One-Shot Learning in Perception

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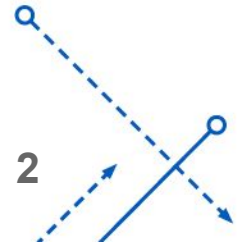
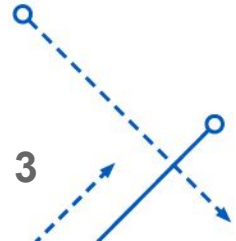


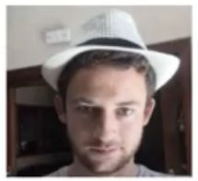
One-Shot Learning



One-Shot Learning

Is the task of learning information about object categories from a single training example.






Low Distance


Large Distance

$$d(img1,img2) \leq \tau$$
$$> \tau$$

Similarity (Distance) of Images

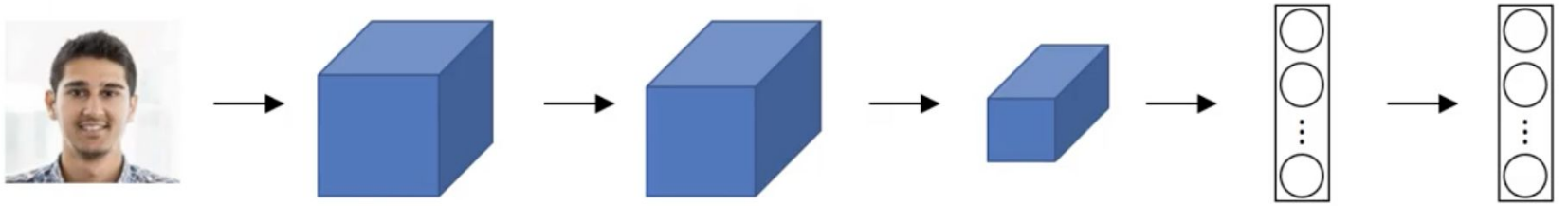
Threshold

Point :

How to get embedding of image with the optimized distance in each categories

One-Shot Learning : Example

Siamese Network



encoding $f(x^{(i)})$

If $x^{(i)}, x^{(j)}$ are the same person, $\left\|f(x^{(i)}) - f(x^{(j)})\right\|^2$ is small.

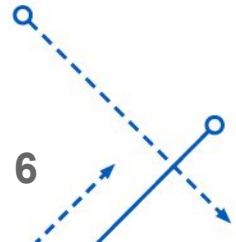
If $x^{(i)}, x^{(j)}$ are different persons, $\left\|f(x^{(i)}) - f(x^{(j)})\right\|^2$ is large.

Triplet Loss

During training, if A,P,N are chosen randomly, $d(A,P) + \alpha \leq d(A,N)$ is easily satisfied.

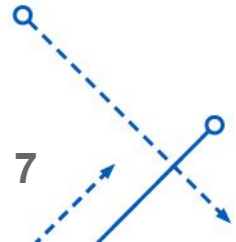
But, many data is required for robust performance.

UBOL
(User Based One-Shot Learning)



