

Pick-a-back: Selective Device-to-Device Knowledge Transfer in Federated Continual Learning

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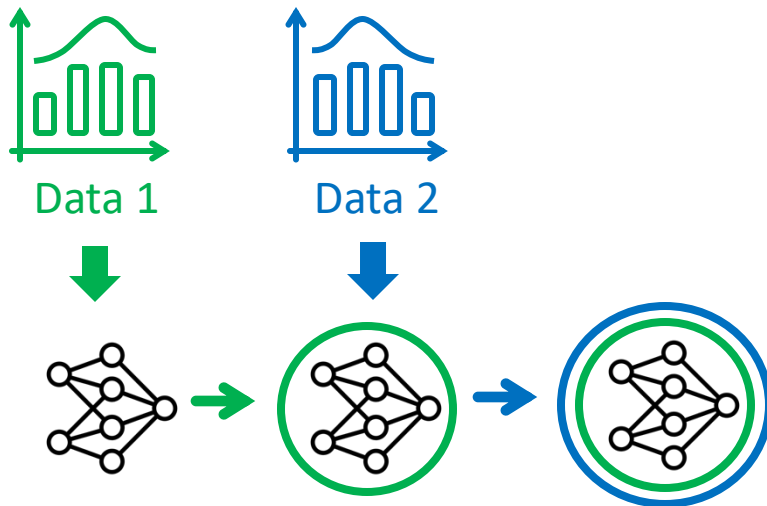


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Federated Continual Learning

