## References

- [1] R. Li, K. Bladin, Y. Zhao, C. Chinara, O. Ingraham, P. Xiang, X. Ren, P. Prasad, B. Kishore, J. Xing *et al.*, "Learning formation of physically-based face attributes," in *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*, 2020, pp. 3410–3419.
- [2] P. Salehi, A. Chalechale, and M. Taghizadeh, "Generative adversarial networks (gans): An overview of theoretical model, evaluation metrics, and recent developments," *arXiv preprint arXiv:2005.13178*, 2020.
- [3] I. J. Goodfellow, J. Pouget-Abadie, M. Mirza, B. Xu, D. Warde-Farley, S. Ozair, A. Courville, and Y. Bengio, "Generative adversarial networks," *arXiv preprint arXiv:1406.2661*, 2014.
- [4] A. Radford, L. Metz, and S. Chintala, "Unsupervised representation learning with deep convolutional generative adversarial networks," *arXiv* preprint arXiv:1511.06434, 2015.
- [5] M.-Y. Liu and O. Tuzel, "Coupled generative adversarial networks," *arXiv preprint arXiv:1606.07536*, 2016.
- [6] T. Karras, T. Aila, S. Laine, and J. Lehtinen, "Progressive growing of gans for improved quality, stability, and variation," *arXiv* preprint *arXiv*:1710.10196, 2017.
- [7] T. Karras, S. Laine, and T. Aila, "A style-based generator architecture for generative adversarial networks," in *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, June 2019.
- [8] "A tutorial on conditional generative adversarial nets + keras implementation," https://medium.com/@ma.bagheri/a-tutorial-on-conditional-generative-adversarial-nets-keras-implementation-694dcafa6282, accessed: 2021-04-26.

- [9] "From gan basic to stylegan2," https://medium.com/analytics-vidhya/from-gan-basic-to-stylegan2-680add7abe82, accessed: 2021-04-29.
- [10] A. Brock, J. Donahue, and K. Simonyan, "Large scale gan training for high fidelity natural image synthesis," *arXiv preprint arXiv:1809.11096*, 2018.
- [11] T. Karras, S. Laine, M. Aittala, J. Hellsten, J. Lehtinen, and T. Aila, "Analyzing and improving the image quality of stylegan," in *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*, 2020, pp. 8110–8119.
- [12] T. Karras, M. Aittala, J. Hellsten, S. Laine, J. Lehtinen, and T. Aila, "Training generative adversarial networks with limited data," in *Proc. NeurIPS*, 2020.
- [13] "A simple explanation of the inception score," https://medium.com/octavian-ai/a-simple-explanation-of-the-inception-score-372dff6a8c7a, accessed: 2021-04-30.
- [14] P. Debevec, T. Hawkins, C. Tchou, H.-P. Duiker, W. Sarokin, and M. Sagar, "Acquiring the reflectance field of a human face," vol. 2000, 07 2000. doi: 10.1145/344779.344855 pp. 145–156.
- [15] "Photogrammetry," https://en.wikipedia.org/wiki/Photogrammetry, accessed: 2021-05-12.
- [16] B. Egger, W. A. Smith, A. Tewari, S. Wuhrer, M. Zollhoefer, T. Beeler, F. Bernard, T. Bolkart, A. Kortylewski, S. Romdhani *et al.*, "3d morphable face models—past, present, and future," *ACM Transactions on Graphics (TOG)*, vol. 39, no. 5, pp. 1–38, 2020.
- [17] B. Gecer, A. Lattas, S. Ploumpis, J. Deng, A. Papaioannou, S. Moschoglou, and S. Zafeiriou, "Synthesizing coupled 3d face modalities by trunk-branch generative adversarial networks," in *European Conference on Computer Vision*. Springer, 2020, pp. 415–433.
- [18] A. Paszke, S. Gross, F. Massa, A. Lerer, J. Bradbury, G. Chanan, T. Killeen, Z. Lin, N. Gimelshein, L. Antiga, A. Desmaison, A. Kopf, E. Yang, Z. DeVito, M. Raison, A. Tejani,

