TOP4HONEYCHAINS

Trustable and Sustainable Open Platform for Smart Honey Value Chains

EST. 2023

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Outline

- About the project
- Digital open data platform
  - Concepts
  - Challenges
- Fraudulent honey market modelling
  - Game theory approach
- Conclusions

!!! Spoiler alert !!!

- Many unanswered questions ahead

Fraudulent honey problem

- 46% of honey on the European market is suspected of being adulterated
  - https://agrinfo.eu/book-of-reports/46-of-honey-on-the-european-market-is-suspected-of-being-adulterated/
  - 2023
- Honey labelling: deal with Council on measures to combat fraud
  - https://www.europarl.europa.eu/news/en/press-room/20240129IPR17211/honey-labelling-deal-with-council-on-measures-to-combat-fraud
  - 2024
- A Sticky Situation: Fraudulent Honey in the EU
  - https://www.iiea.com/publications/a-sticky-situation-fraudulent-honey-in-the-eu
  - 2024
- New test: Supermarket honey is not real
  - https://www.zdf.de/nachrichten/wissen/honig-supermarkt-gepanscht-dna-analyse-100.html
  - 2024

The project

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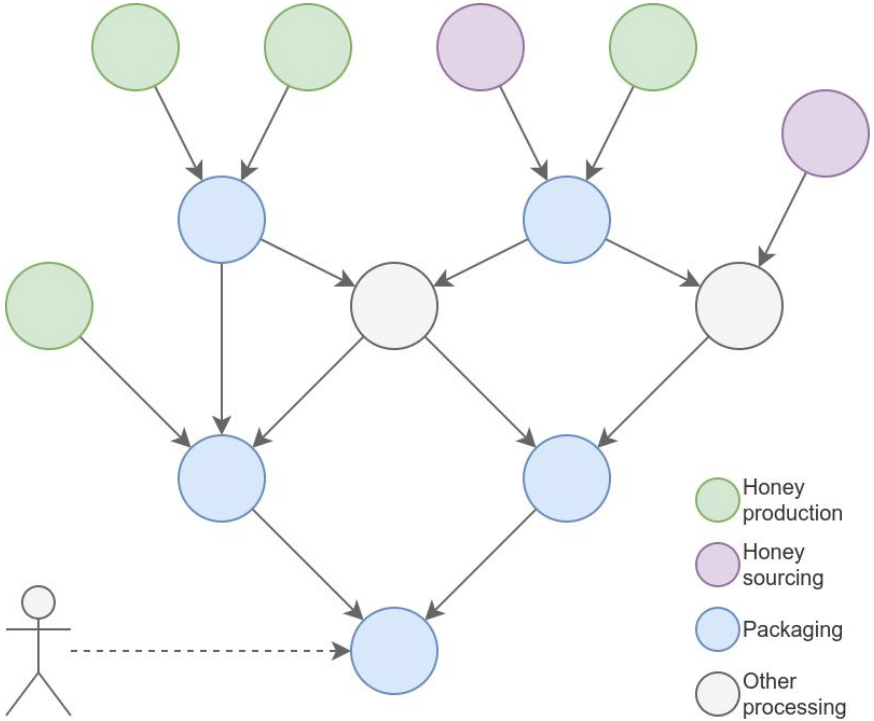
- Sustainability challenges
  - complex relations from farm to fork
  - climate change
  - increasing competitive pressures
  - food safety
- Higher value honey products
  - ensuring quality of honey
  - counteracting honey fraud
  - traceability
- Open data platform
  - innovative digital services
  - trustable, sustainable and adaptive solution