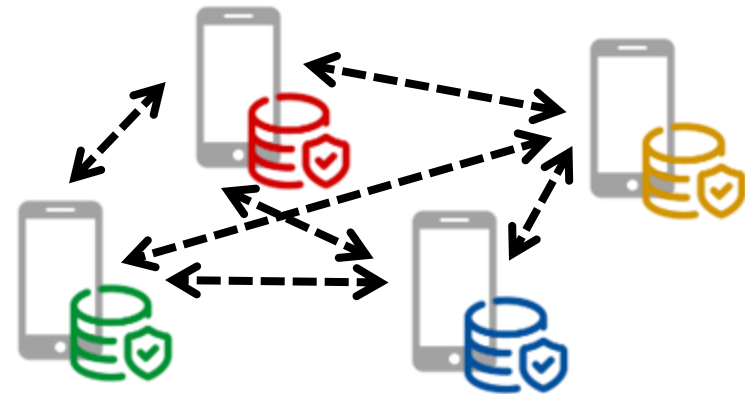
Continual Learning

- Continuously learn a new data w/o forgetting existing knowledge



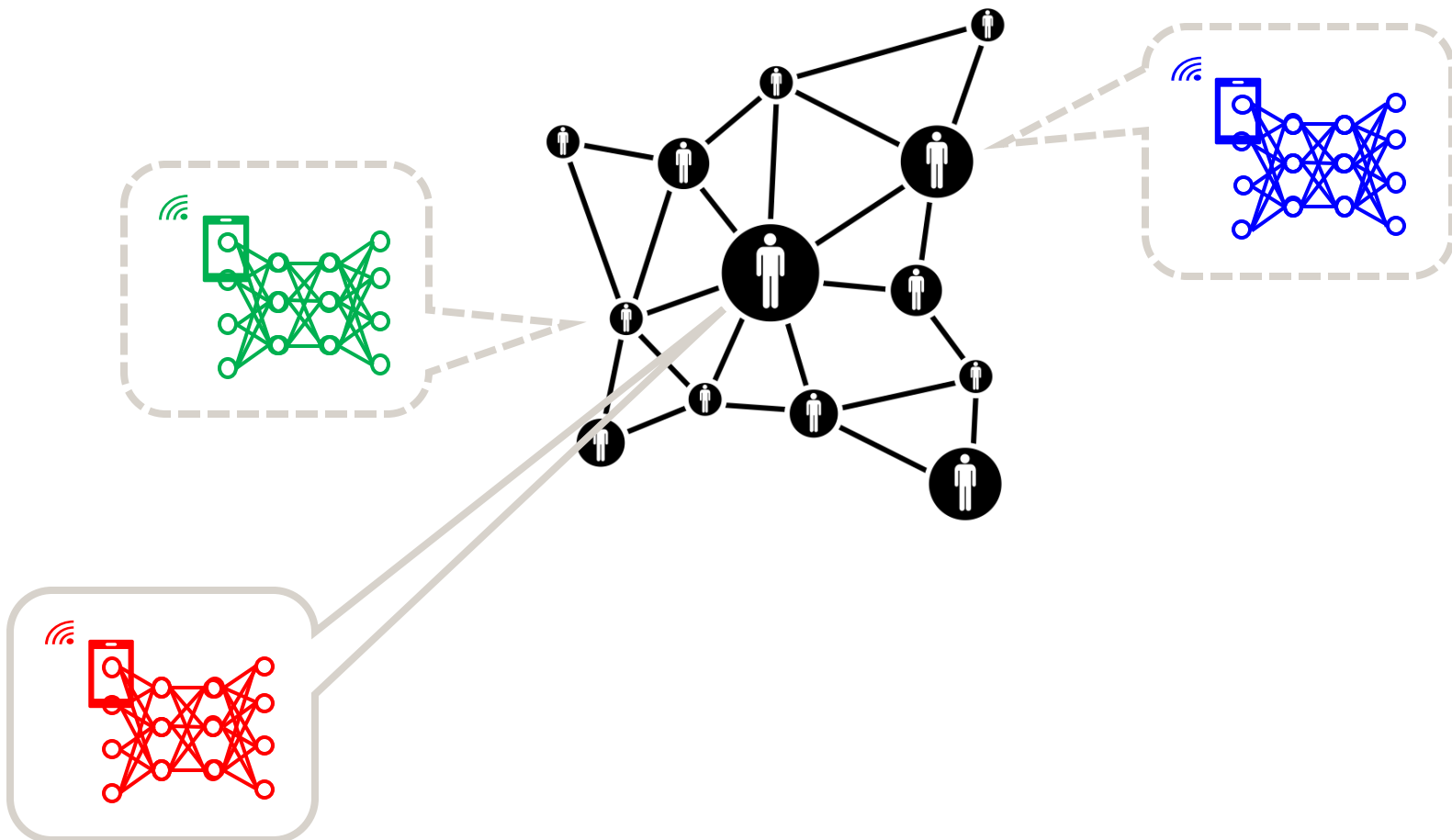
Federated Learning

- Decentralized data
- Collaboratively train a model



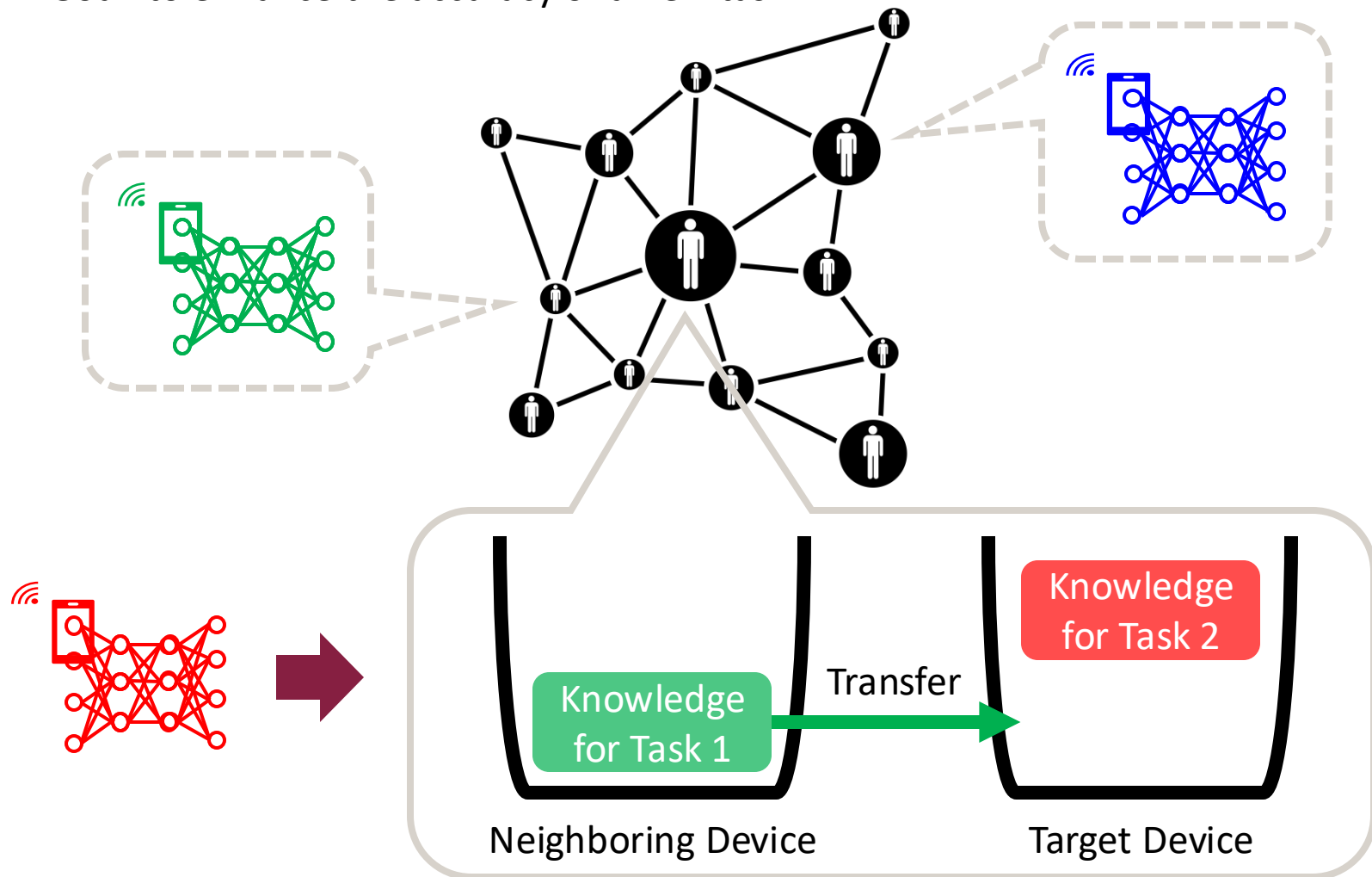
Local continual learning model leverages external knowledge (= model) from neighboring devices in federated learning manner

Device-to-Device Knowledge Transfer



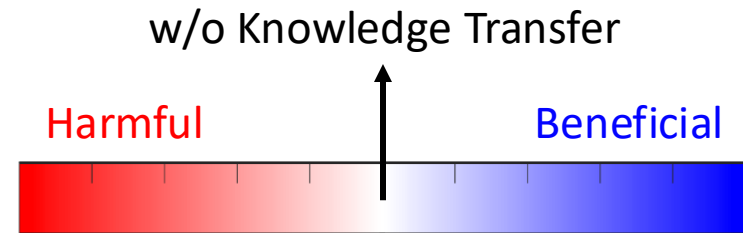
Device-to-Device Knowledge Transfer

- Transfer a certain knowledge between devices
- Goal: to enhance the accuracy of a new task