- S. Chilamkurthy, B. Steiner, L. Fang, J. Bai, and S. Chintala, "Pytorch: An imperative style, high-performance deep learning library," in *Advances in Neural Information Processing Systems* 32, H. Wallach, H. Larochelle, A. Beygelzimer, F. d'Alché-Buc, E. Fox, and R. Garnett, Eds. Curran Associates, Inc., 2019, pp. 8024–8035. [Online]. Available: http://papers.neurips.cc/paper/9015-pytorch-an-imperative-style-high-performance-deep-learning-library.pdf
- [19] V. Blanz and T. Vetter, "A morphable model for the synthesis of 3d faces," in *Proceedings of the 26th annual conference on Computer graphics and interactive techniques*, 1999, pp. 187–194.
- [20] J. Booth, A. Roussos, S. Zafeiriou, A. Ponniah, and D. Dunaway, "A 3d morphable model learnt from 10,000 faces," in *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*, 2016, pp. 5543–5552.
- [21] M. Lüthi, T. Gerig, C. Jud, and T. Vetter, "Gaussian process morphable models," *IEEE transactions on pattern analysis and machine intelligence*, vol. 40, no. 8, pp. 1860–1873, 2017.
- [22] H. Dai, N. Pears, W. A. Smith, and C. Duncan, "A 3d morphable model of craniofacial shape and texture variation," in *Proceedings of the IEEE International Conference on Computer Vision*, 2017, pp. 3085–3093.
- [23] P. Huber, G. Hu, R. Tena, P. Mortazavian, P. Koppen, W. J. Christmas, M. Ratsch, and J. Kittler, "A multiresolution 3d morphable face model and fitting framework," in *Proceedings of the 11th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications*, 2016.
- [24] J. Booth, A. Roussos, E. Ververas, E. Antonakos, S. Ploumpis, Y. Panagakis, and S. Zafeiriou, "3d reconstruction of "in-the-wild" faces in images and videos," *IEEE transactions on pattern analysis and machine intelligence*, vol. 40, no. 11, pp. 2638–2652, 2018.
- [25] V. Blanz, C. Basso, T. Poggio, and T. Vetter, "Reanimating faces in images and video," in *Computer graphics forum*, vol. 22, no. 3. Wiley Online Library, 2003, pp. 641–650.

- [26] D. Vlasic, M. Brand, H. Pfister, and J. Popovic, "Face transfer with multilinear models," in ACM SIGGRAPH 2006 Courses, 2006, pp. 24– es.
- [27] P. Paysan, R. Knothe, B. Amberg, S. Romdhani, and T. Vetter, "A 3d face model for pose and illumination invariant face recognition," in 2009 sixth IEEE international conference on advanced video and signal based surveillance. Ieee, 2009, pp. 296–301.
- [28] T. Gerig, A. Morel-Forster, C. Blumer, B. Egger, M. Luthi, S. Schönborn, and T. Vetter, "Morphable face models-an open framework," in 2018 13th IEEE International Conference on Automatic Face & Gesture Recognition (FG 2018). IEEE, 2018, pp. 75–82.
- [29] T. Li, T. Bolkart, M. Black, H. Li, and J. Romero, "Learning a model of facial shape and expression from 4d scans," *ACM Transactions on Graphics*, vol. 36, pp. 1–17, 11 2017. doi: 10.1145/3130800.3130813
- [30] V. F. Abrevaya, S. Wuhrer, and E. Boyer, "Multilinear autoencoder for 3d face model learning," in 2018 IEEE Winter Conference on Applications of Computer Vision (WACV). IEEE, 2018, pp. 1–9.
- [31] T. Bagautdinov, C. Wu, J. Saragih, P. Fua, and Y. Sheikh, "Modeling facial geometry using compositional vaes," in *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*, 2018, pp. 3877–3886.
- [32] S. Lombardi, J. Saragih, T. Simon, and Y. Sheikh, "Deep appearance models for face rendering," *ACM Transactions on Graphics (TOG)*, vol. 37, no. 4, pp. 1–13, 2018.
- [33] R. Slossberg, G. Shamai, and R. Kimmel, "High quality facial surface and texture synthesis via generative adversarial networks," in *Proceedings of the European Conference on Computer Vision (ECCV) Workshops*, 2018, pp. 0–0.
- [34] V. F. Abrevaya, A. Boukhayma, S. Wuhrer, and E. Boyer, "A generative 3d facial model by adversarial training," 2019.
- [35] A. Ranjan, T. Bolkart, S. Sanyal, and M. J. Black, "Generating 3d faces using convolutional mesh autoencoders," in *Proceedings of the European Conference on Computer Vision (ECCV)*, 2018, pp. 704–720.

- [36] S. Cheng, M. Bronstein, Y. Zhou, I. Kotsia, M. Pantic, and S. Zafeiriou, "Meshgan: Non-linear 3d morphable models of faces," *arXiv preprint arXiv:1903.10384*, 2019.
- [37] M. Schumacher and V. Blanz, "Exploration of the correlations of attributes and features in faces," in 2015 11th IEEE International Conference and Workshops on Automatic Face and Gesture Recognition (FG), vol. 1. IEEE, 2015, pp. 1–8.
- [38] B. Egger, D. Kaufmann, S. Schönborn, V. Roth, and T. Vetter, "Copula eigenfaces," in *Proc. International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications.* (GRAPP), 2016, pp. 50–58.
- [39] G. Shamai, R. Slossberg, and R. Kimmel, "Synthesizing facial photometries and corresponding geometries using generative adversarial networks," *ACM Transactions on Multimedia Computing, Communications, and Applications (TOMM)*, vol. 15, no. 3s, pp. 1–24, 2019.
- [40] Y. Zhou, J. Deng, I. Kotsia, and S. Zafeiriou, "Dense 3d face decoding over 2500fps: Joint texture & shape convolutional mesh decoders," in *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*, 2019, pp. 1097–1106.
- [41] M. Lucic, K. Kurach, M. Michalski, S. Gelly, and O. Bousquet, "Are gans created equal? a large-scale study," *arXiv preprint arXiv:1711.10337*, 2017.
- [42] X. Mao, Q. Li, H. Xie, R. Y. Lau, Z. Wang, and S. Paul Smolley, "Least squares generative adversarial networks," in *Proceedings of the IEEE international conference on computer vision*, 2017, pp. 2794–2802.
- [43] M. Arjovsky, S. Chintala, and L. Bottou, "Wasserstein generative adversarial networks," in *International conference on machine learning*. PMLR, 2017, pp. 214–223.
- [44] M. Mirza and S. Osindero, "Conditional generative adversarial nets," *arXiv preprint arXiv:1411.1784*, 2014.
- [45] E. Härkönen, A. Hertzmann, J. Lehtinen, and S. Paris, "Ganspace: Discovering interpretable gan controls," *arXiv preprint arXiv:2004.02546*, 2020.

