IS4228
Information technology and financial services

Lecture 7
6 Oct, 2021

NUS
National University of Singapore

Group project

- **Groups of 5 or 6**
  - 28 teams, team 7,14,21,28 have 5 members, the others have 6.
- **Randomly assigned, the assignment will be available uploaded to LumiNUS tonight. Please connect with your team members soon.**
- **8-10 min presentation**
- **Presentation on Week 12-13**
  - Section 1 (team 1-14) on Week 12
  - Section 2 (team 15-28) on Week 13

Group project

- **35% of the grade**
- **25% comes from me**
  - Each team needs to submit their slides and make a presentation.
- **5% comes from peer group members**
  - Measures contribution
  - A survey will be sent through Teammates platform, and each individual is required to respond.
  - Negative points could be given for special cases
- **5% comes from other classmates**
  - Each individual is required to submit a grade for all other groups. (Excel template will be provided)

Group project

- **Required**
  - Each group: slides and presentation
  - Each individual: peer evaluation for group members through Teammates
  - Each individual: evaluation for other groups submitted through LumiNUS.
- **Optional (but highly recommended)**
  - Consultation with me on 21, 22 Oct.
  - I will share a google sheet for you to register
  - Email me if you want to schedule consultations at other times.

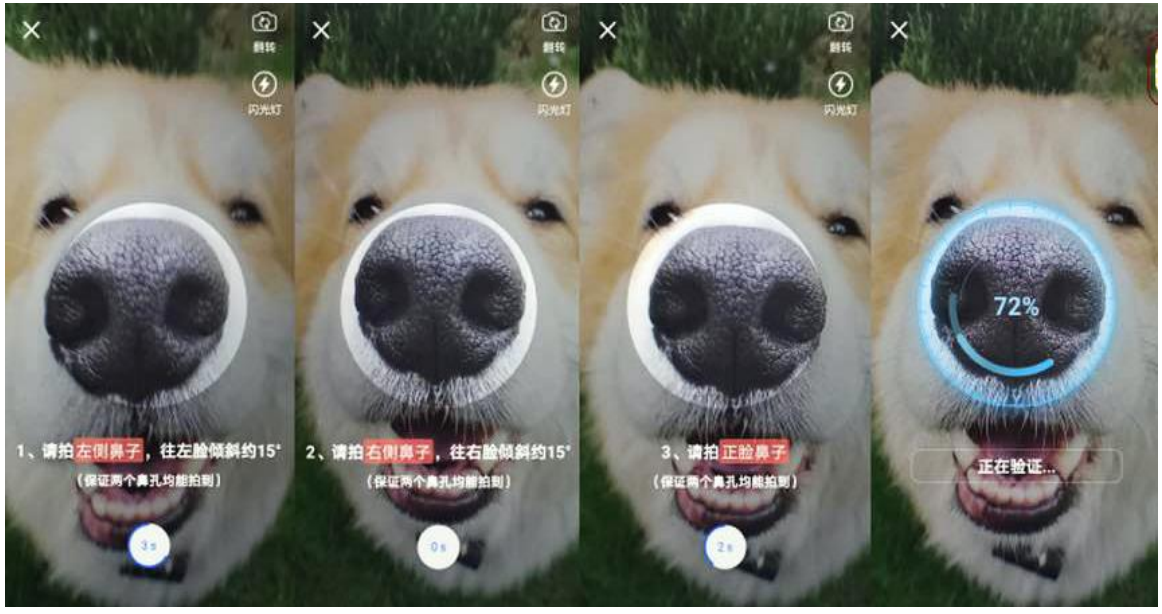
Group project

- **Topic: Imagine a future application of information technologies in finance.**
  - Research on an aspect of a current financial market (stock market, cryptocurrency market, insurance market, P2P lending market, …)
  - Think about how development of technologies may change the dynamics of the industry
  - Talk about one specific (imaginary) technology, and its application in the industry.
  - Could be refinement of the current system or exploitation of current glitches.
  - Pay attention to information.

Group project

- **Evaluation criteria**
- **Innovative**
  - What new things can a technology provide to a financial market
- **Deep**
  - What was the information structure before the application of the technology?
  - What will the information structure be after introducing the technology?
  - Who benefits? Who suffers? What are potential new concerns?...