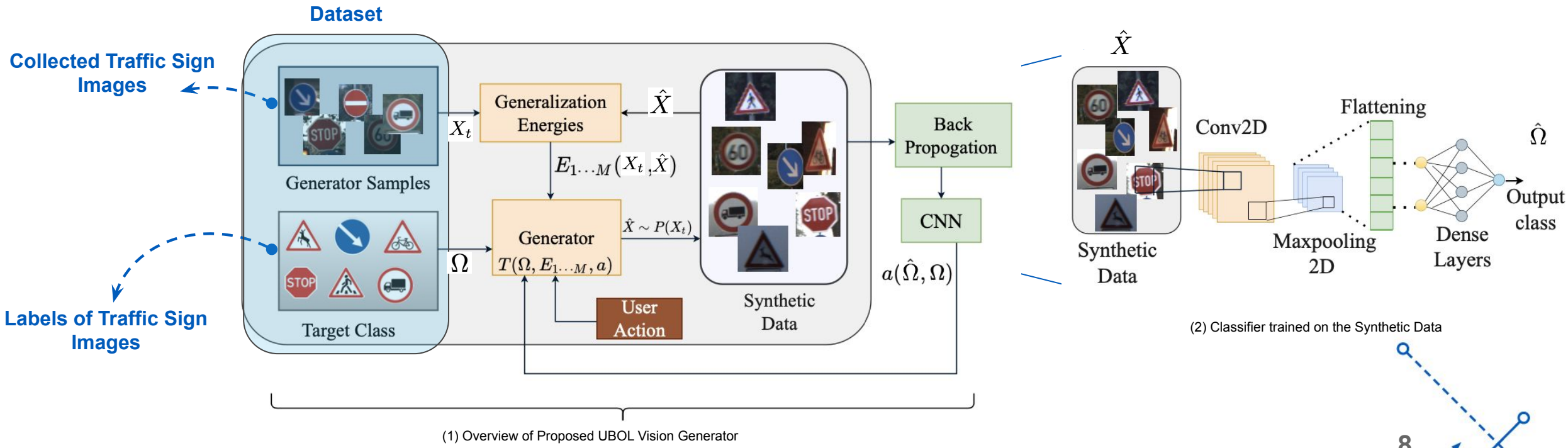
Motivation

- Needs massive manually annotated database to train the perception system for safe autonomous system
- User behavior plays pivotal role as the users can better adapt their driving to different driving conditions compared to the deep learning



Approach

- Making generalization model to data augmentation with the traffic sign data and user behaviors following the sign



Approach

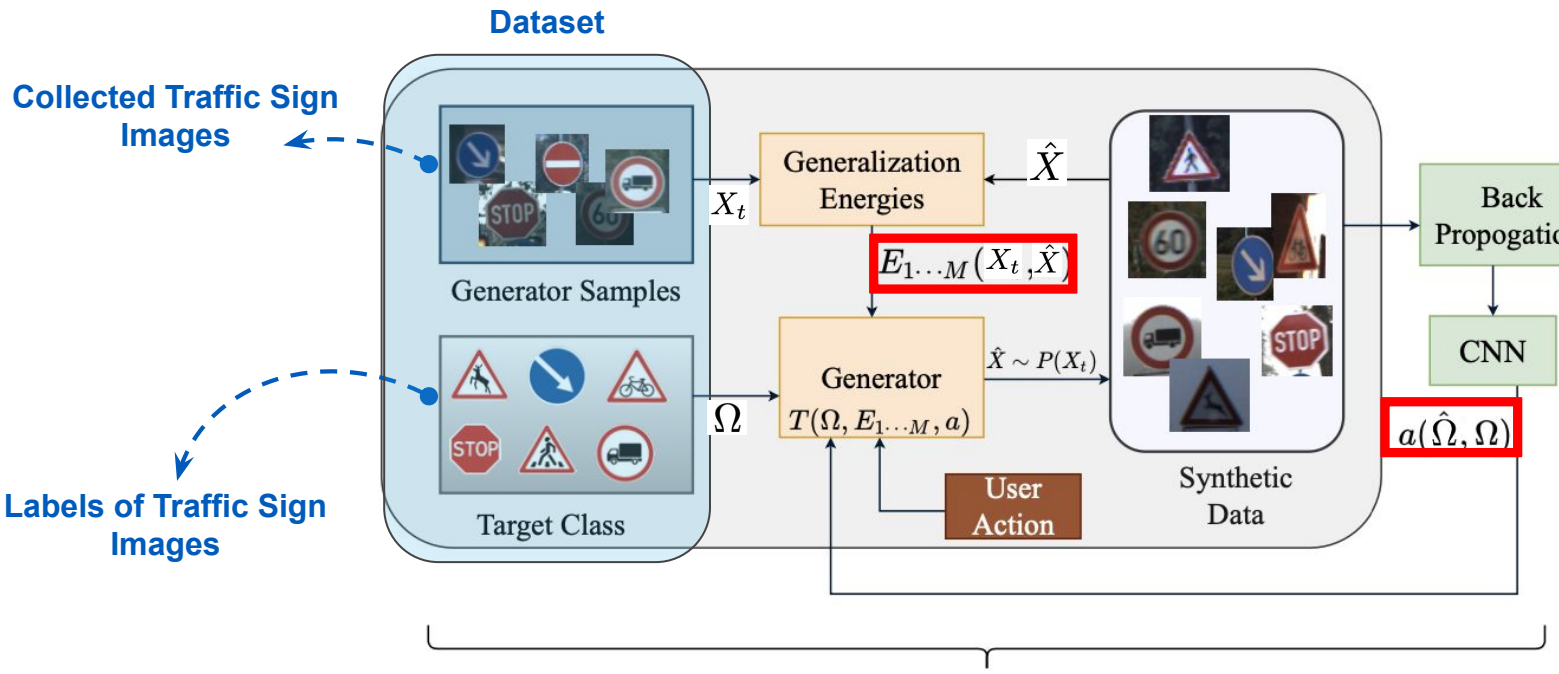
$\Omega = [\sigma_1, \sigma_2, \cdots, \sigma_n]$ → probabilities of each label

$T(\Omega, \cdot) = [t_1(\sigma_1, \cdot), t_2(\sigma_2, \cdot), \cdots, t_n(\sigma_n, \cdot)]$

