

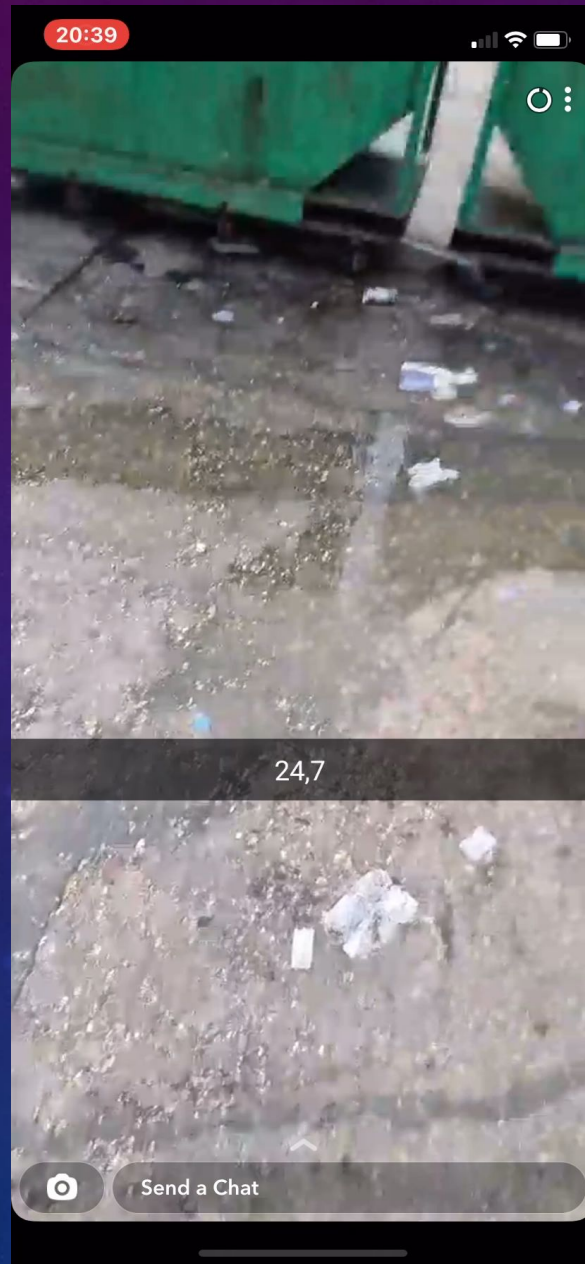
The background features a dark blue gradient with several overlapping circular patterns. These patterns include concentric circles, dashed lines, and solid lines, some with arrows indicating a clockwise direction. Numbers are scattered around the circles, ranging from 140 to 260 in increments of 10. The overall aesthetic is technical and futuristic.

REDUCING FOOD WASTE IN THE AGRI-FOOD SUPPLY CHAIN USING BLOCKCHAIN AND AI

BY SOMDIP DEY

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DID YOU KNOW?



PERSONAL CONNECTION WITH FOOD WASTE

- In 2014, after a tragic accident in the family I sent back all my money to help with the medical bills without thinking how I would buy food for myself for almost a week.
- Ended up “dumpster diving” to survive on food gathered from the bin.
- Led to the development of the world’s first crowd-food sharing platform that enables the user to share their leftovers and food surplus with other people in need.



SHARE.IT

HOME SHARE.IT NETWORK BUY IN ABOUT CONTACT US SIGN IN

Welcome to the World's First Crowd-Fooding Platform!

"Stop wasting food and Share.it" - Codeeepy

FOOD FOR EVERYONE

- 📍 Every day about 21,000 people die of hunger or hunger-related causes
- 📍 You can change this....
- 📍 Every year approximately one third of the food produced in the world, which weighs around 1.3 billion tonnes, are either wasted or get lost
- 📍 Make a difference by sharing food through Share.it

#koding

daniel brake @ddbrake 23m
#koding #Hackathon in its 2nd night and nearing the finishline.
Expand

Matt Huggins @mhuggins 1h
No time to complete a #koding #hackathon entry, but managed to implement some basic redis-backed socket.io messaging. pictwitter.com/s7f87mWSCV
Retweeted by Javascript Digest
Show Media

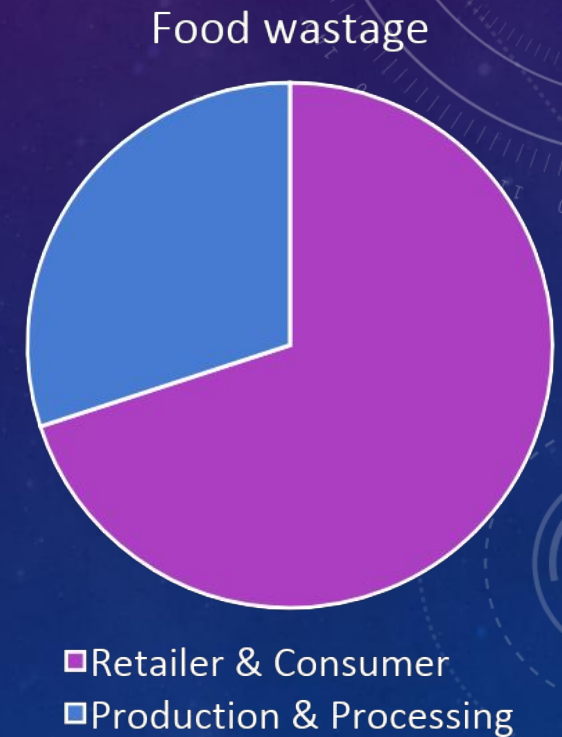
Kenneth Sungcaya @ksungcaya 1h
less than 5 hours to go then I can sleep. 🤪 #hackathon #koding
Expand

Tweet #koding

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WHAT IS THE PROBLEM?