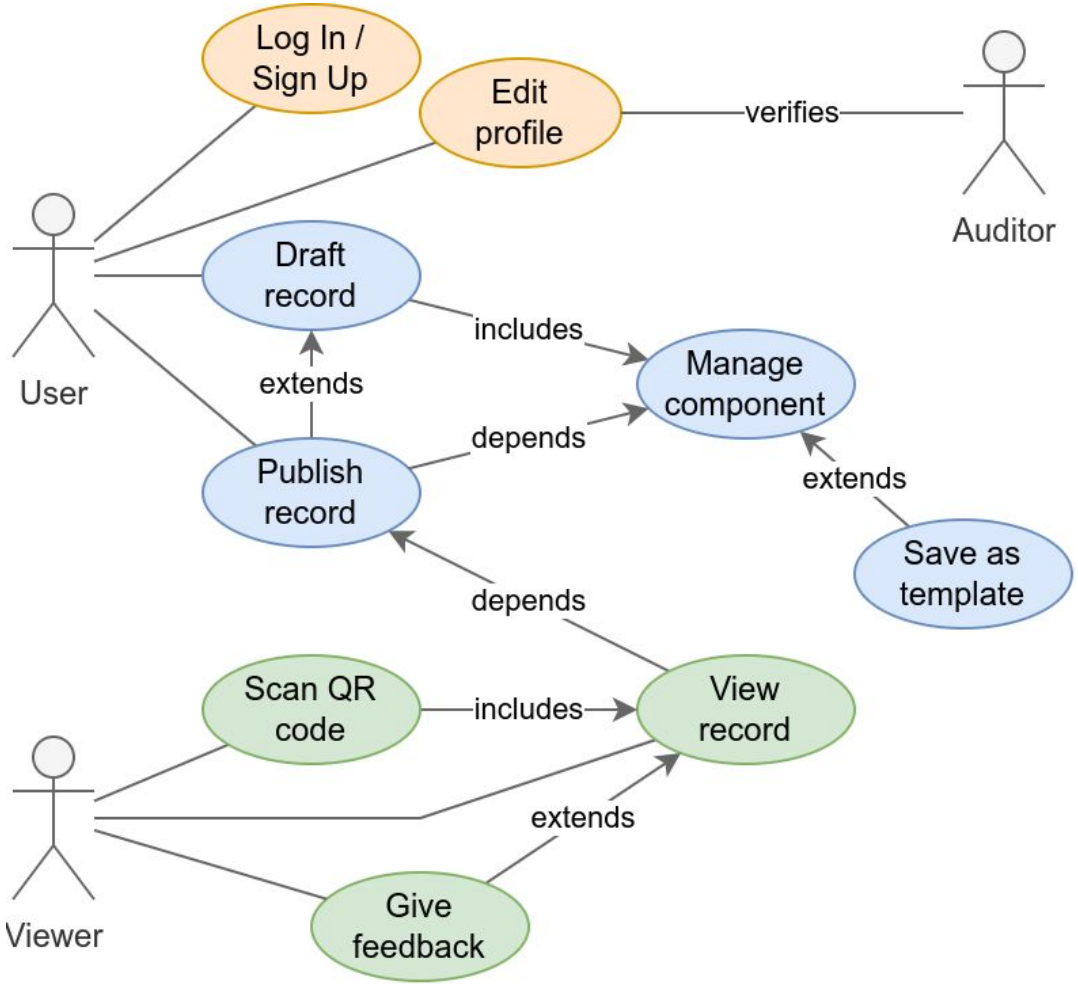
- Turkey
  - Kadir Has University, Coordinator
  - Işik University
  - Apiculture Research Institute, Türkiye Ministry of Agriculture and Forestry
- Poland
  - University of Economics in Katowice
- Argentina
  - Instituto Nacional de Tecnologia Agropecuaria
  - Nexco S.A
  - Cooperativa Agropecuaria Y Apicola Norte Grande Limitada
  - Alimentos Naturales Natural Foods S. A.
- Latvia
  - Latvia University of Life Sciences and Technologies

