

Building a Sustainable, Interdisciplinary, Blockchain Education and Research Program at the University of Wyoming

A proposal in response to a request from the
Wyoming Blockchain Task Force

5 December 2018¹

James Caldwell² Benjamin Rashford³ Nicole Choi⁴

Abstract: Blockchain legislation was unanimously passed by the Wyoming House of Representatives and Wyoming Senate and was signed into law on March 10, 2018, by Governor Mead. This legislation has established Wyoming as a leader at the international forefront of a new technology that promises to dramatically affect the lives of individual citizens, business practices, the day to day processes of government, as well as international trade and relations^{5 6}. The legislation puts Wyoming in the unique position of being a focus of the international community of blockchain technologists. As a direct result of the legislation, a number of blockchain companies have shown significant interest in (re)locating to Wyoming. For Wyoming to capitalize on this unprecedented opportunity to diversify the economy, workforce development in this highly technical area will be crucial. Establishing the University of Wyoming as a leader in blockchain education, research, and applications is perhaps the only path to this goal. A blockchain education and research program based at the University of Wyoming will benefit the State, businesses in Wyoming, the University, and the students who attend UW.

¹ Previous versions dated: 14th November 2018 and 29th October 2018

² Professor and Head, Department of Computer Science, University of Wyoming.

³ Associate Professor and Head, Department of Agricultural and Applied Economics, University of Wyoming

⁴ Associate Professor and Chair, Department of Finance, University of Wyoming

⁵ Deloitte, Blockchain - Perspectives, insights, and analysis.

<https://www2.deloitte.com/us/en/pages/consulting/topics/blockchain.html>,

⁶ *Deep shift: Technology tipping points and societal impact*, World Economic Forum, September 2015, weforum.org.

Blockchain (Distributed Ledger Technology): An Introduction

Blockchain is a new technology that is used to implement secure, distributed, immutable, ledgers. The term *Distributed Ledger Technology* is, in many quarters, replacing the term *blockchain*.

A secure, immutable, distributed ledger is a perfect vehicle for cryptocurrency, but has many other applications. It is useful in any application where multiple parties, who may not necessarily trust one another or, more generally, when the various parties to a transaction may have a different stake in the transaction. It is applicable when multiple parties need to update a common database (ledger) where transactions can be verified by all parties. Currently, such applications are typically mediated by legal contracts, central trusted authorities, or governmental institutions. A fundamental feature of the new technology is that blockchains are being used to decentralize control by replacing institutional trust with digital trust. Digital trust in a blockchain transaction is established by the fact that the ledger is immutable and distributed and can be inspected by all parties.

Blockchain technology saw its first significant application in the Bitcoin cryptocurrency, first introduced in 2009. Since then, no one has been able to hack the bitcoin blockchain, providing an indisputable proof of concept. Because Bitcoin and other cryptocurrencies use a blockchain does not mean blockchains are necessarily cryptocurrencies, in fact, most applications are not related to cryptocurrency.

Because the first significant application of blockchain was in the cryptocurrency world it can be useful to understand how it works there. Bitcoin uses a blockchain to solve the double spending problem providing users with a mechanism that guarantees everyone in the community can trust the record of transactions. Perhaps the most fundamental aspect of any currency is to avoid the possibility that the same unit of currency can be spent twice by the same person. A blockchain is a data-structure that implements a secure, immutable, distributed ledger for recording transactions. In the case of bitcoin, it keeps track of who owns which bitcoin. The ledger is immutable because there is a real world cost (in the form of computational effort, *i.e.* electricity) to add a new block extending the existing blockchain. There is a reward for being the first to complete the computation which allows the blockchain to be extended. The fact that adding a block incurs a significant cost gives a "*Proof of Work*" guarantee to the other parties competing to add the next block to the chain. The reward provides the incentive for many parties (*miners*) to compete to add the next block. The ledger is immutable because the work performed is to build a cryptographic link to previous blocks in the chain. Because blocks are linked cryptographically, and since it is computationally expensive to add even one block, changing the historical record of transactions is infeasible. Anyone/everyone can have a copy of the blockchain, it is *distributed*. Verifying that the work (required to add a block to the chain) was properly done is accomplished by a simple inexpensive computation, so while it is expensive to add a block, verifying that the work was actually performed is essentially free. The security of the chain provides for the *immutability* of the blockchain which also provides a form of digital

trust. Trust in a decentralized blockchain is warranted because of its immutability and because there are many, many duplicate copies spread across the network. Even if it was feasible to change one, it is not feasible to change them all.

