Vries et al. (2021) quantifies language similarity using a lexical-phonetic measure, we opt for using structural vectors derived from counts of dependency links (Bjerva et al., 2019). These provide a fine-grained and data-driven measure of typology, and we derive them from Universal Dependencies 2.11 (UD; Zeman et al., 2022).

We select our candidate languages from the Germanic subset of UD, and measure pairwise cosine similarity values between the structural vectors of these languages (see Figure 2). We evaluate the performance of BERT models such as English BERT (Devlin et al., 2019), German BERT (Chan et al., 2020), Norwegian BERT (Kummervold et al., 2021), Danish BERT (Hvingelby et al., 2020) and Dutch BERTje (de Vries et al., 2019) on language modelling and POS-tagging. We use data from UD to fine-tune LM weights on the target task, using two languages distinct from the model language m : besides target language t , we also use data for an intermediate language i . Language i is selected such that, in terms of cosine similarity of its structural vector with the structural vectors of m

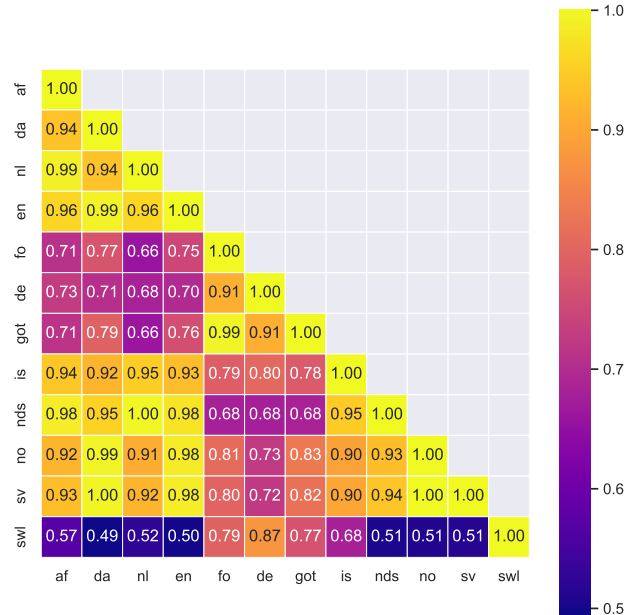


Figure 2: Pairwise cosine similarities between the structural vectors of Germanic languages in UD. The structural vectors compared derive from counts of dependency links following Bjerva et al. (2019).

and t , it is as close to equidistant as possible from both. For example, if m is German (*de*) and t is Norwegian (*no*; cosine similarity of .73), i might be Icelandic (*is*; cosine similarity from German .80 and from Norwegian 0.90) (see Figure 2). We found the POS-tagging is close to a performance ceiling even when fine-tuning our models on small amounts of training data in language t . Typically only 500 sentences are enough to reach F1-scores of 0.85-0.95 depending on the languages involved. This is why we aim to also evaluate our approach on dependency parsing. Moreover, we are expanding to the technique of retraining the lexical layer as an alternative of fine-tuning LM weights.

Our main contribution is the introduction of gradual model adaptation, a monolingual model adaptation framework that is capable of incorporating various measurements of typological similarity in designing intermediate model adaptation steps. By encouraging cross-lingual transfer, this approach may lead to improved performance of LMs on resource-poor languages. Additionally, the framework of gradual model adaptation might also allow us to assess the correlation between various – typological and non-typological – language similarity measures, as well as the efficacy of cross-lingual transfer.

