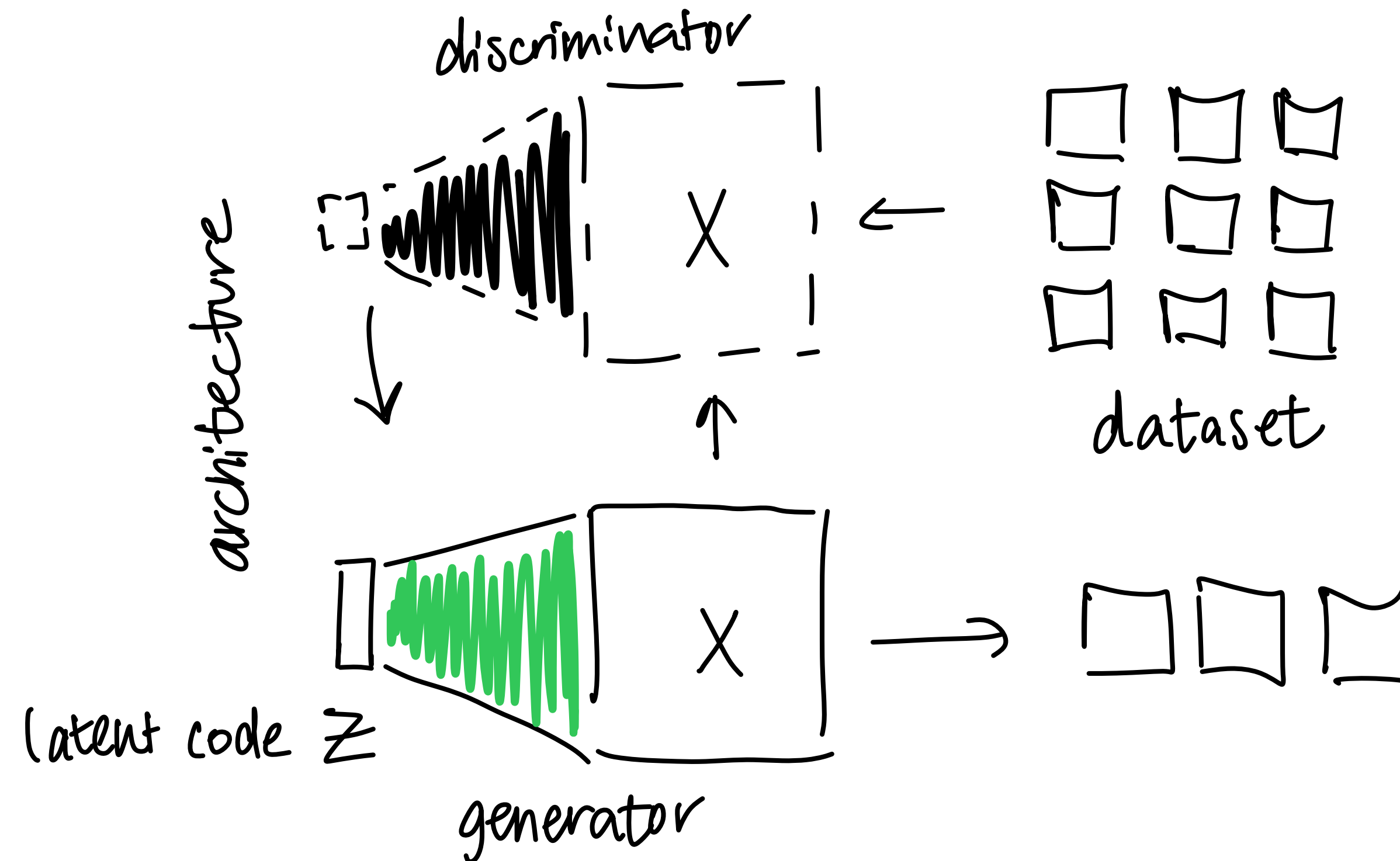


Towards a Framework for Human-AI Interaction Patterns in Co-Creative GAN Applications

Imke Grabe, Miguel Gonzalez-Duque, Sebastian Risi, Jichen Zhu
IT University of Copenhagen, Denmark

HAI-GEN Workshop at IUI 2022

Generative Adversarial Networks (GANs)

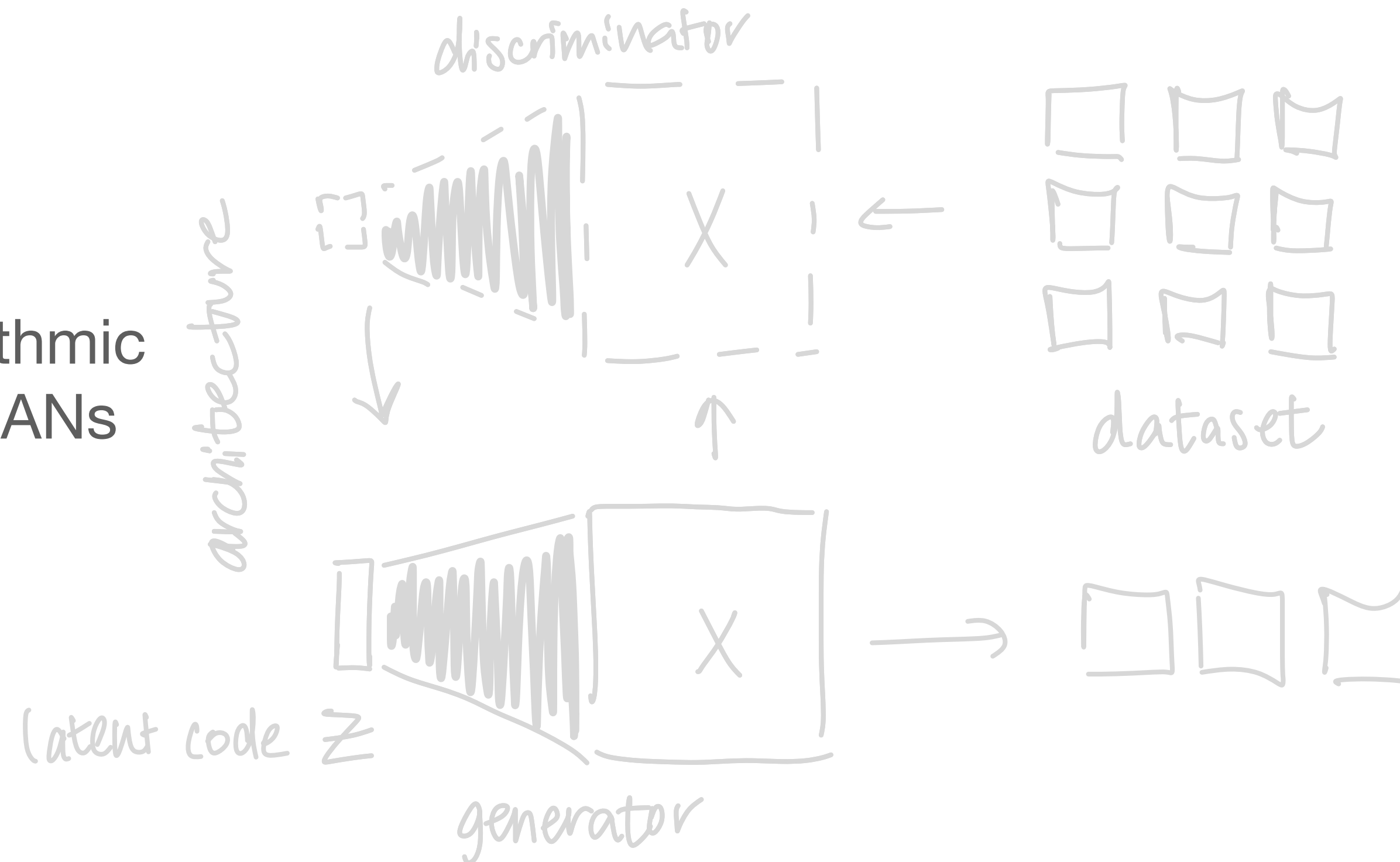


Goodfellow, I. J., Pouget-Abadie, J., Mirza, M., Xu, B., Warde-Farley, D., Ozair, S., Courville, A., & Bengio, Y. (2014). Generative Adversarial Nets. *NIPS'14: Proceedings of the 27th International Conference on Neural Information Processing Systems*, 2, 2672–2680. <http://www.github.com/goodfeli/adversarial>

Shamsolmoali, P., Zareapoor, M., Granger, E., Zhou, H., Wang, R., Celebi, M. E., & Yang, J. (2021). Image synthesis with adversarial networks: A comprehensive survey and case studies. *Information Fusion*, 72, 126–146. <https://doi.org/10.1016/j.inffus.2021.02.014>

Generative Adversarial Networks (GANs)

- Fast-paced algorithmic development of GANs



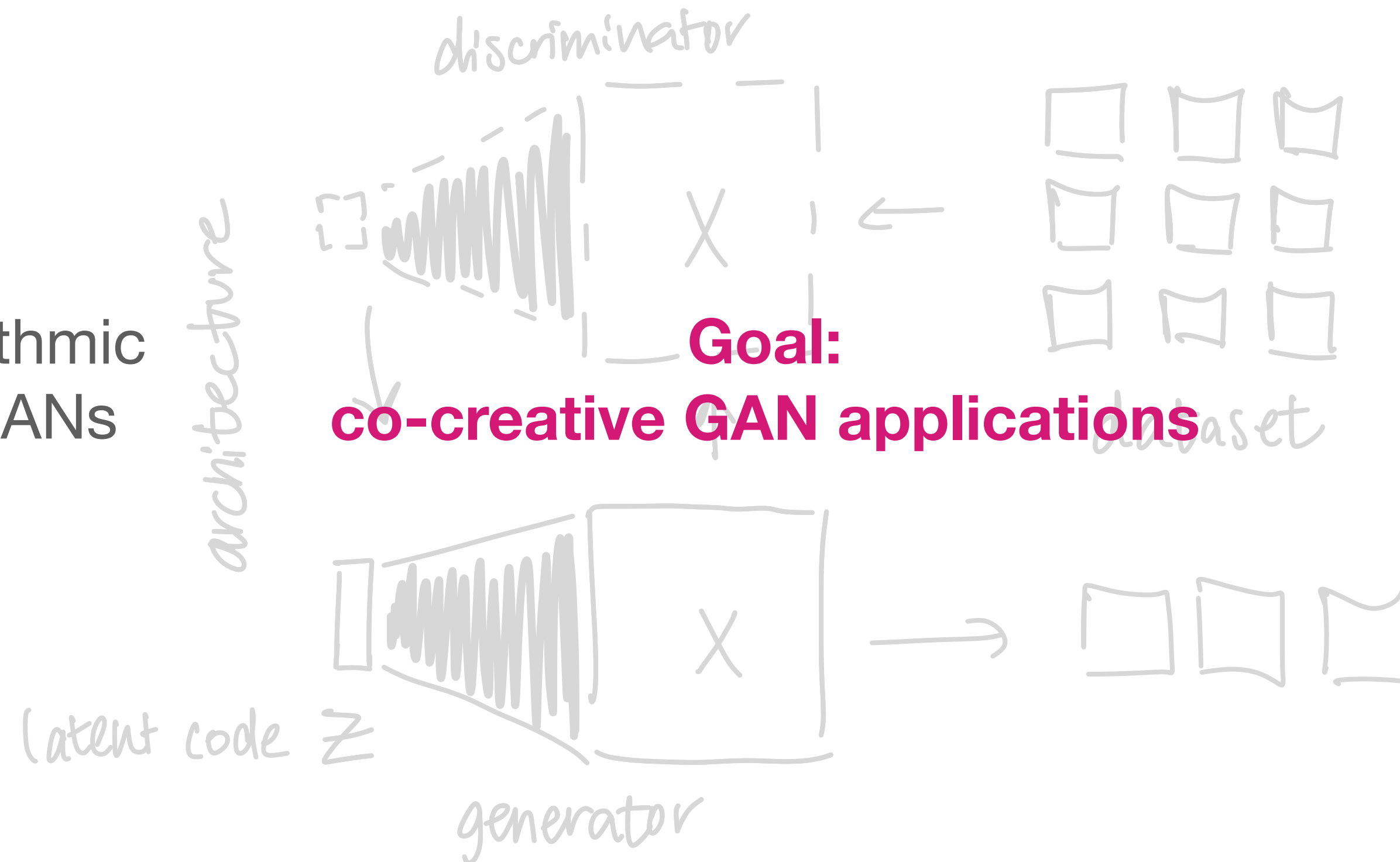
- Open problem: GANs for co-creation

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Related Work

- GANs applied in creative disciplines → knowledge gap: ML—design (Hughes et al., 2021)

Mixed initiative co-creation:

- Mapping actions taken by human and computer in co-creation (Spoto and Oleynik, 2017)
- Expanded to generative models (Muller et al., 2020)

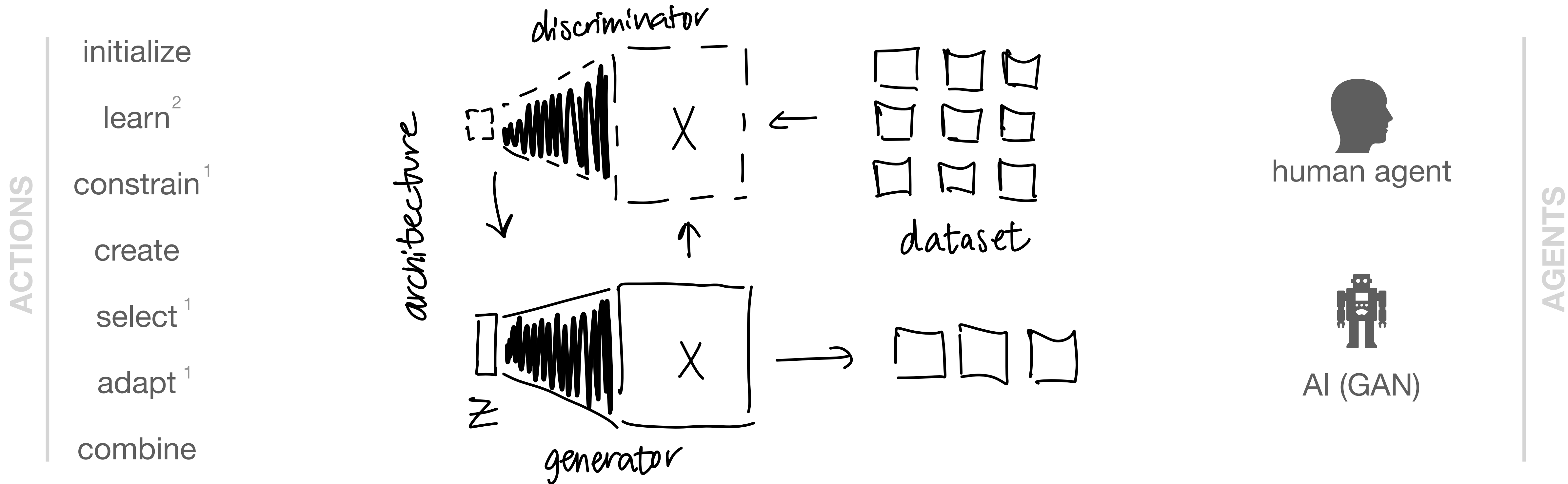
Buschek, D., Mecke, L., Lehmann, F., & Dang, H. (2021, April). Nine Potential Pitfalls when Designing Human-AI Co-Creative Systems. *Joint Proceedings of the ACM IUI 2021 Workshops*. <http://arxiv.org/abs/2104.00358>

Hughes, R. T., Zhu, L., & Bednarz, T. (2021). Generative Adversarial Networks–Enabled Human–Artificial Intelligence Collaborative Applications for Creative and Design Industries: A Systematic Review of Current Approaches and Trends. *Frontiers in Artificial Intelligence*, 4, 604234. <https://doi.org/10.3389/frai.2021.604234>

Spoto, A., & Oleynik, N. (2017). Library of Mixed-Initiative Creative Interfaces. <http://mici.codingconduct.cc/>

Muller, M., Weisz, J. D., & Geyer, W. (2020). Mixed Initiative Generative AI Interfaces: An Analytic Framework for Generative AI Applications. *Proceedings of the Workshop The Future of Co-Creative Systems - A Workshop on Human-Computer Co-Creativity of the 11th International Conference on Computational Creativity (ICCC 2020)*. https://computationalcreativity.net/workshops/cocreative-iccc20/papers/Future_of_co-creative_systems_185.pdf