Honey value chain: a concept

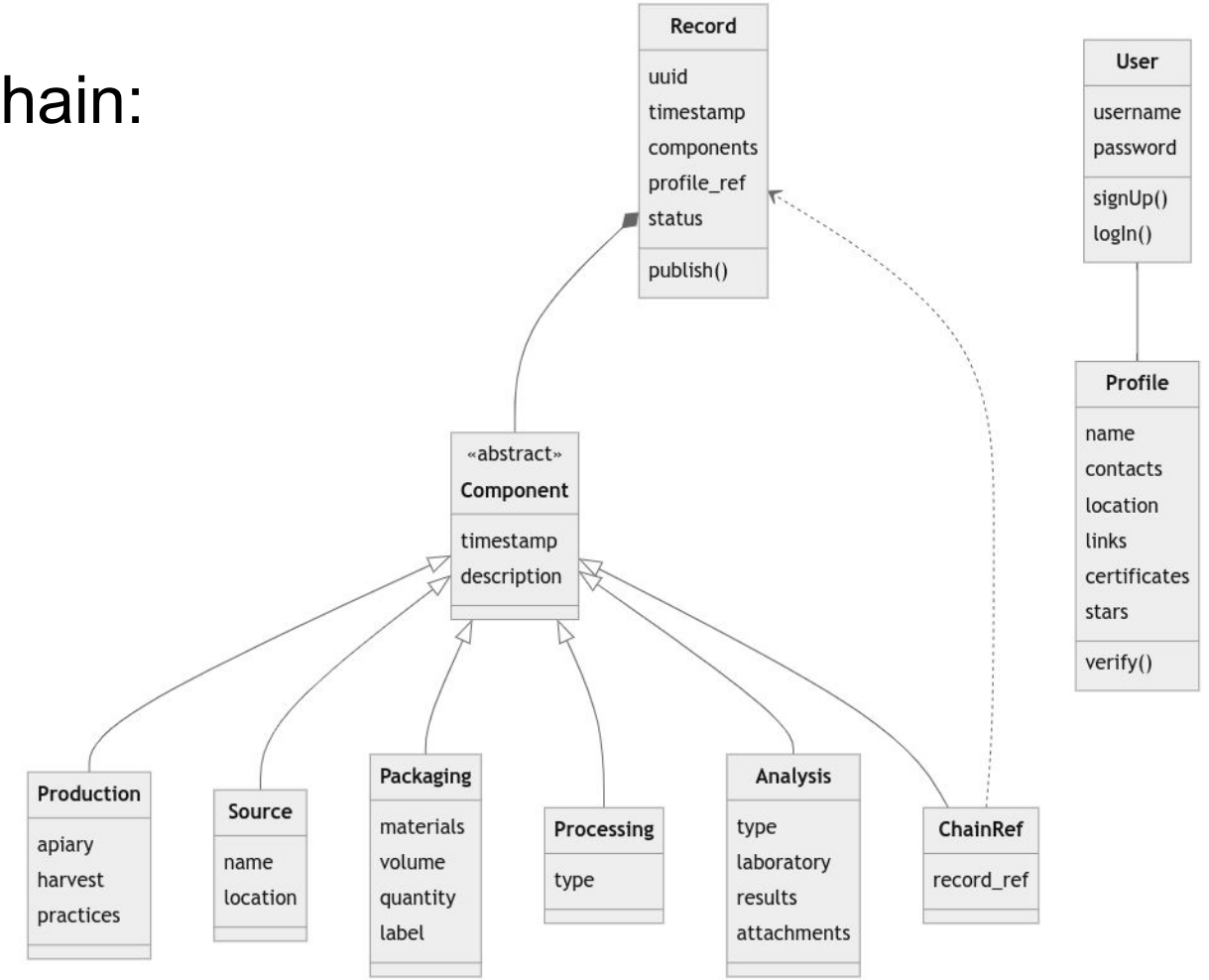
- Information about whole product lifecycle
  - from apiary to table
- Directed graph of records
  - beekeeping practices
  - honey processing peculiarities
  - packaging details
  - sourcing from “external” providers
  - etc.
- Trustable and transparent platform
  - publicly available
  - validated and maintained



Honey value chain: use-cases



Honey value chain: entities



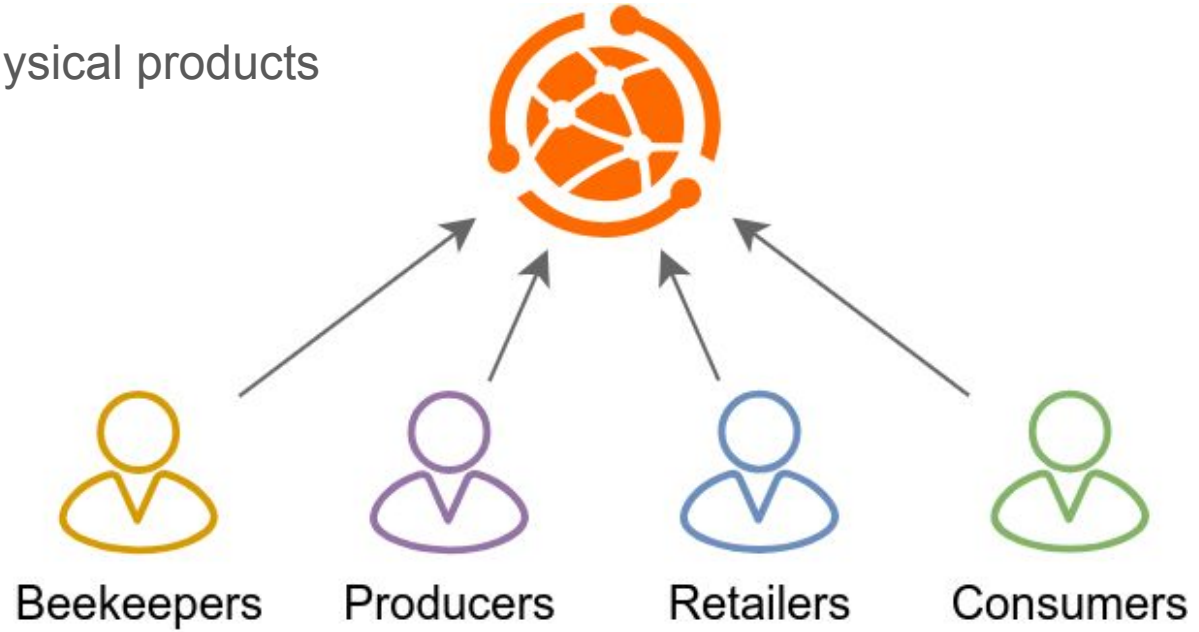
Honey value chain: an example

- Torben Pajari
  - Harvested lime honey near Littshalfield
- Gerhild Kühnel
  - Harvested buckwheat honey near Nabnewstu
- Beewater, GmbH
  - Sourced mixed honey from Asian region
- Ridgeco & Co
  - Blended batch as Mixed honey
  - Sold in bulk as Mixed honey
- Honeydustries
  - Packaged in 250g jars
- Lokilutions, SIA
  - Distributed at Corespace market

