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Artificial Intelligence and Education in China

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Artificial Intelligence and Education in China

Abstract   This paper examines the political economy of artificial intelligence (AI) and education in China, through an analysis of government policy and private sector enterprise. While media and policy discourse often portray China's AI development in terms of a unified national strategy, and a burgeoning geopolitical contestation for future global dominance, this analysis will suggest a more nuanced internal complexity, involving differing regional networks and international corporate activity. The first section considers two key policy documents published by the central Chinese government, which are shown to implicate educational institutions as influential actors in national and regional strategies for AI development, with a significant role in plans to train domestic expertise. The second section outlines three prominent private education companies: New Oriental Group, Tomorrow Advancing Life (TAL), and Squirrel AI. These companies are selected to represent important aspects of China's development of educational AI applications, including the influence of a well-established private education sector, and a growing interest in international corporate activity. The paper concludes with the suggestion that while central government policy reserves a significant role for education in the national AI strategy, the private sector is utilising favourable political conditions to rapidly develop educational applications and markets.

Introduction – a political economy of AI

As a result of government endorsement and a thriving entrepreneurial technology sector, China's artificial intelligence (AI) development is attracting considerable international attention amongst economists (e.g. Barton et al. 2017; Mubayi et al. 2017), and in particular, US-based political analysts (Kempe 2019), security experts (Allen 2019), and military advisers (e.g. DIB 2019). As this paper will suggest, educational concerns – related to the role of universities in AI research, as well as those of producing data-driven technologies for teaching and learning - are now bound up with China's burgeoning role as an international leader in AI development. This paper therefore 'look[s] beyond the traditional "educational" concerns of curriculum and pedagogy, teaching and learning' (Selwyn 2013, p30), to examine the geopolitics of technology development, within which education plays an important, and constitutive role. The political economy analysis in this paper is grounded in three central and interrelated ideas: firstly, that the relationships between AI and education are shaped by an expansive network of actors, rather than simply by technology designers or educators; secondly, that these relationships are defined by contestation rather than consensus; and thirdly, that AI technologies are developed within already-established education and technology contexts, rather than emerging spontaneously.

The central relationship in the networks under examination here is that between governance at the national level and the influence of international economic markets. This focuses research on 'the state-approved (and even state-sponsored) liberalisation of educational technology markets to widespread global competition' (Selwyn 2013, p31). Recent research, primarily in the context of the US, has examined the way these relationships work to privatise the public education sector and infuse the ideals of capitalist commodification and profit into increasingly technologized classrooms and lecture halls (see Poritz & Rees 2017; Mirrlees & Alvi 2019). In this sense, educational AI can be understood as part of a broader political economy of education technology that is foundationally aligned with political orientations, and deeply implicated in corporate strategies, focusing attention on issues of production and consumption in an educational marketplace. The value of a political economy analysis is precisely 'to make explicit issues of power in society' (Selwyn 2013, p30), and this paper therefore aims to highlight how the development of AI technologies in China are prefigured by particular interests in aligning educational policy with geopolitical strategy, and incorporating teaching and learning activities into the business models of the tech sector.

Importantly, the relationships between government and private enterprise can be understood as manifesting through contestation, with each other as well as within themselves. Chantelle Mouffe's political theory of agonism (2013) provides a helpful way of defining this position. Mouffe suggests a distinction between 'the political', as a broad space of struggle, conflict, and the lack of absolute consensus, and 'politics', which takes place within 'the political' as the attempt to present rational and natural order (2013). This work has been usefully applied to the critical study of data-driven technologies by Crawford, who makes a distinction between the messy 'political' reality of 'tensions and contests' between users and designers of algorithmic systems, and an instrumentalist 'politics' discourse, which tends to portray a rational domain of 'calculation engines, making autocratic decisions between variables' (2016, p79). In other words, data-driven technologies, such as AI, can be understood to function in much more complex ways than are often characterised by technical descriptions and promotional discourses, which tend to assume stable systems and a straightforward consensus about the purpose and functioning of technology in society. As Crawford suggests, this dominant view relies on 'putting the technology in the explanatory driver's seat' (2016, p89). In contrast, the notion of 'the political' here frames a broader, and less rational space, in which the roles and intentions of the various actors involved in AI systems - the policy makers, technical designers, corporate managers, and end users - come together in conflictual relations, involving tensions between differing perspectives and underlying world views. Ultimately, it is this 'political' that 'shape[s] public discourse and civic life' (Crawford 2016, p2), rather than the surface reasoning of 'politics'. As the subsequent analysis will demonstrate, this condition of internal conflict - across political and corporate domains, as well as within them - suggests a much more critical and nuanced view of the development of AI in China than is often portrayed in public discourse elsewhere.