- According to FAO, every year more than 1.3 billion tons of food is wasted, which is equivalent to \$2.6 trillion.
- Whereas, more than 820 million people around the world don't have access to proper nutrition.
- Food waste contributes to almost 10% of the global carbon emissions.
- Almost 70% of food waste happens at the retailer and consumer level, whereas 30% of it happens at the production and processing level.



KEY QUESTIONS TO ANSWER

- How can we collect accurate data on food consumption and waste without threatening consumers' privacy?
- How can we raise awareness among the consumers about food waste so that they become conscious of the social and environmental impacts?
- How can we actually help consumers to reduce waste and save money, especially during a time when the cost of living is steadily growing?
- How can we help every stakeholder (production, processing, distribution, retailers and consumers) in the food supply chain to reduce waste and improve sustainability?

SOLUTION TO THE PROBLEM



- Artificial Intelligence
- More specifically, Embedded Machine Learning

WHAT IS EMBEDDED MACHINE LEARNING?

- **Embedded Machine Learning** is a sub-field of machine learning, where the machine learning model is run on embedded systems with limited computing resources such as wearables, edge devices and microcontrollers.
- Privacy and security of data is a key concern to many consumers with respect to AI/ML and embedded machine learning is best suited in this scenario as the ML models trains and infer in the embedded systems.