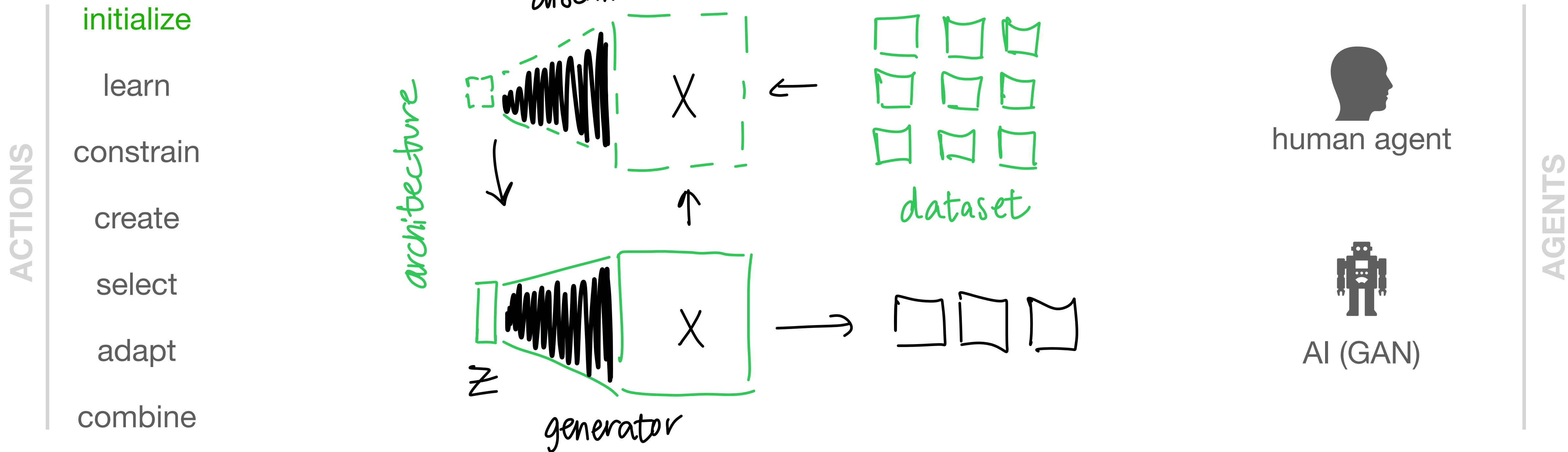
Framework



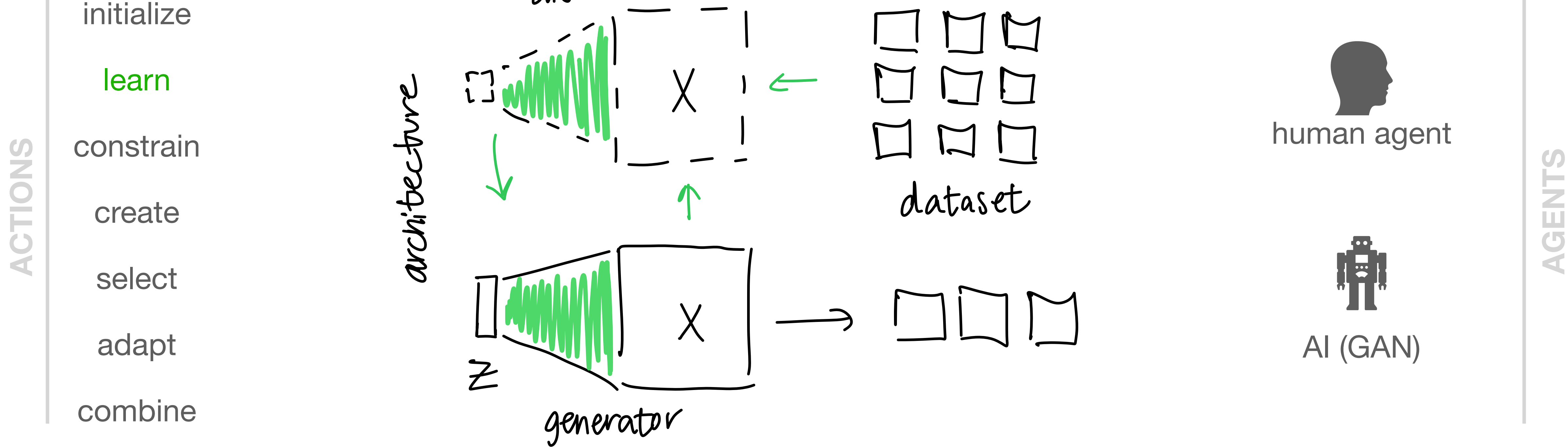
¹ Spoto, A., & Oleynik, N. (2017). *Library of Mixed-Initiative Creative Interfaces*. <http://mici.codingconduct.cc/>

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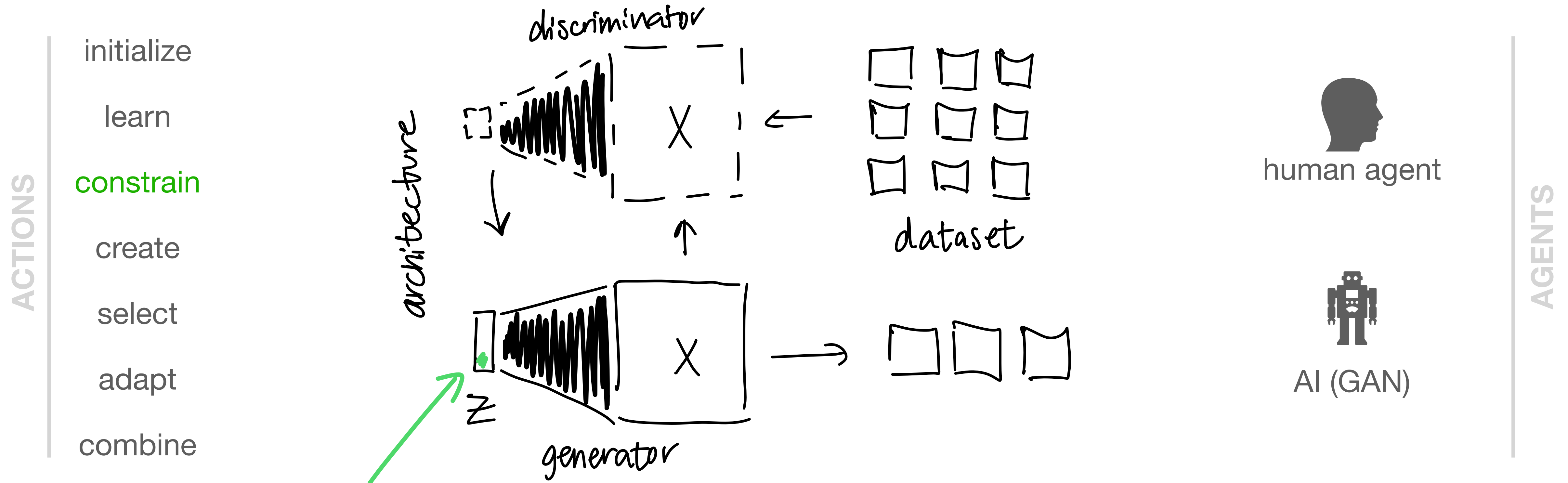
Framework



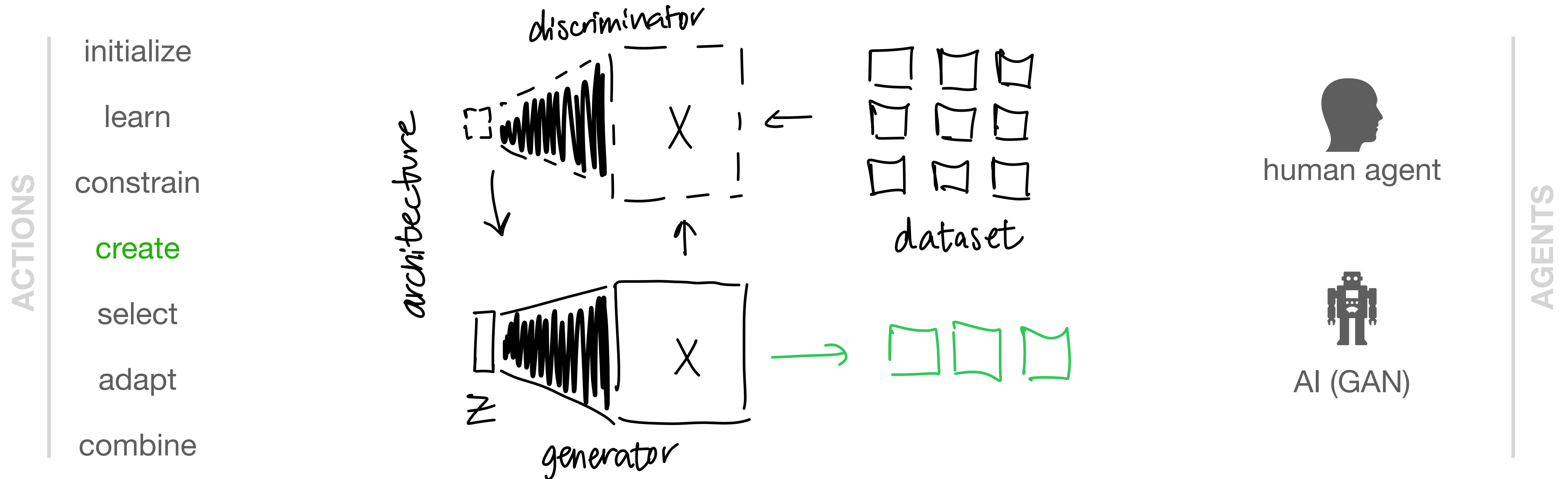
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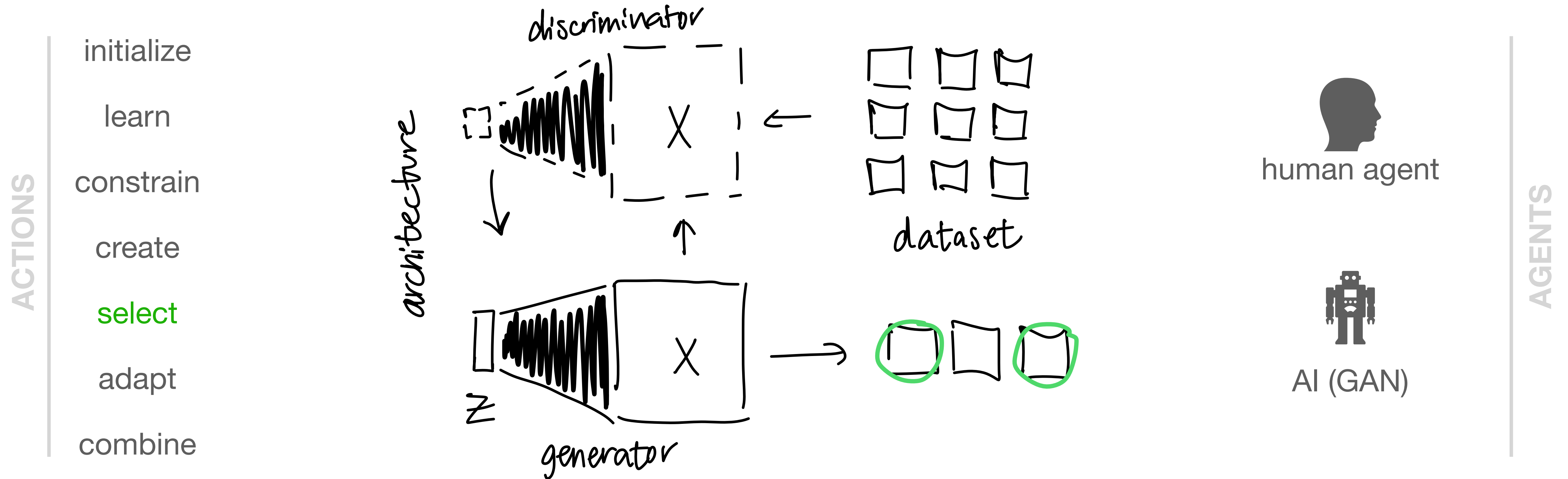
Framework



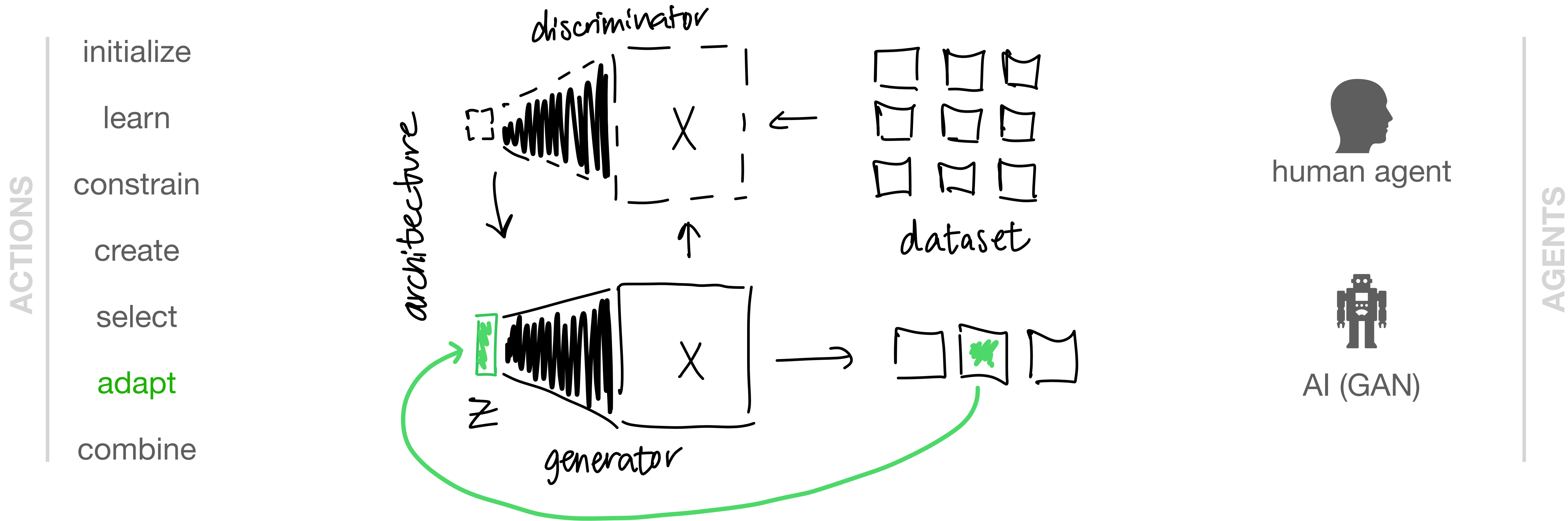
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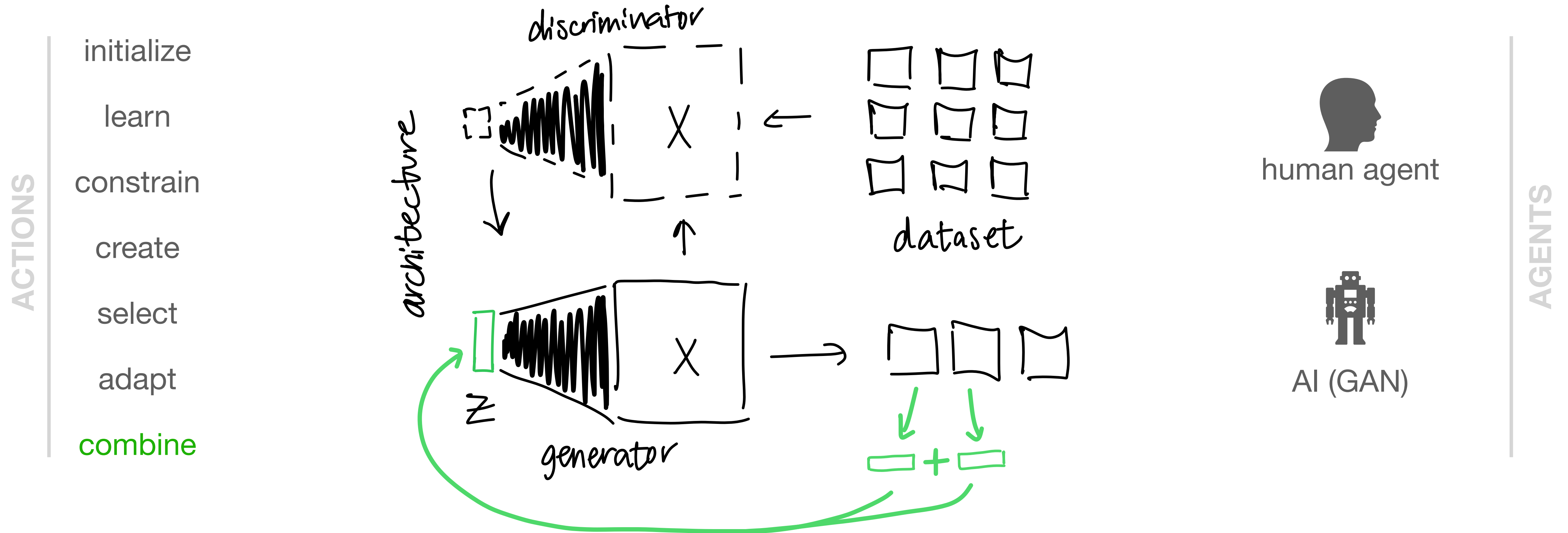
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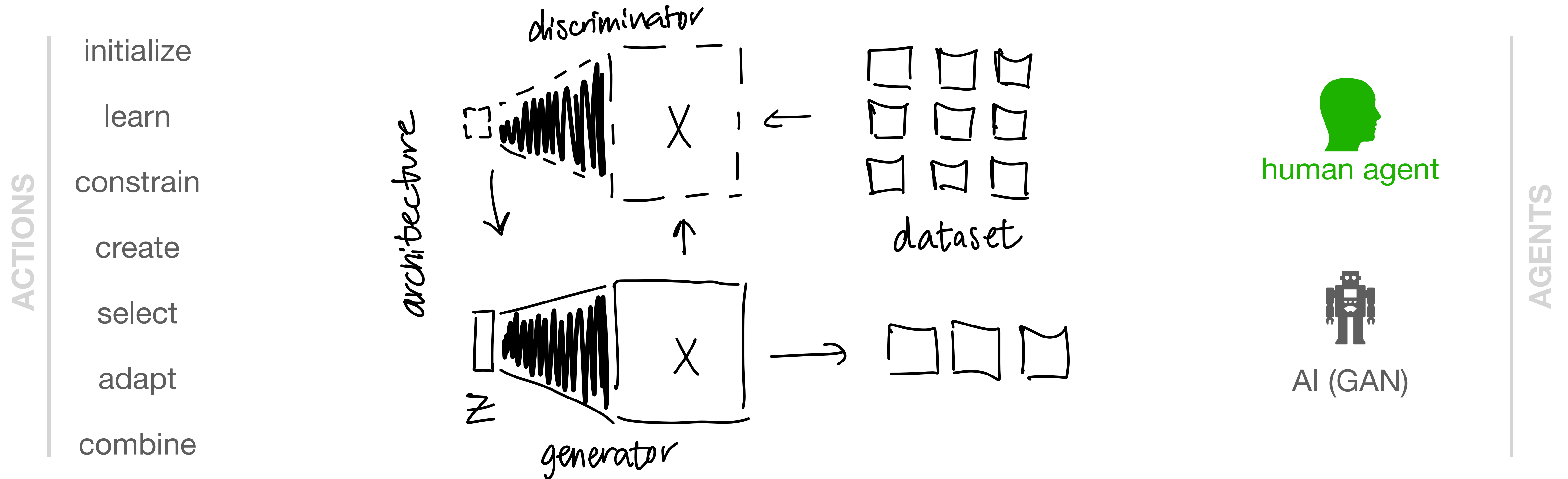
Framework