* Any resemblance to actual events, locales, companies or persons is coincidental

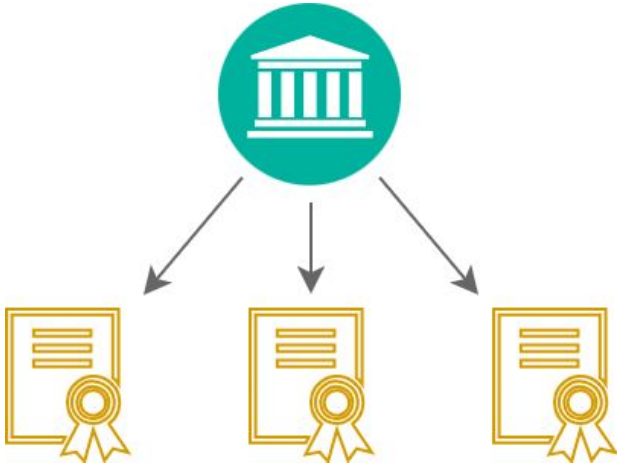
Challenges

- Benefits for main participants
- Validated information
- Link digital tools with physical products



Semi-centralized approach

- Few trusted authorities
- Authorize participants
- Verify records
- Handle disputes
- etc.



- Real-world examples
  - Card payments (VISA, Mastercard)
  - Internet certificate authorities (Let's Encrypt, GlobalSign)
  - General authentication providers (Smart-ID)
  - Government (digital signatures)

- Unclear business case for authorities
  - how to earn money?
- Dispute handling is non-trivial
  - especially on international level
  - politics
- Differences between communities
  - quality expectations
  - biased opinions

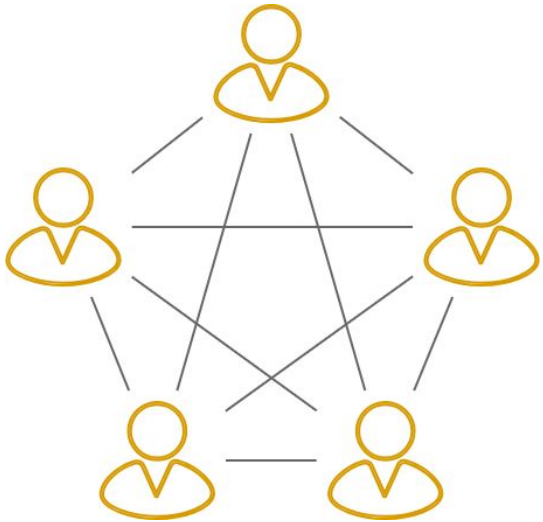
Decentralized approach

- Blockchain
- Distributed ledger
- Peer-to-peer protocol
- All participants are “trusted” equally

- Maintenance
  - changes / fixes are impossible
  - ever growing ledger size
- Community involvement
  - peer-to-peer
  - unclear benefits
- Consensus mechanisms
  - proof-of-work (mining)

Community approach

- Let the community evolve naturally
- Voluntary activities
- Eventually reach “consensus truth”
- Similar to Open Source Software or Wikipedia