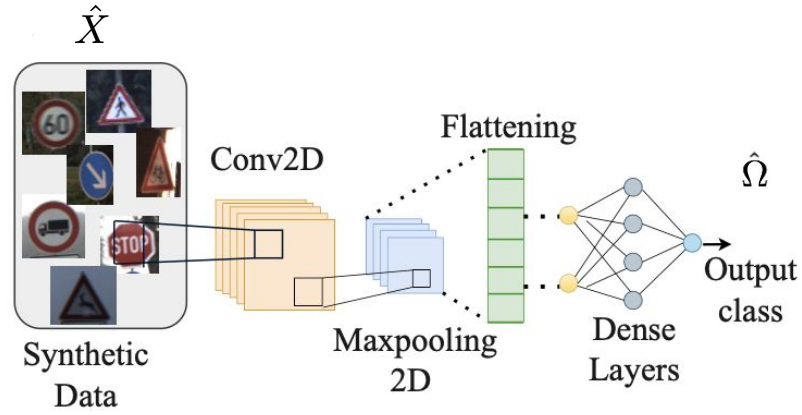
$t(\theta, \cdot)$ → transformation function from label and other parameters to synthesis image

$E_{1\cdots M}(\cdot) = [E_1(\cdot), E_2(\cdot), \cdots, E_M(\cdot)]$

N : number of traffic sign class
M : number of objects in a sample



(1) Overview of Proposed UBOL Vision Generator



(2) Classifier trained on the Synthetic Data

Comparison

TABLE I

ACCURACY RESULTS OF RECOGNITION OF STATE-OF-THE-ART SUPERVISED OBJECT RECOGNITION SYSTEMS WITH RESPECT TO UBOL AFTER TRAINING ON ALL TRAINING DATA FROM GTSRB

	Speed Limits (%)	Unique (%)	Danger (%)	Mandatory (%)	Other Prohibitions (%)	Derestriction (%)
Multi-Scale CNN [30]	98.21	97.87	98.32	96.88	97.09	97.81
Human (best individual) [31]	98.63	97.89	99.21	96.72	98.45	97.14
Random Forests [32]	95.45	92.78	90.76	88.92	93.87	97.82
Committee CNN [33]	99.11	99.32	99.18	99.46	98.76	98.82
LDA baseline [34]	97.61	92.86	88.92	96.84	86.72	90.91
UBOL (AlexNet)	98.91	99.71	99.32	99.19	99.74	99.22
UBOL (GoogleNet)	99.53	99.34	99.62	99.15	99.23	99.86
UBOL (LeNet)	99.49	99.92	99.87	99.72	99.61	99.44

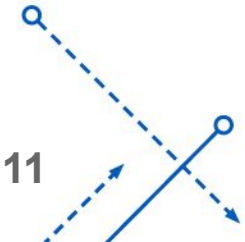
TABLE II

ACCURACY RESULTS OF RECOGNITION ON GTSRB, FOR UBOL AFTER TRAINING ONE-SHOT TRAFFIC SIGN TEMPLATES

	Speed Limits (%)	Unique (%)	Danger (%)	Mandatory (%)	Other Prohibitions (%)	Derestriction (%)
UBOL (AlexNet)	92.65	89.76	91.98	91.93	90.72	88.54
UBOL (GoogleNet)	93.78	92.40	88.63	90.91	89.22	91.54
UBOL (LeNet)	91.23	87.67	88.61	82.90	84.92	87.92

Discussion

- **Pros :**
  - By adopting the user behavior and generalization model, free of the need for a massive manually annotated database to train the perception system for a safe autonomous system.
  - Offered the way to overcome to hard to train generative model with other feature such as user-behavior.
  - The user experience features play a key role in boosting the recognizing the traffic signs.
- **Limits :**
  - New labeled traffic sign have to be manually updated. (it is not zero-shot learning.)
  - Based on generative model, needs large computational cost to train.
  - Required collecting user-behavior data with the image.
  - Cannot reach to level-5 autonomous driving system.

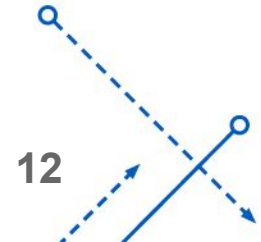


Discussion - What we can do next?