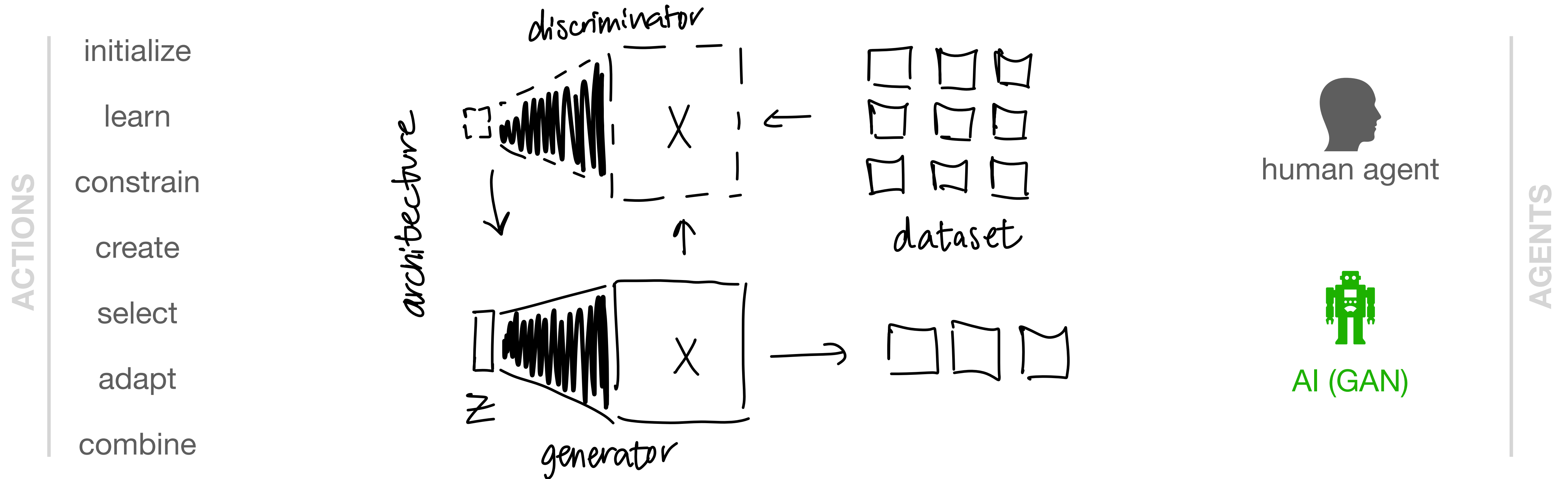
Framework



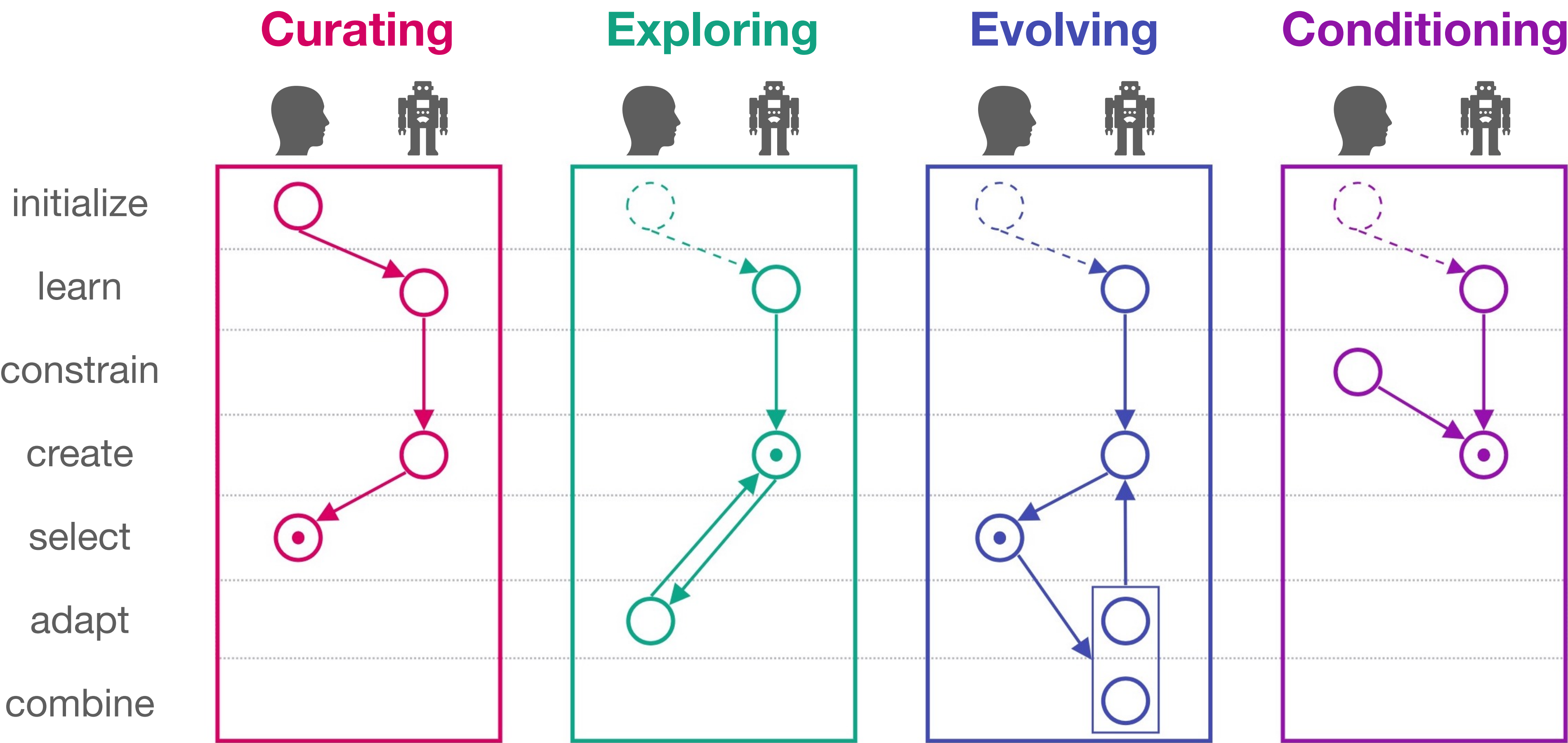
Framework



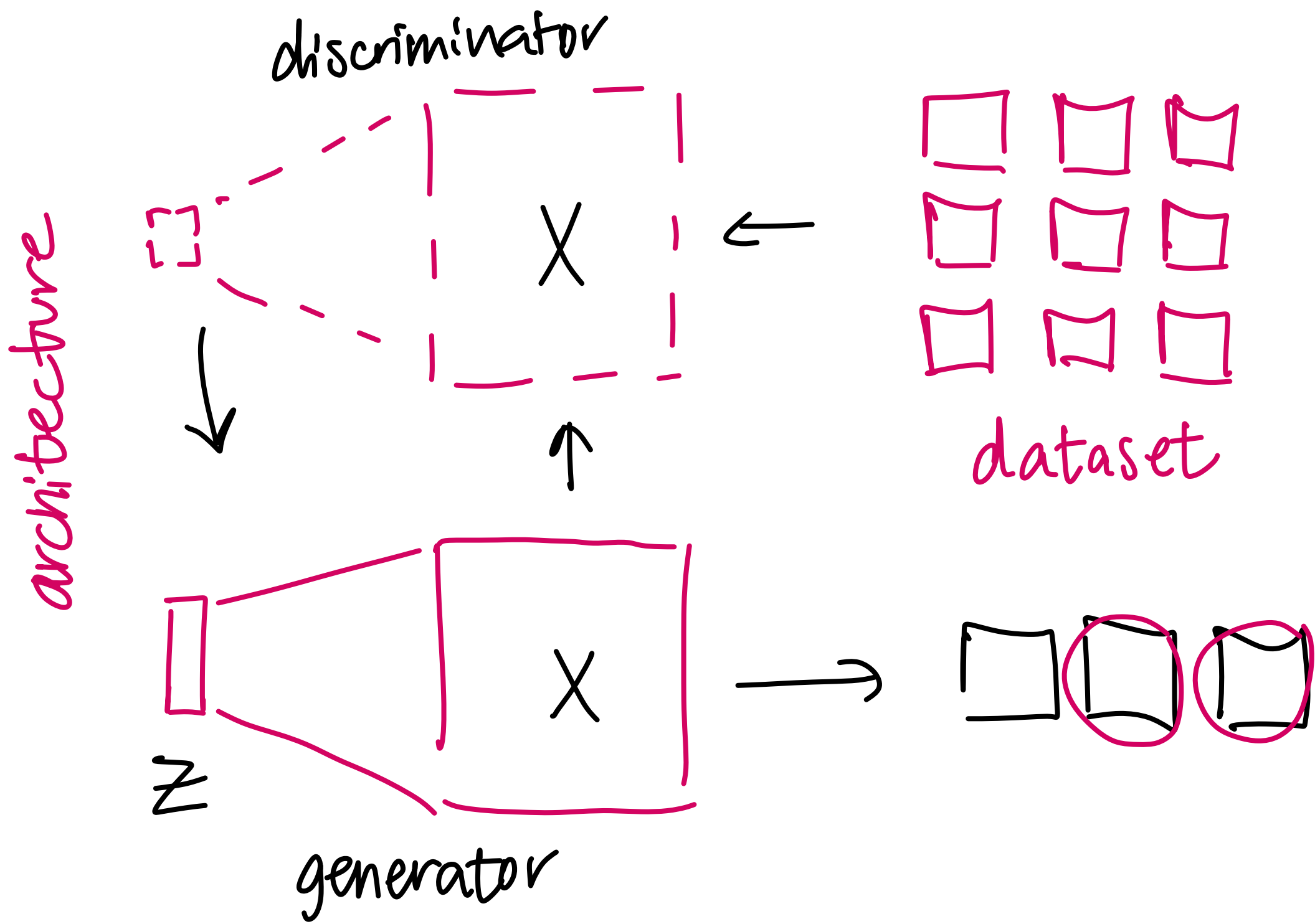
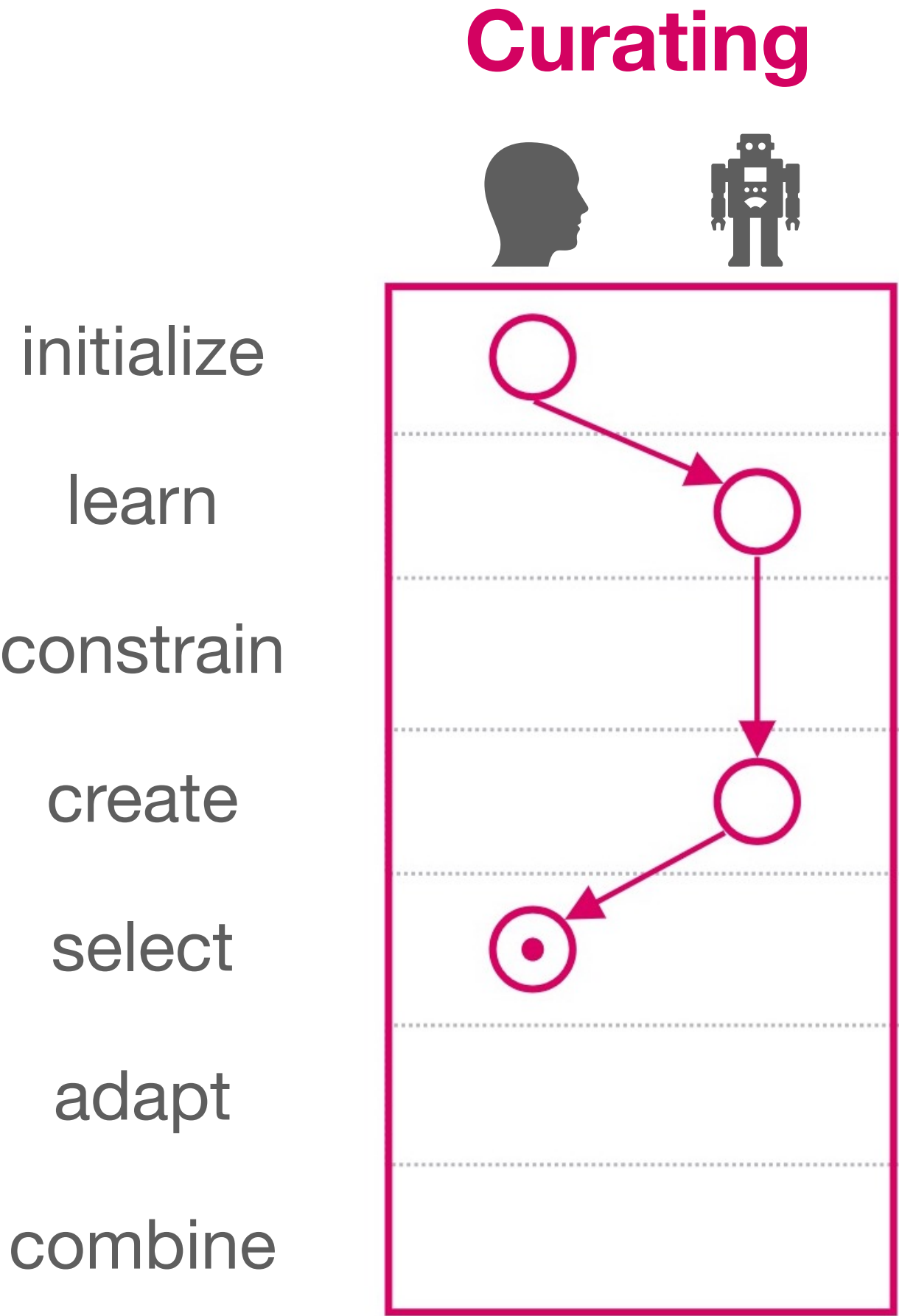
Framework