References

- Judit Ács, Dániel Lévai, and Andras Kornai. 2021. [Evaluating transferability of BERT models on Uralic languages](#). In *Proceedings of the Seventh International Workshop on Computational Linguistics of Uralic Languages*, pages 8–17, Syktyvkar, Russia (Online). Association for Computational Linguistics.
- Mikel Artetxe, Sebastian Ruder, and Dani Yogatama. 2020. [On the cross-lingual transferability of monolingual representations](#). In *Proceedings of the 58th Annual Meeting of the Association for Computational Linguistics*, pages 4623–4637, Online. Association for Computational Linguistics.
- Ankur Bapna and Orhan Firat. 2019. [Simple, scalable adaptation for neural machine translation](#). In *Proceedings of the 2019 Conference on Empirical Methods in Natural Language Processing and the 9th International Joint Conference on Natural Language Processing (EMNLP-IJCNLP)*, pages 1538–1548, Hong Kong, China. Association for Computational Linguistics.
- Yoshua Bengio, Jérôme Louradour, Ronan Collobert, and Jason Weston. 2009. [Curriculum learning](#). In *Proceedings of the 26th Annual International Conference on Machine Learning - ICML '09*, pages 1–8, Montreal, Quebec, Canada. ACM Press.
- Johannes Bjerva, Robert Östling, Maria Han Veiga, Jörg Tiedemann, and Isabelle Augenstein. 2019. [What do language representations really represent?](#) *Computational Linguistics*, 45(2):381–389.
- Branden Chan, Stefan Schweter, and Timo Möller. 2020. [German’s next language model](#). In *Proceedings of the 28th International Conference on Computational Linguistics*, pages 6788–6796, Barcelona, Spain (Online). International Committee on Computational Linguistics.
- Alexis Conneau, Kartikay Khandelwal, Naman Goyal, Vishrav Chaudhary, Guillaume Wenzek, Francisco Guzmán, Edouard Grave, Myle Ott, Luke Zettlemoyer, and Veselin Stoyanov. 2020. [Unsupervised cross-lingual representation learning at scale](#). In *Proceedings of the 58th Annual Meeting of the Association for Computational Linguistics*, pages 8440–8451, Online. Association for Computational Linguistics.
- Wietse de Vries, Martijn Bartelds, Malvina Nissim, and Martijn Wieling. 2021. [Adapting monolingual models: Data can be scarce when language similarity is high](#). In *Findings of the Association for Computational Linguistics: ACL-IJCNLP 2021*, pages 4901–4907, Online. Association for Computational Linguistics.
- Wietse de Vries, Andreas van Cranenburgh, Arianna Bisazza, Tommaso Caselli, Gertjan van Noord, and Malvina Nissim. 2019. [BERTje: A Dutch BERT Model](#). ArXiv:1912.09582 [cs].
- Jacob Devlin, Ming-Wei Chang, Kenton Lee, and Kristina Toutanova. 2019. [BERT: Pre-training of deep bidirectional transformers for language understanding](#). In *Proceedings of the 2019 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies, Volume 1 (Long and Short Papers)*, pages 4171–4186, Minneapolis, Minnesota. Association for Computational Linguistics.
- M. S. Dryer and Martin Haspelmath. 2013. *The World Atlas of Linguistic Structures*. Max Planck Digital Library, München.
- Fahim Faisal and Antonios Anastasopoulos. 2022. [Phylogeny-inspired adaptation of multilingual models to new languages](#). In *Proceedings of the 2nd Conference of the Asia-Pacific Chapter of the Association for Computational Linguistics and the 12th International Joint Conference on Natural Language Processing (Volume 1: Long Papers)*, pages 434–452, Online only. Association for Computational Linguistics.
- Neil Houlsby, Andrei Giurgiu, Stanisław Jastrzebski, and Bruna Morrone. 2019. Parameter-Efficient Transfer Learning for NLP. In *Proceedings of the 36th International Conference on Machine Learning*, page 10, Long Beach, California.
- Rasmus Hvingelby, Amalie Brogaard Pauli, Maria Barrett, Christina Rosted, Lasse Malm Lidegaard, and Anders Søgaard. 2020. [DaNE: A named entity resource for Danish](#). In *Proceedings of the Twelfth Language Resources and Evaluation Conference*, pages 4597–4604, Marseille, France. European Language Resources Association.
- Pratik Joshi, Sebastin Santy, Amar Budhiraja, Kalika Bali, and Monojit Choudhury. 2020. [The state and fate of linguistic diversity and inclusion in the NLP world](#). In *Proceedings of the 58th Annual Meeting of the Association for Computational Linguistics*, pages 6282–6293, Online. Association for Computational Linguistics.
- Per E Kummervold, Javier De la Rosa, Freddy Wetjen, and Svein Arne Bryggjeld. 2021. [Operationalizing a national digital library: The case for a Norwegian transformer model](#). In *Proceedings of the 23rd Nordic Conference on Computational Linguistics (NoDaLiDa)*, pages 20–29, Reykjavik, Iceland (Online). Linköping University Electronic Press, Sweden.
- Patrick Littell, David R. Mortensen, Ke Lin, Katherine Kairis, Carlisle Turner, and Lori Levin. 2017. [URIEL and lang2vec: Representing languages as typological, geographical, and phylogenetic vectors](#). In *Proceedings of the 15th Conference of the European Chapter of the Association for Computational Linguistics: Volume 2, Short Papers*, pages 8–14, Valencia, Spain. Association for Computational Linguistics.
- Jonas Pfeiffer, Ivan Vulić, Iryna Gurevych, and Sebastian Ruder. 2020. [MAD-X: An Adapter-Based](#)