ANSWER TO ALL QUESTIONS

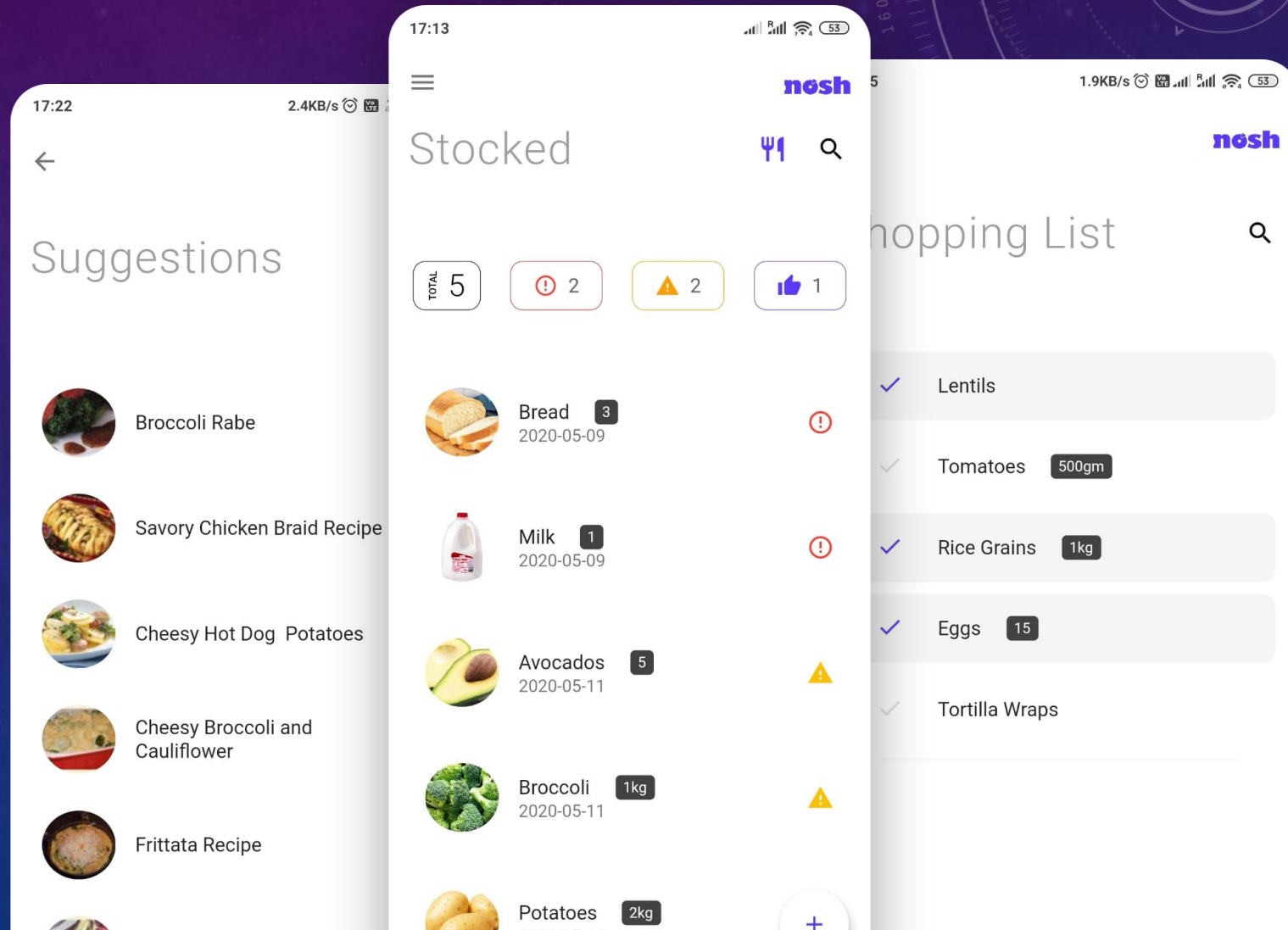
Personal nosh Assistant = PnA

Or simply called – nosh

~ nosh = food in English

The nosh app is an Artificial Intelligence (AI) powered All-in-One food management and consumption application to help the user optimize consumption by managing food more effectively while reducing food waste at home, living a healthier lifestyle and save money.

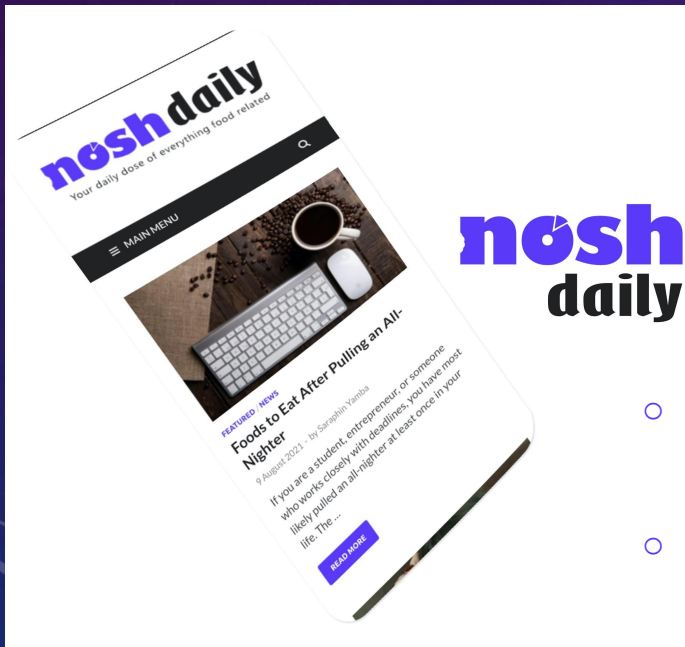
Website: <https://nosh.tech>



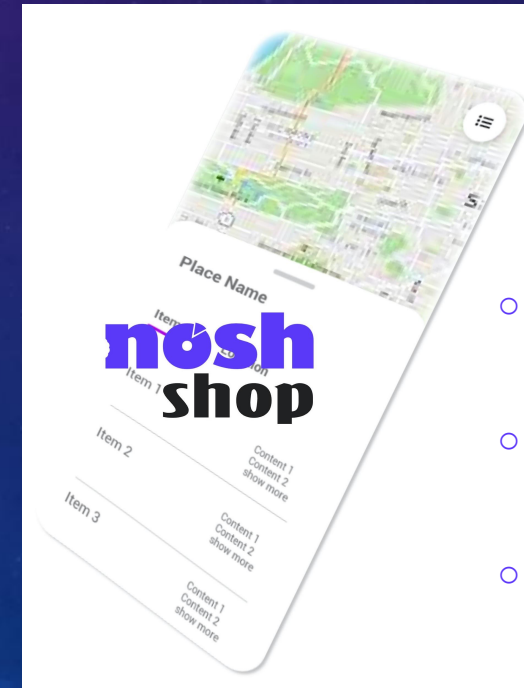
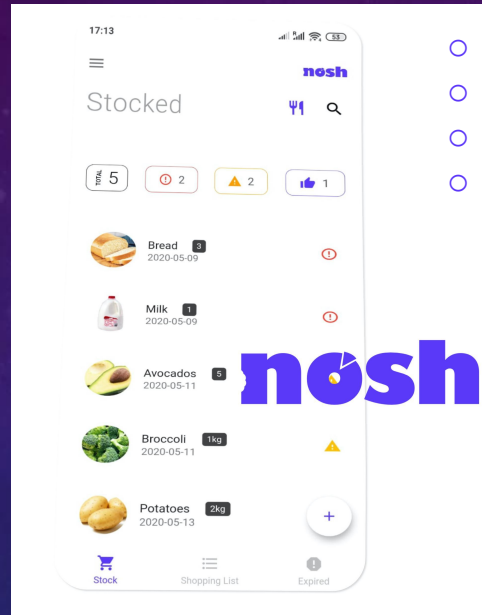
TRIFECTA SERVICES WITHIN NOSH

- Optimize food consumption.
- Save money.
- Reduce food waste.