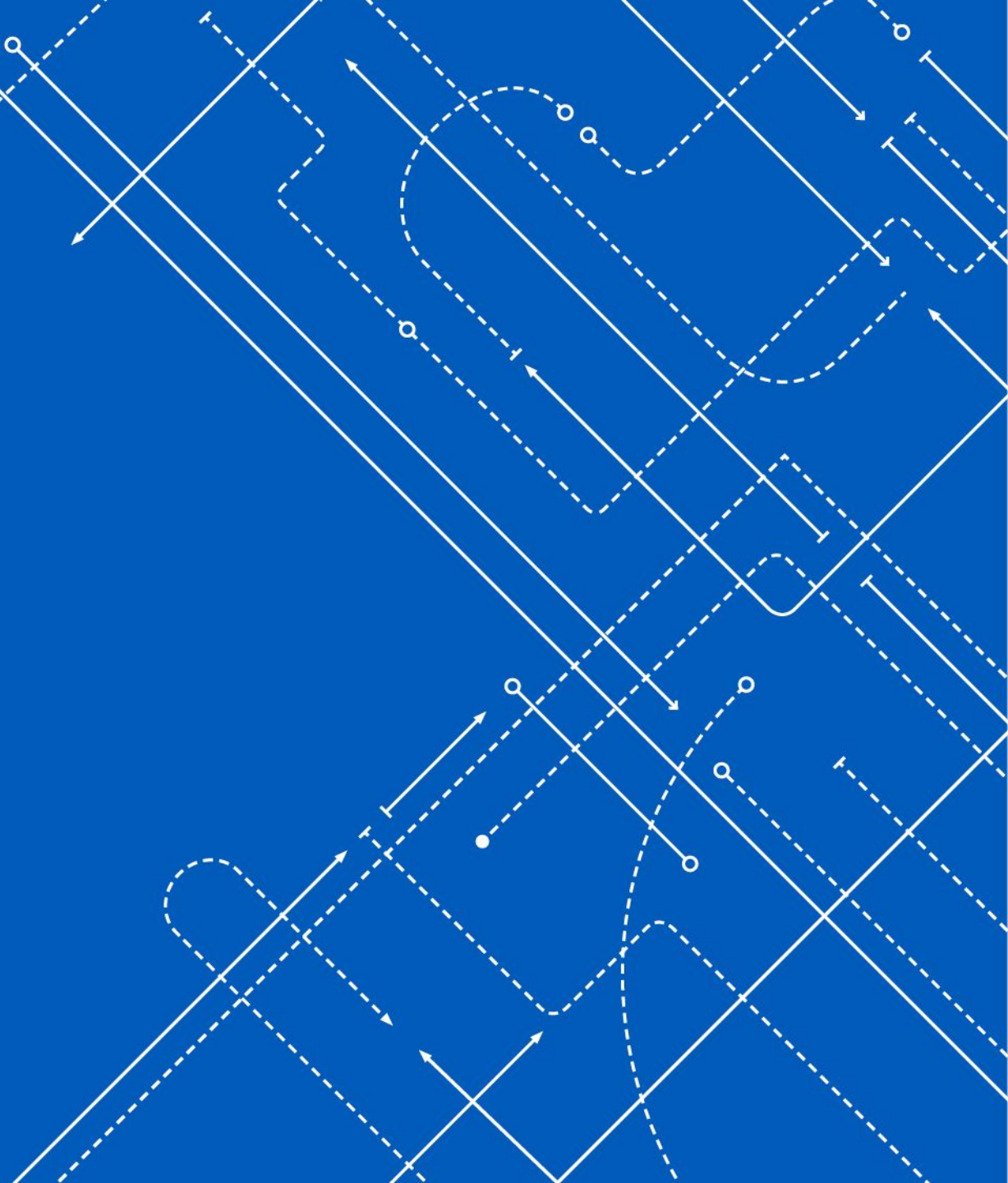
- **Data augmentation** using GAN was effective to improve the performance of the perception model.
- Try to **find other features** to overcome the limited data and helps generation of data

So,

- Consider **the perception model or architecture with telemetry system.**
  - Developing CAN-BUS scanning and networking module
  - Studying the Collective Perception Systems
    such as, Sensor Fusion, Zero-shot Learning, and Swarm Intelligence



