AI (and GIS) in Digital Economy: What Looks Good and What’s Real

Calton Pu
Professor and J. P. Imlay Chair in Software
College of Computing, Georgia Tech

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Digital Economy

- Looking Good and It’s Real
- Top ten companies by net worth:
  - Tech companies: Apple (USD$1T), Microsoft, Google
  - Electronic commerce: Amazon, Alibaba
  - Communications and social media: Tencent, Facebook
  - Finance (early adopters of mainframes): Berkshire Hathaway, JPMorgan Chase, Bank of America
- Big and small companies run on IT
Cloud & Big Data (commercial)

- Looking Good and It’s Real
- Google market cap $741B
  - Probably more data than anyone else

- 13 declared data centers around the world; drawing 260MW in 2011 (2,259,998 MWh total).
Cloud & Big Data (government)

- Looking Good and It’s Real
- NSA (maybe more than Google)

- Utah Data Center (circa 2016), drawing 65MW (about half of Salt Lake City)
Cloud & Big Data (Forecast)

- Looking Good and It’s Real
- New data center construction keeps growing
  - 2017 (whole year): $74B
  - 2018Q1: $27B
- Growth of big data
AI Milestone: 1997 [Chess]

- IBM Deep Blue defeats Kasparov (world champion)
AI Milestone: 2011 [Q&A]

- IBM Watson wins *Jeopardy!* (against champions)
AI Milestone: 2016 [Go]

- AlphaGo defeats Lee Sedol (No. 1 ranking player)
AI in Restricted Domains

- Looking Good and It’s Real
- Domain 1: Unstoppable in well-defined games
  - 1997 [Chess]: Deep Blue defeats Kasparov
  - 2011 [Q&A]: IBM Watson wins Jeopardy! game
  - 2016 [Go]: AlphaGo defeats Lee Sedol
AI Milestone: 2005 [Autonomous Vehicles]

- [DARPA Grand Challenge]: 131 miles (in desert)
AI Milestone: 2007 [Autonomous Vehicles]

- [DARPA Urban Challenge]: 55 miles (in closed airport)
AI in Restricted Domains

- Looking Good, but the reality gets complicated
- Domain 2: Autonomous vehicles
  - 2005 [DARPA Grand Challenge]: 131 miles of desert trails (won by a Stanford team)
  - 2007 [DARPA Urban Challenge]: 55 miles of urban roads (won by a CMU team)
  - Lots of buzz, tests, pilot projects, investments
Looking Good: Waymo (Google) in Atlanta
Reality: It’s OK; There is a Human in Them.

- Quote from my mother (who lives in Mountain View)
Looking Good: Driverless Shuttles

- Sydney Olympic Park, plus Las Vegas, Grand Rapids, Paris, Atlanta, …, (trying to bridge the “last mile”)
Real Solution for the Last-Mile Problem
Looking Good: Chatbots
Looking Good: Microsoft Xiaoice

- Real success story, but likely less than 100% AI
Deceptive Input: Microsoft Tay

- 2016 Test: shutdown within one day (not back)
Concept Drift in Real World Data

  - Good model goes bad rather quickly

Second divergence in 2012–2013 for U.S.
AI in the Real World

- Deployments of IBM Watson in commercial applications have needed a lot of human assistance
- Autonomous vehicles still need human drivers (when outside of restricted environments)
- Smart City projects have been primarily successful demos and promising stories
- Everything still looking very good
- Reality: serious research challenges (deceptive input, concept drift)
Real Success (with a Pinch of AI)

- Georgia Tech MOOC: 10,000+ enrolled in 2018
Looking Good: an AI Teaching Assistant

- Reality: a successful experiment, and we still use human TAs (no plans to switch to AI)
Real Success: Big GIS Data

● Looking Good and It’s Real
● Illustrative examples on sensor and satellite data on the environment
  ▪ University of Tokyo (Prof. Kitsuregawa): DIAS (Data Integration and Analysis System)
  ▪ Zhejiang University (Prof. Jianwei Yin)
Currently 20+PB and growing exponentially

Many data sources from around the world
App (1): Multi-model Ensemble Prediction

Comparison Results

Past
Future
More Rain
App (2): Fishery Habitat Prediction

Concrete application to habitat of neon flying squid
Growth of Global Natural Disasters

https://standeyo.com/NEWS/10_Earth_Changes/100305.nat.diz.increasing.warning.html
Growing Economic Damages

![Bar chart showing economic damages over different periods from 1984-2013. The x-axis represents the years (84-88, 89-93, 94-98, 99-03, 04-08, 09-13) and the y-axis represents the economic damage in a specific currency (e.g., dollars). The damages increase significantly from the early to the later periods.]
2015 Kinugawa River Large Scale Flooding

- Dike collapse; rebuilding (7 days); drainage (10 days)

Four Dams in Upstream of Kinugawa River

App (3): Real-time Flood Prediction

Notes
- Observation
- Ensemble prediction

2011 Typhoon No.23 @ Aimata Dam

2011 Typhoon No.23 @ Maebashi

2011 Typhoon No.15 @ Murakami

2011 Typhoon No.15 @ Maebashi
Predictive Discharge for Dams

Peak shaving of flood flow

Recovery of reservoir capacity after flood

Optimum outflow = inflow

outflow=0

outflow=inflow

discharge from dam
App (4): Water Pollution Detection (ZJU)

- Aug. 2015, GF-2(3.2m), detected black and odorous water by ratio method (West Lake district, Hangzhou)
Asian Water Cycle Initiative
AWCI: 18 Demonstration Basins

Countries included:
- Uzbekistan
- Nepal
- Bhutan
- Myanmar
- Mongolia
- Thailand
- Laos
- Korea
- Pakistan
- Bangladesh
- India
- Sri Lanka
- Malaysia
- Japan
- Vietnam
- Philippines
- Cambodia
- Indonesia
African Water Cycle Coordination Initiative
AfWCCI: Niger River : Station Map

Legend
- Rain (354)
- Discharge (36)
- Dam (4)
- Groundwater (1289)
What Looks Good and Is Real

● AI and ML have many successes
  ▪ Defeating champions in games (chess, Jeopardy, go)
  ▪ Restricted domains (autonomous vehicles in desert)

● Lots of promise and hope
  ▪ Investments (e.g., IBM Watson, Tesla, Kitty Hawk)
  ▪ Deployments have been less than fully autonomous
There Are Real Challenges

● Real world data introduce serious and open research challenges for ML and AI
  ▪ Concept drift (e.g., Google Flu Trends)
  ▪ Deceptive input (e.g., Microsoft Tay)

● Looking Good can also be Real:
  ▪ Big GIS Data with a pinch of AI, e.g., environmental monitoring and control in water management

● UN: National Institutional Arrangements promote information sharing towards Sustainable Development Goals, particularly in developing countries