Backbone Knowledge

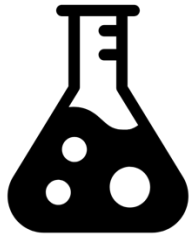
Target Task (To Learn)	avg	69	71	69	71	70	71	71	69	71	71	72	71	70	72	72	71	71	71	72	70	69
	15	40	43	40	40	43	41	40	40	41	39	46	40	40	42	42	43	38	42	45	41	42
	1	55	57	55	60	56	62	62	57	61	58	59	58	56	58	59	59	58	60	59	58	57
	17	57	58	56	57	55	56	58	54	59	60	59	59	56	59	59	56	59	59	57	59	58
	16	60	61	62	61	62	64	63	59	59	61	63	64	62	62	62	61	63	64	62	64	61
	18	62	68	63	66	65	68	68	64	68	65	64	67	68	64	64	65	66	65	66	66	64
	12	66	70	67	71	67	72	67	70	73	75	71	70	70	73	73	72	71	72	72	69	69
	3	67	71	68	71	69	69	69	69	68	72	72	71	68	72	72	71	71	70	68	65	67
	14	68	70	69	71	73	73	75	66	71	71	71	75	69	76	75	70	73	69	74	73	66
	7	69	71	71	72	70	70	72	69	73	74	72	71	71	71	71	72	71	72	70	70	69
	6	71	73	67	73	70	72	73	69	72	73	75	74	71	73	73	74	74	76	76	73	67
	8	73	75	72	76	74	75	76	74	75	76	76	77	74	77	75	74	76	70	77	75	71
	2	73	73	72	75	72	72	71	72	75	73	73	74	72	73	74	75	74	73	74	73	72
	4	74	74	70	76	75	74	74	74	73	74	76	75	73	73	75	73	74	76	72	72	71
	13	75	76	77	74	75	77	78	74	76	74	77	78	76	77	76	78	76	77	79	76	76
	19	76	78	74	76	79	78	76	78	76	77	80	78	77	76	77	79	77	78	77	77	73
	5	76	80	78	80	81	80	79	78	79	78	77	76	80	80	79	81	78	79	78	76	77
	10	77	79	79	82	78	79	81	76	80	81	79	79	77	81	80	78	79	81	79	80	78
	9	77	74	73	75	74	77	76	72	77	75	71	75	74	79	77	76	75	77	79	75	71
	20	81	83	82	84	82	83	83	81	85	85	85	86	84	84	82	84	83	86	83	82	81
	11	84	85	82	75	84	84	83	83	83	84	83	84	83	85	82	82	84	83	84	83	84
		X	15	1	17	16	18	12	3	14	7	6	8	2	4	13	19	5	10	9	20	11
		Backbone Task (Learned)																				



- Mostly **beneficial**... but some are more beneficial
- Each task has each different **beneficial** knowledge

“Which one to select?”

Selective Knowledge Transfer



“Who is more likely to be good at science?”

I am good at math!



Student A

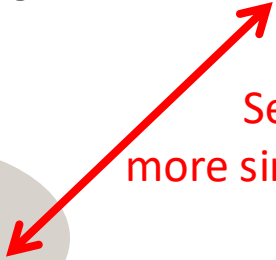
vs.

I am good at English!



