

Research Assessment Exercise 2020
Impact Overview Statement

University: The Chinese University of Hong Kong

Unit of Assessment (UoA): UoA 13 Computer Studies/Science (incl. Information Technology)

Total number of eligible staff of the university in the UoA: 39

(1) Context - context for the individual case study(ies)

The UoA's research on *Computer Studies/Science* (incl. *Information Technology*) has created impacts by (i) establishing spin-outs, (ii) opening employment opportunities, (iii) improving quality of services (QoS), (iv) enhancing industry productivity, and (v) preventing frauds in commercial transactions. The influence of the impacts has extended far beyond the local region to the international level, as is evidenced by the great number and diversity of beneficiaries in both the private and public sectors. This document demonstrates the above with three case studies: ***Deep Learning in Computer Vision (DLCV)***, ***Automated Data-driven sOftware Reliability Engineering Impact on IT Industry (ADORE)***, and ***Protecting Billions of Stake-holders from Critical Security Vulnerabilities in Single-Sign-On (SSO) and Mobile Payment Systems via Scalable Security Testing and Code Analysis (MobiSec)*** :

- DLCV describes the success of *SenseTime*, which is a major spin-out from the UoA, and has grown into a world-renowned AI company today. It currently has a *customer base of over 700 major partners worldwide* – such as NVIDIA, Honda, Alibaba, Massachusetts Institute of Technology, Qualcomm, etc. – and provides *leading services in multiple markets, such as smart city, smartphone, entertainment, finance, retail, automobile*, to name just a few.
- ADORE is a general framework for combatting the difficult issue of software unreliability and QoS unpredictability. It has benefited *over 370 institutions worldwide*, including tech-giants like Microsoft, Huawei, and Tencent.
- MobiSec documents the achievements of our faculties and their research teams in identifying a long string of severe vulnerabilities in prominent mobile platforms – from “big names” including AliPay, Facebook, Google, Sina, Tencent– that *affect billions of users*, and can be exploited by hackers to generate fraudulent transactions for financial gains.

(2) Approach to impact - the unit's approach to impact during the assessment period for impact

The most important approaches taken by the UoA to encourage impact-generating endeavors can be summarized as *innovation, interaction, and development*.

Innovation in Research. The UoA has been consistently pushing for research outcome competitive at the world stage. Three specific policies have worked very well towards that purpose. First, obviously, hire the best: having been extremely selective in faculty hiring, the UoA is proud to host a large number of scientists with excellent standings in their disciplines. Second, uphold an exacting standard in faculty appraisals: discovery of world-class findings has long become a compulsory criterion for securing a good appraisal result, as is especially true for substantiations and promotions. Third, form a critical mass in crucial areas to tackle directions of strong resistance: The UoA has identified four strategic areas in which the expertise of its faculty members can be put together to form a critical mass. These areas are (i) foundation of computer science, (ii) artificial intelligence (AI) and machine learning (ML), including applying AI/ML techniques to other subfields, in particular, computer vision, (iii) big-data analytics and knowledge management, and (iv) computer and cyber security. The three impact cases selected fall in areas (ii), (iii), and (iv), respectively.

Interaction with the Key Users. Almost every successful project from the UoA tells the story of a great marriage between *technology* and *people*, that is, of how technological advancement is transformed into concrete solutions addressing important issues in reality. To maximize the possibility of such transformation, the UoA has been applying incentive-based policies that motivate faculties to interact with the beneficiaries of their research, which are typically companies with decent market shares, as well as the local and national governments. An example of such policies is to provide one-to-one matching support to funds secured from the industry or governments, namely,

every external dollar is matched with an internal dollar. Besides encouraging interactions with the key users, the policy also helps to invest a good portion of the UoA's budget on the burgeoning areas that are yet to be visible to academia.

Development of System Prototypes. The UoA has made it a strategic direction to develop information systems that serve as real-life "proofs of concepts" and are ready to be deployed in practical applications. A part of the UoA's budget is earmarked to assist the faculties in implementing their algorithms into tools and prototypes, which has brought three direct benefits. First, those implementations are usually made available to the general public, thus effectively promoting the relevant findings and shortening the cycle of impact generation. Second, a large amount of feedback can be easily solicited from the users, especially on performance benchmarking against the existing solutions in the market. Third, outstanding systems, especially when open-sourced, almost for sure catch attention from the industry rapidly, which often quickly turns into fresh connections with potential beneficiaries.

(3) Strategy and plans - strategy and plans for supporting impact

Besides strengthening the current approaches that have been proven effective, the UoA plans to introduce new strategies to maximize the non-academic impacts of its research activities. The characteristics of those strategies can be summarized as (i) *coordinated*, (ii) *funded*, and (iii) *market-minded*. First, the UoA has appointed an impact coordinator, who has extensive experience in building connections between academia and industry, to oversee the impact-oriented activities. Second, the UoA is to benefit significantly from a new funding scheme introduced at the university level whose goal is to provide financial support to projects with excellent impact prospects. Third, the UoA will devote considerable efforts to monitoring the markets related to computer science and engineering in an all-around manner, striving to identify opportunities in their earliest forms. This is achieved in part by seeking advice from an advisory board that consists of prominent industry leaders (including vice presidents of Microsoft Asia-Pacific and the Alibaba group) and senior academic members (including world-renowned professors from Georgia Tech, NUS, and Stanford). The list of board members can be found at <https://www.erg.cuhk.edu.hk/erg/AdvisoryBoard>.

(4) Relationship to case studies - the relationship between the unit's approach to impact and the submitted case studies

The UoA's three impact case studies, DLVC, ADORE, and MobiSec serve as evidence on the effectiveness of the approaches described earlier in (2). First, all cases are the outcome of innovative research findings. This is best exemplified by DLVC, which compiles a string of achievements of the multimedia lab (MMLab) in the UoA. In 2015, MMLab published the first algorithm in the world that is able to beat human beings in the accuracy of face recognition. Snatching the best paper award in AAAI 2015 (a premium conference in AI), that algorithm later became a cornerstone of the software products from SenseTime. In 2016, the DeepID-Net system of MMLab won the champion of ImagNet, which is one of the most prestigious competition events in computer vision, defeating strong competitor systems from Google and Facebook. In the same year, MMLab won another champion at ActivityNet, which is a highly-regarded competition in video analytics, with their UntrimmedNet system. The articles behind the last two systems were published in TPAMI, a leading journal on pattern analysis.

Second, all cases involved intensive interactions with the key users in their respective systems. This can be best seen from MobiSec which explicates how our faculties collaborated with major all-in-one platforms to identify the vulnerabilities in their systems. The vital contributions of our faculties were officially acknowledged by all those companies, most with public announcements, and prompted rapid actions from these companies ranging from software patching to even service termination.

Finally, all cases, obviously, required heavy system-level implementation. This is best demonstrated by ADORE, where researchers of the UoA went through lengthy development cycles with the engineers in Microsoft, Huawei, and Tencent to modify the core components of those companies' systems in order to incorporate the proposed QoS prediction algorithms into the local contexts.