Another important dimension of deepening our understanding of AI and education in China is to examine the existing contexts within which the policies and corporate educational practices related to these technologies are situated. As Selwyn suggests, a political economy

analysis is sensitive to the 'the continuities *and* the discontinuities between old and new forms of technology use in education' (2013, p32, emphasis original), and it is imperative in the context of this paper to look beyond the general discourses of 'innovation' and 'disruption' that tend to accompany the promotion of AI in order to assess how the contemporary landscape in China corresponds to older and already-established education and technology activity. It is beyond the scope of this paper to provide a comprehensive history of both science and technology development and educational practices in China, however across the subsequent analysis sections, some key examples of contexts relating to government strategy and private education will be included.

The Chinese context
This paper seeks to understand what makes the context of Chinese educational AI development distinct from those of elsewhere, and it is precisely in the political and economic orders that these idiosyncrasies are most apparent, rather than necessarily in the design and development of the technologies themselves, which largely reflect the direction of research internationally. Indeed, it is the examples of rapid development and scaled deployment of Chinese educational AI – features, it will be argued, of the political context – that have attracted international attention (for example Hao 2019), rather than necessarily the novelty of the technical functions, such as speech or facial recognition, which are well-established areas of AI research elsewhere. It is for this reason that the paper focuses on the relationships between government policy and commercial education technology development in order to suggest some of the foundations upon which specific educational AI systems are being designed and used in China.

Furthermore, the kind of political economy analysis described above offers additional value as a way of countering some of the common-place assumptions that tend to accompany commentary on technology developed in China. The Chinese context for educational AI development is better understood, not as an isolated national endeavour, but one that is inextricably connected to international activity, thus requiring perspectives that acknowledge the involvement of multiple actors. As Ding and Costigan suggest, 'national AI capability is such a fuzzy concept' (2019, p27), yet this tends to be the way the Chinese context is represented across a range of policy and media discourse. Central to this portrayal has been the notion of an 'AI arms race' (Borowska 2019), in which an ascendant China is now threatening a previously dominant US. Exemplifying this narrative, Kempe[1] suggests China is 'on track to take the commanding heights of AI' in which 'the consequences could be historic in nature', for the reason that '[c]ountries that are most innovative and technologically advanced tend to dominate international relations' (Kempe 2019). Contemporary geopolitics therefore appears to be increasingly articulated through assumed national capacities for AI development, in which 'China's prowess in the field will help fortify its position as the dominant economic power in the world' (Knight 2017). Others suggest that the apparent threat from Chinese AI development requires the US to regain their

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[1] CEO of US think tank the Atlantic Council

dominance through global regulation (Prakash 2018)[2]. In a somewhat bizarre twist in these geopolitical contestations, a research team from China recently published details of an AI system capable of making predictions about global events, and offering automated suggestions for foreign policy decisions (see Zhang et al. 2018). Here, not only is China's AI development seen as a danger to geopolitical stability, but it's supposed capacity to employ these very same data science techniques to enhance its foreign policy power suggests, for some, an additionally ominous form of future politics (Prakash 2019a).

Alongside policy discourse, recent years have also seen a tendency for 'China bashing' (Qiu 2016, p7), or indeed a 'scary China' (Yang 2019) narrative in the media, specifically related to the development of Chinese technologies. Inclinations to interpret Chinese technology development in terms of Western dystopic fictions (see Jefferson 2018) amplify the sense of a fundamental difference to the Chinese context, and a threatening agenda to the production of AI. Much of this media discourse is underpinned by long-standing cultural assumptions about the unified and homogeneous character of China's population, who are supposedly 'obsessed with education' (Chu 2013, p5). This uncritical and entrenched view of 'the Chinese as a giant, homogeneous, mass of humanity' (Chu 2013, p13) directly shapes media representations, which tend to portray educational AI developed in China as 'a grand experiment' (Hao 2019), rather than very specific initiatives located in particular regions, cities, or schools. It is therefore the internal complexities and contradictions that need to be surfaced, as a way of countering the common-place 'myth' that 'China's approach to AI is defined by its top-down and monolithic nature' (Ding 2018, p3).

AI Policy in China
In 2017, the Chinese government published the *State Council's National Strategy for AI Development*[3], and it is the release of this policy document, perhaps more than any other single event in recent years, which has garnered international attention around the development of technology in China, and encouraged the idea of a grand national strategy for global AI dominance. The document frequently appears in media reporting as a foundational moment in China's AI development (e.g. Knight 2017; Thompson 2018), and is the subject of numerous policy analyses (e.g. Ding 2018; Webster et al. 2017; Lee & Triolo 2017), with a predominant focus on the geopolitical and economic significance of the technology. The often-quoted schedule within the policy includes the aim, by 2030, of establishing China as the principal international centre for innovation, 'with a core AI industry gross output exceeding RMB 1 trillion' (Ding 2018, p10). Worked through the policy is also an underlying aspiration to become self-sufficient in the production of AI by reducing dependencies on both foreign technologies and overseas expertise (Allen 2019).

