



**Technology and Economic Development: Markets and Networks**  
**Campus Center (C2-E049) Loc: Abu Dhabi**  
**Jan 23, 2018-May 11, 2018**

**Instructors:**

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**Course Number ECON-UH 2411** (Spring 2018)

*Lecture Times:* Tu/Th 4:05 pm to 5:20pm

*Office Hours:* Wednesdays 3 - 5pm, Bldg A5 Room 1121 **and** immediately after each class

*Location:* C2-E049 Abu Dhabi

*Staffing:* In addition to the faculty members teaching the class, there will be dedicated Center for Technology and Economic Development (CTED) staff coordinating the research and any possible research field visits.

**Course Information:**

*Pre-requisites:* Introduction to Computer Science OR Introduction to Microeconomics OR Computer Programming for Engineers OR permission of instructor.

*Course Description:* This course will cover topics on the interface between economics and computer science, with special emphasis on issues of importance to economically developing regions. Students will work in teams to tackle real-world and interdisciplinary problems. Students will address questions of markets and economic development using Information and Communications Technologies for Development (ICTD) techniques in the context of development through visits to NYU field sites in the UAE, Ghana and Ethiopia. The course will use Network and Graph Theory as well as modern game theory as the underlying tool of analysis. There will also be exposure to practical elements of developing ICTD interventions

and projects, with emphasis on mobile phone apps and others which can be delivered in developing country contexts.

*Research:* At the end of the class, through a competitive process, some students will be invited to conduct research on CTED projects related to the class in the UAE, Ghana, Ethiopia or New York.

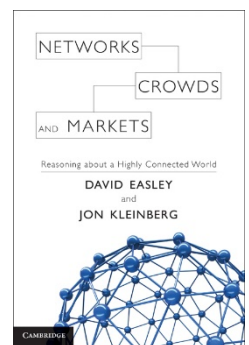
*Learning Outcomes:*

Students will be able to:

1. Explain the fundamental economic models as they relate to development economics.
2. Explain the fundamental information and communication technologies as they relate to development.
3. Have a strong grasp of Network theory as the tool for (1) and (2) above.
4. Analyze and evaluate tradeoffs inherent in intervention and policy design.
5. Evaluate proposed ICTD interventions and designs in terms of incentives, sustainability, and technical feasibility.
6. Design ICTD interventions that are sustainable and appropriate to development contexts.
7. Work in interdisciplinary teams to work on real-world problems to meet local, national, and international economic development goals.
8. Work in teams across time-zones and continents to complete a class project.

*Required Text:* The following text is required and has been ordered for student purchase at the bookstore.

Networks, Crowds, and Markets: Reasoning About a Highly Connected World (NCM)  
(See <http://www.cs.cornell.edu/home/kleinber/networks-book/>)



*Further Readings:* These will be given in class in pdf format and placed on the class webpage (to be announced later).

*Teaching and Learning Methodologies:* This is a lecture based course that will rely primarily on prepared lectures and in class and out of class exercises. Group interactions will be strongly

encouraged, as students would be required to complete necessarily assigned readings of chapters before coming to class.

*Maximum Enrollment:* 22 students

## Course Policies

### Grading System

Due Date (each day late loses X% of grade)	Activity	% of Grade
	Class Participation	10%
	Problem Sets	10%
Thursday Feb 22, 2018	Midterm #1	20%
Thursday April 19, 2018	Midterm #2	20%
Monday April 23rd, 2018	Blog Article	5%
Monday April 30 <sup>th</sup> , 2018	End of Semester Paper/Project Due	30%
May 1 and 3, 2018	Submission & Presentation of PowerPoint	5%
		100%

The class paper will be based on a project, with different phases required at set dates during the course: the problem identification with statement of existing attempts at solving the problem in the literature; a summary of the app or process for solving the problem; a project proposal with budget numbers and plan of actions; and then the full completed project with a statement of funding and ex post evaluation of the project.

## SYLLABUS

### (1) Introduction: Markets and Information

We begin with an overview of the class. Some of the research projects at the Center for Technology and Economic Development (CTED) will be described, and students will be introduced to our field research centers in Abu Dhabi and Africa. We then review basic concepts of markets and information – decision making when there is randomness, Bayes rule, and the application to an analysis of mobile phone apps, weather and index insurance, and price alerts for poor farmers. An introduction to building apps will be provided. Field examples of randomized control trials for assessing apps will be discussed.