- Framework for Multi-Task Cross-Lingual Transfer.** In *Proceedings of the 2020 Conference on Empirical Methods in Natural Language Processing (EMNLP)*, pages 7654–7673, Online. Association for Computational Linguistics.
- Jonas Pfeiffer, Ivan Vulić, Iryna Gurevych, and Sebastian Ruder. 2021. **UNKs everywhere: Adapting multilingual language models to new scripts.** In *Proceedings of the 2021 Conference on Empirical Methods in Natural Language Processing*, pages 10186–10203, Online and Punta Cana, Dominican Republic. Association for Computational Linguistics.
- Telmo Pires, Eva Schlinger, and Dan Garrette. 2019. **How multilingual is multilingual BERT?** In *Proceedings of the 57th Annual Meeting of the Association for Computational Linguistics*, pages 4996–5001, Florence, Italy. Association for Computational Linguistics.
- Edoardo Maria Ponti, Helen O’Horan, Yevgeni Berzak, Ivan Vulić, Roi Reichart, Thierry Poibeau, Ekaterina Shutova, and Anna Korhonen. 2019. **Modeling language variation and universals: A survey on typological linguistics for natural language processing.** *Computational Linguistics*, 45(3):559–601.
- Phillip Rust, Jonas Pfeiffer, Ivan Vulić, Sebastian Ruder, and Iryna Gurevych. 2021. **How good is your tokenizer? on the monolingual performance of multilingual language models.** In *Proceedings of the 59th Annual Meeting of the Association for Computational Linguistics and the 11th International Joint Conference on Natural Language Processing (Volume 1: Long Papers)*, pages 3118–3135, Online. Association for Computational Linguistics.
- Ahmet Üstün, Arianna Bisazza, Gosse Bouma, and Gertjan van Noord. 2020. **UDapter: Language adaptation for truly Universal Dependency parsing.** In *Proceedings of the 2020 Conference on Empirical Methods in Natural Language Processing (EMNLP)*, pages 2302–2315, Online. Association for Computational Linguistics.
- Ahmet Üstün, Arianna Bisazza, Gosse Bouma, and Gertjan van Noord. 2022. **UDapter: Typology-based language adapters for multilingual dependency parsing and sequence labeling.** *Computational Linguistics*, 48(3):555–592.
- Shijie Wu and Mark Dredze. 2019. **Beto, bentz, becas: The surprising cross-lingual effectiveness of BERT.** In *Proceedings of the 2019 Conference on Empirical Methods in Natural Language Processing and the 9th International Joint Conference on Natural Language Processing (EMNLP-IJCNLP)*, pages 833–844, Hong Kong, China. Association for Computational Linguistics.
- Shijie Wu and Mark Dredze. 2020. **Are all languages created equal in multilingual BERT?** In *Proceedings of the 5th Workshop on Representation Learning for NLP*, pages 120–130, Online. Association for Computational Linguistics.