Much less attention has been given to the role of education within Chinese AI policy, as well as the potential impact of government strategy on educational institutions and activities. This

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[2] Prakash suggests global regulation of 'AI trade, overseen by the US: 'the U.S. should create the world's first "AI Trade Organization" or AITO. Just like in the 20th century, when the U.S. created the World Trade Organization (WTO) to govern traditional trade, AITO would govern AI trade.' (Prakash 2019b)
[3] Sometimes translated as 'New Generation Artificial Intelligence Development Plan'

is despite specific references to the foundational role of higher education within the *State Council's National Strategy for AI Development*, which outline 'a long-term view to growing AI talent through constructing an AI academic discipline and creating pilot AI institutes' (Ding 2018, p5). In other words, the ambitions of China's AI development appear conditional on a higher education system tuned towards the production of specific AI expertise. Indeed, the particular significance of higher education to China's AI strategy is evidenced by a second policy document, released the following year in 2018: the *Action Plan for Artificial Intelligence Innovation in Colleges and Universities*. This policy aims to:

> accelerate the innovation and application of artificial intelligence in the field of education, use intelligent technology to support the innovation of talent training model, the reform of teaching methods, and the improvement of educational governance capabilities, and build an intelligent, networked, personalized and lifelong education system. (MEPRC 2018)

In order to achieve this grand vision, the policy provides three core objectives, concerned with: establishing university infrastructures and curricula capable of adapting to AI, by a target date of 2020; enhancing research and development, as well as the workforce training in specific skills related to AI, by a target date of 2025; and finally, Chinese universities becoming global leaders in AI innovation, by a target date of 2030 (MEPRC 2018). This central role for educational institutions seems particularly important to highlight in the development of AI, given the more typical interest in private sector 'disruption' and technology entrepreneurialism. The policy outlines plans to build 'colleges and universities into an important source of global artificial intelligence technology innovation' (MEPRC 2018). Further detail is provided regarding the role of such institutions, which will 'further strengthen the advantages of basic research, discipline development and personnel training' (MEPRC 2018). Universities therefore appear to be identified as essential sites, not only for research and development, but also for establishing new educational programmes and qualifications that can produce the kind of expertise and workforce required for an AI-infused future economy. This is made more explicit in a section on 'Improv[ing] the personnel training system in the field of artificial intelligence' (MEPRC 2018), which identifies a number of objectives, including course and curricula development, industry engagement, entrepreneurship, and international exchange linked to the much-publicised 'Belt and Road' infrastructure project[4]. This 'deep integration of artificial intelligence and education' (MEPRC 2018) therefore appears grounded in the notion of training new generations of AI experts.

Particularly notable is the aim of developing AI as a core disciplinary subject, along with the establishment of 'first-discipline' examples at specific universities; a formal identification of the best degree programme in a given subject in China. This can be seen as a response to calls from a number of professors in China to consolidate AI teaching, which is often seen as

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[4] A vast regional development project, formally announced in 2015 - see
http://english.www.gov.cn/news/top_news/2015/03/28/content_281475079055789.htm - to connect Asian, African, and European countries over land and maritime routes for the purposes of trade and infrastructure development.

'scattered' amongst other more established disciplines, such as computer science and statistics (see Xu *et al.* 2018). Chinese universities appear to be responding accordingly, with reports of more than 50 institutions setting up new degree programmes in AI-related subjects (see Xu *et al.* 2018). The policy also includes the aim of developing interdisciplinary qualifications, termed 'AI + X', identifying the need for combined degrees through which AI is taught as an applied subject, with specific relevance to 'mathematics, computer science, physics, biology, psychology, sociology, law and other disciplines' (MEPRC 2018). Further, the policy suggests a 'universal education' for AI, incorporating formal and informal training opportunities, appearing to leave little, at least in terms of adult education, untouched by technological reform.