- [46] A. Shoshan, N. Bhonker, I. Kviatkovsky, and G. Medioni, "Gan-control: Explicitly controllable gans," *arXiv preprint arXiv:2101.02477*, 2021.
- [47] A. Krizhevsky, V. Nair, and G. Hinton, "Cifar-10 (canadian institute for advanced research)." [Online]. Available: http://www.cs.toronto.edu/~kriz/cifar.html
- [48] Z. Zhao, S. Singh, H. Lee, Z. Zhang, A. Odena, and H. Zhang, "Improved consistency regularization for gans," *arXiv preprint arXiv:2002.04724*, 2020.
- [49] L. Tran and X. Liu, "On learning 3d face morphable model from inthe-wild images," *IEEE transactions on pattern analysis and machine intelligence*, vol. 43, no. 1, pp. 157–171, 2019.
- [50] H. Nyquist, "Certain topics in telegraph transmission theory," *Transactions of the American Institute of Electrical Engineers*, vol. 47, no. 2, pp. 617–644, 1928.
- [51] H. Blumberg, "Hausdorff's grundzüge der mengenlehre," *Bulletin of the American Mathematical Society*, vol. 27, no. 3, pp. 116–129, 1920.
- [52] K. He, X. Zhang, S. Ren, and J. Sun, "Deep residual learning for image recognition," in *Proceedings of the IEEE conference on computer vision and pattern recognition*, 2016, pp. 770–778.
- [53] O. Russakovsky, J. Deng, H. Su, J. Krause, S. Satheesh, S. Ma, Z. Huang, A. Karpathy, A. Khosla, M. Bernstein, A. C. Berg, and L. Fei-Fei, "ImageNet Large Scale Visual Recognition Challenge," *International Journal of Computer Vision (IJCV)*, vol. 115, no. 3, pp. 211–252, 2015. doi: 10.1007/s11263-015-0816-y
- [54] S. Wold, K. Esbensen, and P. Geladi, "Principal component analysis," *Chemometrics and intelligent laboratory systems*, vol. 2, no. 1-3, pp. 37–52, 1987.
- [55] L. Van der Maaten and G. Hinton, "Visualizing data using t-sne." *Journal of machine learning research*, vol. 9, no. 11, 2008.
- [56] A. Borji, "Pros and cons of gan evaluation measures," *Computer Vision and Image Understanding*, vol. 179, pp. 41–65, 2019.

- [57] T. Salimans, I. Goodfellow, W. Zaremba, V. Cheung, A. Radford, and X. Chen, "Improved techniques for training gans," *arXiv preprint arXiv:1606.03498*, 2016.
- [58] C. Szegedy, V. Vanhoucke, S. Ioffe, J. Shlens, and Z. Wojna, "Rethinking the inception architecture for computer vision," in *Proceedings of the IEEE conference on computer vision and pattern recognition*, 2016, pp. 2818–2826.
- [59] S. Kullback and R. A. Leibler, "On information and sufficiency," *The annals of mathematical statistics*, vol. 22, no. 1, pp. 79–86, 1951.
- [60] M. Heusel, H. Ramsauer, T. Unterthiner, B. Nessler, and S. Hochreiter, "Gans trained by a two time-scale update rule converge to a local nash equilibrium," *arXiv preprint arXiv:1706.08500*, 2017.
- [61] P. J. Besl and N. D. McKay, "Method for registration of 3-d shapes," in *Sensor fusion IV: control paradigms and data structures*, vol. 1611. International Society for Optics and Photonics, 1992, pp. 586–606.
- [62] W. Chen, J. Gao, H. Ling, E. J. Smith, J. Lehtinen, A. Jacobson, and S. Fidler, "Learning to predict 3d objects with an interpolation-based differentiable renderer," *arXiv preprint arXiv:1908.01210*, 2019.
- [63] Y. Zhao, Q. Xu, W. Chen, C. Du, J. Xing, X. Huang, and R. Yang, "Mask-off: Synthesizing face images in the presence of head-mounted displays," in 2019 IEEE Conference on Virtual Reality and 3D User Interfaces (VR). IEEE, 2019, pp. 267–276.
- [64] Y. HaCohen, E. Shechtman, D. B. Goldman, and D. Lischinski, "Non-rigid dense correspondence with applications for image enhancement," *ACM transactions on graphics (TOG)*, vol. 30, no. 4, pp. 1–10, 2011.