- Daniel Zeman, Joakim Nivre, Mitchell Abrams, Elia Ackermann, Noëmi Aepli, Hamid Aghaei, Željko Agić, Amir Ahmadi, Lars Ahrenberg, Chika Kennedy Ajede, Salih Furkan Akkurt, Gabrielè Aleksandraviciūtė, Ika Alfina, Avner Algom, Chiara Alzetta, Erik Andersen, Lene Antonsen, Katya Aplonova, Angelina Aquino, Carolina Aragon, Glyd Aranes, Maria Jesus Aranzabe, Bilge Nas Arican, Hórunn Arnardóttir, Gashaw Arutie, Jessica Naraiswari Arwidarasti, Masayuki Asahara, Katla Ásgeirsdóttir, Deniz Baran Aslan, Cengiz Asmazoğlu, Luma Ateyah, Furkan Atmaca, Mohammed Attia, Aitziber Atutxa, Liesbeth Augustinus, Elena Badmaeva, Keerthana Balasubramani, Miguel Ballesteros, Esha Banerjee, Sebastian Bank, Verginica Barbu Mititelu, Starkaður Barkarson, Rodolfo Basile, Victoria Basmov, Colin Batchelor, John Bauer, Seyyit Talha Bedir, Juan Belieni, Kepa Bengoetxea, Yifat Ben Moshe, Gözde Berk, Yevgeni Berzak, Irshad Ahmad Bhat, Riyaz Ahmad Bhat, Erica Biagetti, Eckhard Bick, Agnė Bielinskienė, Kristín Bjarnadóttir, Rogier Blokland, Victoria Bobicev, Loïc Boizou, Emanuel Borges Völker, Carl Börstell, Cristina Bosco, Gosse Bouma, Sam Bowman, Adriane Boyd, Anouck Braggaa, Kristina Brokaitė, Aljoscha Burchardt, Marie Candito, Bernard Caron, Gauthier Caron, Lauren Cassidy, Maria Clara Castro, Tatiana Cavalcanti, Gülşen Cebiroğlu Eryiğit, Flavio Massimiliano Cecchini, Giuseppe G. A. Celano, Slavomír Čepľo, Neslihan Cesur, Savas Cetin, Özlem Çetinoğlu, Fabrizio Chalub, Liyanage Chamila, Shweta Chauhan, Ethan Chi, Taishi Chika, Yongseok Cho, Jinho Choi, Jayeol Chun, Juyeon Chung, Alessandra T. Cignarella, Silvie Cinková, Aurélie Collomb, Çağrı Çöltekin, Miriam Connor, Daniela Corbetta, Marine Courtin, Mihaela Cristescu, Philemon Daniel, Elizabeth Davidson, Leonel Figueiredo de Alencar, Mathieu Dehouck, Martina de Laurentiis, Marie-Catherine de Marneffe, Valeria de Paiva, Mehmet Oguz Derin, Elvis de Souza, Arantza Diaz de Ilaraza, Carly Dickerson, Arawinda Dinakaramani, Elisa Di Nuovo, Bamba Dione, Peter Dirix, Kaja Dobrovoljc, Timothy Dozat, Kira Droganova, Puneet Dwivedi, Christian Ebert, Hanne Eckhoff, Sandra Eiche, Marhaba Eli, Ali Elkahky, Binyam Ephrem, Olga Erina, Tomaž Erjavec, Aline Etienne, Wograinne Evelyn, Sidney Facundes, Richárd Farkas, Federica Favero, Jannatul Ferdousi, Marília Fernanda, Hector Fernandez Alcalde, Jennifer Foster, Cláudia Freitas, Kazunori Fujita, Katarína Gajdošová, Daniel Galbraith, Federica Gamba, Marcos Garcia, Moa Gärdenfors, Sebastian Garza, Fabrício Ferraz Gerardi, Kim Gerdes, Filip Ginter, Gustavo Godoy, Iakes Goenaga, Koldo Gojenola, Memduh Gökırmak, Yoav Goldberg, Xavier Gómez Guinovart, Berta González Saavedra, Bernadeta Griciūtė, Matias Gironi, Loïc Grobol, Normunds Grūzītis, Bruno Guillaume, Céline Guillot-Barbance, Tunga Güngör, Nizar Habash, Hinrik Hafsteinsson, Jan Hajič, Jan Hajič jr., Mika Hämmäläinen, Linh Hà Mỹ, Na-Rae Han, Muhammad Yudistira Hanifmuti, Takahiro Harada, Sam Hardwick, Kim Harris, Dag Haug, Johannes Heinecke, Oliver Hellwig, Felix Hen-