While the *State Council's National Strategy for AI Development* and the *Action Plan for Artificial Intelligence Innovation in Colleges and Universities* are rather explicit in their aims of aligning higher education with political aspirations for AI supremacy, the educational features of these policies should also be understood in terms of the desire for self-sufficiency within the broader geopolitical contestations of technology development (see Allen 2019; Laskai and Toner 2019). A nationalist outlook frames much of the *Colleges and Universities* policy, which calls for AI development to 'build a strong country of education, a strong country of science and technology, and a smart society' (MEPRC 2018), with a key part of this vision being the training of domestic expertise. A recent influential report from the Chinese Institute for Science and Technology Policy (CISTP 2018) indicates some of the motivations behind this drive to train native AI capabilities: the paper offers a methodology for ranking both international 'AI talent', and a higher-level 'top AI talent', and highlights some assumed deficiencies in the latter category where China is concerned – ranking only 6th globally (CISTP 2018). Presumably intensifying government concerns over this shortage in expertise is the substantial number of Chinese nationals who study AI-related subjects abroad, and who often subsequently gain employment in prestigious development teams outside of China, mainly in the US (Sheehan and Ma 2019). The response from the Chinese government has been to endorse a range of '[n]ational-level and local-level "talent programs"' which are 'gathering AI researchers to work in China' (Ding 2018, p5). For example, the 'Ten Thousand Talents' scheme appears specifically directed towards attracting AI scholars working abroad to return to research and development positions in China, with significant financial incentives (Ding 2018). While the talent schemes are considered to have had mixed success (Ding 2018), these efforts signal the importance placed, not just on the research capacity of higher education as a key site for AI development, but also on the potential to train future personnel[5]. Zhou Ming, deputy director of the Education and Examination Centre under the Ministry of Industry and Information Technology, was recently quoted as suggesting that China faced 'an AI talent shortage of more than 5 million' (see Li 2018). Such estimations place workforce training centre stage in China's ambitions for AI. Furthermore, these contestations and desires for AI expertise reveal what may be one of the central and underlying objectives of Chinese government policy: to shift the

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[5] This strategy is not limited to the public sector, with China's tech giants setting up 'their own overseas AI institutes to recruit foreign talent' (Ding 2018, p5). Thus 'both Chinese government actors and commercial players are aggressively building up and recruiting AI talent from around the world' (Sheehan & Ma 2019).

geographical location of university AI power, away from elite US institutions towards those in China. The establishment of internationally-leading AI schools, can therefore be understood as a central feature of broader geopolitical rivalry, in which reputation and innovation in the production of AI technologies is seen as indispensable to future economic prosperity, and ultimately, global dominance.

While there is clearly a much more complex picture behind these policy aims, involving international networks and trajectories through which AI expertise is produced and exploited, there is also an internal complexity to China's AI governance that requires attention. Recent research identified 845 provincial-level policy documents relating to AI development, produced 'in the light of local conditions to steer local AI industry deployments' (CISTP 2018, p78). This suggests a much more nuanced policy landscape compared to the national vision described previously, and in particular, a varied approach: Jiangsu province boasts the greatest number of AI policies at 73, while Heilongjiang province has the least, at just 6 (CISTP 2018, p79). Significantly, the research also links high numbers of local policies with the emergence of 'three core regions' (CISTP 2018, p80), specifically those around Beijing, Shanghai, and Guangzhou, which vastly outpace other areas in AI development activity, but are also distinguished by their own existing networks. For example, the Beijing region includes 'many state-level scientific research institutions, numerous research institutes and many innovative industrial parks' (CISTP 2018, p80). The development and implementation of AI in China therefore needs to be understood in the context of these vastly different regional capacities. As Lehmann argues, city-level politics further define China's development of AI, with the Beijing Academy of Artificial Intelligence (BAAI) emerging as a leading group:

> formed from a coalition of academic and private sector leaders, with backing from some of Beijing's most influential institutions and corporations in AI, including Peking University, Tsinghua University, the Chinese Academy of Sciences, Baidu, ByteDance, Megvii, Meituan-Dianping, and Xiaomi. (Lehmann 2019, p21)

This demonstrates the way high-level national policy is being implemented by local combinations of government, higher education institutions, and the private sector. Therefore, rather than straightforward, top-down governance, China's AI development can be seen as arising from 'bureaucratic agencies, private companies, academic labs, and subnational governments [that] are all pursuing their own interests to stake out their claims to China's AI dream' (2018, p3), portraying a much more contested domain. While the next section turns specifically to an exploration of the private sector, and its substantial and distinctive role in Chinese AI development, the BAAI example suggests an acutely central role for universities in this arrangement. A key example is the BAAI's response to recruiting AI talent, which has been implemented in Beijing through the 'Zhiyuan Scholars'[6] programme. As Lehmann

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[6] An initiative by BAAI to recruit 100 AI experts per year for three years, see: http://bjrb.bjd.com.cn/html/2019-04/18/content_11878962.htm

notes, of the 65 experts recruited, [o]nly four currently work in the private sector, while all others are professors, researchers, and leaders of academic and research institutions' (Lehmann 2019, p23). For Lehmann, the work of the BAAI 'is an example of the Chinese bureaucracy's recurring pattern of top-down directives and bottom-up execution' (2019, p24), and indicates a potentially significant level of power and agency for universities in directing the development of AI research.