Corporate Blockchain Investments, Jobs, and Universities

Significant investments in blockchain technology have already been made by many major corporations. The applications areas are as varied as retail, entertainment, supply chains and logistics, oil and gas⁷, insurance, supply chain management⁸, healthcare, real estate, charity, financial services, journalism, credentialing (of students and others), and transportation and shipping. The list grows continually, but uses of blockchain in the area of food supply-chain applications are among the best developed so far. Among the early adopters is Walmart.⁹

The blockchain job market is booming for workers with skills in the technology or its application.¹⁰¹¹ Blockchain positions are among the highest paying.¹² These are the kind of jobs we'd like to attract to Wyoming and blockchain is the kind of cutting edge technology ecosystem we'd like to prepare University of Wyoming students to thrive in.

Blockchain classes are being offered at many top universities¹³ and are reported to be among the most popular courses being offered¹⁴. The Computer Science Department at the University of Wyoming has been offering a blockchain related course or content since the Fall 2017 semester. Other departments in the university are similarly starting to introduce blockchain related content.

ENDOW

In November 2016, Governor Mead established the ENDOW¹⁵ Initiative to diversify the Wyoming economy with the goal of making it less tied to the ups and downs of the cyclical oil and gas markets. Among the ENDOW recommendations are to embrace change and disruptive technologies. Building on the legislation passed in 2018, Blockchain technology is exactly the kind of technology Wyoming hopes to target. The Wyoming legislation, modeled on Swiss

⁷ <https://media.consensys.net/ondiflo-blockchain-for-oil-and-gas-9de5e01cd680>

⁸ How Blockchain Will Transform The Supply Chain And Logistics Industry, B. Marr, Forbes, March 23, 2018

<https://www.forbes.com/sites/bernardmarr/2018/03/23/how-blockchain-will-transform-the-supply-chain-and-logistics-industry/#64c8c4a65fec>

⁹ <https://www.nytimes.com/2018/09/24/business/walmart-blockchain-lettuce.html>

¹⁰ As one example, the number of job advertisements at indeed.com are up over 200% since last year, and over 600% the year before. Joe Lubin, CEO of Consensus, reported 16 open positions for every blockchain qualified job seeker.

¹¹ <https://www.computerworld.com/article/3235972>

¹² <https://www.indeed.com/salaries/Blockchain-Salaries> ranging from \$51,00 (Marketing) to \$146,621 per year for Principal Software Engineer.

¹³ <https://www.wired.com/story/latest-course-catalog-trend-blockchain-101/>

¹⁴ <https://www.insidehighered.com/news/2018/08/13/rising-profile-blockchain-academe>

¹⁵ ENDOW: Economically Needed Diversity Options for Wyoming.

regulations, is the first of its kind in the US¹⁶; there are pending bills in at least seven states that emulate Wyoming. The State, the University, the Wyoming Business Council, and others have made many efforts over the years to attract more tech companies to Wyoming. The blockchain legislation passed last year has heightened interest in Wyoming among many of the leaders in the blockchain community. This broad interest from a booming tech sector is a once in a generation opportunity for Wyoming. The fortuitous timing and confluence of events is one that could not have been planned, it is an opportunity for the State and the University.

The plan outlined here explicitly addresses a number of the goals outlined by ENDOW. Blockchain is explicitly mentioned in the Transforming Wyoming report as a disruptive technology the state should embrace.¹⁷ The same report says, “We must be a state of innovators and swiftly develop the necessary ecosystem for new technologies to thrive.” This plan addresses that goal in the context of the new, blockchain friendly environment created by the new legislation.

University of Wyoming Strategic Plan

The plan presented here is entirely consistent with the University of Wyoming Strategic Plan¹⁸ and directly addresses goals as outlined below.