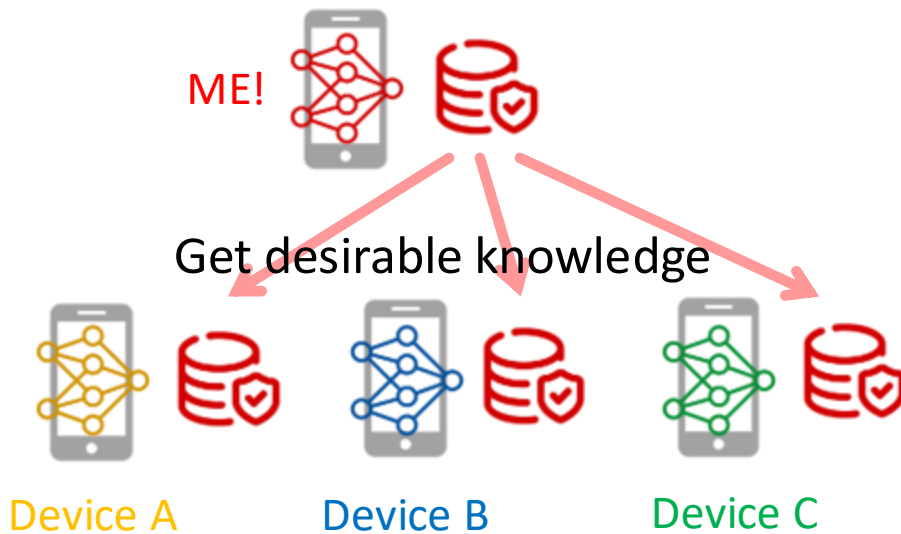
Student B

Seems more similar

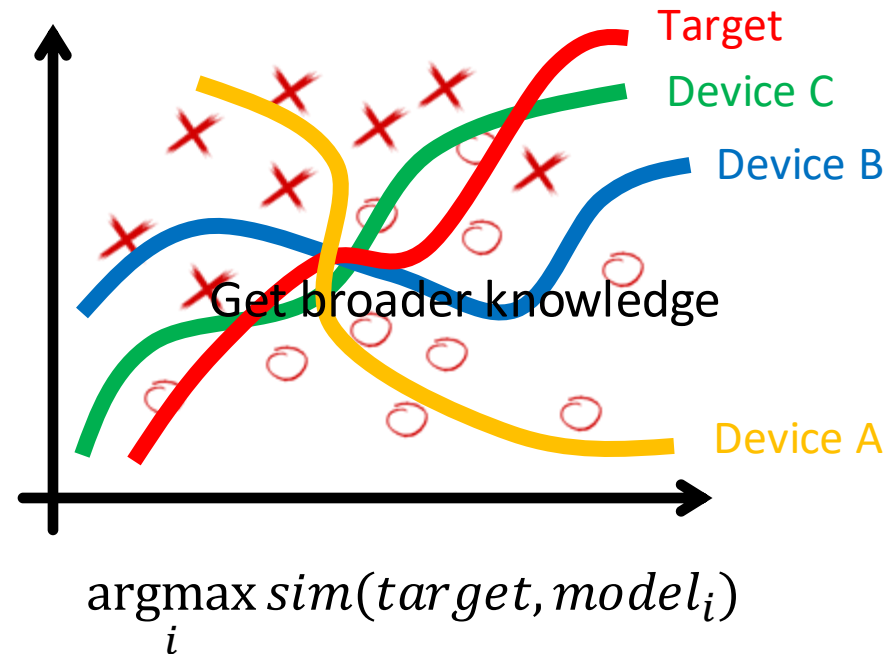


Pick-a-back: Selective Device-to-Device Knowledge Transfer

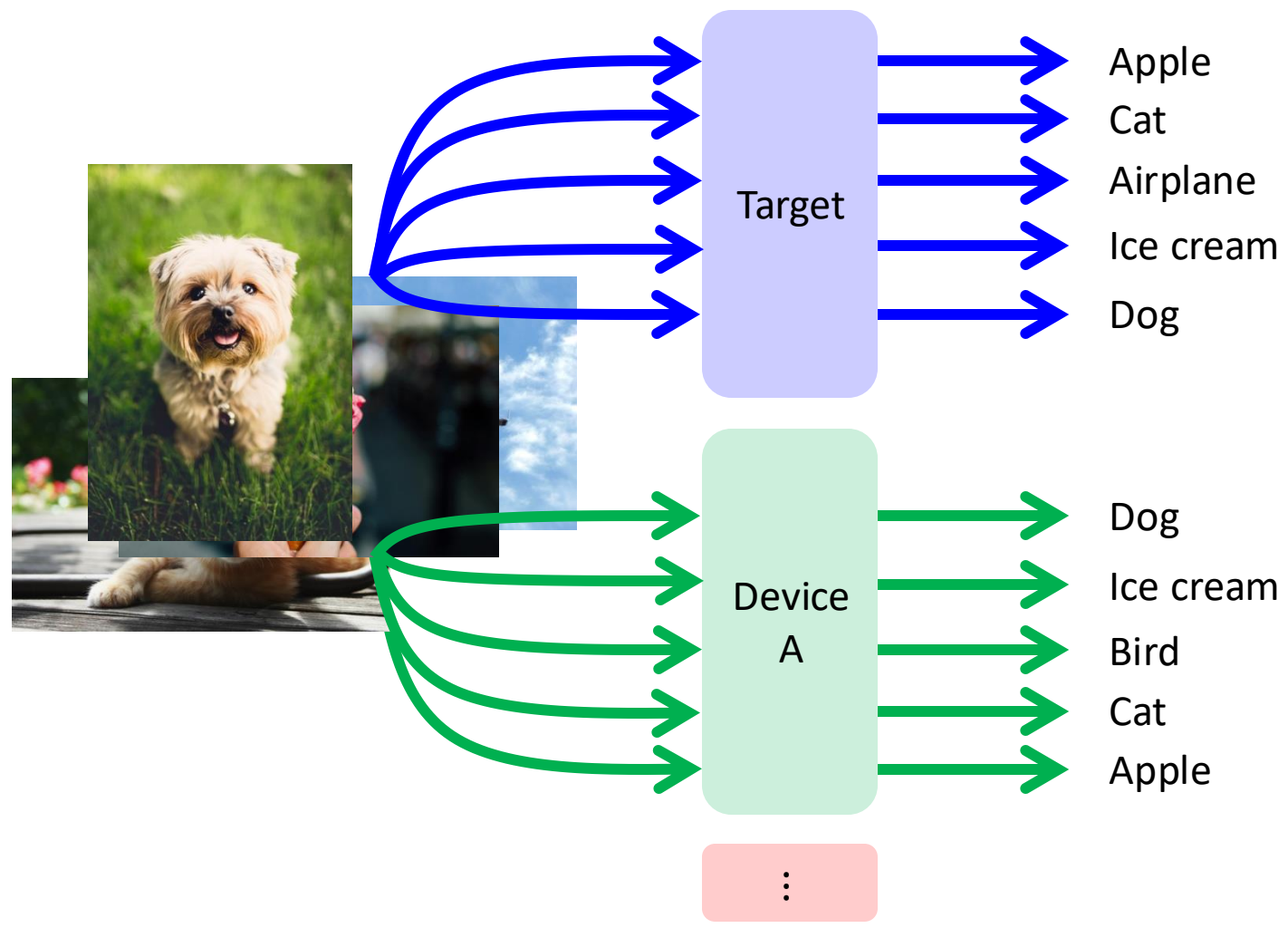
- **STEP 1.** Send my partial data to neighboring devices