- Manage food more effectively
- Get smart recipe suggestions
- In-app shopping planning
- Intelligent analytics on food consumption



- Get daily deals & offers on food products including groceries
- Get latest news and media content on everything food related



- Buy food products including groceries at an affordable price
- Feed hungry and malnourished people through every purchase
- Share or sell food to other people nearby

WHAT'S SO SPECIAL ABOUT NOSH?

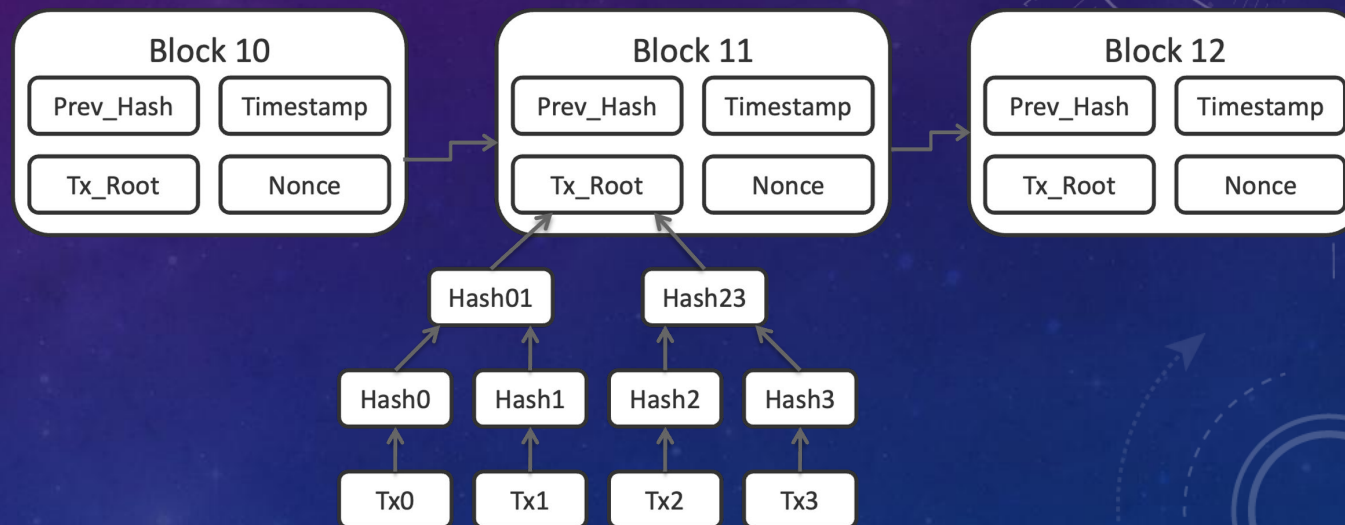
- Nosh provides in-app intelligent data analytics on food consumption and wastage such that the consumer can make data-driven decisions on what food to buy or not to buy the next time they go out shopping.
- Using embedded machine learning on nosh, it is capable of learning what type of food is consumed or wasted in which region of the world without threatening the user's privacy.
- Nosh has already helped more than 17,400 consumers to save more than 200,000 different types of food items and reduce carbon emissions by more than 127 tons.
- Nosh is one of the largest repository of food consumption and wastage data in different regions of the world as the app is available in more than 176 countries in the world.

2 KEY INNOVATIONS

- Digitizing food supply chain data using blockchain to make it easily accessible and traceable to any stakeholders in the supply chain to improve food safety.
- Using machine learning and blockchain to optimize waste in the supply chain to reduce food waste and improve sustainability of the planet.

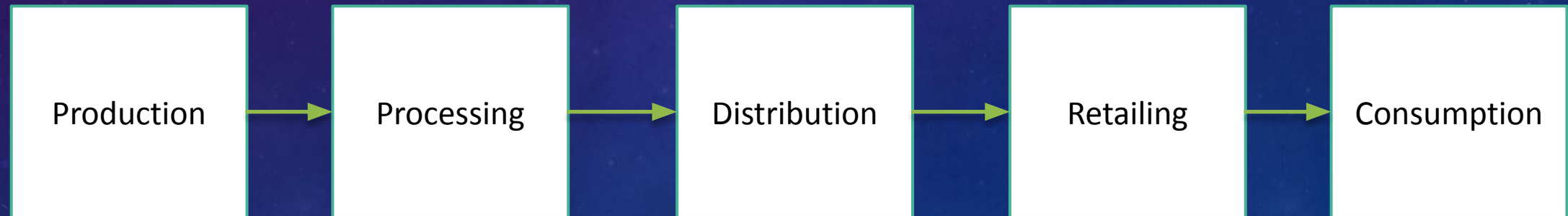
WHAT IS BLOCKCHAIN?