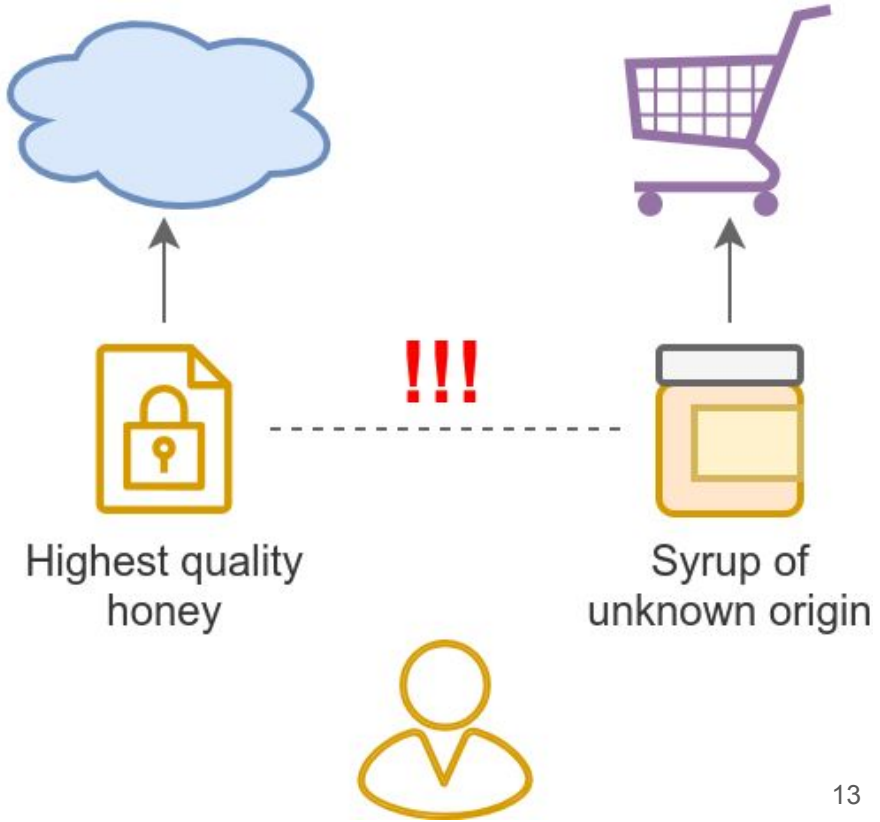


- Hard to achieve objective truth
  - opinions, influencers, marketing, paid reviews
  - information bubbles
- Current situation “de facto”
  - large producers maintain own communities
  - closed data platforms
  - only some information is published
  - no means to verify records

Digital tools vs Physical products

- Digital tools
  - convenience for users
  - time-proven security measures
  - easy verification
- Physical products
  - subject to environmental effects
  - no inherent verification means
  - easy tampering

- How to ensure digital records match products?
  - authorities
  - regulations
  - expensive verification
- Organizational challenge rather than IT



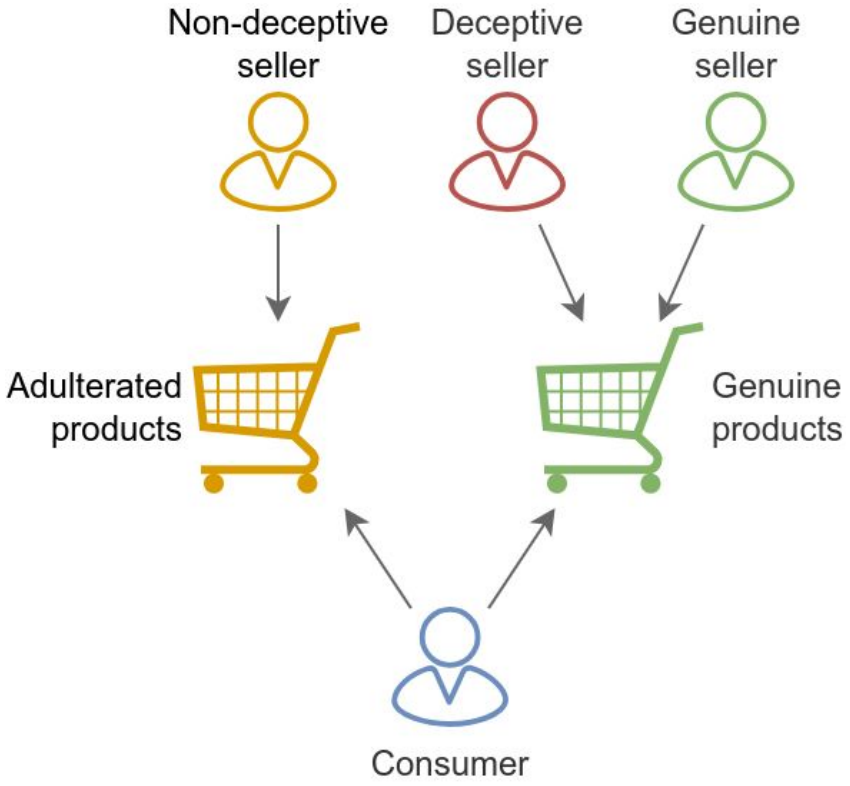
Game theory and honey fraud modelling (WIP)

- Game theory
  - mathematical models
  - **strategic interactions**
  - social sciences, economics, laws, politics, international affairs, military, etc.
- Game
  - process with two or more involved sides
- Player
  - game participant
  - aims to realize its own interests
- Strategy
  - player's course of action
  - best outcomes
  - depends on behaviour of other players

Zhao, Y., Zhu, Q. (2020). Combating Online Counterfeits: A Game-Theoretic Analysis of Cyber Supply Chain Ecosystem. In: Zhu, Q., Baras, J.S., Poovendran, R., Chen, J. (eds) Decision and Game Theory for Security. GameSec 2020. Lecture Notes in Computer Science(), vol 12513. Springer, Cham. https://doi.org/10.1007/978-3-030-64793-3_18