Goal 1: Driving Excellence - As blockchain applications are inherently *interdisciplinary*, and are in essence, *entrepreneurial*, this plan address the subgoal to develop such programs. The program here directly addresses *workforce development* by offering students the opportunity to be certified in the new technology which is in high demand across the country. Blockchain based companies looking to relocate to Wyoming are specifically seeking these skills.

Goal 2: Inspiring Students - There are a few existing online blockchain programs, but none (yet) are being offered by accredited universities. This is likely to change quickly, but *online certificate programs* could attract significant *enrollment* from professional looking to enhance their *credentials* in the area.¹⁹

Goal 3: Impacting Communities - The *outreach* opportunities are already here, with the department of Agricultural and Applied Economics receiving requests for extension programs that address applications of blockchain technologies in agriculture. Beef Chain is an example of a home grown Wyoming LLC that is already applying this technology to cattle ranching with the help of UW faculty members in the departments of Computer Science, Agricultural and Applied Economics, and Finance. As described above, the program explicitly addresses a number of

¹⁶ While there are regulatory environments elsewhere in the world, the Wyoming legislation is the first passed by an elected body anywhere in the world.

¹⁷ [Transforming Wyoming: 20-Year Economic Diversification Strategy, ENDOW, August 2018.](#)

¹⁸ [BREAKING THROUGH: 2017-2022: A Strategic Plan for the University of Wyoming, July 10, 2017](#)

¹⁹ As evidence for this claim, online M.S. program in Computer Science are a significant source of revenue at many colleges and universities.

goals of *ENDOW*. If they are carefully designed, online certificate Blockchain and FinTech programs may well be taken by graduates in appropriate degree programs at *Wyoming Community Colleges*. This would provide a certification beyond the AA or AS degree, but would require fewer courses than a full B.S.

The Proposal

Blockchain technology is inherently interdisciplinary. Blockchains work because of a combination of deep results from both computer science and economics. From *computer science*, blockchains are built on the theory and implementation of trusted distributed computing systems, distributed consensus algorithms, sophisticated data-structures, and digital cryptography. On the *economics* side are finance, contracts, monetary theory, behavioral economics, the new field of cryptoeconomics, supply chains, and game theory. The number of application areas is growing quickly, but applications to the supply chain for foods is perhaps the most mature.

To build a sustainable blockchain education and research program we propose to add four new faculty positions to the University of Wyoming across three colleges and three departments. There will be two positions in the College of Engineering and Applied Sciences in the Department of Computer Science, one position in the College of Business in the Department of Finance, and one position in the College of Agriculture in the Department of Agricultural and Applied Economics.

Blockchain is such a new technology that there essentially are no senior level experts, so we are proposing hiring Assistant Professors and/or Professors of Practice. The expectation is that this cohort of four new faculty members will:

- i.) offer introductory courses in the areas of blockchain technology and finance,
- ii.) collaborate in developing and offering a robust *blockchain certificate program*,
- iii.) support an interdisciplinary *FinTech*²⁰ *certificate program*,
- iv.) will work together to obtain research funding and run interdisciplinary projects, and
- v.) will serve as a resource to the State of Wyoming on blockchain related matters.

In order to start this program as early as possible (new faculty starting in August 2020) we recommend that funding take the form of a combination of expendable and endowed funds. Expendable funds will allow for the initiation of searches in the Fall of the academic year following the appropriation. Endowed funds will allow for ongoing support to the program for faculty retention, addressing ongoing research and computing equipment needs, travel, and to support blockchain outreach activities.

College of Engineering and Applied Sciences - Department of Computer Science (2 positions)
Within the computer science field, blockchain technology depends primarily on two areas,

²⁰ *FinTech* is the application of computational methods, big data, and blockchain (tech) to problems in Finance

trusted distributed computing and cryptography. The two faculty hires will be in some combination of the two areas. For Assistant Professors, we expect the standard requirements, i.) a Ph.D. in computer science or a closely related field, ii.) evidence of the ability to do research in the areas mentioned above, evidence typically takes the form of a publication record in peer-reviewed conferences and/or journals, iii.) evidence of teaching excellence, and iv.) a desire to help in blockchain related outreach activities in the state. A Professor of Practice position will require, i.) evidence of industrial experience in the blockchain space, ii.) with a desire to teach, iii.) advising Wyoming based companies looking to build blockchain based applications, iv.) participate in blockchain based outreach activities in the state. Having two faculty in Computer Science will allow the department to offer introductory level programming courses to a broad segment of the student population and to offer advanced courses to support certificate programs in Blockchain and a FinTech certificate. Both areas directly address the workforce issues the state faces in the blockchain and tech areas.