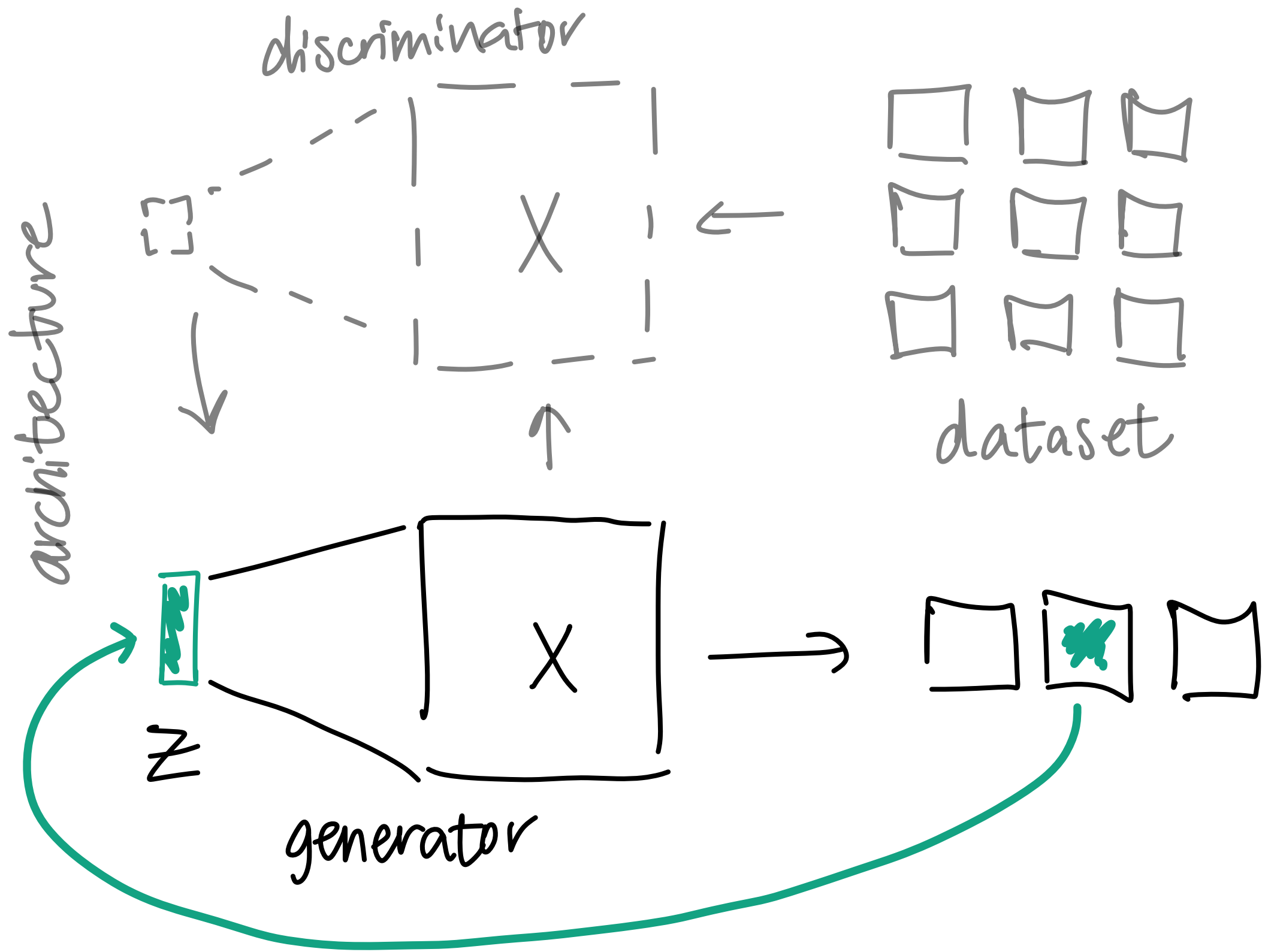
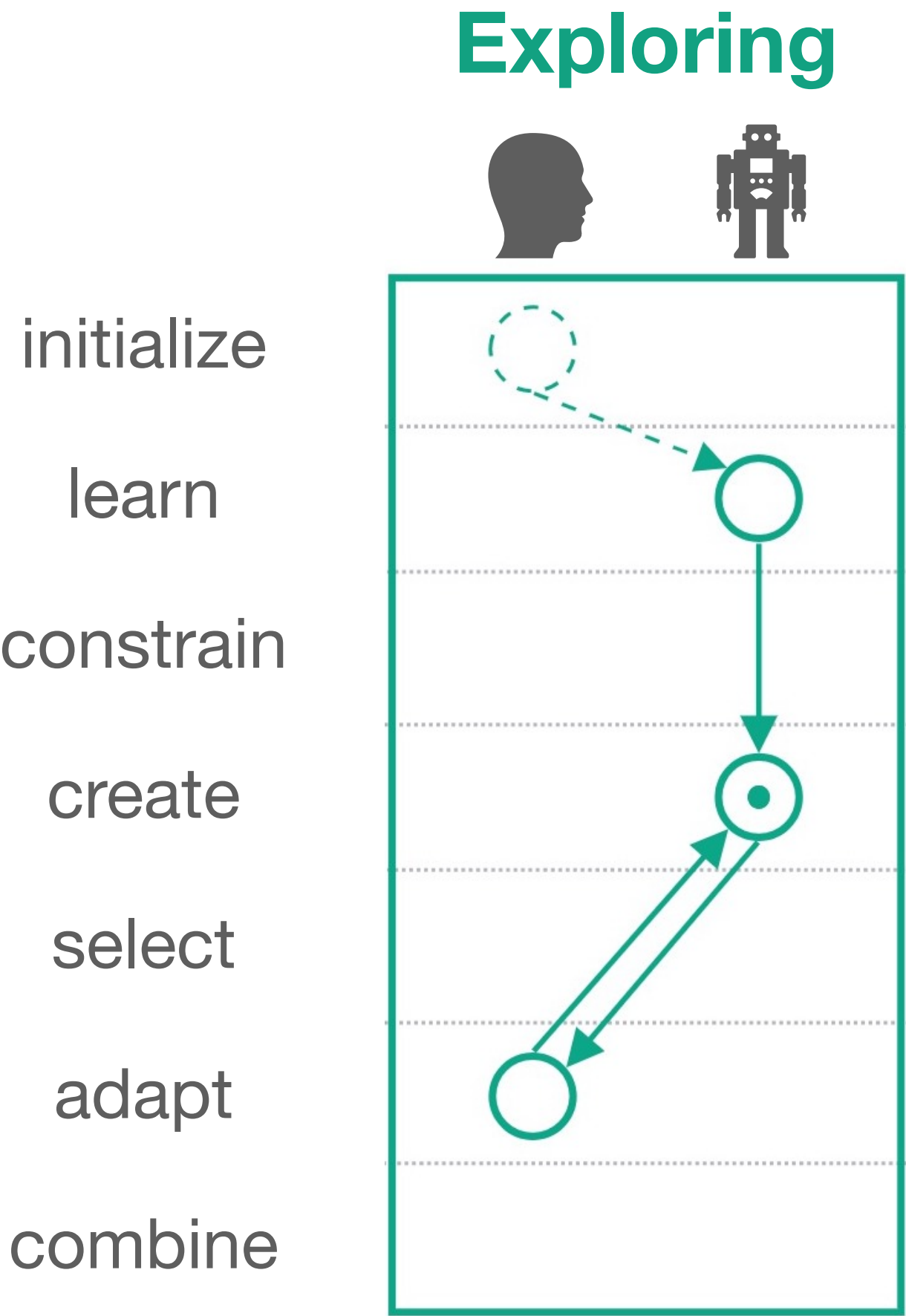
Interaction Patterns