Thank You



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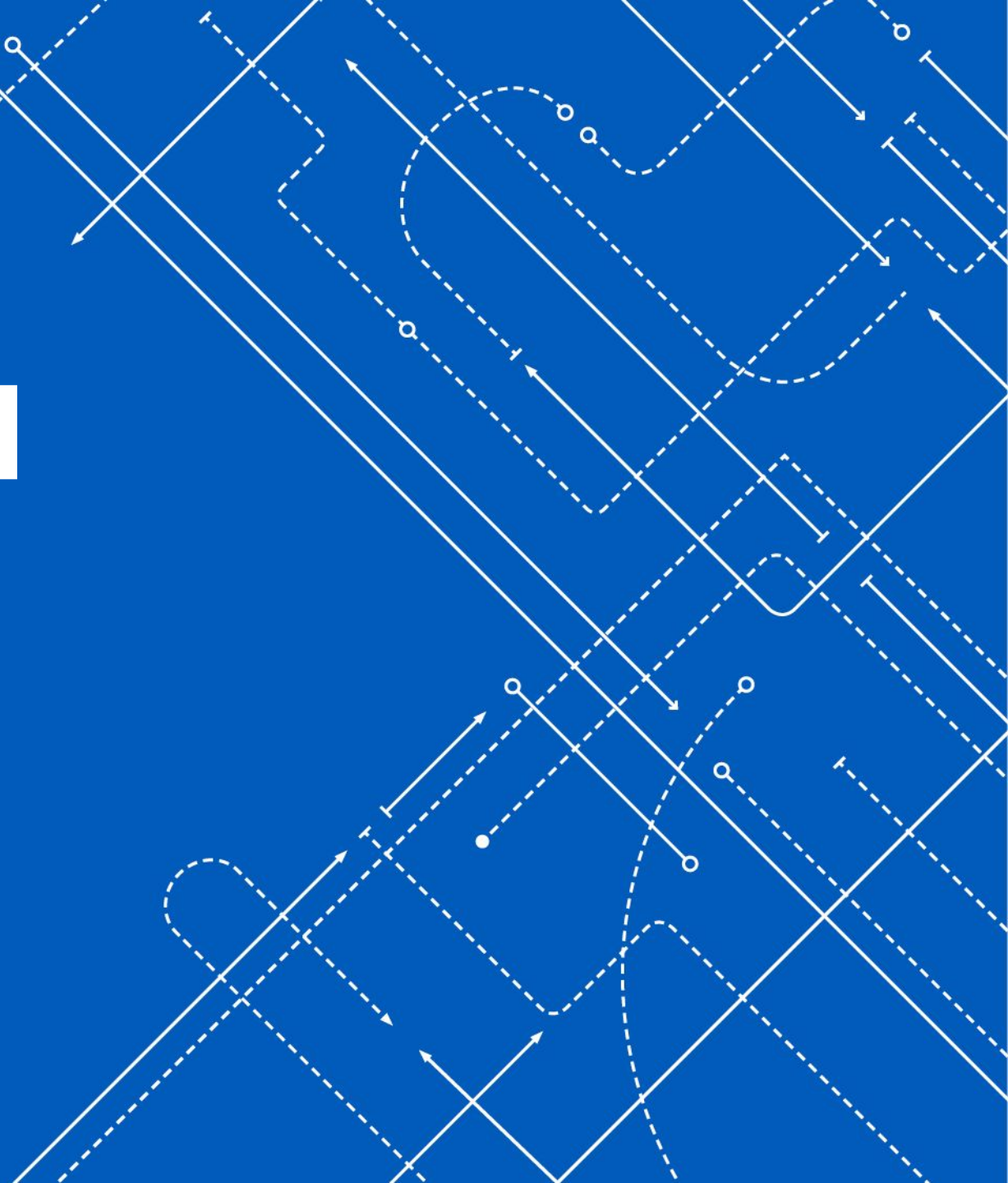