Furthermore, a surface reading of China's AI policies overlooks important historical dimensions to both Chinese education and science and technology developments. The State Council AI policy should be understood within the context of a much broader science and technology strategy (Ding 2018), which has been inextricably linked to China's politics and governance since the early 20th century (Qiu 2017). As Wang (2018) shows, while AI research specifically did not emerge in earnest in China until the 1980s, its development has consistently been influenced by political ideology – through Soviet cybernetics in the 1950s, the split with Russia in the 1960s, and the eventual resurgence of science and technology after the end of cultural revolution in the late 1970s. As such, it is important to view China's AI development as persistently influenced by 'political ideologies and struggles, diplomatic relations, and [the] economy' (Wang 2018). The policies discussed previously therefore represent a deep-seated continuity of interest in employing, and shaping, science and technology, and specifically AI, for political ends. Moreover, the history of educational reform in China has been closely aligned with the politics of science and technology development (Yu et al. 2012)[7]. The resurgence of science and technology after the cultural revolution, and the very beginnings of Chinese AI research, resulted from the broad market-economy reforms of Deng Xiaoping (邓小平), which were accompanied with the immediate transformation of higher education. In a speech at the National Conference on Education, right at the end of the cultural revolution in 1978, Deng announces that 'education must meet the requirements of our country's economic development' (Schell and Shambaugh 1999, p220), signalling an alignment with the 'market-based economic and policy mechanisms' (Yu et al. 2012, p15) that have characterised China's governance until the present day. Indeed, it is this broader economic transformation – for some, 'the most spectacular in history' (see Chu 2013, p5) - that has led to a powerful and prosperous private sector, and a substantial number of companies pursuing the development of AI specifically for use in educational settings.

Corporate Educational AI
In contrast to the idea that China's government are seeking to centralise control of AI development for purely political ends, Lee (2018) characterises Chinese AI policy, as discussed in the previous section, as a broad endorsement, and a deliberate avoidance of regulation, in order to encourage the flourishing of the private sector. While, as will be

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[7] Further back in China's history, Yu et al. (2012) note that science and technology education is introduced in the modern era, as a direct response to internal beliefs about 'China's backwardness' following the collapse of the Qing Dynasty (Yu et al. 2012, p10). In the 'post-revolution' era, science education was 'directed to serve industrial, agricultural and the national defense sectors' (Yu et al. 2012, p13). However, due to the devastating effects of the cultural revolution in the late 1960 and early 1970s, the 'existing higher education system, including any Chinese, Western and Soviet traditions and practices, was nearly wiped out' (Yu et al. 2012, p14).

elaborated, the relationship between central governance and commercial activity is not quite as seamless as Lee (2018) implies, AI companies in China have certainly attracted international attention for their rapid development of products. One example is SenseTime (商汤科技, or Shang Tang Technology), a company specialising in facial recognition, which has been suggested to be China's largest unicorn[8] (Shu-Ching 2018), and the world's most valuable AI start-up (Vincent 2018). However, within this clearly thriving area, the development of specifically educational AI can be understood as occupying a special place amongst the entrepreneurial cultures of China's technology sector. As Hao (2019) suggests, start-ups working on education projects in particular receive tax-breaks from the government, and are generally seen as safe options for investors. This section outlies three prominent Chinese private education companies that appear to have taken advantage of this context to develop AI for use in educational settings: New Oriental Group, Tomorrow Advancing Life (TAL), and Squirrel AI. This is by no means an exhaustive or definitive account of the private sector, however the three organisations discussed below represent an important way of understanding the origins and trajectory of educational AI development in China: the growth of data-driven technologies from established extra-curricular educational provision; the fast-paced development of ostensibly sophisticated products and the expansion of substantial educational markets; and an increasingly international outlook.

New Oriental Group

The New Oriental Education and Technology Group is the largest private education company in China. Their renown in China is perhaps signified by the 2013 film *American Dreams in China* (中国合伙人 – translated literally as 'Chinese business partners'), which depicted the origins of the company as a provider of English language teaching[9]. Founded in 1993, the company boasts 89 schools, 1,125 learning centres, over 30,100 teachers, and 18 bookstores (NOETG 2015a). Alongside English language teaching, the New Oriental Group also focus on preparation for the Graduate Record Examinations (GRE) for admission to US graduate schools, as well as a focus on domestic extra-curricular exam preparation, such as the Gaokao (高考) Chinese college entrance exam. The size of the company demonstrates the high demand for such extra-curricular provision in China, where the education system is seen as highly competitive (Yu et al. 2012). The New Oriental Group are headquartered in the Haidian district of Beijing, which is the location of many of the country's best known technology firms, as well as China's two elite universities: Peking University and Tsinghua University. The company have long been embedded in this local network of tech start-ups, entrepreneurs, investors, and highly-qualified graduates. The company provide online education through their 'Koolearn' (新东方在线) platform, comprised of over 2000 courses (NOETG 2015a). Claiming to have had 40.5 million student enrolments across their services (NOETG 2015a), the company presumably have access to considerable volumes of data. Recent news of the development of AI projects is therefore highly significant. Two related projects were announced in October 2018: a strategic initiative called 'N-Brain' aimed at