- **STEP 2.** Select a model with the most similar decision boundary



Pick-a-back: Selective Device-to-Device Knowledge Transfer



Pick-a-back: Selective Device-to-Device Knowledge Transfer

- STEP 1. Send my partial data to neighboring devices
- STEP 2. Select a model with the most similar decision boundary

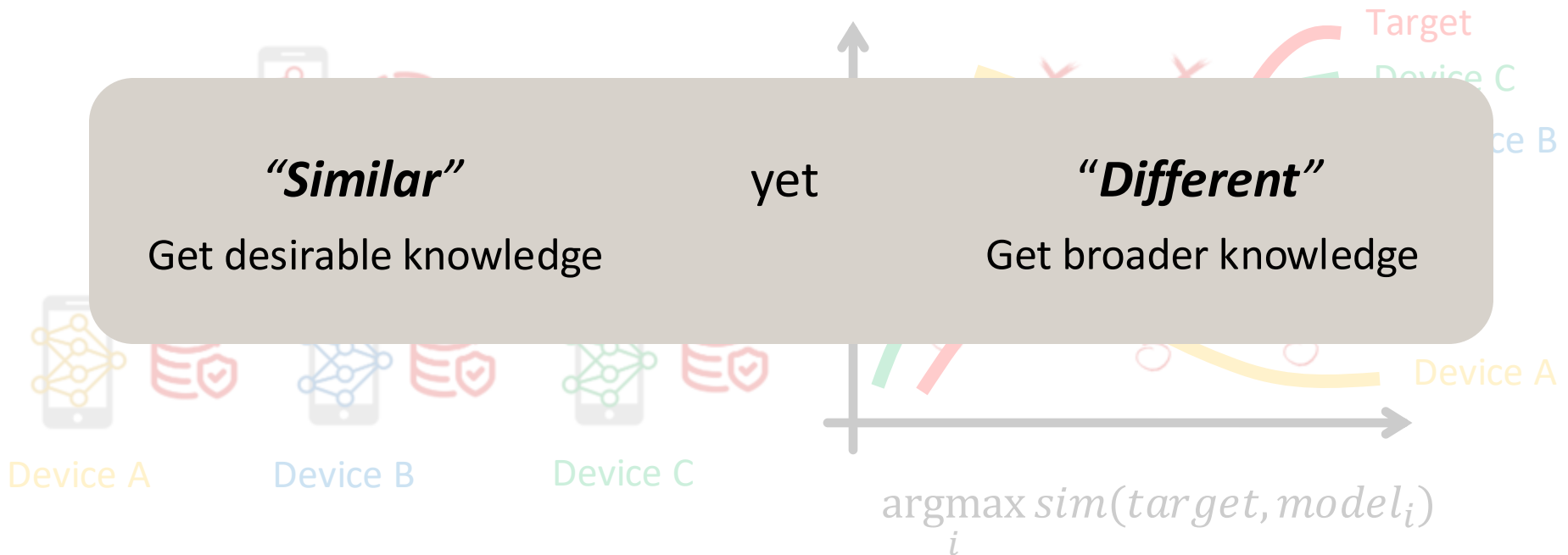
“Similar”