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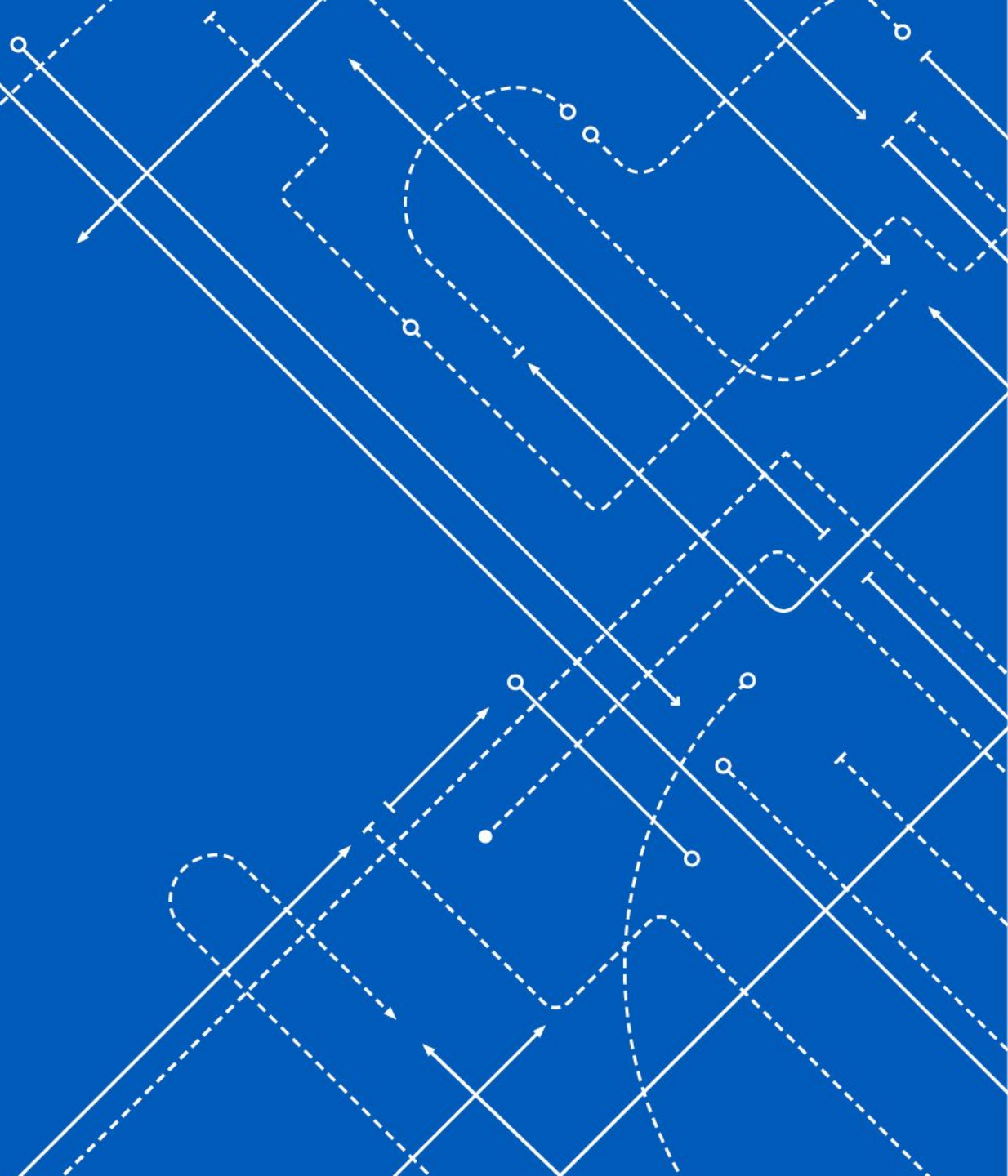

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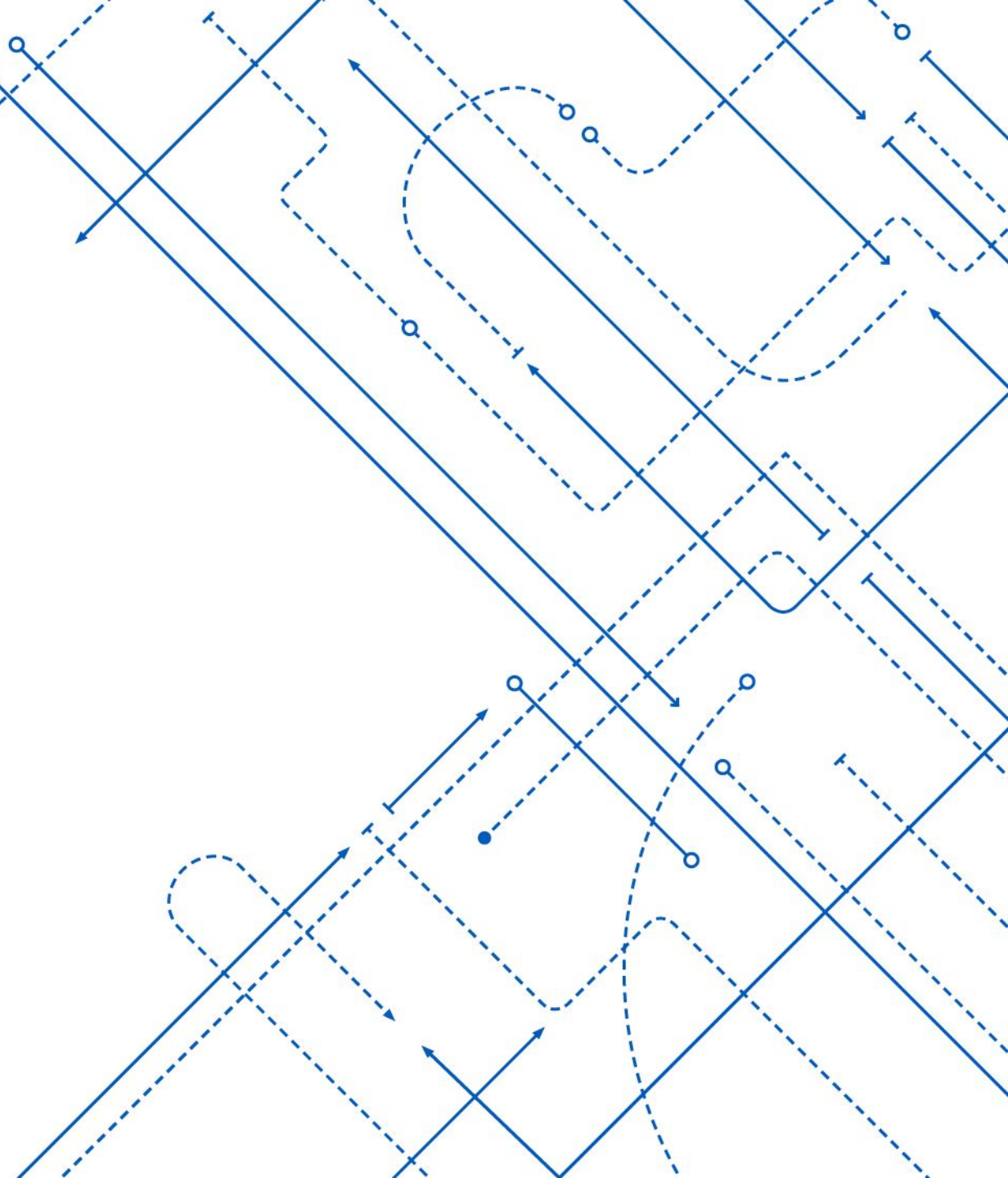