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[8] 'Unicorn' refers to a start-up company valued at over 1 billion US dollars, a term coined by venture capital investor Aileen Lee
[9] The teaching of English is a further demonstration of the outward looking orientation of *New Oriental,* and the film specifically depicts the attempts of the company founders to obtain US visas.

'building cooperation among AI-related institutions, investors and businesses', and an application aimed at applying this work directly in teaching activity, named 'AI Class Director[10]' (Xu 2018). The N-Brain initiative is indicative of the particular kind of collaborations and networks through which educational AI is being developed in China, involving a partnership with the University of Illinois in the US to establish research labs, as well as an investment deal with GSV Capital (Xu 2018), a Silicon Valley venture capital firm who list Coursera, CourseHero, Spotify, Palantir, and Dropbox in their 'top 10 investments[11]'. This suggests a much more international orientation to AI development than the nationalistic framing in government policy, and a highly-corporatized mode of operation - detailed information for potential investors appears prominently on the New Oriental Group website (NOETG 2015b).

While clearly in a development phase, the 'AI Class Director' appears to promise typically extensive features, presumably enabled by the large volumes of data this company has access to, involving:

> face and speech recognition, facial attributes analysis, natural language processing and other AI tech to track each student's class performance in real time, analyze their emotions, participation and results in a quantitative approach, giving advice accordingly (Qiao Lei quoted in Xu 2018)

However, despite the broad scope of technical aspects suggested here, a specific focus on English language is emphasised in the suggestion that the system can:

> grade and correct a child's pronunciation and generate personalized learning reports based on data, enabling the AI to understand Chinese students' English learning and improve the experience and outcome' (Xu 2018).

This suggests that the 'AI Class Director' specialises, perhaps unsurprisingly, in the New Oriental Group's core and original business of English language education. The 'AI Class Director' system is being developed by BlingABC[12], a subsidiary of the New Oriental Group which has developed an online platform for pairing primary school children with teachers from English-speaking countries (the Chief Executive of which is Qiao Lei quoted above). While it is not clear precisely what data is being used to train this feature of the 'AI Class Director', the BlingABC platform functions by linking children with English teachers through live video feeds, presumably generating considerable volumes of voice recordings. Additionally significant here is the way in which New Oriental Group's development of AI derives directly from its business of extra-curricular educational provision, which has been aimed at students of higher socio-economic status in China. Specifically, this population of students includes those interested in learning English for some form of international activity, as well as those aiming to achieve high scores in the Chinese college entrance exam, and thus

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[10] This could also be translated simply as 'AI Class Teacher'
[11] http://gsvcap.com/top-10-investments/
[12] see https://www.blingabc.com/

a place in the higher tier universities[13]. This means, not only that the data underpinning projects such as the 'AI Class Director' derive from the activity and behaviour of particular, and often privileged, Chinese student populations, but also that this development of educational AI is oriented towards selective, and somewhat elite, educational pathways.

Tomorrow Advancing Life (TAL)

Founded in 2003, and also headquartered in the Haidian district of Beijing, Tomorrow Advancing Life (TAL) has also emerged as a significant developer of educational AI. It is important to note that TAL is the English name of the company, launched in 2013, and not a direct translation from the Chinese 好未来, or Hao Wei Lai, meaning 'Good Future'[14]. This change in the company name indicates a growing interest in international recognition. The company was listed on the New York stock exchange in 2010, and has also matured into an investor in other educational initiatives, notably the San Francisco-based online education provider Minerva in 2014, and the New York-based education technology company Knewton in 2016. The company presents itself as an overtly corporate entity[15], detailing information for both 'entrepreneurs' and 'investors' prominently on its website[16]. This demonstrates the increasing involvement in global education technology markets, and growing power, of Chinese education technology companies. Significantly, part of the strategic investment in Knewton involved TAL acquiring so-called 'adaptive' technology (Vinton 2016), for which the US company have become well-known. This suggests relationships of exchange rather than competition between US and Chinese companies, through which the technical features of educational AI are traded, reused, and adapted. TAL are also networked with academic partners, for example through a recently-announced collaboration with Tsinghua University to establish an AI research centre (see Zhang 2017).