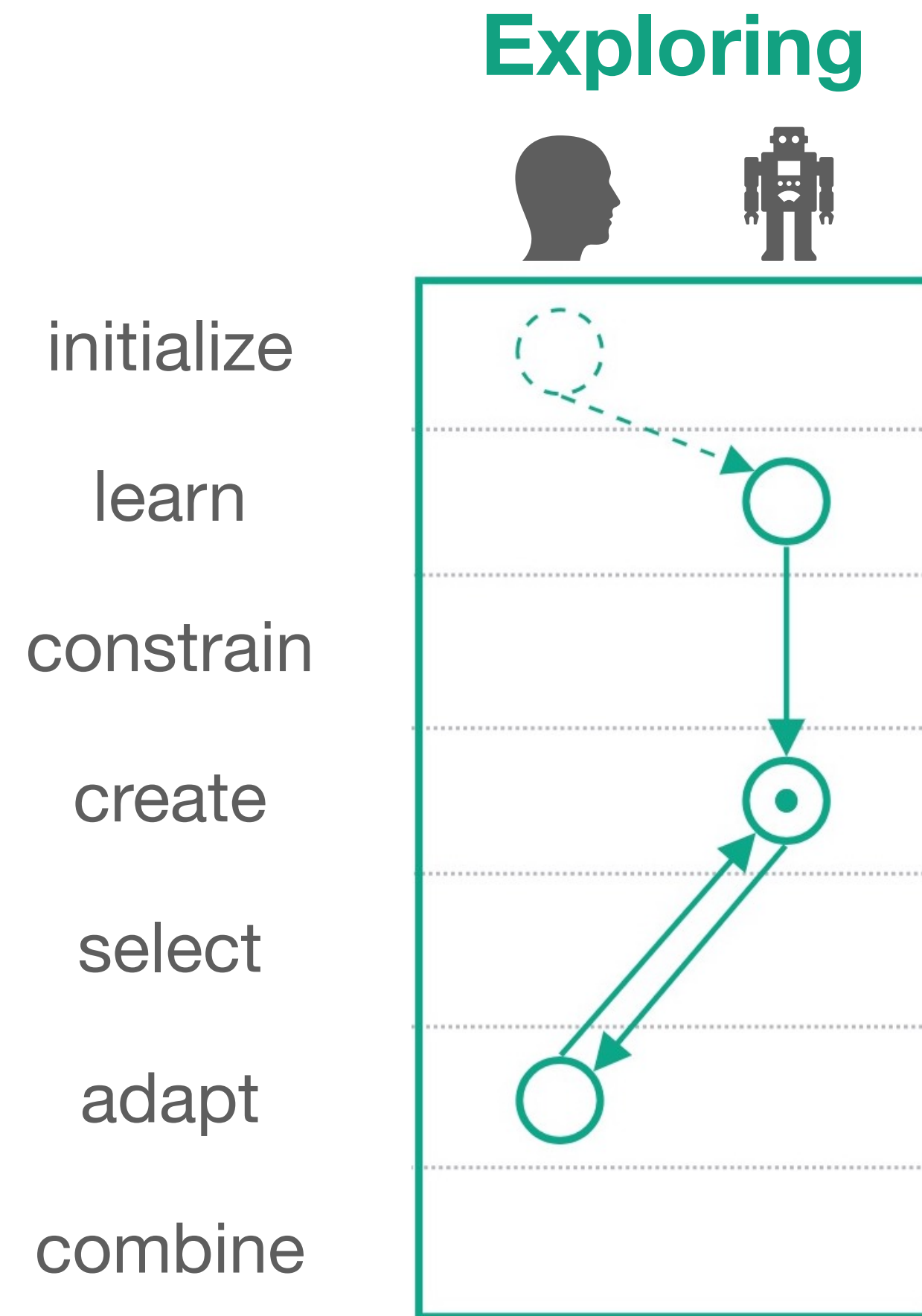
Interaction Patterns ●○○○



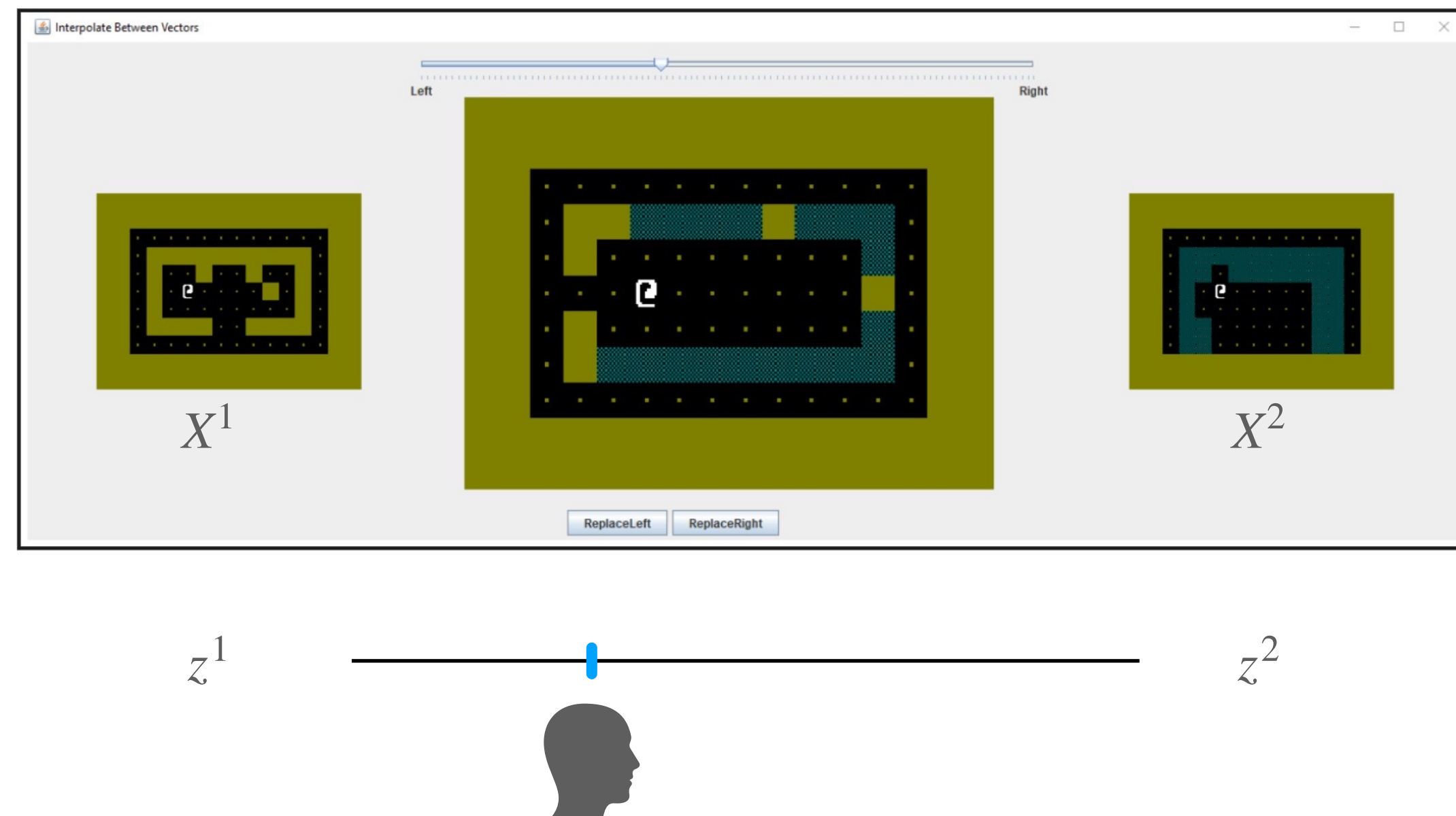
Interaction Patterns ○ ● ○ ○



Interaction Patterns



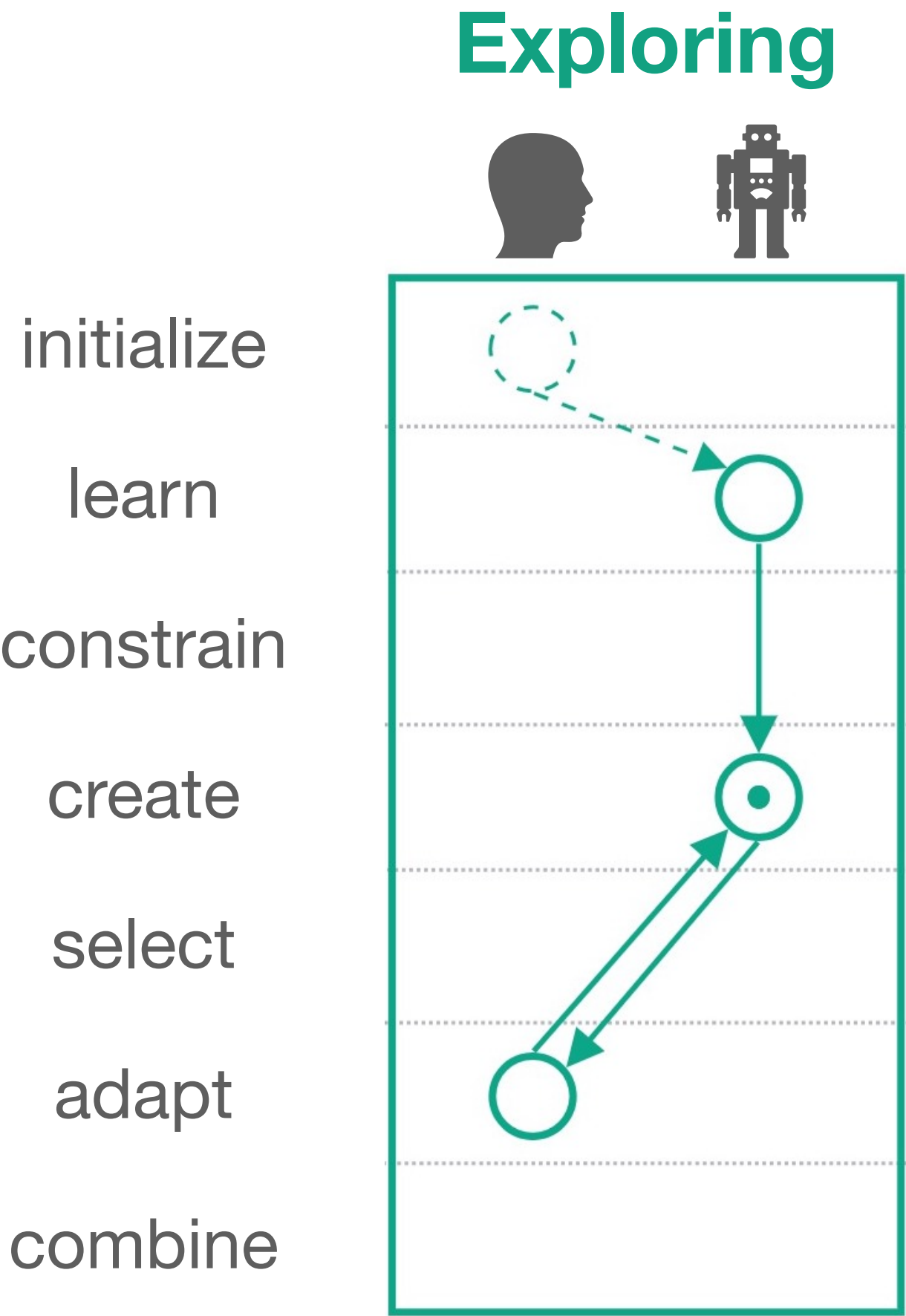
Interpolation



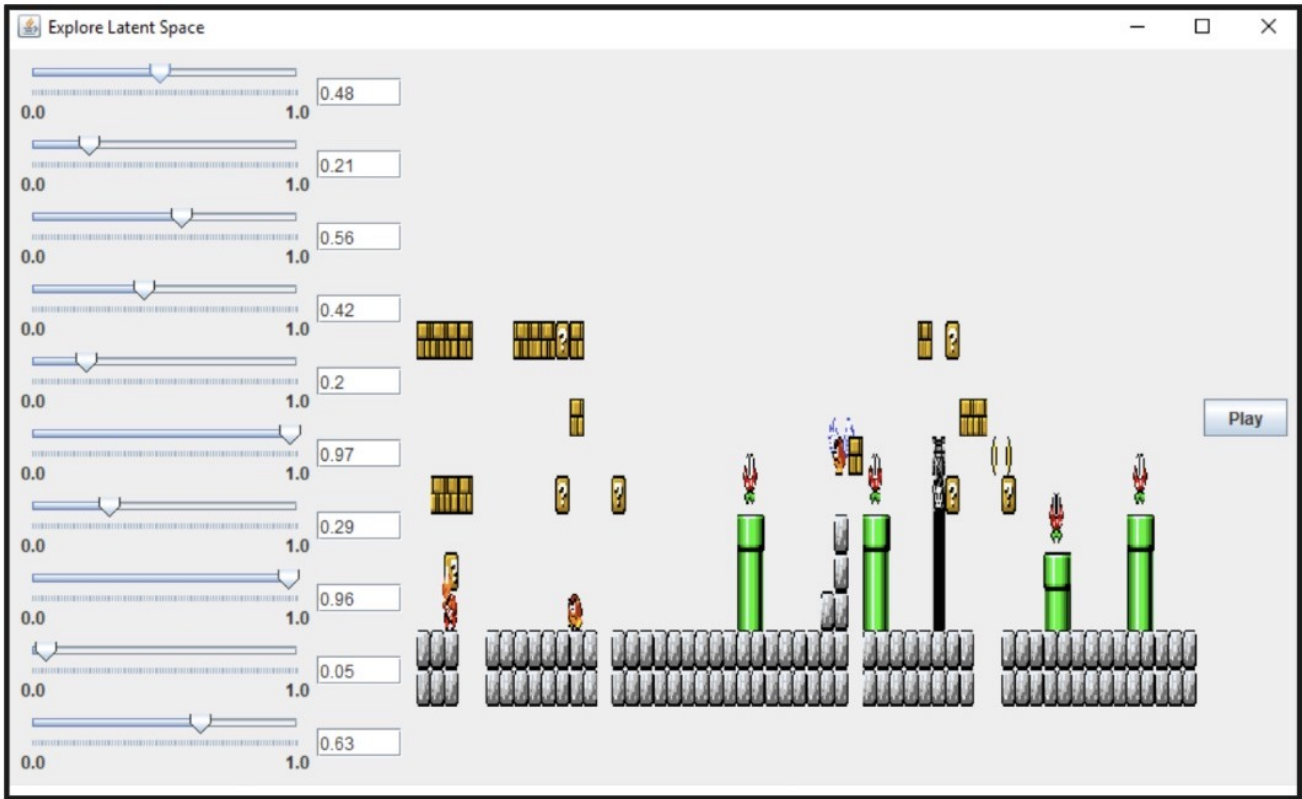
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Zaltron, N., Zurlo, L., & Risi, S. (2020). CG-GAN: An Interactive Evolutionary GAN-Based Approach for Facial Composite Generation. *Proceedings of the AAAI Conference on Artificial Intelligence*, 34(03), 2544–2551. <https://doi.org/10.1609/aaai.v34i03.5637>

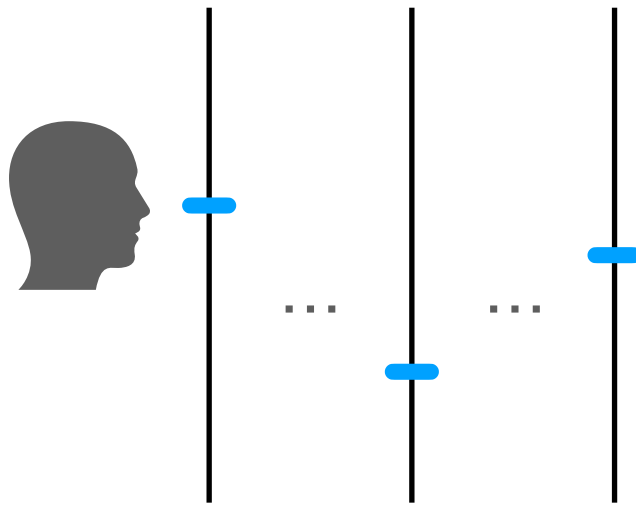
Interaction Patterns ○ ● ○ ○



Latent features

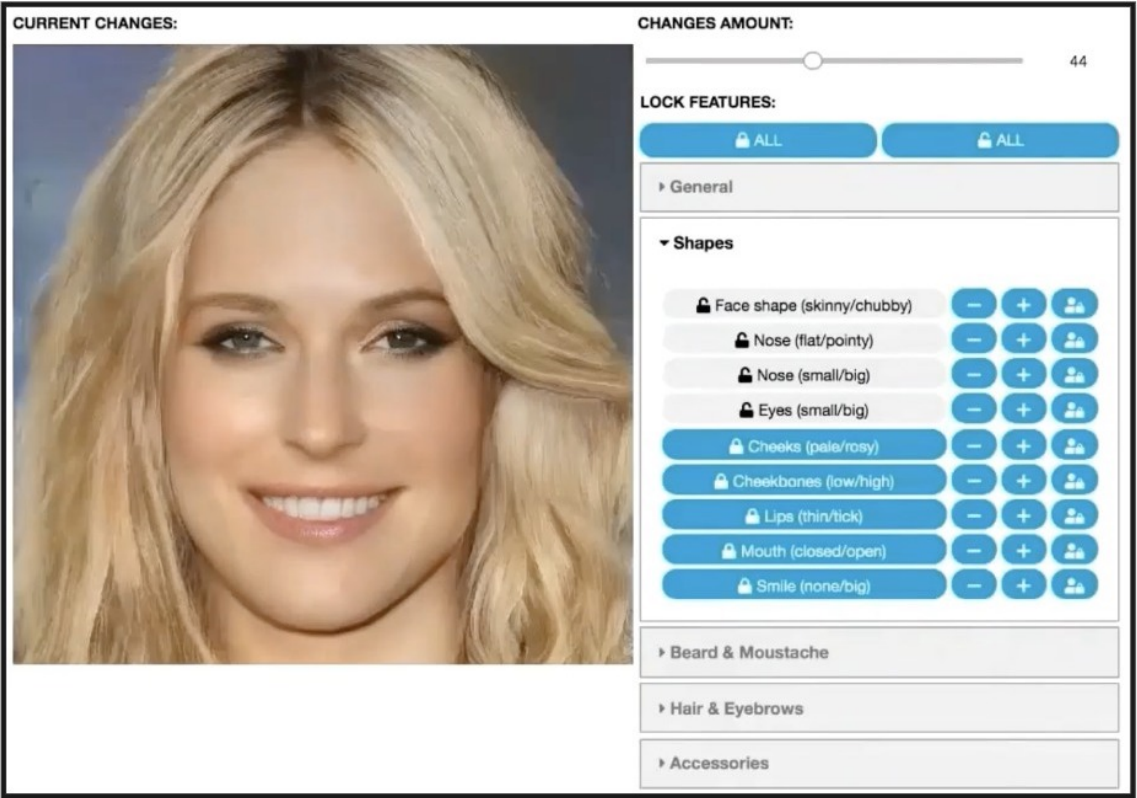
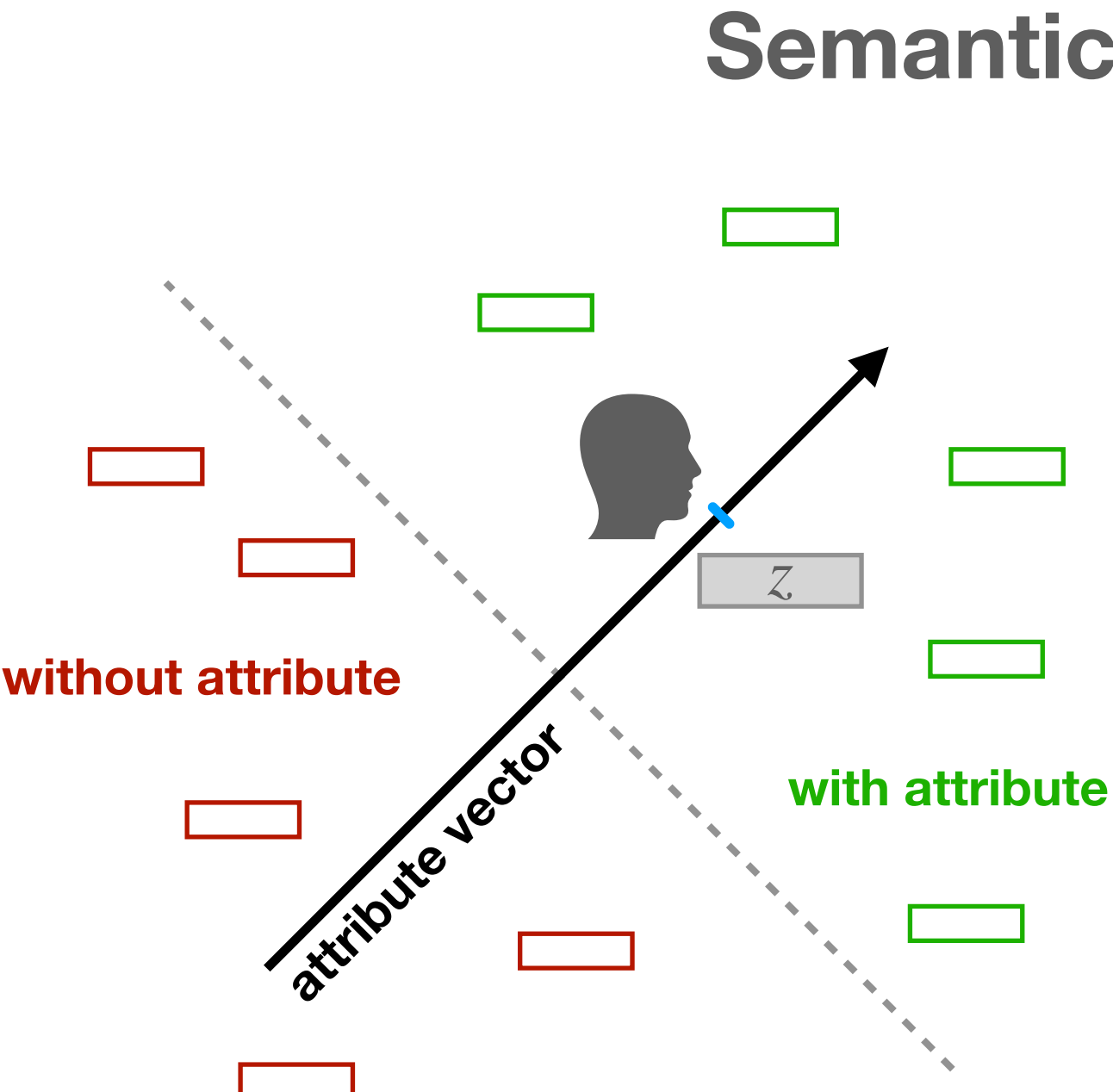
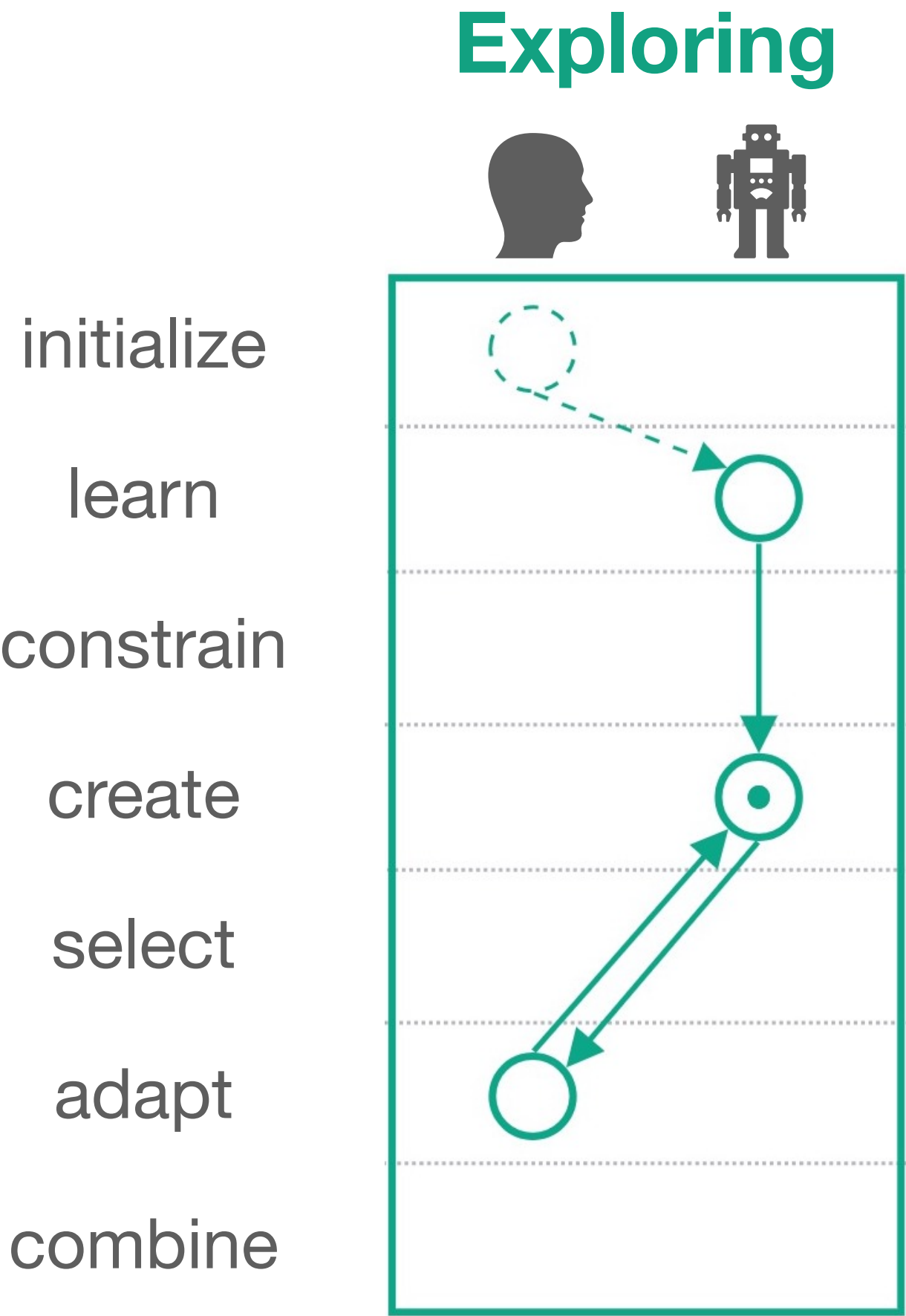