Get desirable knowledge

yet

“Different”

Get broader knowledge



Experimental Results

- Only two negative cases among 20 cases

Client ID	15	1	17	16	18	12	3	14	7	6	8	2	4	13	19	5	10	9	20	11	Avg
w/o Backbone	40.0	55.0	57.2	60.4	51.8	66.0	67.4	67.6	69.2	70.8	72.6	73.0	74.2	75.2	75.8	76.4	77.0	77.4	81.2	84.0	69.1
FedAVG	24.4	31.6	34.6	38.0	32.0	39.6	31.8	32.0	49.0	37.8	29.8	34.0	26.4	30.8	35.8	45.4	27.2	23.4	35.6	39.0	33.9
ProgressiveNet	44.6	58.8	54.4	63.0	64.4	68.0	71.2	68.2	69.2	70.6	73.8	72.4	70.4	73.0	74.0	78.8	77.2	73.6	84.6	83.8	69.7
PackNet	38.0	55.0	56.4	59.4	63.8	69.0	68.2	72.2	71.2	72.8	74.4	72.0	70.2	74.8	79.6	78.0	78.6	76.8	82.6	80.2	69.7
WSN	34.2	53.8	49.4	53.4	59.8	60.2	63.6	63.0	66.8	65.0	64.6	65.4	66.6	62.6	61.2	67.6	66.6	58.6	74.0	79.8	61.8
FedWeIT	40.0	52.5	55.0	56.0	56.2	60.5	56.7	60.5	67.0	65.2	60.2	65.0	66.0	64.2	65.0	65.7	66.7	51.0	68.7	77.8	61.0
FCCL	37.0	54.4	52.4	60.6	62.2	68.2	67.2	64.4	68.2	70.6	72.8	72.4	68.4	77.0	73.8	75.0	78.6	68.8	79.2	78.2	67.5
Uniform	41.5	58.6	57.6	62.1	65.6	70.7	69.7	71.6	71.2	72.5	74.7	73.0	73.7	76.4	77.1	78.7	79.4	75.2	83.5	83.0	70.8
Internal	43.2	55.4	56.8	62.2	67.8	67.0	69.0	71.4	73.8	74.8	76.8	71.8	73.4	76.2	79.2	77.6	81.0	79.2	82.0	83.8	71.1
Random	39.8	59.0	56.6	59.2	67.6	72.6	68.2	73.0	71.4	71.4	75.6	72.8	74.4	76.4	78.0	78.2	77.8	74.6	84.2	83.8	70.7
Upper	46.4	62.4	60.0	64.2	67.8	74.8	72.2	75.6	73.8	75.6	77.0	75.0	76.0	79.4	80.0	80.6	81.6	79.2	86.2	85.4	73.7
Pick-a-back	46.4	59.0	60.0	63.2	64.4	72.6	71.8	75.6	72.4	72.2	77.0	73.0	72.8	76.2	76.0	80.2	78.2	75.8	84.2	85.4	71.8

- Accuracy improvement by up to 51.9 % (vs. ImageNet-Pretrained +24.4%)

Client ID	1	2	3	4	5	Avg
Pretrained	28.9	90.5	42.4	49.9	37.1	49.8
w/o Backbone	8.3	66.3	7.4	28.2	12.7	24.6
Pick-a-back	49.5	77.4	44.0	46.4	64.6	56.4
	(+41.2)	(+11.1)	(+36.6)	(+18.2)	(+51.9)	(+31.8)

Take-Home Message

Nowadays, knowledge is everywhere...

01 *Hard to have a good AI model?*

Seek assistance from external indirect knowledge

02 *Which model to select?*

Similar model can give a beneficial yet broader knowledge



*Please check details from
“Pick-a-back: Selective Device-to-Device Knowledge
Transfer in Federated Continual Learning”
in ECCV 2024!*



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