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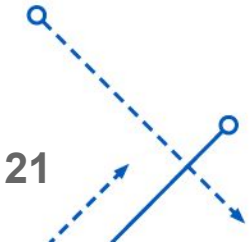

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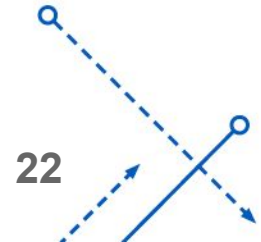

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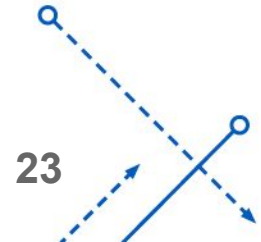

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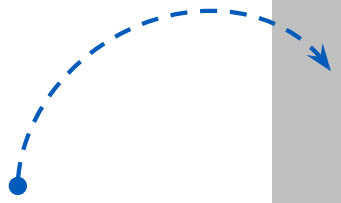

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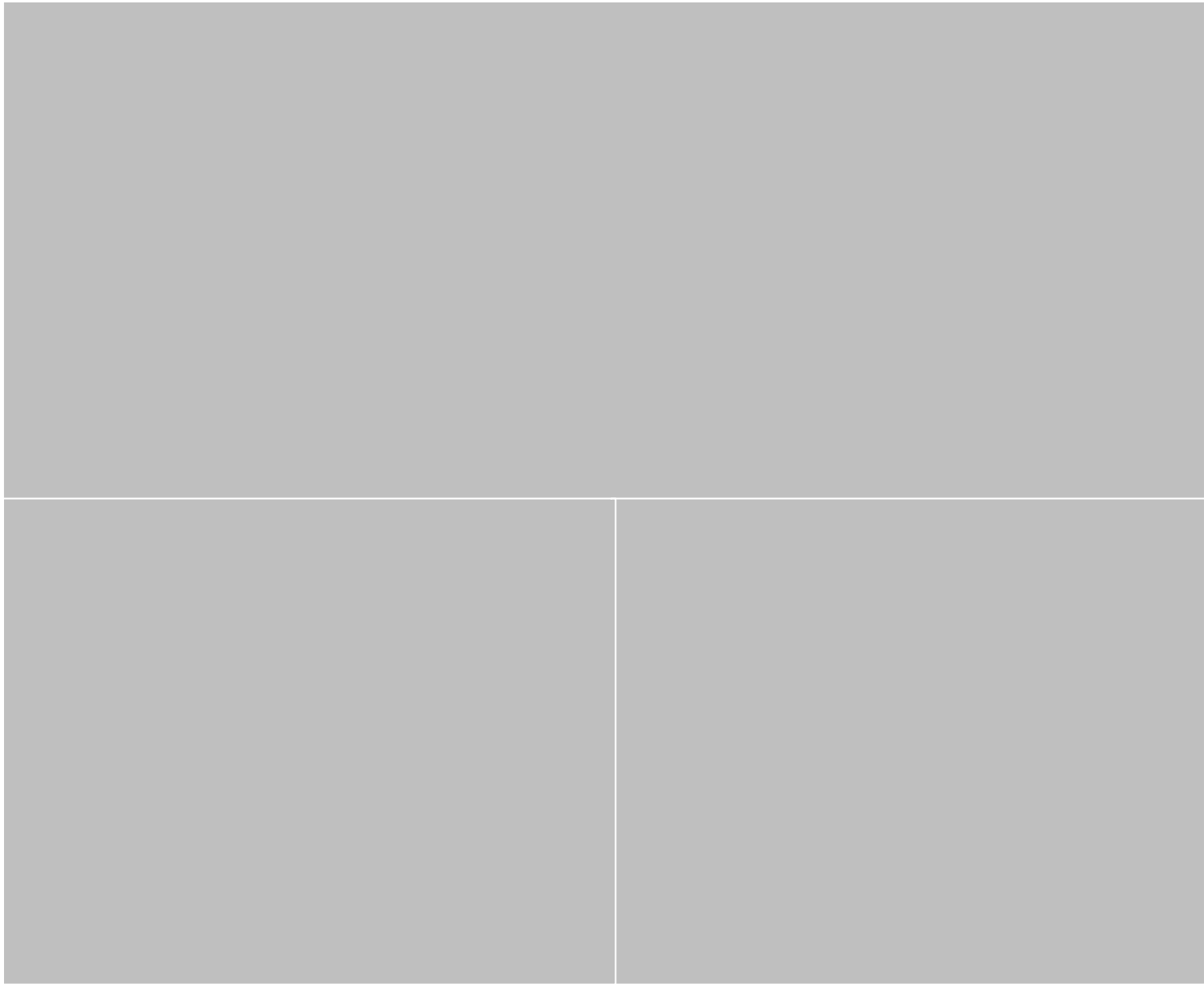