*Readings: NCM Chapter 22 (sections 1-5 only).*

### (2) Graph Theory and Social Networks

This section will begin with an introduction to some of our research projects in the field which have important geographic/spatial network attributes. These will include agricultural systems and transport networks in developing regions as well as commodity exchanges. These will involve Global Information System (GIS) and global position systems (GPS) analyses.

This section will then provide the basic language and tools used in describing and analyzing networks – graph theory. Examples will be provided to illustrate the basic power of network theory ideas. As an illustration, the small worlds ideas (“Six Degrees of Separation”) will be presented. Other initial examples from today’s social media online networks and the internet will be provided. The Twitter network will be used as an illustration. Simple computer based methods of analysis will also be provided.

- An introduction to Social graphs: Internet, Web, Social Networks, Facebook and Search
- Graph structure and formation
- How to analyze basic properties of graphs: degree sequence, connectedness, directed vs undirected graphs, cycles, trees, connected components, cut, strongly and weakly connected components
- Strong ties and Weak ties
- Facebook network and Facebook API
- The Twitter Network - The Twitter API – getting data from Twitter; Information flow in Twitter (Retweet networks); Rumor spreading on Twitter

*Readings: Chapters 1- 5.*

### **(3) Game Theory**

Most social networks have people acting strategically and taking actions as a function of what they perceive others to be doing and so as to get the best out of the network. This is the realm of Game Theory. This section will go through basic game theory – the terminology and key concepts. Auctions and the theory behind them will be studied in this context. Rational behavior in networks often results in very unintuitive outcomes, as will be illustrated in the context of traffic networks. The students will be introduced to real life problems in developing countries and potential mobile phone app solutions to them – particularly problems of trading in markets.

- Basics of Game Theory
- Traffic
- Auctions – first price, second price, Nash equilibria; Common Values and the Winner's Curse.
- Mobile Apps and computer networks for trading;

*Readings:* Chapters 6, 8, and 9.

### **(4) Markets and Strategic Interaction on Networks**

Many networks often involve the matching of different types of players into pairs – buyers and sellers in a market for example. This section will describe the network theory in analyzing such networks, particularly real life trading networks. The concepts of bargaining and power in such networks will be presented. Examples in real life trading networks will be presented. The role of intermediaries will also be presented within the context of the network theory.

Illustrations of these models will be taken from on-going field research by the Center for Technology and Economic Development researchers, primarily in the area of food and agricultural networks and commodities exchanges.

- Farmer-Trader Networks
- Commodities Exchanges
- Food Transport Networks

*Readings:* Chapters 10-12.

### **(5) Mobile Banking Technologies and Digital Money; Information Networks, the World-Wide Web and Sponsored Search Markets.**

This section begins with a discussion of mobile money and Grameen style group lending networks. We then discuss digital assets and money (bitcoin type technologies) and the associated security and encryption issues.

This section will then apply material from early sections in a discussion on the web and other social networks. We will explain why these are best studied within the context of networks. We

will indicate how modern internet search engines use algorithms involving classic models of network analysis, bringing in earlier studied concepts of power, centrality, etc, in web page ranking methods. We will study how search engine and other internet based sites derive revenues from advertising sales which in turn require the analysis of matching markets within a network discussed in earlier sections.

*Readings: Chapters 13-15.*

## **(6) Network Dynamics: Population Models**

In this section, we use the tools of network theory to study network dynamics – how things like ideas, rumors and disease propagate within a network. We will also discuss some classic models of the evolution of the ethnic composition of a housing neighborhood. We will also introduce the concepts of information cascading and also celebrated ideas on tipping points in a network, and what makes for successful commercial products or ideas.

Applications to mobile phone based weather insurance and other trading markets will be used as illustrations.

