



HCI and Design

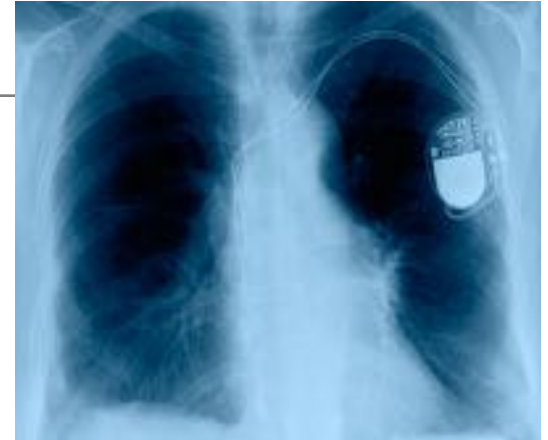
SPRING 2016

Today

Computing and the developing world

- Overview
- Version 1.0
- Version 2.0
- Some of Nicki's projects

New technologies provide new benefits



Most new technologies benefit a small fraction of the global population

80% of world's population lives in developing regions

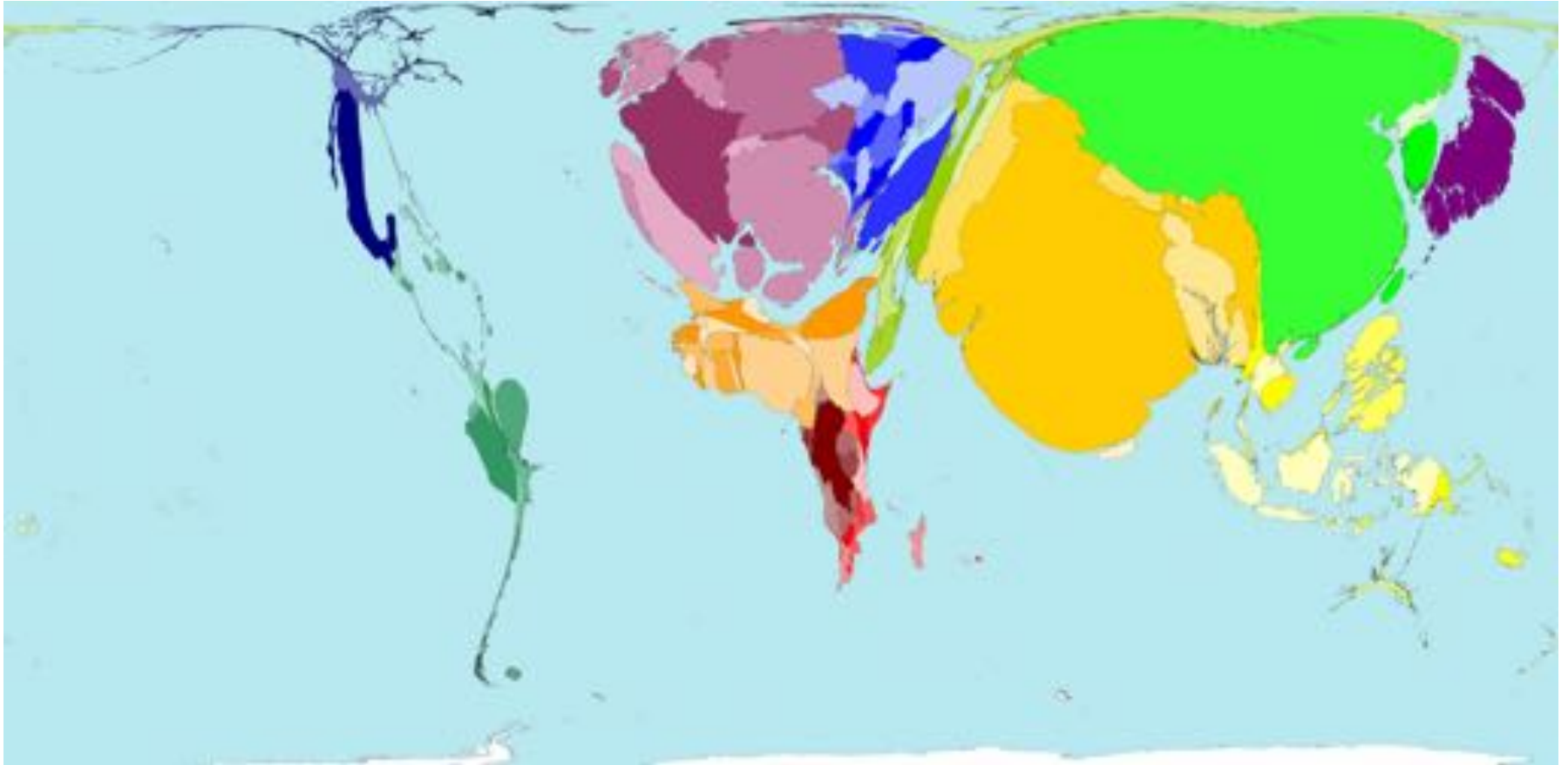


A Map of the World



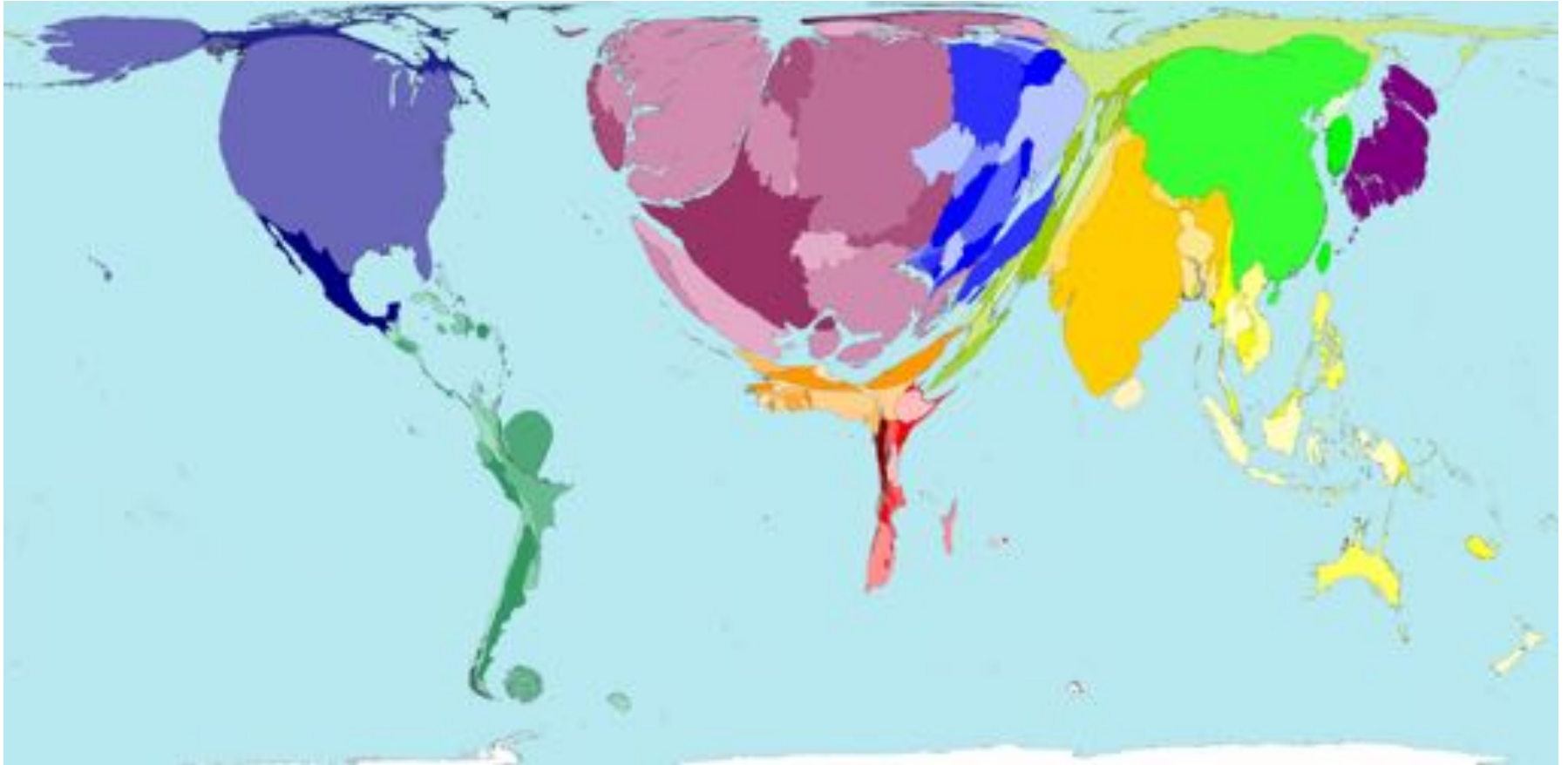
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Global Wealth Distribution: circa 1500