Group project: example



- **Pet insurance market**
- **Not established because pets are hard to identify**
- **Pet nose print identifier**
- **Provides identification information of pets**
- **Pet insurance becomes possible with this information technology**
- **Provides efficiency to pet insurance market, which benefits both the pet owners and insurance companies.**

Group project: example

- **Resale markets of concert tickets**
- **Concert tickets can be tokenized**
- **Blockchain technologies can be used to share information on the ownership and demand of the tickets**
- **The resale markets can be much more efficient**
- **The consumers will benefit from it**
- **The concert organizer may or may not benefit from it**
  - Some consumers may have more willingness to buy due to the existence of a liquid resale market
  - Some consumers may just buy from the resale market

Overview

- **What is information?**
- **Information structure**

What is information?

- **Information is defined from different aspects in different disciplines.**
  - Telecommunication
  - Quantum physics
  - …
  - Information systems
  - Finance

What is information?

- **The randomness of happening of an event and the probability of its prediction as a news is known as information.**
- **Individual (algorithm, …) has uncertainties about the happening of an event due to his or her lack of information.**
- **He or she holds beliefs towards the uncertainties.**
- **The beliefs can be updated upon receiving of information.**
  - Bayesian update
- **The beliefs can be different across individuals due to their different information.**

Discounted cash flow analysis

- **Determine the asset's expected cash flow**
- **Choose discount rate that reflects asset's risk**
  - Risk-free interest rate
  - Risk premium
  - Equity cost of capital
  - …
- **Calculate present value**

Information and risk

- **Risk comes from lack of information.**
- **Risks in financial market**
  - Systematic risk of market, firm-specific risk,…
- **Investors do not have perfect information about how the economy and each specific firm runs.**
- **CAPM assumption: Investors have homogeneous expectations regarding the volatilities, correlations, and expected returns of securities.**
  - Investors have the same information

Information and risk

- **In an efficient market, there is no information asymmetry: everyone have the same information and thus the same understanding of the market.**
- **Practically, there is information asymmetry in the market.**
  - Risk is different for different investors.
  - Some benefits from it, some suffers from it.
  - Generally, information asymmetry reduces the efficiency of the market.
- **On the other hand, a function of the market is actually aggregating information.**

Overview

- **What is information?**
- **Information structure**

Information structure

- **The information that each individual has, including**
  - the information on the happening of an event
  - the information on others' information on the happening of the event
  - the information on others' information on other's information on the happening of the event
  - ….
- **Higher order beliefs**

Common knowledge

- **Something is common knowledge if**
  - everyone know it
  - everyone know that everyone know it
  - everyone know that everyone know that everyone know it
  - …

- **“Almost common knowledge” can be very different from common knowledge**

The blue-eyed islanders puzzle

There is an island upon which a tribe resides. The tribe consists of 1000 people, with various eye colors. Yet, their religion forbids them to know their own eye color, or even to discuss the topic; thus, each resident can (and does) see the eye colors of all other residents, but has no way of discovering his or her own (there are no reflective surfaces). If a tribesperson does discover his or her own eye color, then their religion compels them to commit ritual suicide at noon the following day in the village square for all to witness. All the tribespeople are highly logical and devout, and they all know that each other is also highly logical and devout (and they all know that they all know that each other is highly logical and devout, and so forth).

The blue-eyed islanders puzzle

Of the 1000 islanders, it turns out that 100 of them have blue eyes and 900 of them have brown eyes, although the islanders are not initially aware of these statistics (each of them can of course only see 999 of the 1000 tribespeople).

One day, a blue-eyed foreigner visits to the island and wins the complete trust of the tribe.

One evening, he addresses the entire tribe to thank them for their hospitality.

However, not knowing the customs, the foreigner makes the mistake of mentioning eye color in his address, remarking “it is interesting to see blue-eyed person like myself in this region of the world”.

The blue-eyed islanders puzzle

- What effect, if anything, does this statement have on the tribe?
- No? Because his comments do not tell the tribe anything that they do not already know (everyone in the tribe can already see that there are several blue-eyed people in their tribe).
- Yes?

The blue-eyed islanders puzzle

- **What if there is only one person in the tribe that has blue eyes?**
  - He or she will realize that the traveler is referring to him or her, and thus commits suicide on the next day, because no one else in the tribe has blue eyes.
- **What if there are two in the tribe that have blue eyes?**
  - Each of them will think, if I am not blue-eyed, then the other guy with blue eyes will know that the traveler is referring to him or her and thus commit suicide on the next day.
  - If no one commit suicide on the next day, then I have blue eyes, so I should commit suicide 2 days later.