$$z = [z_1, \dots, z_i, \dots, z_n]$$

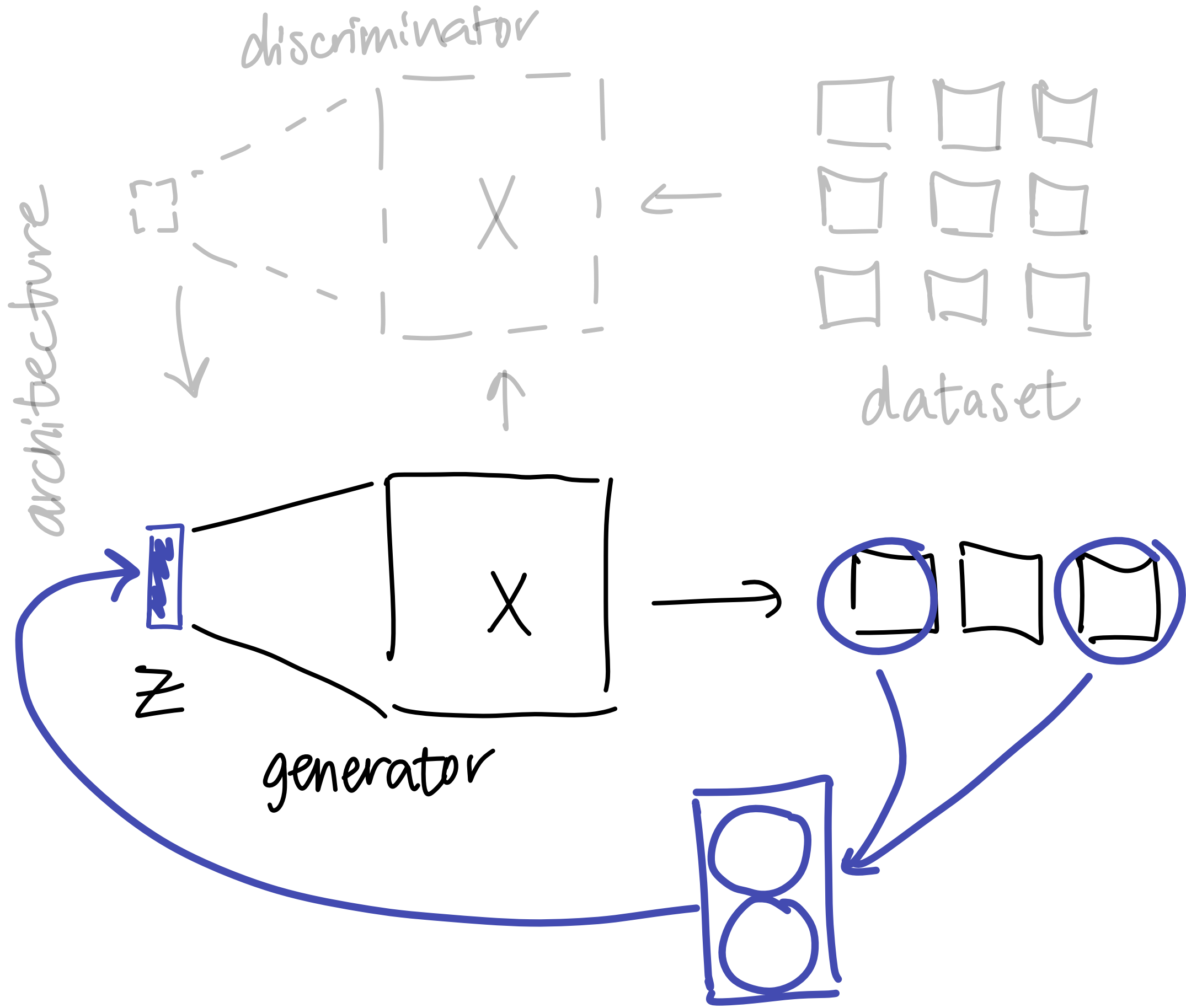
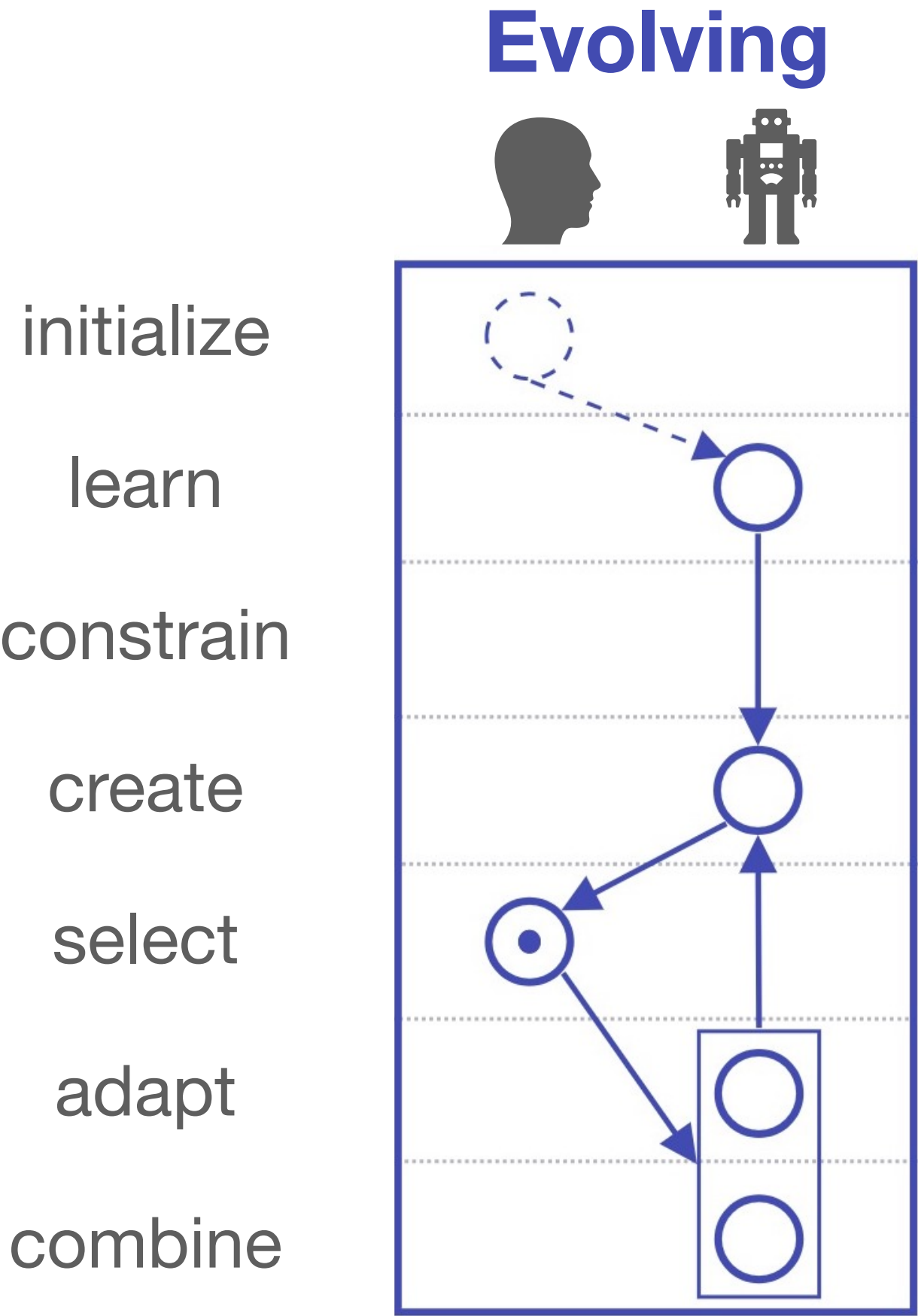


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Interaction Patterns ○ ● ○ ○

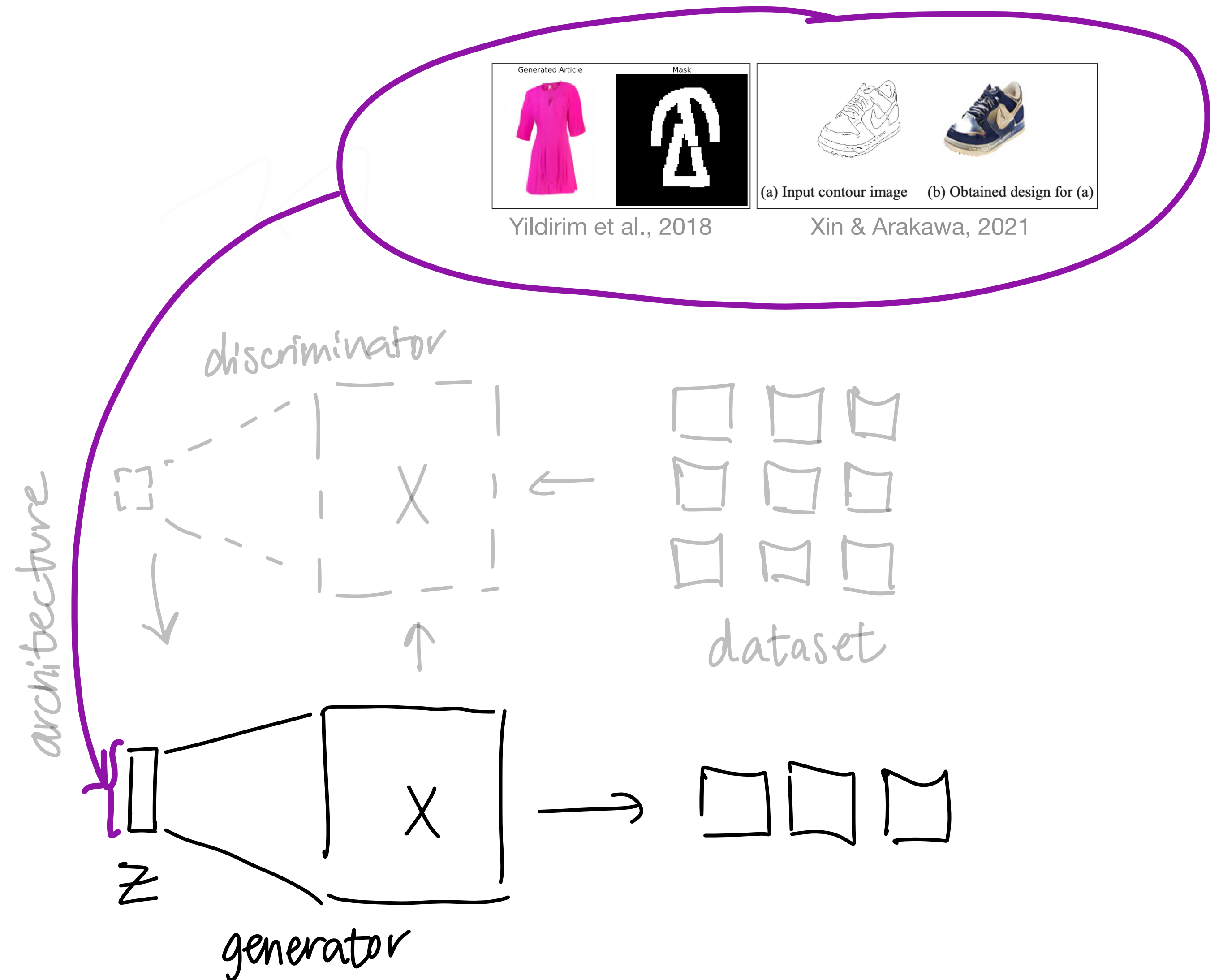
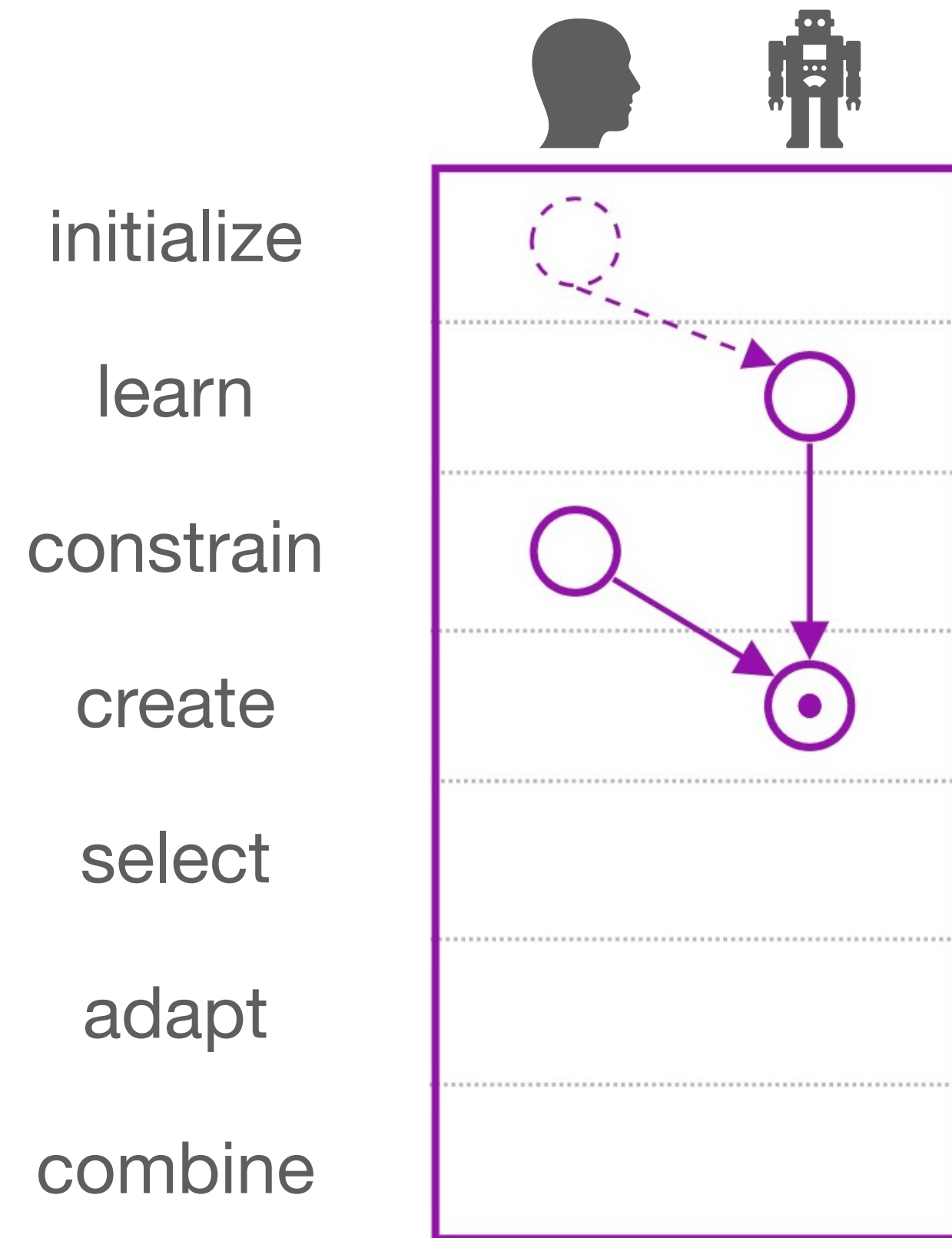


Interaction Patterns ○ ○ ● ○



Interaction Patterns ○ ○ ○ ●

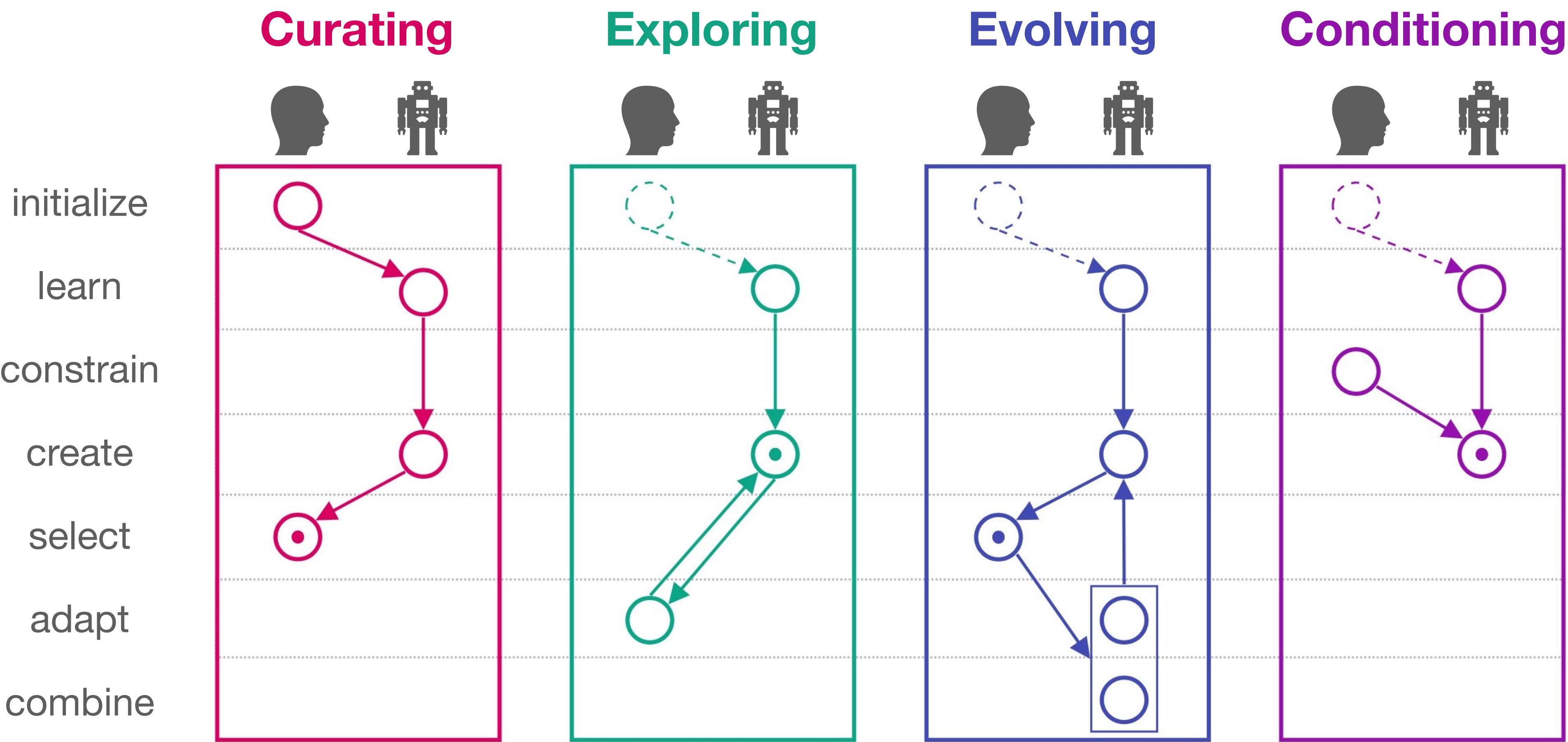
Conditioning



Yildirim, G., Seward, C., & Bergmann, U. (2018, June 20). Disentangling Multiple Conditional Inputs in GANs. *KDD 2018 Conference AI for Fashion Workshop*. <http://arxiv.org/abs/1806.07819>