- A blockchain is a digital ledger or in other words, a growing list of records, called blocks, which are linked with each other using cryptographic functions.
- Key features include: **Decentralized, Transparent, Open-Source, Autonomous, Immutability & Anonymity.**



ONE ASSUMPTION ABOUT FOOD SUPPLY CHAIN

- Farm-to-Fork food supply chain consisting of 5 phases:
 - Production, Processing, Distribution, Retailing and Consumption



DIGITIZING FOOD SUPPLY CHAIN DATA

- Although there are standards available such as the General Food Law in the EU and the Food Safety Modernization Act (FSMA) in the U.S., which try to standardize the traceability of the digital information of food production in some of the stages of the food supply chain, these standards are regional, and currently, there is no holistic standardization of the tracking and recording data for food traceability purposes in all stages of the food supply.
- IBM and Walmart partnered to digitize food supply chain data.
- Several other researchers and industry practitioners also developed blockchain based frameworks to digitize food supply chain data for improved traceability.

References:

- Zhao, Guoqing, et al. "Blockchain technology in agri-food value chain management: A synthesis of applications, challenges and future research directions." *Computers in Industry* 109 (2019): 83-99.
- Tian, Feng. "An agri-food supply chain traceability system for China based on RFID & blockchain technology." *2016 13th international conference on service systems and service management (ICSSSM)*. IEEE, 2016.

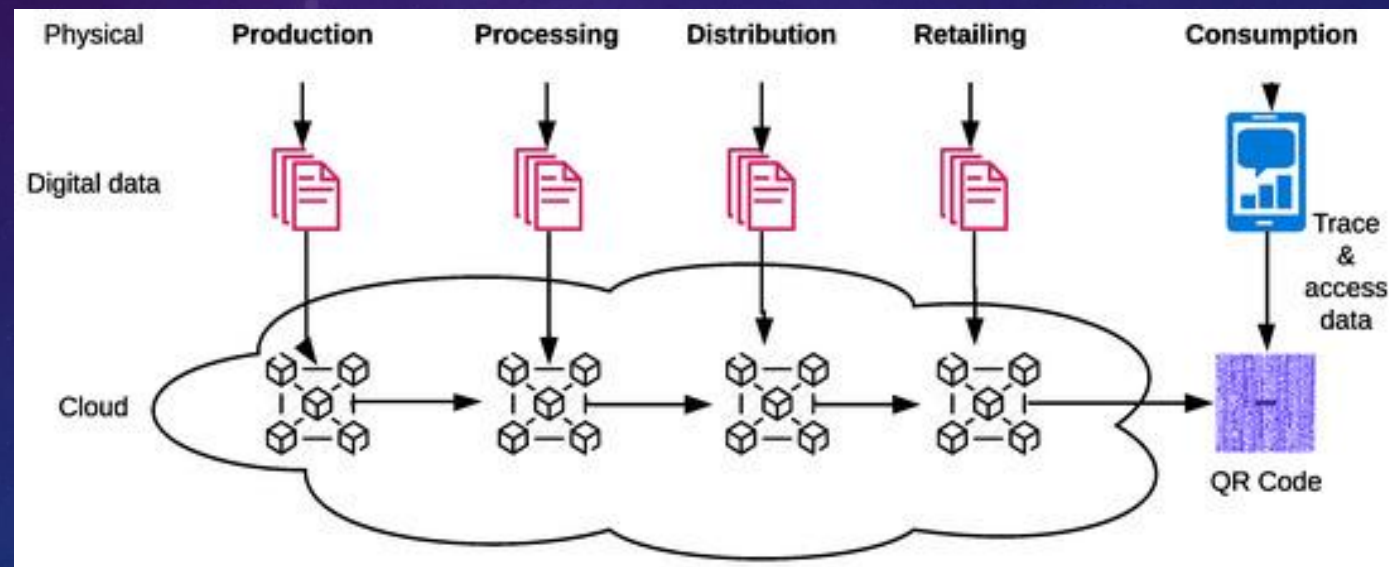
ENTERS THE SUPER-HERO: QR CODE



- QR Code is an effective information transmission medium, which is widely used in product traceability, advertising, mobile payment, passport verification and other fields.
- The QR code is defined as 40 symbol versions (to carry various data payloads) and four user-selectable Error Correction Levels (ECLs): L, M, Q and H, which is capable of error handling up to 30%.