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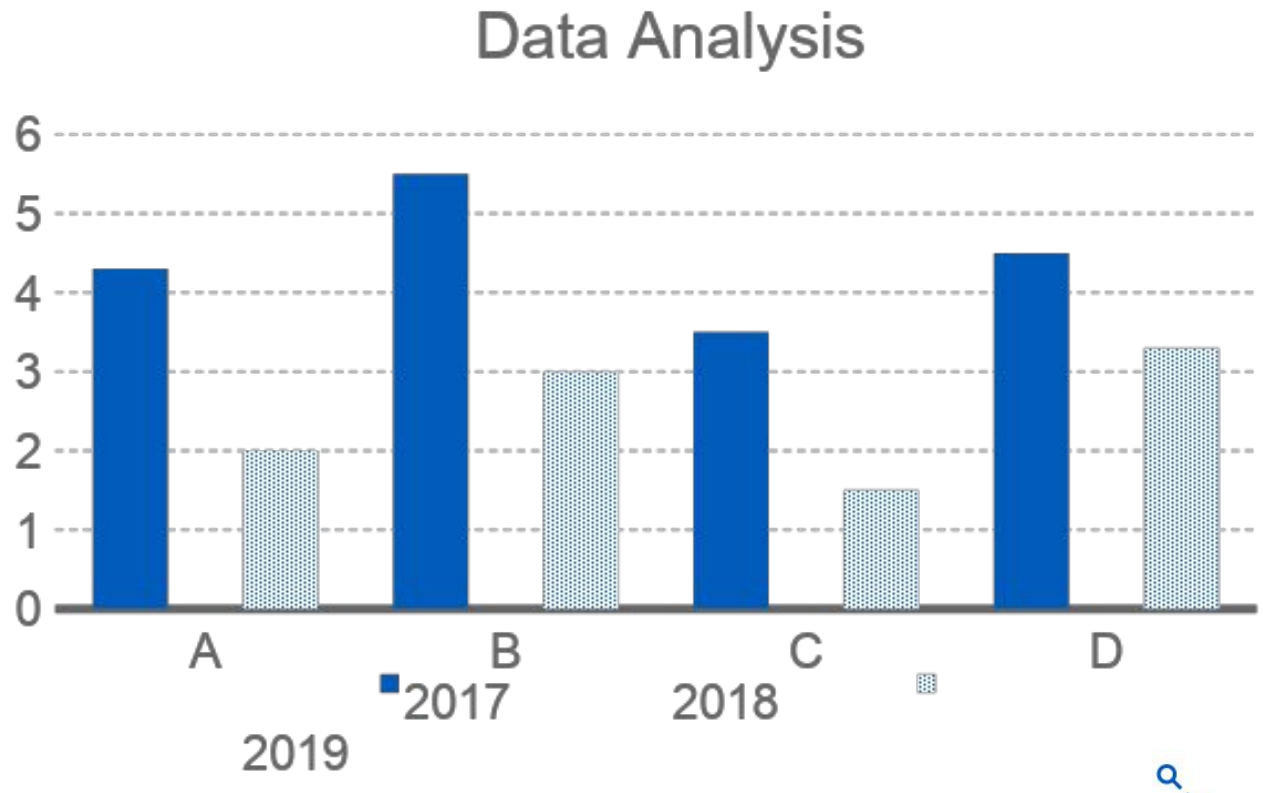

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