nig, Barbora Hladká, Jaroslava Hlaváčová, Florinel Hociung, Petter Hohle, Marivel Huerta Mendez, Jena Hwang, Takumi Ikeda, Anton Karl Ingason, Radu Ion, Elena Irimia, Olájidé Ishola, Artan Islamaj, Kaoru Ito, Siratun Jannat, Tomáš Jelínek, Apoorva Jha, Katharine Jiang, Anders Johannsen, Hildur Jónsdóttir, Fredrik Jørgensen, Markus Juutinen, Hüner Kaşıkara, Andre Kaasen, Nadezhda Kabaeva, Sylvain Kahane, Hiroshi Kanayama, Jenna Kanerva, Neslihan Kara, Ritván Karahóga, Boris Katz, Tolga Kayadelen, Sarveswaran Kengatharaiyer, Jessica Kenney, Václava Kettnerová, Jesse Kirchner, Elena Klementieva, Elena Klyachko, Arne Köhn, Abdullatif Köksal, Kamil Kopacewicz, Timo Korriakangas, Mehmet Köse, Alexey Koshevoy, Natalia Kotsyba, Jolanta Kovalevskaitė, Simon Krek, Parameswari Krishnamurthy, Sandra Kübler, Adrian Kuqi, Oğuzhan Kuyrukçu, Aslı Kuzgun, Sookyoung Kwak, Veronika Laippala, Lucia Lam, Lorenzo Lambertino, Tatiana Lando, Septina Dian Larasati, Alexei Lavrentiev, John Lee, Phng Lê Hồng, Alessandro Lenci, Saran Lertpradit, Herman Leung, Maria Levina, Cheuk Ying Li, Josie Li, Keying Li, Yixuan Li, Yuan Li, KyungTae Lim, Bruna Lima Padovani, Krister Lindén, Nikola Ljubešić, Olga Loginova, Stefano Lusito, Andry Luthfi, Mikko Luukko, Olga Lyahevskaya, Teresa Lynn, Vivien Macketanz, Menel Mahamdi, Jean Maillard, Ilya Makarchuk, Aibek Makazhanov, Michael Mandl, Christopher Manning, Ruli Manurung, Büşra Marşan, Cătălina Măranduc, David Mareček, Katrin Marheinecke, Stella Markantonatou, Héctor Martínez Alonso, Lorena Martín Rodríguez, André Martins, Jan Mašek, Hiroshi Matsuda, Yuji Matsumoto, Alessandro Mazzei, Ryan McDonald, Sarah McGuinness, Gustavo Mendonça, Tatiana Merzhevich, Niko Miekka, Karina Mischenkova, Margarita Misirpashayeva, Anna Misilä, Cătălin Mititelu, Maria Mitrofan, Yusuke Miyao, AmirHossein Mojiri Foroushani, Judit Molnár, Amirsaeid Moloodi, Simonetta Montemagni, Amir More, Laura Moreno Romero, Giovanni Moretti, Keiko Sophie Mori, Shinsuke Mori, Tomohiko Morioka, Shigeki Moro, Bjartur Mortensen, Bohdan Moskalevskyi, Kadri Muischnek, Robert Munro, Yugo Murawaki, Kaili Müürisep, Pinkey Nainwani, Mariam Nakhil, Juan Ignacio Navarro Horñi-acek, Anna Nedoluzhko, Gunta Nešpore-Bērzkalne, Manuela Nevaci, Lng Nguyễn Thị, Huyền Nguyễn Thị Minh, Yoshihiro Nikaido, Vitaly Nikolaev, Ratima Nitisaroj, Alireza Nourian, Hanna Nurmi, Stina Ojala, Atul Kr. Ojha, Hulda Óladóttir, Adédayo Olúòkun, Mai Omura, Emeka Onwuegbuzia, Noam Ordan, Petya Osenova, Robert Östling, Lilja Øvrelid, Şaziye Betül Özateş, Merve Özçelik, Arzucan Özgür, Balkız Öztürk Başaran, Teresa Paccosi, Alessio Palmero Aprosio, Anastasia Panova, Hyunji Hayley Park, Niko Partanen, Elena Pascual, Marco Passarotti, Agnieszka Patejuk, Guilherme Paulino-Passos, Giulia Pedonese, Angelika Peljak-Łapińska, Siyao Peng, Cenel-Augusto Perez, Natalia Perkova, Guy Perrier, Slav Petrov, Daria Petrova, Andrea Peverelli, Jason Phelan, Jussi Piitulainen, Rodrigo Pintucci, Tommi A Pirinen, Emily Pitler, Magdalena Plamada,