REVOLUTIONIZING SUPPLY CHAIN WITH FOODSQRBLOCK

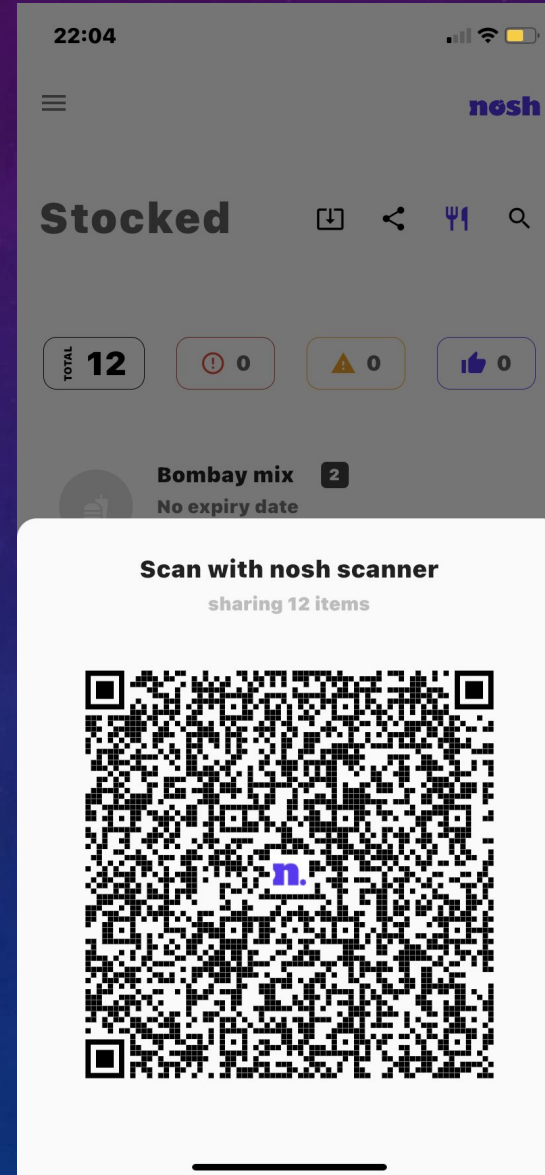
- Our solution is **FoodSQRBlock** (Food Safety Quick Response Block) framework*.
- QR code is used to retrieve the food data from the blockchain in the Farm-to-Fork supply chain.



* Dey, Somdip, et al. "FoodSQRBlock: Digitizing food production and the supply chain with blockchain and QR code in the cloud." *Sustainability* 13.6 (2021): 3486.

CURRENTLY USED IN NOSH

- nosh users can share their food inventory with other nosh users in super fast speed.



NEXT CHALLENGE?

- If we can digitize food supply chain data for traceability and accessibility, how can we optimize waste in the supply chain?

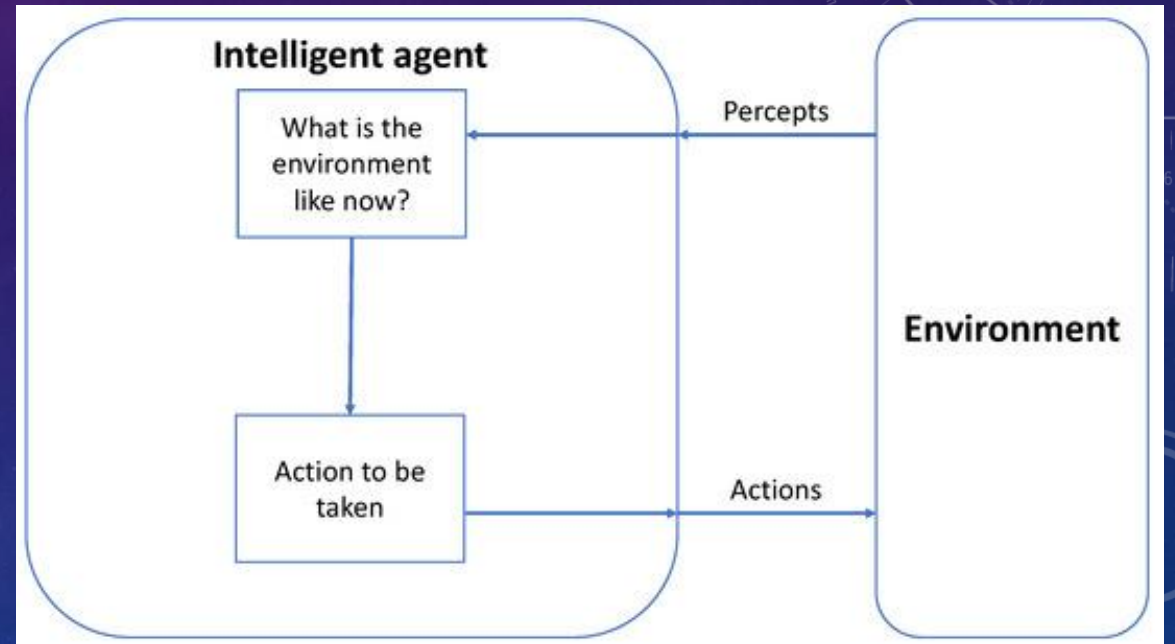
SMARTNOSHWASTE: BLOCKCHAIN BASED MACHINE LEARNING FRAMEWORK

- SmartNoshWaste* is a blockchain based multi-layered framework utilizing cloud computing, QR code and reinforcement learning to reduce waste in the food supply chain.

*Dey, Somdip, et al. "SmartNoshWaste: Using Blockchain, Machine Learning, Cloud Computing and QR Code to Reduce Food Waste in Decentralized Web 3.0 Enabled Smart Cities." *Smart Cities* 5.1 (2022): 162-176.

WHAT IS REINFORCEMENT LEARNING

- Reinforcement learning (RL) is a type of machine learning algorithm, where an intelligent agent, which is a computing system that perceives its environment to take actions autonomously in order to achieve cumulative rewards based on the knowledge gathered from the environment.