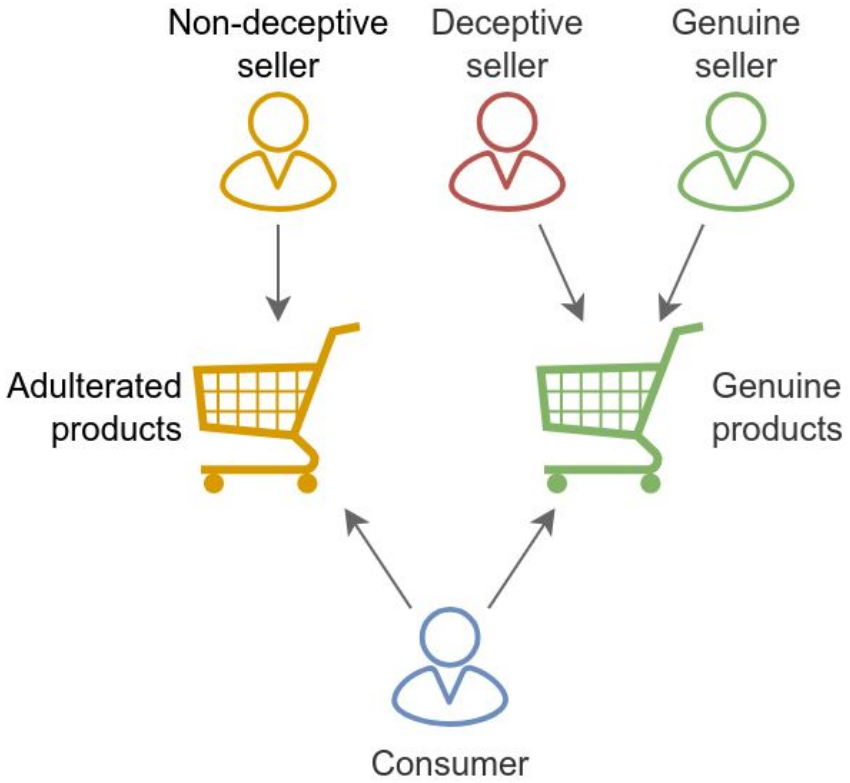
Game schematic

- Markets
  - Non-deceptive adulterated products
    - “Jars of syrup”
  - Genuine and deceptive adulterated products
    - “Jars of honey”
    - “Look-alike jars of honey”
- Sellers
  - Fraudulent sellers try to sell adulterated products with various levels of deceptiveness
  - Genuine seller tries to sell genuine products
- Consumer
  - Chooses “most-valued” option among offers



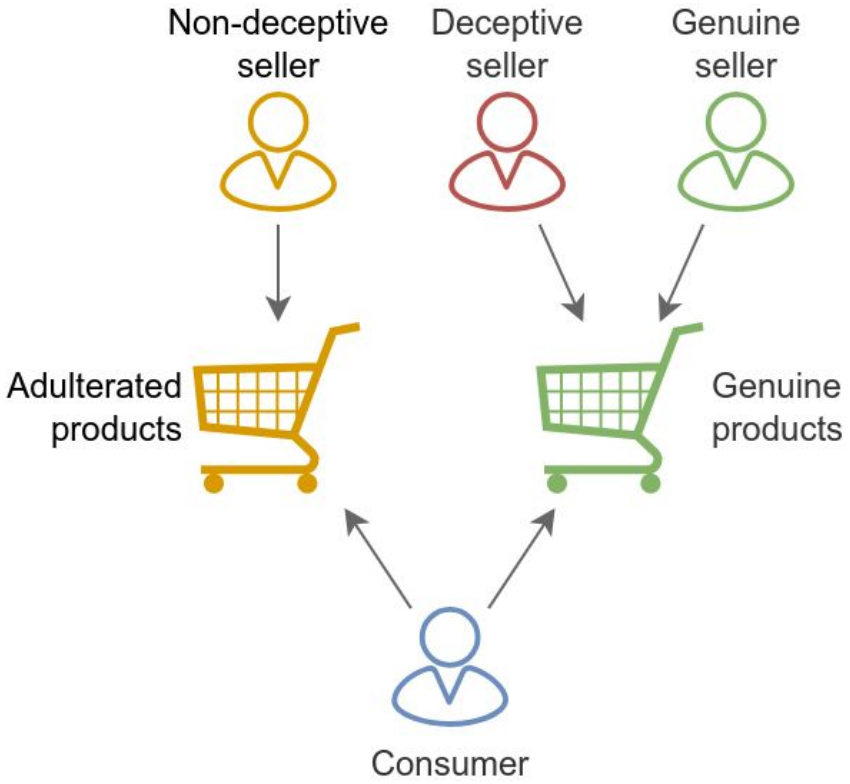
Consumer model

- Product valuation
  - how important is product authenticity?
  - how easy is to deceive (vigilance)?
- Actions
  - buy nothing
    - zero utility
  - buy adulterated product
    - utility depends on product valuation and its price
  - try to buy genuine product
    - utility depends on product valuation, its price and probability of being deceived
- Strategy
  - select action with highest utility