Barbara Plank, Thierry Poibeau, Larisa Ponomareva, Martin Popel, Lauma Pretkalniņa, Sophie Prévost, Prokopis Prokopidis, Adam Przepiórkowski, Robert Pugh, Tiina Puolakainen, Sampo Pyysalo, Peng Qi, Andriela Rääbis, Alexandre Rademaker, Mizanur Rahman, Taraka Rama, Loganathan Ramasamy, Carlos Ramisch, Fam Rashel, Mohammad Sadegh Rasooli, Vinit Ravishankar, Livy Real, Petru Rebeja, Siva Reddy, Mathilde Regnault, Georg Rehm, Ivan Riabov, Michael Rießler, Erika Rimkutė, Larissa Rinaldi, Laura Rituma, Putri Rizqiyah, Luisa Rocha, Eiríkur Rögnvaldsson, Ivan Roksandic, Mykhailo Romanenko, Rudolf Rosa, Valentin Roşca, Davide Rovati, Ben Rozonoyer, Olga Rudina, Jack Rueter, Kristján Rúnarsson, Shoval Sadde, Pegah Safari, Benoît Sagot, Aleksí Sahala, Shadi Saleh, Alessio Salomoni, Tanja Samardžić, Stephanie Samson, Manuela Sanguinetti, Ezgi Samıyar, Dage Särg, Marta Sartor, Mitsuya Sasaki, Baiba Saulīte, Yanin Sawanakunanon, Shefali Saxena, Kevin Scannell, Salvatore Scarlata, Nathan Schneider, Sebastian Schuster, Lane Schwartz, Djamé Seddah, Wolfgang Seeker, Mojgan Seraji, Syeda Shahzadi, Mo Shen, Atsuko Shimada, Hiroyuki Shirasu, Yana Shishkina, Muh Shohibussirri, Maria Shvedova, Janine Siewert, Einar Freyr Sigurðsson, João Ricardo Silva, Aline Silveira, Natalia Silveira, Maria Simi, Radu Simionescu, Katalin Simkó, Mária Šimková, Haukur Barri Simonarson, Kiril Simov, Dmitri Sitchinava, Maria Skachedubova, Aaron Smith, Isabela Soares-Bastos, Barbara Sonnenhauser, Shafi Sourov, Carolyn Spadine, Rachele Sprugnoli, Vivian Stamou, Steinhór Steingrímsson, Antonio Stella, Abishek Stephen, Milan Straka, Emmett Strickland, Jana Strnadová, Alane Suhr, Yogi Lesmana Sulestio, Umut Sulubacak, Shingo Suzuki, Daniel Swanson, Zsolt Szántó, Chihiro Taguchi, Dima Taji, Yuta Takahashi, Fabio Tamburini, Mary Ann C. Tan, Takaaki Tanaka, Dipta Tanaya, Mirko Tavoni, Samson Tella, Isabelle Tellier, Marinella Testori, Guillaume Thomas, Sara Tonelli, Liisi Torga, Marsida Toska, Trond Trosterud, Anna Trukhina, Reut Tsarfaty, Utku Türk, Francis Tyers, Sveinbjörn Hórdarson, Vilhjálmur Hörsteinsson, Sumire Uematsu, Roman Untilov, Zdeňka Uřešová, Larraitz Uria, Hans Uszkoreit, Andrius Utka, Elena Vagnoni, Sowmya Vajjala, Rob van der Goot, Martine Vanhove, Daniel van Niekerk, Gertjan van Noord, Viktor Varga, Uliana Vedenina, Giulia Venturi, Eric Villemonte de la Clergerie, Veronika Vincze, Natalia Vlasova, Aya Wakasa, Joel C. Wallenberg, Lars Wallin, Abigail Walsh, Jing Xian Wang, Jonathan North Washington, Maximilian Wendt, Paul Widmer, Shira Wigderson, Sri Hartati Wijono, Vanessa Berwanger Wille, Seyi Williams, Mats Wirén, Christian Wittern, Tsegay Woldemariam, Tak-sum Wong, Alina Wróblewska, Mary Yako, Kayo Yamashita, Naoki Yamazaki, Chunxiao Yan, Koichi Yasuoka, Marat M. Yavrumyan, Arife Betül Yenice, Olcay Taner Yıldız, Zhuoran Yu, Arlisa Yuliawati, Zdeněk Žabokrtský, Shorouq Zahra, Amir Zeldes, He Zhou, Hanzhi Zhu, Anna Zhuravleva, and Rayan Ziane. 2022. [Universal dependencies 2.11](#). LINDAT/CLARIAH-CZ digital library at the Insti-

tute of Formal and Applied Linguistics (ÚFAL), Faculty of Mathematics and Physics, Charles University.