WE NEED A METRIC FOR THE REWARD

$$P_{YYQXNM}^i = C_{YYQXNM}^i + S_{YYQXNM}^i + W_{YYQXNM}^i$$

- P , C , S and W are the total amount of produce for a particular food item, total amount of the food item consumed, the surplus of the food item kept for food security and the amount wasted of the food item, respectively.
- In the equation, $YYQXN$ represents the year (YY) and the quarter ($QXNM$, where $X \in \{1,2,3,4\}$, $N \in \{1,2,3\}$ and $M \in \{1,2,3,4\}$) of the particular food item being produced, respectively.

METRIC IS USEFUL FOR EVERY PHASE IN FOOD SUPPLY CHAIN

Production:

$$P_{YYQXN}^1 = C_{YYQXNM}^1 + S_{YYQXNM}^1 + W_{YYQXNM}^1$$

Processing:

$$P_{YYQXN}^2 = C_{YYQXNM}^2 + S_{YYQXNM}^2 + W_{YYQXNM}^2$$

Distribution:

$$P_{YYQXN}^3 = C_{YYQXNM}^3 + S_{YYQXNM}^3 + W_{YYQXNM}^3$$

Retailing:

$$P_{YYQXN}^4 = C_{YYQXNM}^4 + S_{YYQXNM}^4 + W_{YYQXNM}^4$$

Consumption:

$$P_{YYQXN}^5 = C_{YYQXNM}^5 + S_{YYQXNM}^5 + W_{YYQXNM}^5$$

FOOD PRODUCTION IS INTERDEPENDENT ON EACH PHASE

- Because of supply and demand food production is interdependent on each phase in the food supply chain.

$$C_{YYQXN}^{i-1} + S_{YYQXNM}^{i-1} + W_{YYQXNM}^{i-1} = P_{YYQXNM}^i$$

REWARD IN SMARTNOSHWASTE

- If we consider a variable — f — that denotes the amount of food that should be reduced or increased in the food surplus to minimize wastage in that a particular phase of supply chain

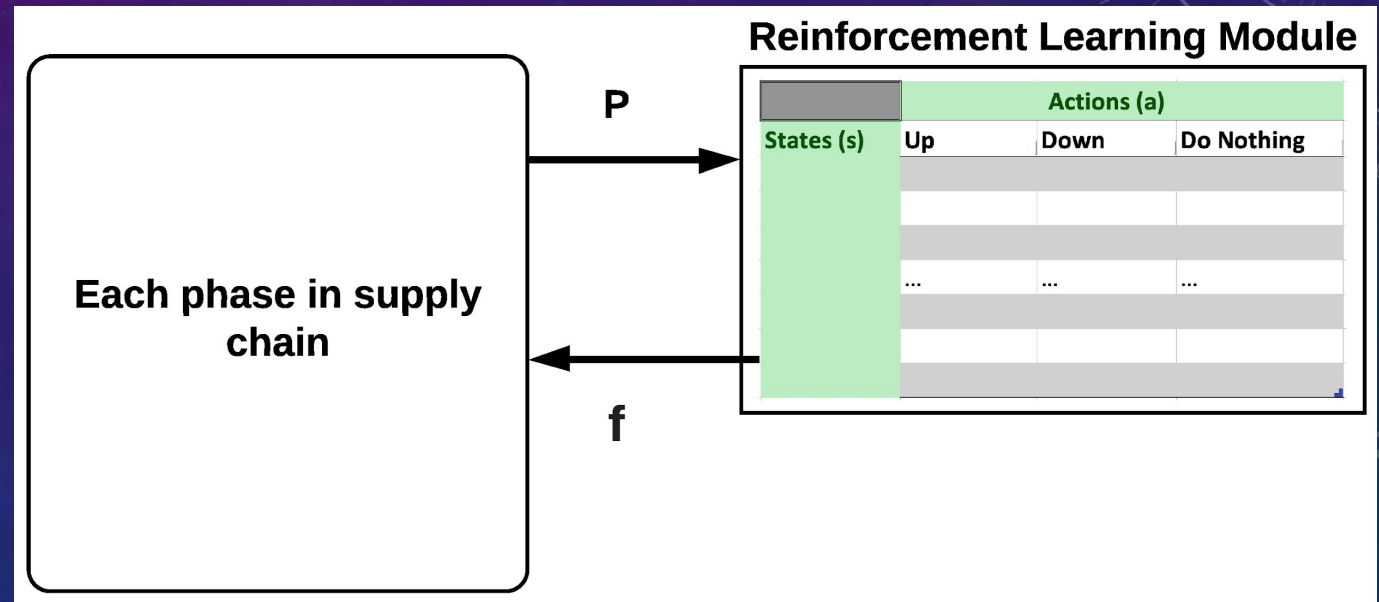
$$P_{YYQXNM}^i = C_{YYQXNM}^i + \left(S_{YYQXNM}^i + f \right) + W_{YYQXNM}^i$$

- f — can be positive, negative, or zero. **Actions:** Up, Down, Do nothing.

$$R : \text{minimize } \left(W_{YYQXNM}^i \right) \longrightarrow S_{YYQXNM}^i + f$$