College of Business - Department of Accounting and Finance (1 position)

Economics and Finance have played a significant role in the development of blockchain based technologies. As important as the computer science contributions, consensus based on competition, proof of work, proof of stake, and other mechanisms yet to be discovered, are based in economics and finance.

In the field of Finance, the desired skill set for an assistant professor would include the standard academic hiring requirements such as: i) a Ph.D. in finance, economics or closely related field, ii) evidence of the ability to do research and publish blockchain related papers in high-quality peer-reviewed journals, iii) expertise in various forms of financial markets and securities, iv) ability to integrate the technological advances in the area of blockchain into the finance curriculum, v) ability to aid in developing the blockchain and fintech certificates. A professor of Practice position would require significant experiences in related industries, without a requirement for a Ph.D. degree. discussions about blockchain based systems, and iv.) a willingness to do educational outreach to industries in Wyoming seeking to adopt blockchain technologies. A Professor of Practice position will trade off the Ph.D. and publication requirements for an individual with real-world experience in the blockchain space.

College of Agriculture - Department of Agricultural and Applied Economics (1 position)

Supply chains are ubiquitous in all aspects of agriculture and food safety, and provenance is a difficult problem with growing importance. Blockchains are being used as a way to prove safety and provenance and are already having a significant impact on business practices in the agricultural industry. On the safety side, the technology will provide the means of targeting food recalls based on fine grained assessments of identified sources of contamination. More and more, consumers demand knowledge about where the food they eat comes from and blockchains provide the technology to make this information available. As mentioned before, blockchains are already having an impact with Walmart, Kroger, and others investing heavily in the technology. In addition to blockchain, 'big data' more generally continues to transform the

agricultural industry at a rapid pace - from satellite imagery and drone data, to field sensors and RFID traceability technology, to scanner and internet data on consumers - data availability is influencing every step in the food supply chain. A new position in Agricultural and Applied Economics will ensure the University of Wyoming has the expertise and capacity to stay at the cutting edge of these developments in agriculture, to train the future leaders of agriculture in the state and beyond, and to conduct research and outreach that contributes to economic development in the agricultural sector.

The basic requirements for an Assistant Professor in Agricultural and Applied Economics will include: i) a PhD in Agricultural and Applied Economics or a related field, ii) a demonstrated record of effective teaching, iii) evidence of the ability to do research and publish in high-quality peer-reviewed journals in the field, and iv) expertise in agricultural supply chains and agribusiness. In addition to these basic requirements, the new faculty member for this position will be expected to have: i) research and teaching experience related to big data applications in agriculture; ii) a track record of effective interdisciplinary teaching and research; and iii) demonstrated experience in outreach and engagement, and an interest in working with producers and policymakers to provide applied expertise on blockchain technologies and other big data applications in the State of Wyoming.

Budget

At the request of the Wyoming Blockchain Task Force, Prof. Caldwell and President Emeritus Richard McGinity presented an earlier version of this proposal at the Cheyenne Task Force meeting on October 29, 2018. At that meeting the Task Force voted unanimously to send a letter to President Nichols and the University of Wyoming Trustees that they intended to write legislation to appropriate funds. The budget in the original proposal had been shared, but not vetted with the University Administration. The revised budget below is based on recommendations from President Nichols and other administrators.

The request is for a continuing legislative appropriation of ~\$830,000 per year to support *four new faculty positions* at the university: two in the Computer Science Department; one in the Finance Department; and one in Agricultural and Applied Economics. *Startup funds* to support the new faculty would be spent over the first two years and would be covered by the University and Colleges housing the department homes of the new faculty. Additionally, an endowment fund in the amount of \$3,000,000 would be raised over 5 years with a 2:1 match by the UW Foundation, \$1,000,000 from the state and \$2,000,000 raised by the Foundation. State matching funds would become available (for up to 5 years) when letters of commitment from donors are been obtained by the Foundation.

