CAREER: Towards Reliable and Optimized Data-Driven Cyber-Physical Systems using Human-Centric Sensing

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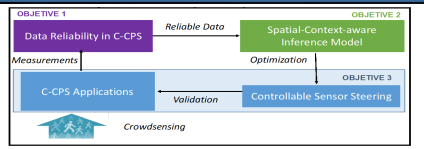
https://www.wangdong.org/sslab/index.html

Project Overview: Create a new Data-driven Crowdsensing-based CPS (C-CPS) Design and Implementation (DCCDI) framework to address the data reliability, crowd rationality and optimized sensor steering challenges in building reliable and optimized CPS using humans as sensors.



Smart Urban Monitoring | Disaster Damage Assessment | Intelligent Transportation

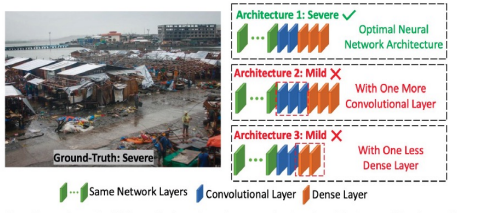
Challenge:

- Data Reliability
- Crowd Rationality
- Closed-loop Crowdsensing based-CPS (C-CPS) Design

Scientific Impact:

- The current C-CPS framework has been studied in a disaster damage assessment application
- It can be further generalized and applied to other C-CPS domains (e.g., crowdsensing based anomaly detection, intelligent transportation, smart urban sensing)

Solution:



The above figure shows the DDA results from three deep neural network architectures with only *one layer difference* in neural network architectures. In particular, *Architecture 2* has only one more convolutional layer compared to *Architecture 1*. *Architecture 3* has only one less dense layer compared to *Architecture 1*.

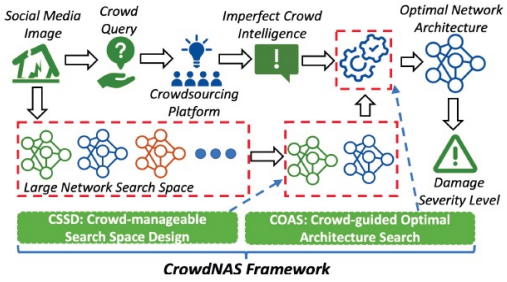


Table 3. Performance Comparisons on Typhoon Hagupit Dataset (Varying Crowd Query Ratios)

Category	Algorithm	$\alpha = 10\%$ F1-Score	$\alpha = 10\%$ AC-Score	$\alpha = 10\%$ MCC	$\alpha = 15\%$ F1-Score	$\alpha = 15\%$ AC-Score	$\alpha = 15\%$ MCC	$\alpha = 20\%$ F1-Score	$\alpha = 20\%$ AC-Score	$\alpha = 20\%$ MCC
Random	Random	0.3105	0.0020	0.0022	0.3850	0.0501	0.0519	0.3950	0.0621	0.0650
AI Only	InceptionNet	0.6709	0.4492	0.4692	0.6211	0.3403	0.3604	0.6521	0.4018	0.4186
	DenseNet	0.6707	0.4644	0.4682	0.6645	0.4355	0.4425	0.6894	0.4805	0.4808
	VGG	0.6708	0.4407	0.4656	0.6335	0.3382	0.4022	0.6211	0.3252	0.3883
Crowd-AI	CrowdLearn	0.6460	0.4046	0.4170	0.6024	0.2995	0.3223	0.5590	0.2318	0.2466
	Deep Active	0.6459	0.4226	0.4268	0.7018	0.5063	0.5079	0.6956	0.4886	0.4892
	Hybrid Para	0.6956	0.4752	0.4788	0.6770	0.4428	0.4457	0.6521	0.4010	0.4058
NAS	NASNetLarge	0.6211	0.3661	0.3948	0.6273	0.3524	0.3956	0.6397	0.3734	0.4251
	NASNetMobile	0.6149	0.3422	0.4095	0.6086	0.3161	0.3677	0.6521	0.3909	0.4434
	DARTS	0.4596	0.1644	0.1750	0.5403	0.1873	0.2014	0.5155	0.1994	0.2057
	ProxylessNAS	0.6583	0.3948	0.4338	0.6583	0.3900	0.4333	0.6708	0.4193	0.4560
	UnNAS	0.5403	0.2009	0.2271	0.5031	0.0961	0.1394	0.5652	0.2419	0.2711
Our Model	**CrowdNAS**	**0.7142**	**0.5149**	**0.5197**	**0.7329**	**0.5375**	**0.5412**	**0.7515**	**0.5654**	**0.5723**

Table 7. Computational Time Comparisons on Typhoon Hagupit Dataset (seconds) - Varying Crowd Query Ratios

Algorithm	Training Time $\alpha = 10\%$	Training Time $\alpha = 15\%$	Training Time $\alpha = 20\%$	Inference Time $\alpha = 10\%$	Inference Time $\alpha = 15\%$	Inference Time $\alpha = 20\%$	Total Time $\alpha = 10\%$	Total Time $\alpha = 15\%$	Total Time $\alpha = 20\%$
InceptionNet	0.6561	0.9113	1.2151	0.0509	0.0509	0.0507	0.7070	0.9622	1.2658
DenseNet	0.6743	0.9441	1.2261	0.1252	0.1255	0.1255	0.7995	1.0696	1.3516
VGG	0.6240	0.8850	1.1346	0.0218	0.0219	0.0218	0.6458	0.9069	1.1564
CrowdLearn	0.6171	0.8415	1.1221	0.0230	0.0231	0.0214	0.6401	0.8646	1.1435
Deep Active	0.6093	0.8349	1.1283	0.0217	0.0216	0.0215	0.6310	0.8565	1.1498
Hybrid Para	0.7040	0.9963	1.3284	0.0240	0.0223	0.0210	0.7280	1.0186	1.3494
NASNetMobile	0.7199	0.9641	1.2855	0.1162	0.1175	0.1201	0.8361	1.0816	1.4056
NASNetLarge	0.7222	0.9948	1.3628	0.1780	0.1699	0.1782	0.9002	1.1647	1.5410
DARTS	0.1573	0.2225	0.2967	0.0099	0.0100	0.0101	0.1672	0.2325	0.3068
ProxylessNAS	1.0789	1.1366	1.1554	0.0122	0.0121	0.0126	1.0911	1.1487	1.1680
UnNAS	0.8428	0.8571	0.9050	0.0144	0.0148	0.0149	0.8572	0.8719	0.9198
CrowdNAS	0.0215	0.0217	0.0220	0.0213	0.0214	0.0217	**0.0428**	**0.0431**	**0.0437**

- Yang Zhang, Lanyu Shang, Ruohan Zong,, Ziyi Kou, Lanyu Shang, Dong Wang. CrowdNAS: A Crowd-guided Neural Architecture Searching Approach to Disaster Damage Assessment, The 25th ACM Conference On Computer-Supported Cooperative Work And Social Computing (CSCW 22), November, Virtual Conference, 2022.

Broader Impacts:

- Contribute to a powerful C-CPS paradigm that can transform many aspects of our society (e.g., disaster damage assessment, smart urban sensing, environment, transportation).
- Integrate the research with the course "Social Sensing and Human-Cyber-Physical Systems" at UIUC
- Train undergraduate and graduate students at UIUC
- Organize ACM/IEEE ASONAM 23 in CISE research community.
- Distribute research results through publications in related venues.

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