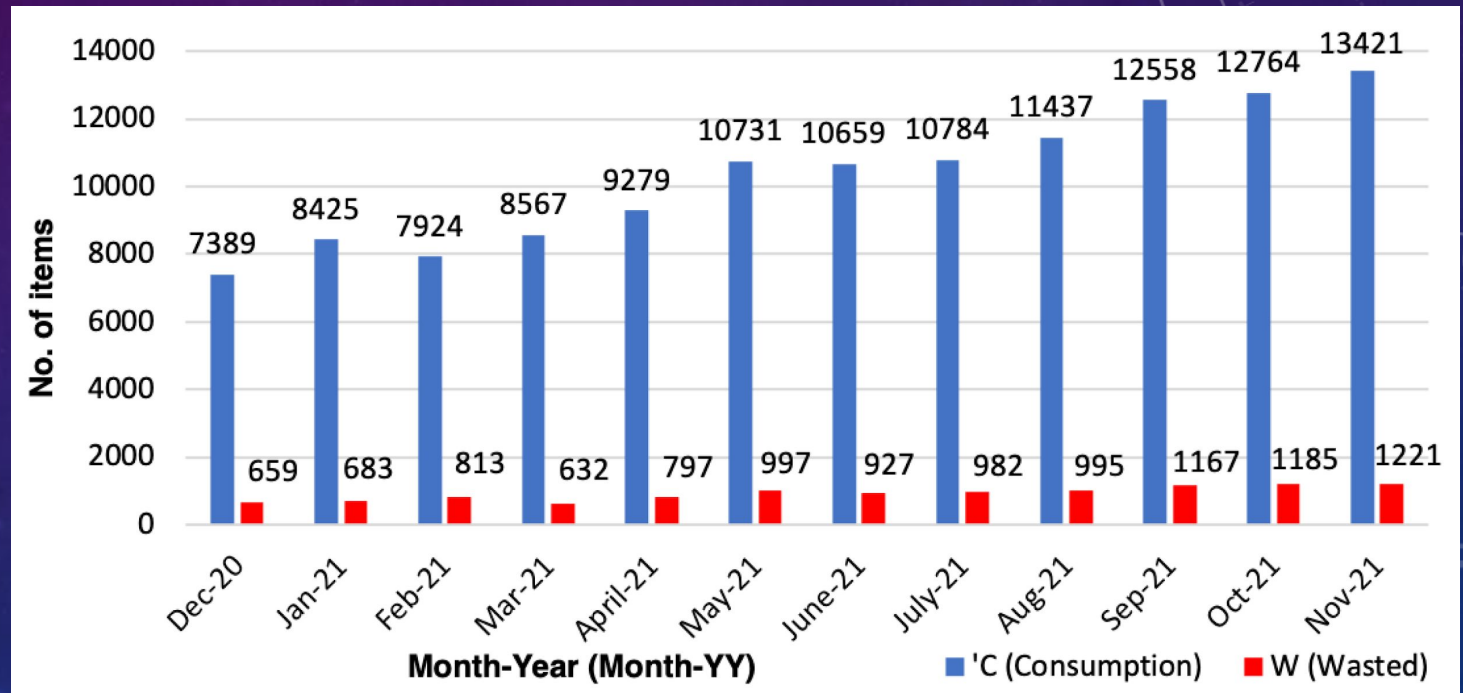
REINFORCEMENT LEARNING IN SMARTNOSHWASTE

- The reinforcement learning agent of SmartNoshWaste is implemented at each stakeholder in each phase in the supply chain.
- If we optimize waste at each stakeholder in each phase of the supply chain that leads to overall waste optimization in the food supply chain.



EXPERIMENTAL RESULTS

- We implemented SmartNoshWaste to test waste optimization on 134,996 potato consumption data collected worldwide via the nosh app over a 1 year period (December 2020 to November 2021).
- We were able to reduce waste by **9.46%**.



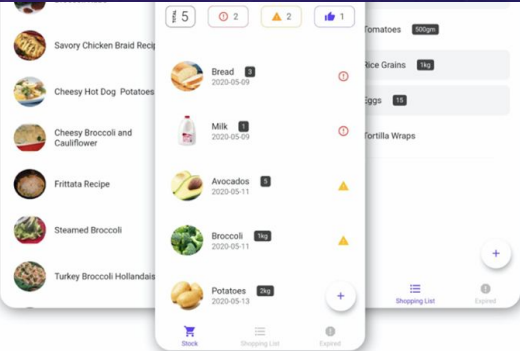
Consumption and wastage data of potatoes collected via the nosh app where the Y-Axis represents the number of items consumed ('C) or wasted (W) and X-Axis represents the months of the year when the data was collected.

CONCLUSION

- AI/ML and blockchain are very effective in optimizing waste without threatening food security in the supply chain.
- AI/ML and blockchain are still in their infancy comparatively and these methods are the foundation of what's about to come in the near future.

THANK YOU! ANY QUESTIONS?

- Email dey@nosh.tech or somdip.dey@essex.ac.uk
- Website: <https://nosh.tech>



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while reducing food waste at home

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