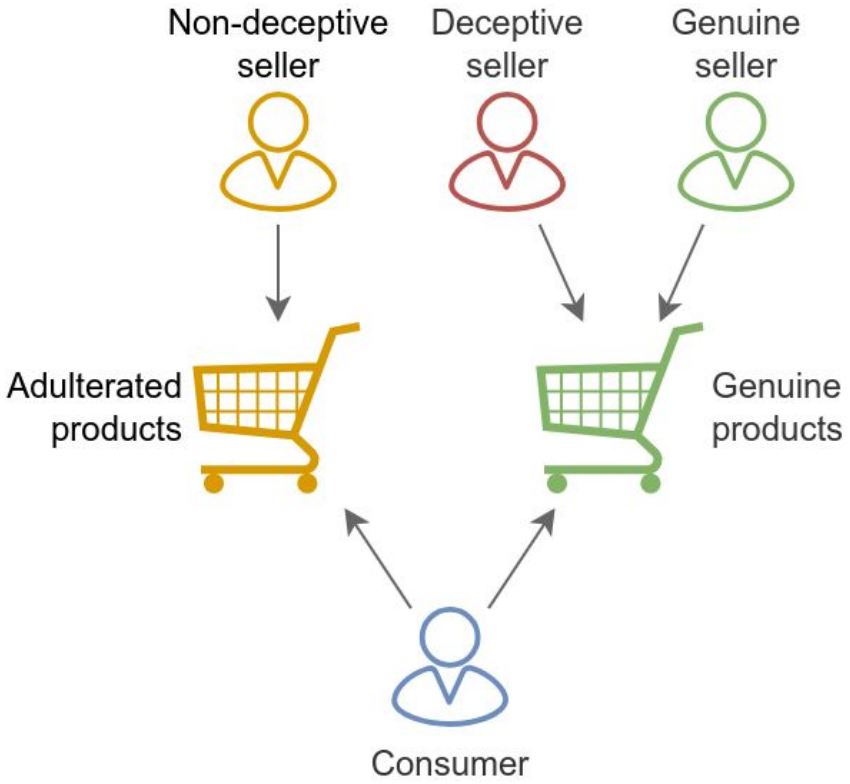
Market price model

- Genuine market price
  - amount of products on market
  - adulterated and genuine
- Adulterated market price
  - amount of products on market
  - genuine market price
    - price-following strategy
- Market share
  - proportion of consumers choosing each market



Seller models

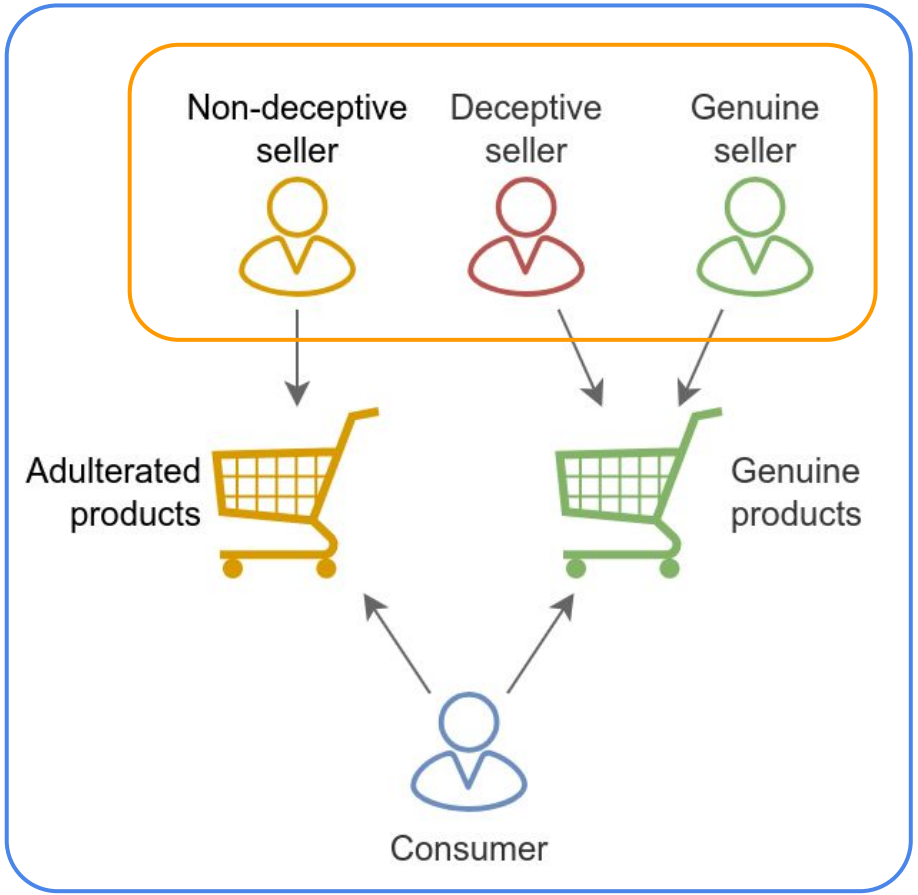
- Non-deceptive seller
  - market share and price
  - low production costs
- Genuine seller
  - market share and price
  - high production costs
  - amount of adulterated products
- Deceptive seller
  - market share and price
  - medium production costs
  - amount of genuine products
  - probability and amount of penalty
- Strategy
  - select amount of products to produce
    - impacts product price
  - maximize profit