TAL advertise a large number of 'sub-brands', projects, and applications, appearing to demonstrate extensive deployment of educational AI-related products. Through a dedicated 'AI Lab', the company describe the application of 'visual, voice, natural language processing and machine learning to assist students in teaching, inspiring students' classroom interest and intelligent interaction' (TAL 2017b). One well-publicised system developed through the TAL AI lab is the 'Mo Jing' (魔镜), or 'magic mirror' system, which claims to incorporate an extensive range of technologies, including facial recognition. A recent report described the system in the following terms:

> Through the combination of software and hardware, the classroom has eyes (camera), ears (microphone), brain (the cloud) and other organs (iPad), so that the teaching process becomes quantified' (People's Daily 2018)

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[13] Higher tier universities in China are known as '985s', after 'Project 985' to establish 'world leading' Chinese universities. A second tier level of universities are known as '211s', after a project to develop specific institutions towards key disciplinary areas.

[14] Furthermore, TAL changed its name from an earlier incarnation as 学而思, or Xue Er Si, which directly translates as 'Learn and Think'. The name Xue Er Si lives on in one of the organisations 'sub-brands' Xueersi.com, an online learning platform.

[15] Interestingly, however, TAL also publicise Communist Party of China (CPC) organisational information, however only on the Chinese and not on the English version of their website. A TAL CPC branch was set up in 2017, and is comprised of 19% (5498) of employees, of which 984 are in leadership positions (TAL 2017a).

[16] See http://en.100tal.com/entrepreneurs and https://ir.100tal.com/

As with the New Oriental Group, TAL have extensive experience in scaled educational provision, from which they presumably have access to substantial archives of data with which to ground their AI development. For example, Zhang Guohui, head of TAL's Xue Er Si (学而思) Online School recently reported more than 7 million students registered on their platform, and from which they have 'accumulated around 10,000 hours of voice samples in the past year' (Cheng 2018). TAL also promote an 'Intelligent Teaching System', 'Intelligent Practice System', and 'Personalised Learning System' as products that specifically draw on educational 'big data' (TAL 2017b). These products appear to be particularly directed towards extra-curricular coaching and support for school-related subjects, English language teaching, and 'study abroad' training, reflecting the emphasis of the New Oriental Group discussed previously. TAL's extensive development of educational AI is therefore also underpinned by data collected from very specific populations of learners, and focused on providing technologies to support fairly privileged educational pathways within the broad spectrum of the Chinese education system. Furthermore, in a similar way to the New Oriental Group, TAL's development if educational AI appears to be driven by a desire to cultivate markets within a lively private education sector, with a high demand for extra-curricular provision.

However, what distinguishes TAL from the New Oriental Group is a more extensive commitment to developing educational AI, for which the company have recently been selected by the Chinese Ministry of Science and Technology to represent the area of 'smart education' in the 'National New Generation Artificial Intelligence Open Innovation Platform' (AIOIP), or 'National AI team' (see Larsen 2019). As such, TAL are expected to 'promote deep integration of AI with the real economy' (Larsen 2019, p17), and support the entrepreneurial development of other small and medium-sized companies, through the establishment of business networks and the sharing of data and software. As Larsen suggests, the structure of the 'National AI team' constitutes:

> a new model of AI development … where government-designated platforms and related public-private partnerships emphasize an experimental, gradual, and decentralized approach to selectively opening public domains and associated data repositories' (Larsen 2019, p17).

TAL therefore appear to be in a powerful position with respect to defining how private educational companies in China will be able to develop further relationships with the mainstream education system. As Larsen further explains,

> leading private sector enterprises are endorsed to apply innovative AI solutions to optimize public institutions and the provision of public goods and services, often implemented on a local and regional basis. (Larsen 2019, p17)

This provides some insight into how the relationship between central government policy and private enterprise is being envisioned in China, suggesting substantial agency for regional

networks, but also significant influence for commercial organisations. For the development of educational AI, TAL would appear to be in a leading role, with the endorsement to not only acquire and manage public educational data, but also to define the future development of the sector. However, while members of the 'National AI team' are 'the de facto architects of system-wide standards and interfaces', these are also 'shaped in collaboration with research institutes, universities, and policymakers' (Larsen 2019, p18). Such corporate influence, therefore, while substantial, should be understood as existing within networks of different regional actors, involving potentially conflicting aims.