The blue-eyed islanders puzzle

- **What if there are n individuals in the tribe that have blue eyes?**
  - After n-1 days and no one suicide, everyone know that there are more than n-1 individuals in the tribe that have blue eyes, but the ones with blue eyes can only see n-1 among others who have blue eyes, so they themselves must have blue eyes. Therefore, all the blue-eyed individuals will commit suicide after n days.
- **So, in the original question, the effect is, everyone in the tribe with blue eyes will commit suicide after 100 days.**

The blue-eyed islanders puzzle

- **The traveler's statement does not communicate any information about the event itself (there is blue-eyed in the tribe).**
- **But, the statement makes this (there is blue-eyed in the tribe) a common knowledge.**
- **Without this statement**
  - If there are two people with blue eyes (denoted A and B), A didn't know that B know that there is blue-eyed in the tribe, B also didn't know that A know that.
  - If there are three people with blue eyes (A, B and C), A didn't know that B know that C know that there is blue eyed in the tribe,…
  - …

The Electronic Mail Game

Two players, 1 and 2, are involved in a coordination problem. Each has to choose between two actions A and B. There are two possible states of nature, a and b. In the state of nature a(b), the players get a positive payoff, M, if both choose the action A(B). If they choose the same action but it is the "wrong" one they get 0. If they fail to coordinate, then the player who played B gets -L, where L > M, and the player who played A gets zero. Assume that the state a is the more likely event. The information about the state of nature is known initially only to player 1.

- **It is dangerous for a player to play B unless he is confident enough that his partner is going to play B as well.**

The Electronic Mail Game

- **Without communication: player 2 will play A, so player 1 will also play A to coordinate, no matter what is the state of nature.**
- **What about there is a electronic mail communication system as following?**
  - There is an electronic device at each player's location and signals can be communicated between them.
  - There is a "small" probability $\epsilon > 0$, that the message does not arrive at its destination
  - At the risk of creating discord, the electronic mail network is set up to send a confirmation automatically if any message is received, including not only the confirmation of the initial message but a confirmation of the confirmation; and so on.

The Electronic Mail Game

- **When player 1 gets the information that the state of nature is b, his computer automatically sends a message (a blip) to player 2 and then player 2's computer confirms the message and then player 1's computer confirms the confirmation and so on.**
- **If a message does not arrive, then the communication stops.**
- **No message is sent if the state of nature is a.**
- **At the end of the communication phase the screen displays to the player the number of messages his machine has sent. Let T_i, be a variable for the number of messages i's computer sent (the number on i 's screen).**

The Electronic Mail Game

- **If the two machines exchange an infinite number of messages, then we may say that the two players have common knowledge on what is the state of nature.**
  - They can coordinate on the right action
- **However, due to the small probability ϵ of losing message, the communication will stop at a finite number.**
  - "Almost common knowledge"
- **Player 1 (and similarly player 2) faces uncertainty: given that he sent T_1 messages, he does not know whether player 2 did not get the T_1^{th} message, or whether player 2 got the T_1^{th} message, but the T_1^{th} confirmation has been lost.**
- **What will be the players' strategies in this case?**

The Electronic Mail Game

- **When $T_2 = 0$ (player 2 did not get the signal from player 1), player 2 does not whether player 1 did not send the signal or the signal is lost.**
  - Player 2 will play A to be safe
- **When $T_1 = 1$ (player 1 sent a signal but did not get confirmation from player 2), player 1 does not know whether $T_2 = 0$ (the signal is lost on the way to player 2) or $T_2 = 1$ (the signal is lost on the way back to player 1).**
  - Player 1 will play A to be safe
- **When $T_2 = 1$, player 2 does not know whether $T_1 = 1$ or $T_1 = 2$, and therefore will play A to be safe.**
- **…**

The Electronic Mail Game

- **For any finite number T_1 and T_2, the players will play A**
  - Player 1 know player 2 know player 1 know…(for a finite number of layers) that the state of nature is b
  - Player 2 know player 1 know player 1 know…(for a finite number of layers) that the state of nature is b
- **Same as no communication at all**
- **In this constructed extreme case, "almost common knowledge" leads to the same result as no information, which is very far from the result of common knowledge.**

Information structure and financial markets

- **Information structure matters!**
- **Information structure matters for financial markets.**
- **If you have insider information about a company and therefore have some unusual orders for its stock.**
  - What if the others know that you have insider information?
  - What if the others just think you are a student who knows a bit of finance?

Information structure and financial markets

- **If you use machine learning to trade**
  - What if others know that you are using ML?
  - What if they even know what algorithm you are using?
  - What if you do not know that they know the algorithm you are using?
  - What if you know that they know the algorithm you are using?

- **Information technology can change information structure.**
  - Social network, blockchain,…

Key takeaways

- **Risk is dependent on information**
- **Different individuals can have different beliefs on the risk of an event (security,…) because they have different information.**
- **Information structure matters**
- **Information technology can communicate (discover) information and change information structure.**

Thank you!