Xin, C., & Arakawa, K. (2021). Object Design System by Interactive Evolutionary Computation Using GAN with Contour Images. *Human Centred Intelligent Systems - Proceedings of KES-HCIS 2021 Conference*, 244, 66–75. https://doi.org/10.1007/978-981-16-3264-8_7

Interaction Patterns



Combining Patterns ○ ● ● ○

Evolving + Exploring



initialize

learn

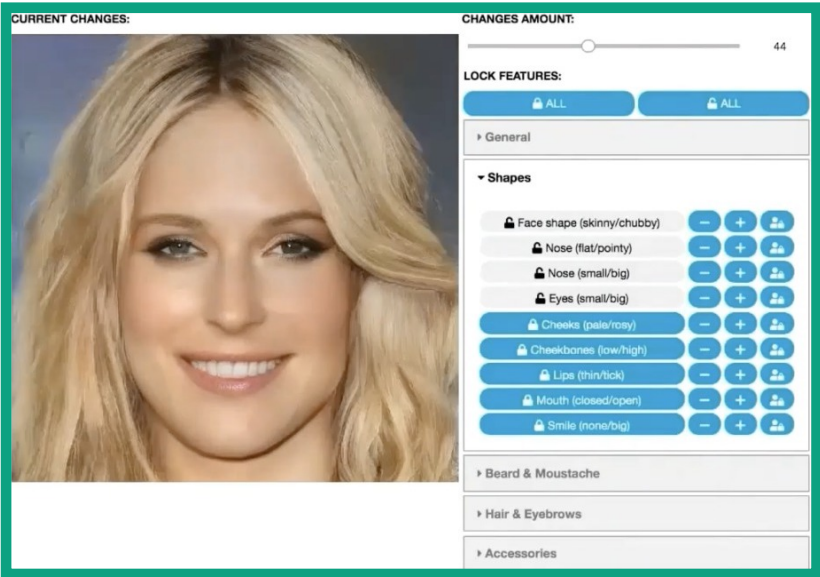
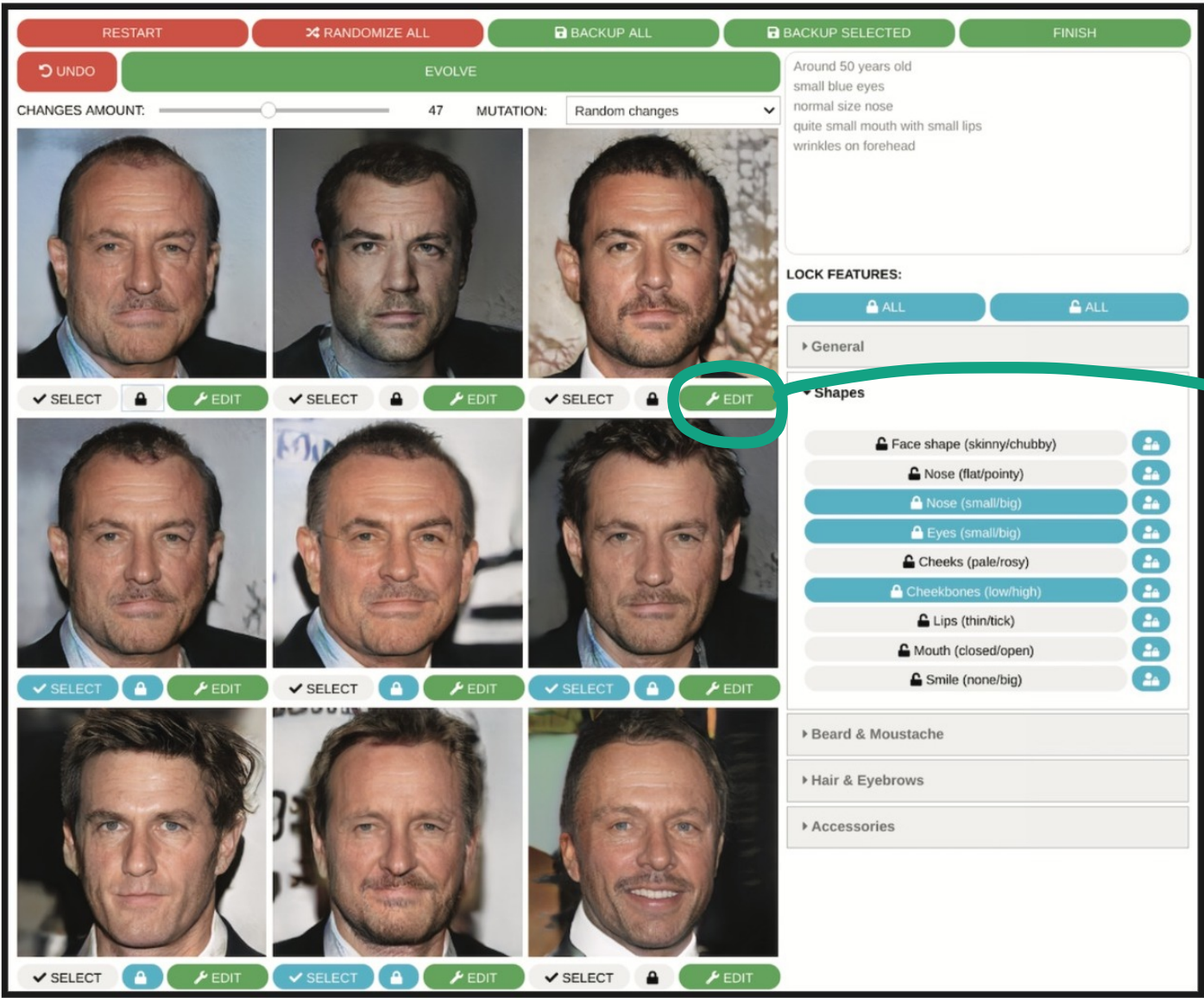
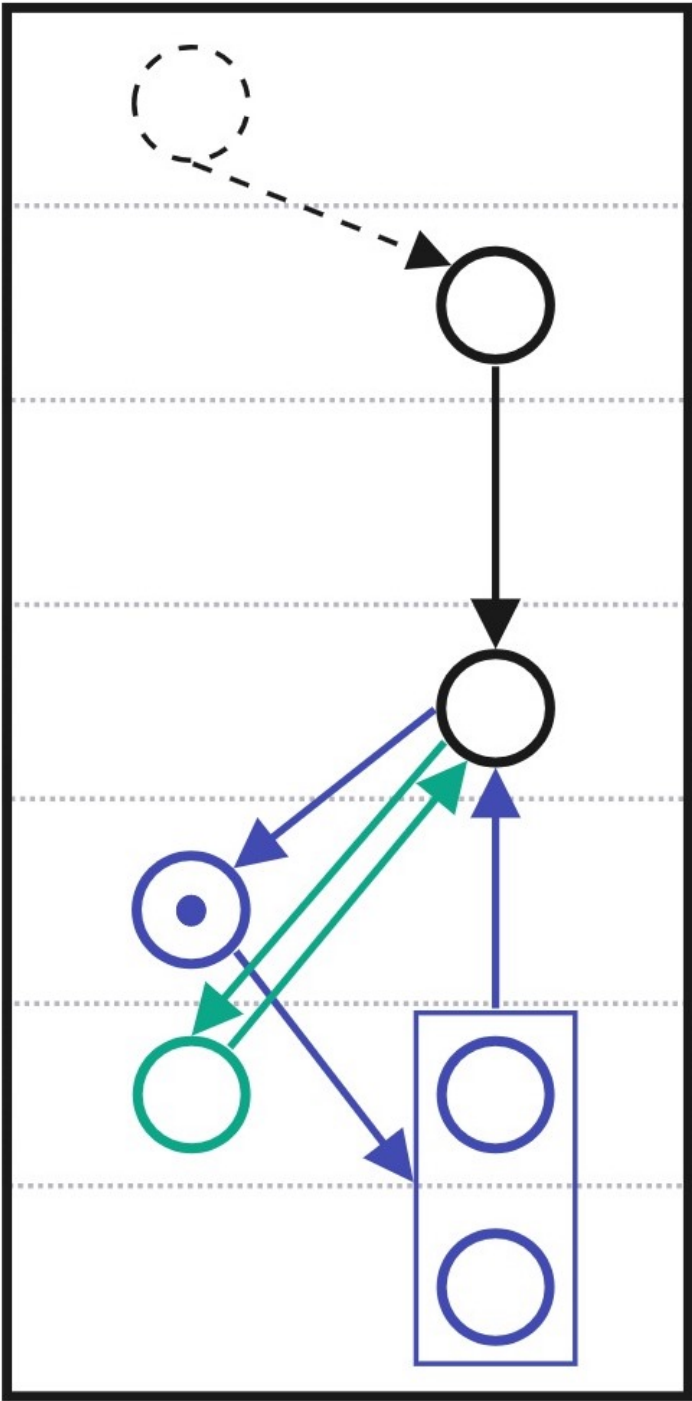
constrain