YiXue (Squirrel AI)

One key example of a newer educational AI company is YiXue Education (乂学教育), who are behind the prominent 'Squirrel AI'. Despite being founded in Shanghai in 2014, Squirrel AI already claims 'over 1700 schools', and '3,000 teaching staff in more than 200 cities across more than 20 provinces and autonomous regions in China' (YiXue n.d. b). Notably, while operating within the specific networks of the Shanghai region, Squirrel AI lists TAL and the New Oriental Group as funders (see Cheng 2018). Distinguishing Squirrel AI from the previous two companies discussed here is the more direct and unambiguous cultivation of an international reputation (Hao 2019), as well as the focus on developing and promoting a single educational AI application. Squirrel AI recently announced the recruitment of Tom Mitchell, E. Fredkin University Professor at Carnegie Mellon University, and general machine learning luminary, as their Chief AI Officer (YiXue n.d. a). Other team members include Richard Tong, formerly of US-based Knewton, and Dan Bindman, formerly of the educational AI software *Assessment and Learning in Knowledge Spaces* (ALEKS), developed at the University of California Irvine. Squirrel AI have also publicised the collaborative development of AI research centres with the Chinese Academy of Science, and the American research institute SRI international (founded by Stanford University), as well as 'major' research partnerships with Carnegie Mellon University and University of California Berkeley (YiXue n.d. b), and further collaborations with MIT and Harvard (Hao 2019). This constitutes a more overt attempt to position Squirrel AI as a prominent international educational AI enterprise, rather than necessarily as a purely Chinese entity. As Hao suggests, Squirrel AI is 'one of the best-poised [educational AI companies] to spread overseas' (Hao 2019).

Alongside the cultivation of corporate and academic partners in the US, Squirrel AI brands itself around a single educational application, rather than a suite of technologies: an adaptive learning system that gathers fine-grained data about individual students' abilities in order to calculate personalised pathways through course curricula. While the technology currently appears to be driven largely by a 'question pushing system' in order to gather precise data about student progress, co-founder Wei Cui suggested in a recent report that:

> real-time heart rate, brain wave and facial expression recognition during learning
> will be added for comprehensive analysis. Each student will be equipped with a

virtual personal assistant to provide better learning services for them (Cui quoted in Squirrel AI Learning 2019)

Despite this promise of a technically sophisticated system combining a complex range of features, the focus on so-called 'adaptive learning' in educational AI reflects the development of data-driven technologies elsewhere, and appears to demonstrate the influence of their recently recruited US-based team members. Nevertheless, Squirrel AI's business firmly reflects that of the New Oriental Group and TAL discussed previously, providing extra-curricular private education to select populations of students in China. Moreover, Squirrel AI's product should also be understood in terms of the Chinese educational context into which it is being developed and deployed (see Hao 2019); one grounded in standardisation and competition. The AI system, including the promise of a 'virtual personal assistant' described above, is undoubtedly oriented towards highly standardised curricula, and very specific learning routines, such as exam preparation. Moreover, it is an application that appears to be developed specifically to respond to the desire for private extra-curricular education in China, and the cultivation of a marketplace for an educational product, much more so that any underlying pedagogical justification. While Squirrel AI have ambitions to spread their business into mainstream schools in China (see Hao 2019), their products also appear likely to appeal to national education systems elsewhere, particularly those placing a high value on standardisation and testing.

What is perhaps most significant across the three companies outlined in this section is the opportune use of central government endorsement to rapidly develop AI applications and aggressively pursue educational markets, competing within and across regions. It is this pursuit of marketable products that appears to define the general approach of the private sector, rather than any underlying educational rationale for the design and development of AI applications.

Conclusions
Ultimately, it is tensions between state-led and market-driven approaches, rather than simplistic notions of a uniform nationalistic strategy, that characterise AI development in China (Nelson 2019). As this paper has described, these tensions also define and shape the educational landscape. As the discussion of policy has revealed, amongst the broad strategy for national AI development, educational institutions are envisioned as key actors, both in the sense of leading research and development, as well as training the new generations of technical experts required to maintain a technology-driven economy. In practice, AI development appears to be taking place through specific regional networks involving local governments, educational institutions, and private sector companies. Rather than perceiving the relationships between government and education as novel, AI policy should also be understood within the context of the recent history of science and technology development in China, which has maintained a vision of close educational support for political endeavours. However, contemporary national policy has also produced conditions in which private sector enterprise has gained considerable influence and agency within regional development networks. Private education companies have further utilised favourable political conditions to

develop and expand ways of applying AI technologies to their particular areas of extra-curricular provision. This appears to have produced ostensibly sophisticated AI applications that are largely underpinned by the desire to develop educational markets, rather than implement any particular or explicit pedagogical rationale. Education in China is therefore experiencing the effects of AI development on two fronts: from central and regional governments, interested in engineering educational institutions towards strategic AI research and training; and from an increasingly influential corporate sector, developing AI applications with the potential to intensify an already standardised and competitive system, and driven by a powerful interest in private enterprise.

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