		Yearly		Totals
NEW FACULTY (State Funding)				
Computer Science 1	Salary	\$135,000		
	Fringe 43.3%	\$58,455		
Computer Science 2	Salary	\$135,000		
	Fringe 43.3%	\$58,455		
	<i>SubTotals</i>	\$386,910		\$386,910
Finance	Salary	\$185,000		
	Fringe (43.3%)	\$80,105		
	<i>SubTotals</i>	\$265,105		\$265,105
Agricultural Economics	Salary	\$125,000		
	Fringe (43.3%)	\$54,125		
	<i>SubTotals</i>	\$179,125		\$179,125
YEARLY PERSONNEL EXPENDITURES		\$831,140		\$831,140
FACULTY STARTUP (UW funding)		Year 1	Year 2	
Computer Science 1		\$125,000	\$125,000	
Computer Science 2		\$125,000	\$125,000	
Finance		\$45,000	\$40,000	
Agricultural Economics		\$25,000	\$25,000	
<i>SubTotals</i>		\$320,000	\$315,000	\$635,000
ENDOWED MATCHING FUNDS				
State		\$1,000,000		\$1,000,000
UW Foundation Match (2 to 1)				
College of Engineering and Applied Sciences		\$931,034		
College of Business		\$637,931		
College of Agriculture		\$431,034		
<i>SubTotals</i>		\$2,000,000		\$2,000,000
<i>Total Endowment</i>				\$3,000,000
Faculty Expenditures		Year 1	Year 2	Year 3 on
Continuing STATE Funding / Faculty		\$831,140	\$831,140	\$831,140
Startup Funding (over 2 years) UW part		\$320,000	\$315,000	0
		\$1,151,140	\$1,146,140	\$831,140
Endowment		Within 5 years		
STATE Funded Endowment		\$1,000,000		
UW Foundation Matching funds (2:1 match)		\$2,000,000		
TOTAL		\$3,000,000		

New Educational Programs enabled by this Proposal

The specific programs at the University of Wyoming that will be enabled by the proposed funding include an interdisciplinary *Blockchain Certificate Program*, an interdisciplinary *FinTech Certificate Program*, and the resources to teach *introductory courses on blockchain technology*. Certificate programs will be offered online and we believe will prove very popular with professionals already in the workforce. These would be the first such programs available in the region. As mentioned above, blockchain courses at other universities have been among the most popular on their respective campuses. There will be real synergy between the courses offered for the certificates, with, some courses counting toward more than one certificate.

Also, new faculty will be training graduate students at the M.S. and Ph.D. levels. Students graduating with advanced degrees will be a crucial component of a workforce development strategy for companies looking to establish operations in Wyoming, the region, and the nation.

We expect the combination of introductory courses and online certificate programs will attract students to the University of Wyoming who would not have otherwise come. At this point, it is difficult to predict actual numbers, but that analysis is part of the established certificate approval program.

Online Blockchain Certificate Program - The blockchain certificate program will include approximately four to five courses that will be designed so that students from a number of disciplines (though not all) will be able to add the certificate to their program of study without delaying a four year graduation. This will certainly be true for students with majors in the three departments included here, but also, we expect majors in other disciplines will be able to integrate the blockchain certificate onto their programs of study. Certainly, students in a number of other Engineering, Business, and Agriculture degree programs will be able to do this. Course topics will include both blockchain system design and programming, the economics and finance of blockchain, designing smart contracts, and an interdisciplinary applications course that will serve as a capstone.

Online FinTech Certificate Program - FinTech (Financial Technology) is the integration of technology to facilitate and automate financial applications. This topic is broader than blockchain alone, it also must include data analytics, artificial intelligence, and machine learning. The faculty hired under this proposal will provide the support for teaching blockchain technologies to students pursuing this certificate. The certificate will include four or five courses in Finance and Computer Science to enable students studying in various majors to obtain the fintech certificate. Computer Science and Business students will be able to add this certificate into their program of study without delaying a four year graduation. We expect students in other disciplines to be able to do so as well.