The games

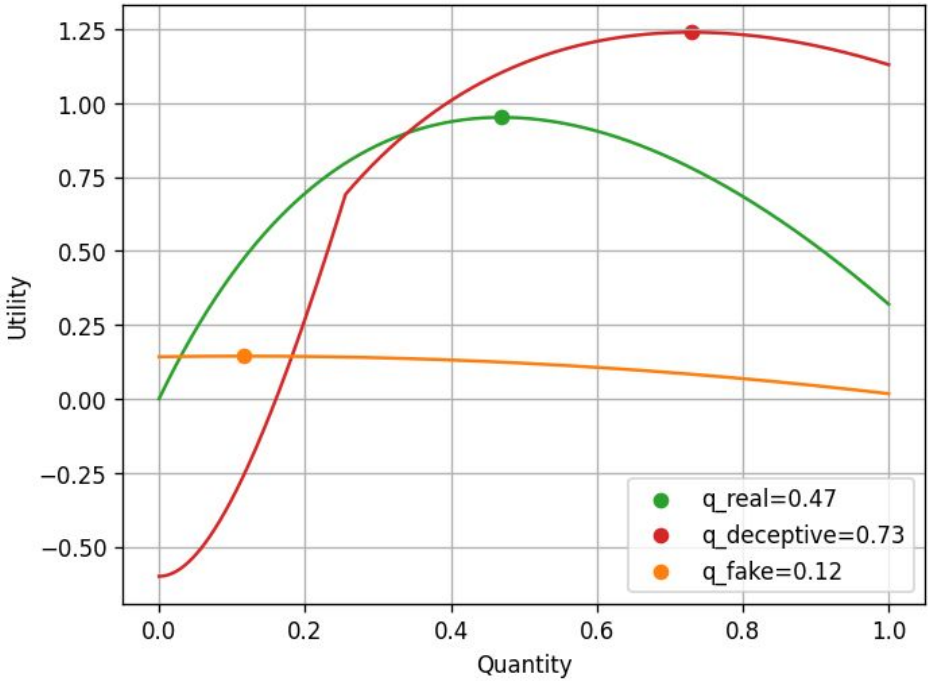
- Stackelberg Game
  - “leader-follower game”
  - sellers influence prices by choosing their production volumes
  - consumer observes offered prices and selects an action with highest utility
- Nash Game
  - competition among sellers
  - equilibrium: no player can gain by changing own strategy

- Iterative simulation
  - initial values and parameters
  - converges to stable equilibrium



Simulation results

- Adulterated market is not a problem
  - consumers can be attracted to genuine market by lowering prices
  - increasing amount of genuine products
- Deceptive products on genuine market are severe threat
  - affect market share
  - less differences between markets
- Non-deceptive seller's best strategy
  - lower prices to attract some consumers
- Deceptive seller's best strategy
  - saturate market with deceptive products
  - benefit from lower production costs
- Genuine seller's best strategy
  - lower price to attract consumers
  - lower production to balance higher production costs (market saturation)



Conclusions

- “Educate” consumers
  - reduce tolerance for adulterated products
  - increase vigilance
- Force high prices on adulterated products
  - attract more genuine sellers
  - weaken fraudulent sellers’ impact on price making
- Improve penalizing mechanisms
  - suppress deceptive products
  - quality standards
  - product lifetime traceability

$$u_g = \frac{q_g}{q_g+q_d}p - q_g c_g$$

$$u_d = (1-\gamma)\frac{q_d}{q_g+q_d}p - q_d c_d - \gamma s$$

- Sales
- Production costs
- Penalty

Thanks for your attention!

Questions?