create

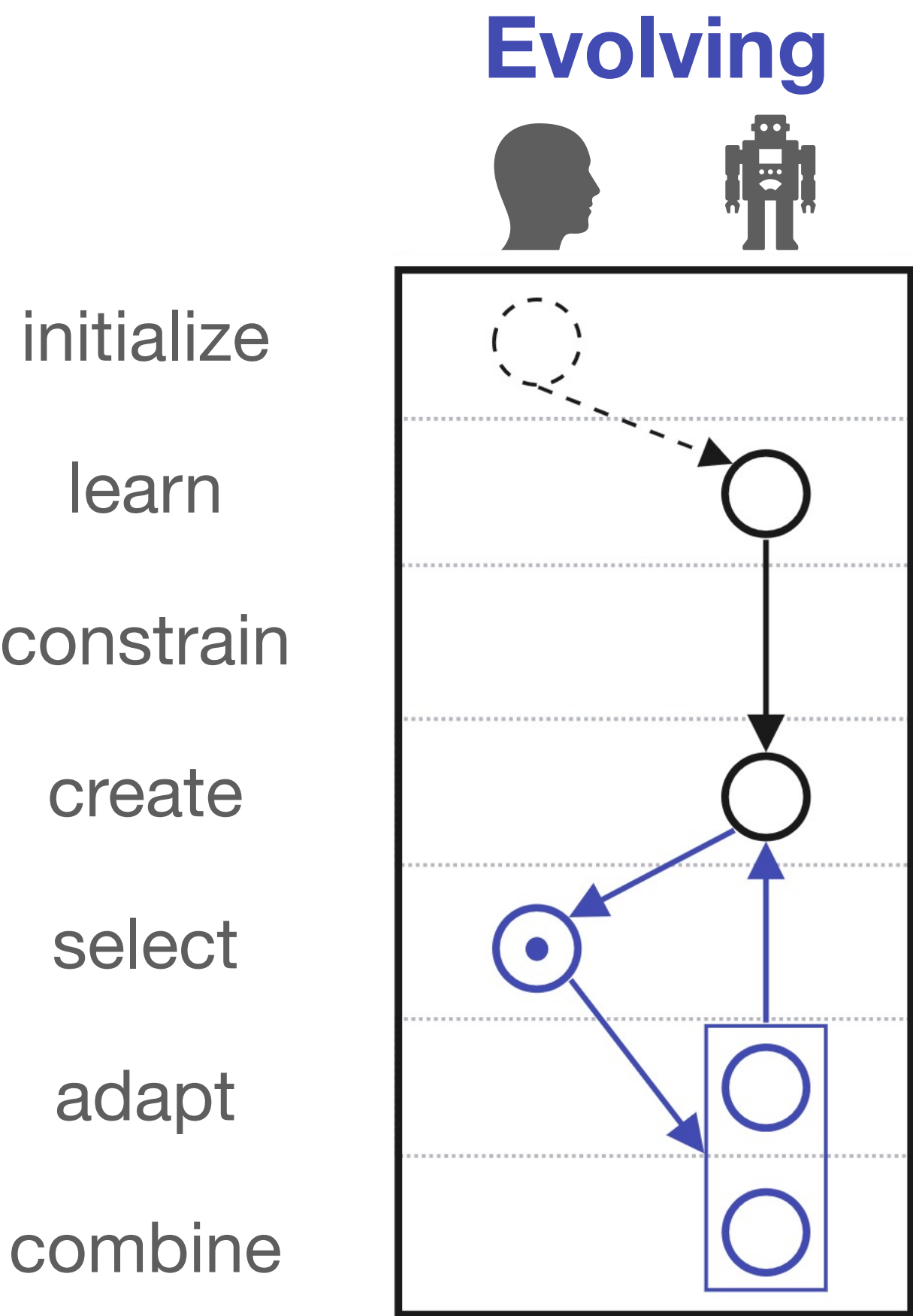
select

adapt

combine

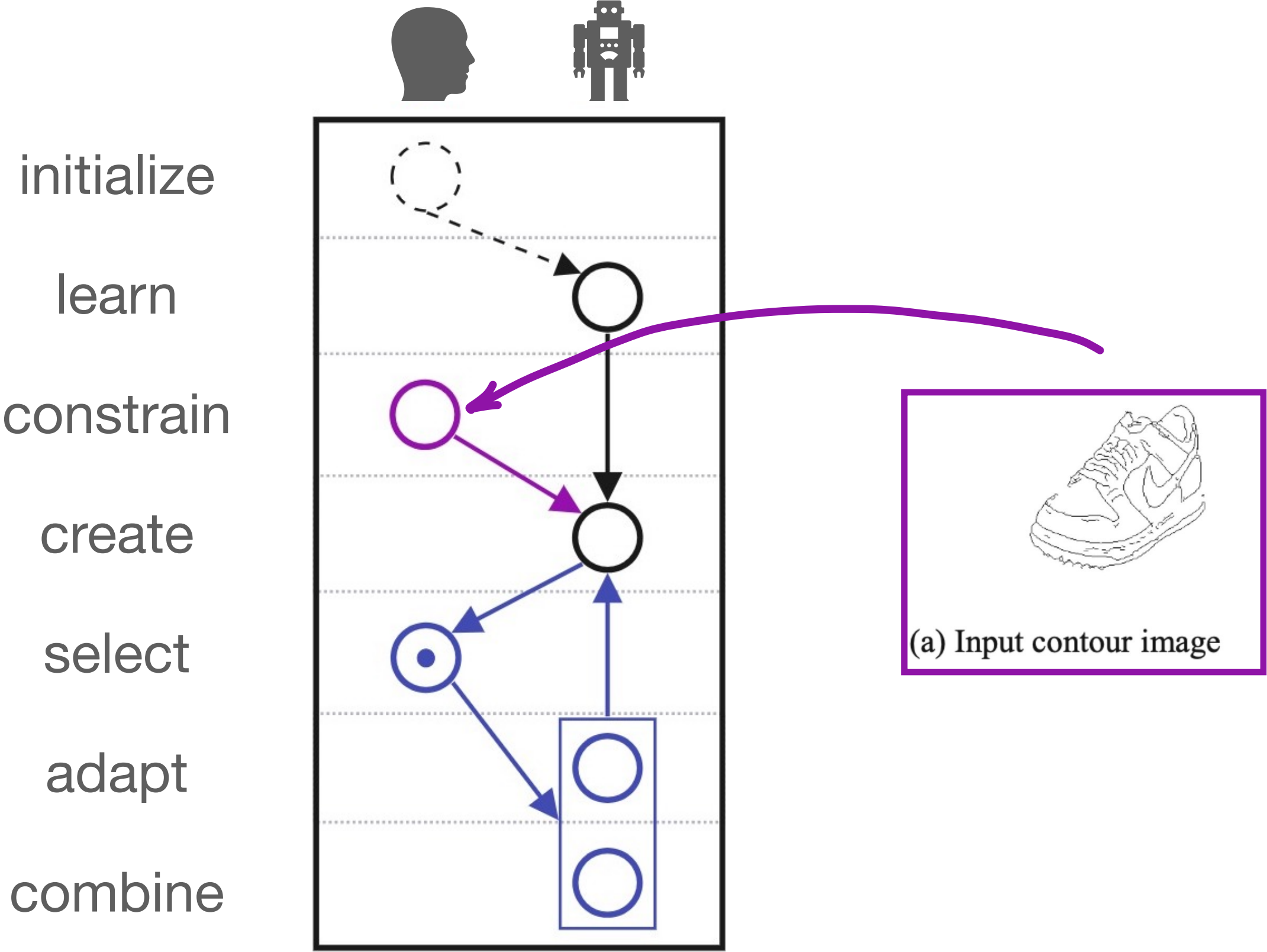


Combining Patterns ○ ○ ● ○

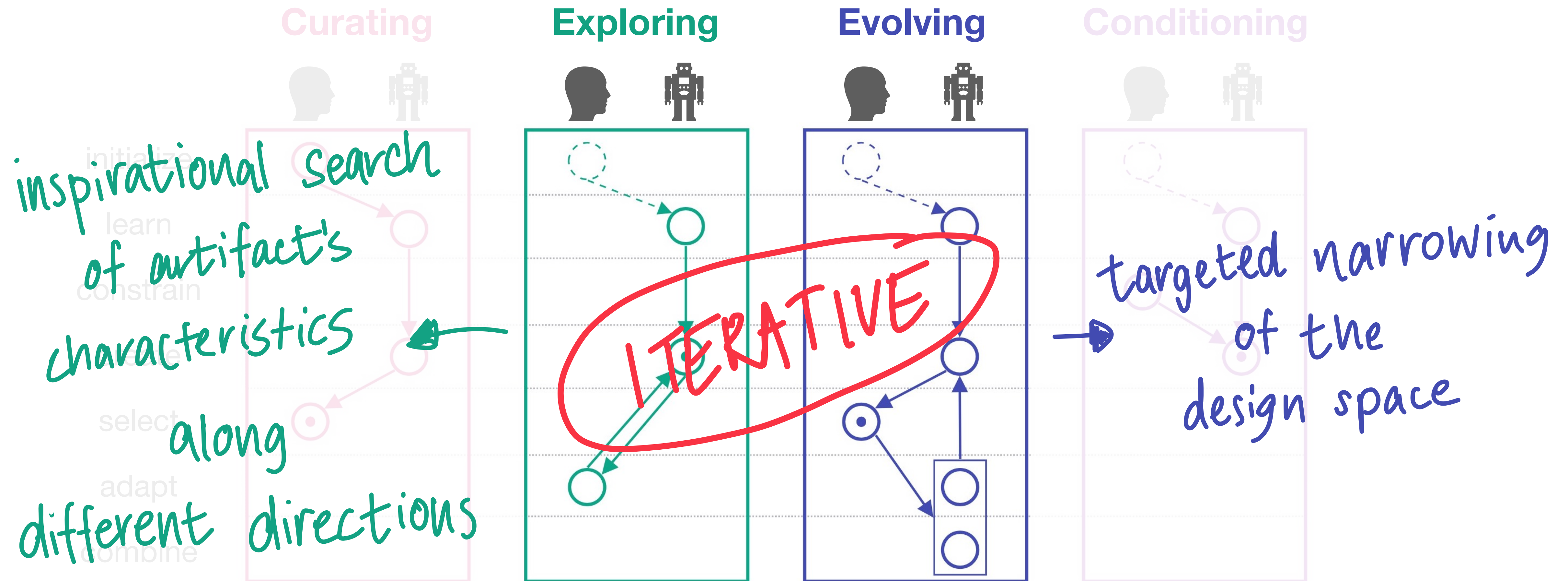


Combining Patterns ○ ○ ● ●

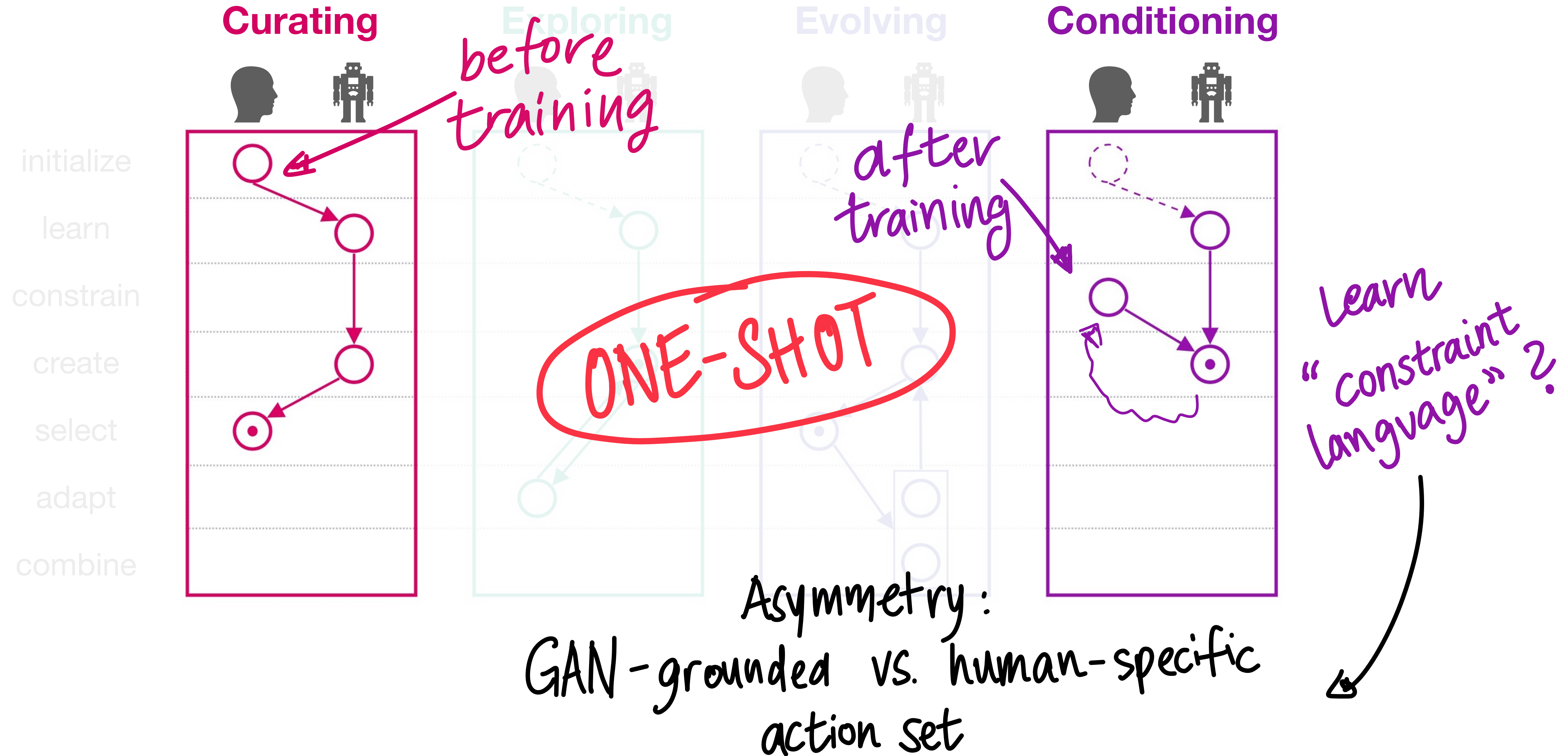
Evolving + Conditioning



How do they support co-creativity?



How do they support co-creativity?



Conclusion

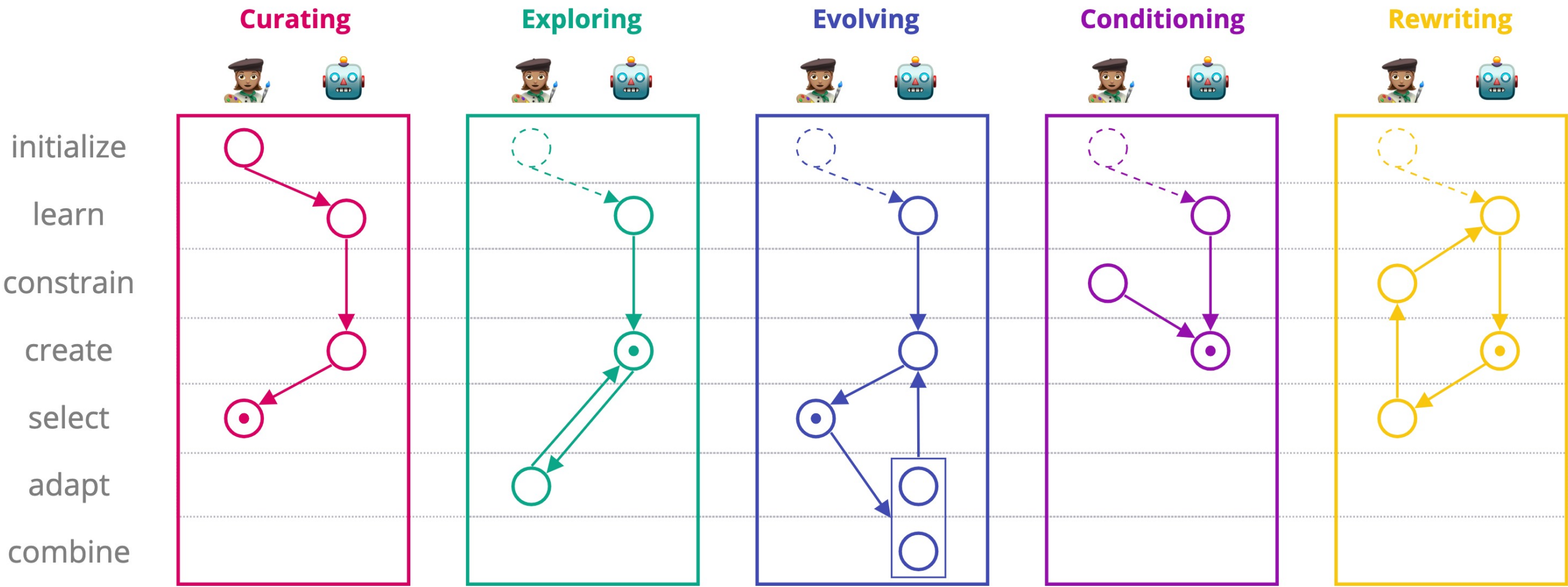
- Preliminary framework to identify interaction patterns in co-creative GAN applications
- Inform the design of co-creative processes with GANs by bridging the gap between ML and design
- Alternative interaction patterns?

Future directions

- expanding dataset and interaction patterns

Table 1
Selection of GAN studies.

Application	Domain	Curating	Exploring	Evolving	Conditioning
Kato et al. [32]	clothing	•			
Elgammel et al. (CAN) [31]	art	•			
Bau et al. (GANPaint) [39]	photos		•		
Schrum et al. [21]	games		•	•	
Bontrager et al. (DeepIE) [41]	objects			•	
Xin and Arakawa [43]	objects			•	•
Zaltron et al. (CG-GAN) [23]	faces		•	•	
Simon (Artbreeder) [36]	diverse		•	•	
Gajdacz et al. (CREA.blender) [33]	objects		•	•	
Zhao and Ma [44]	clothing				•
Zhu et al. (FashionGAN) [25]	clothing				•
Yildirim et al. [42]	clothing				•



Alternative Patterns?

Rewriting



initialize

learn

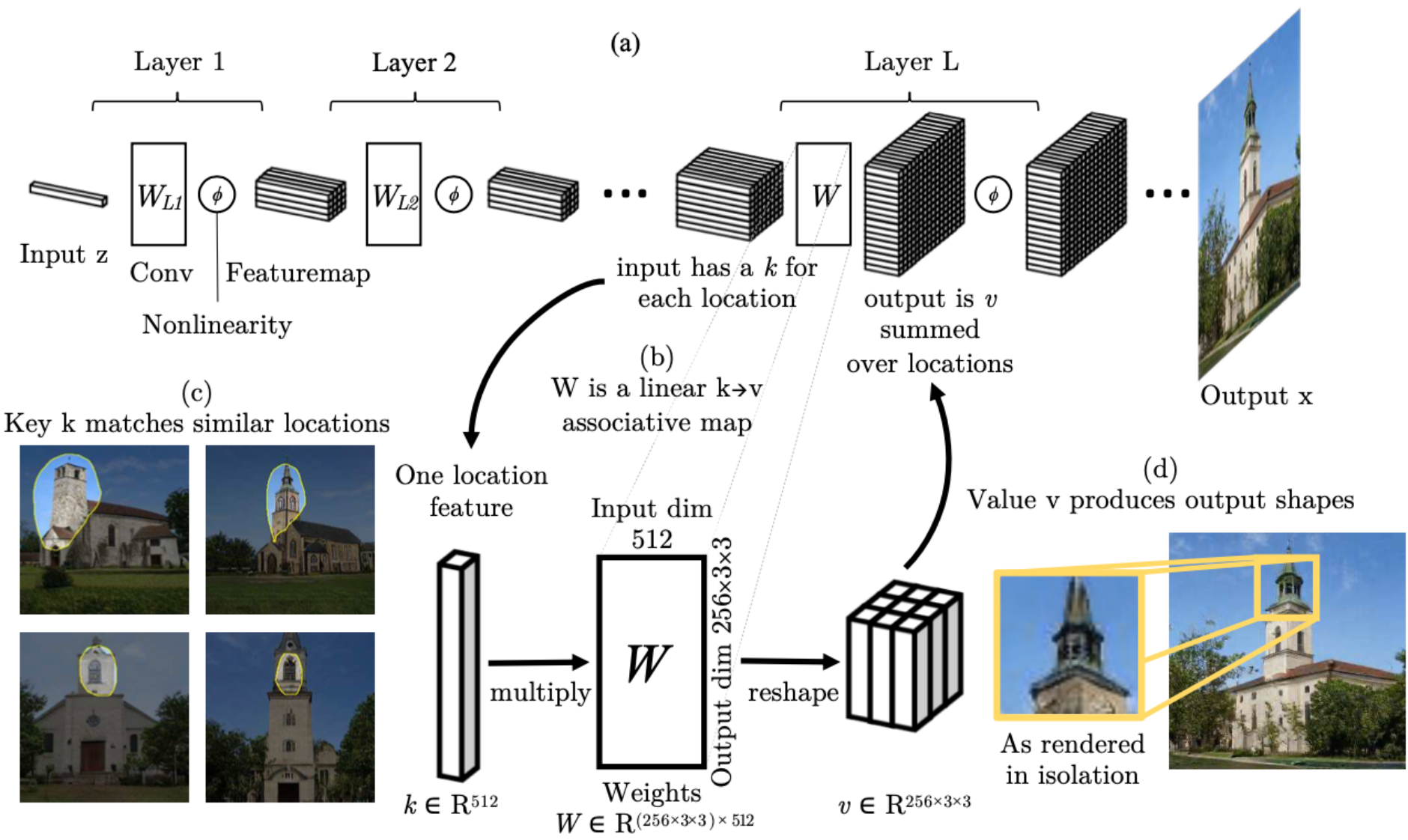
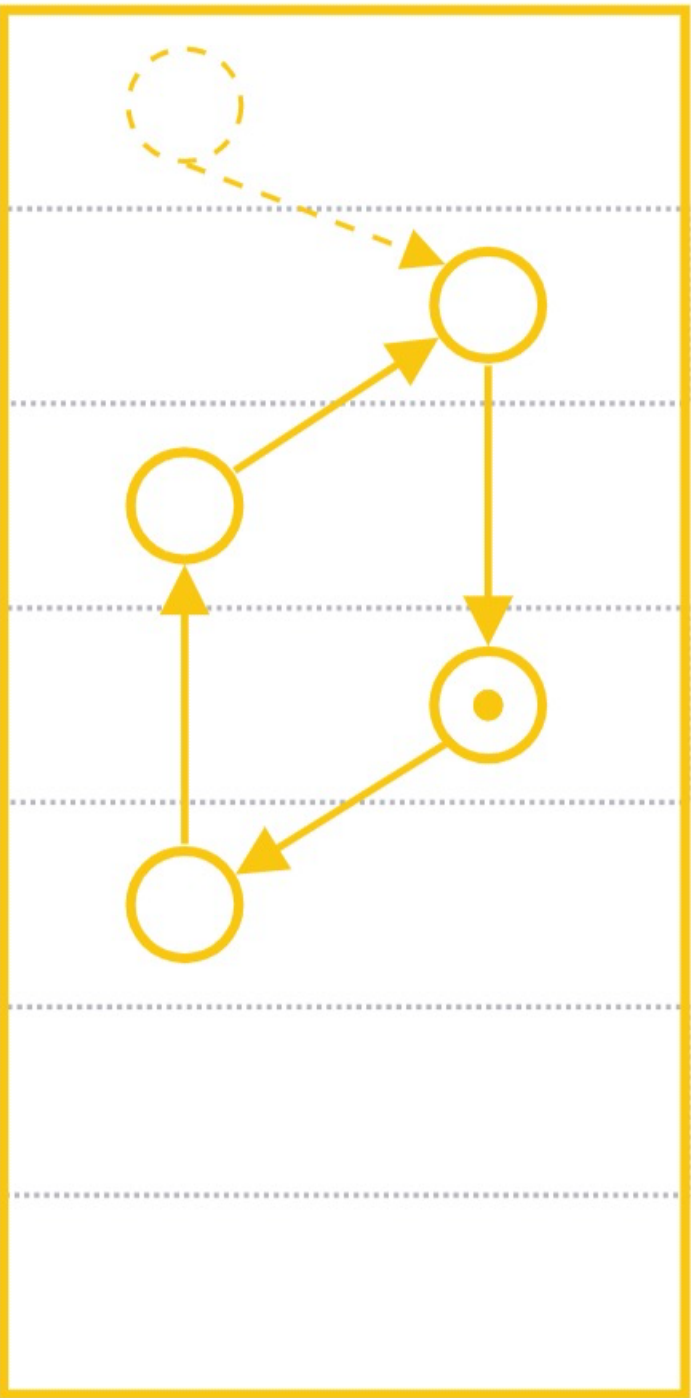
constrain

create

select

adapt

combine



Future directions

- Expanding dataset and interaction patterns
- How do GANs offer new possibilities for personalised designs?

From designing *with* GANs to designing the GAN *itself*.

Thank you!

Questions?