*Readings: Chapter 7, Chapters 16-18, and Chapter 22.*

### Inference from Web Data and Twitter

- Google Flu Trends
- Extracting and Analyzing News Data: Detailed description
- News analysis for Drought and Food Security Problems
- News analysis for Disease Surveillance
- Twitter based Opinion mining
- Twitter based Disease Surveillance
- Social Interaction Patterns and Spread Models

### Markets

- Aggregate Beliefs and the "Wisdom of Crowds"
- Prediction Markets and Stock Markets
- The Market for Lemons
- Signaling Quality
- Quality Uncertainty On-Line: Reputation Systems and Other Mechanisms

## **(7) Institutions and Aggregate Behavior**

This section begins with a discussion of some of the CTED research in the area of governance and crowdsourcing of information, illustrated by real life governance issues and problems faced by people in developing countries, particularly in rural regions. There will be a

discussion of some tools used in this area – crowdsourcing apps, apps for collection of farm data, big data – text analytics and general and Satellite image processing and machine learning.

This section will continue the discussion of social institutions. We will look at voting procedures– and its many interesting paradoxes, as well as issues around property rights especially in the context of negative externalities. In this context recent developments in crowdsourcing, especially on the mobile phone in developing nations will be discussed.

Illustrations will be taken from the following Mobile Apps for Crowdsourcing and Voting

- Mechanical Turk, Crowdfunder, etc.
- mobile crowdsourcing enabled new markets and services in different settings, including market information systems, cascades, network effects.
- Mobile crowdsourcing and Politics – Elections; Ushahidi.

*Readings: Chapters 23-24.*

# STUDENT PROJECT AREAS

Depending upon student interest, special lectures will be given to encourage student papers in the areas listed below.

## Project Area #1: Build your own Mobile App

### Mobile Devices and Proliferation

- Evolution of Network connectivity: Rural vs Urban connectivity
- Mobile Connectivity Market: Voice, SMS, 2G, 3G, 4G/LTE
- Dumbphones vs smartphones - capabilities and constraints
- Voice, SMS, Data – The medium and the message
- Mobile App proliferation in Smartphones – Android Market, iPhone AppStore
- Proliferation of Mobile Applications in different developmental application domains
- Pure Server based Apps: How MPesa works?
- SMS-based Mobile App platforms: FrontlineSMS, RapidSMS, UjU
- Smartphone based Mobile App Platforms: Open Data Kit
- Android Programming API, Programming a simple App on Android
- Real world examples: mhealth, mobile banking, Esoko

### Mobile Human Computer Interaction

- Challenges deploying Mobile Apps on the field.
- An introduction to HCI: Understanding users and their context (methods)
- Tools and methods for collecting data: observations, surveys, interviews, recording, logging
- Some theory: cognitive science, situational action models, activity theory
- Design methodologies
- Evaluations: usability study, user studies
- Voice vs Text based Apps: The ongoing discussion
- Case studies



## Project Area #2: Mobile Health

- Mobile health data collection tools
- Mobile diagnostic tools
- Teleconsultation and Telemedicine initiatives
- Health Economics: Cost, Quality, Access
- Mobile Health networks

## Project Area #3: Mobile Money and Remittances

- Conventional money transfer models
- Western Union and its networks
- Mobile Money and Remittances. Safaricom.
- How to design your own money payments system.
- UAExchange.
- Branchless Banking
- MPesa model
- Eko, Gcash service models
- New opportunities for mobile payment solutions
- Need for better security! – Google Payout, Square

## Project Area #4: Big Data, Markets and Inference

### Simple Text Analytics Tools

- Simple Text Parsing techniques
- Extracting simple metrics: Word Frequency, Inverse Document Frequency, TF-IDF
- Basics of Simple Classification of Data
- Simple techniques for extracting features
- Web APIs: Extracting, Cleaning and Parsing Web Data
- A tutorial of Python Libraries to parse data

### Simple Inference tools

- Basics of Classification, Feature Extraction and Inference
- How to use a simple machine learning algorithm: Training and Testing
- A simple example of Inference using a machine learning algorithm

- Show a detailed example of how to apply an inference algorithm for Web Data

#### Inference from Web Data and Twitter

- Google Flu Trends
- Extracting and Analyzing News Data: Detailed description
- News analysis for Drought and Food Security Problems
- News analysis for Disease Surveillance
- Twitter based Opinion mining
- Twitter based Disease Surveillance
- Social Interaction Patterns and Spread Models

#### Markets, Big Data and Inference

- How big data can be used to infer interesting information about various markets?
- Market Forecasting
- Behavior forecasting
- Inference of critical indices