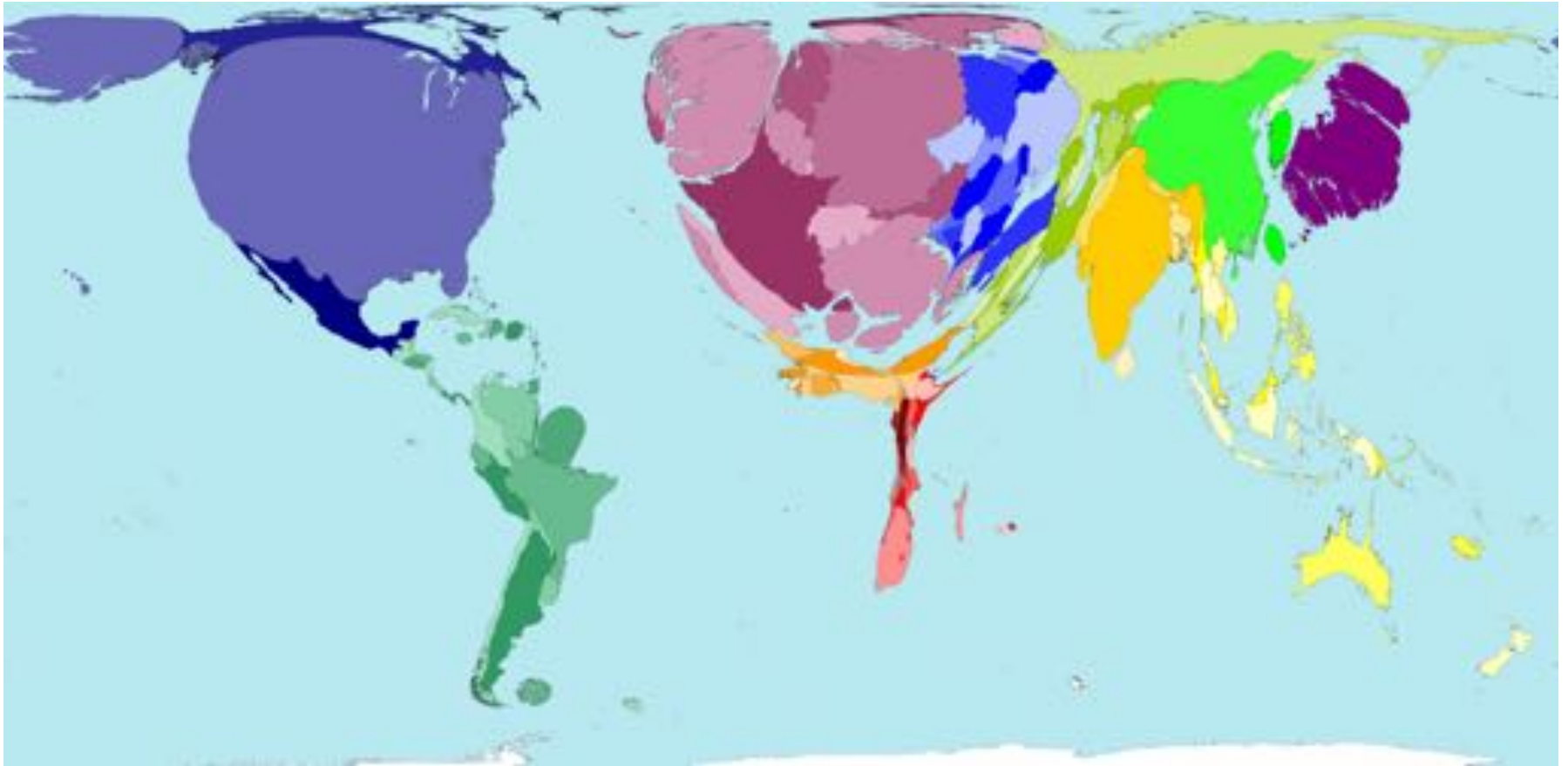
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Global Wealth Distribution: circa 1900



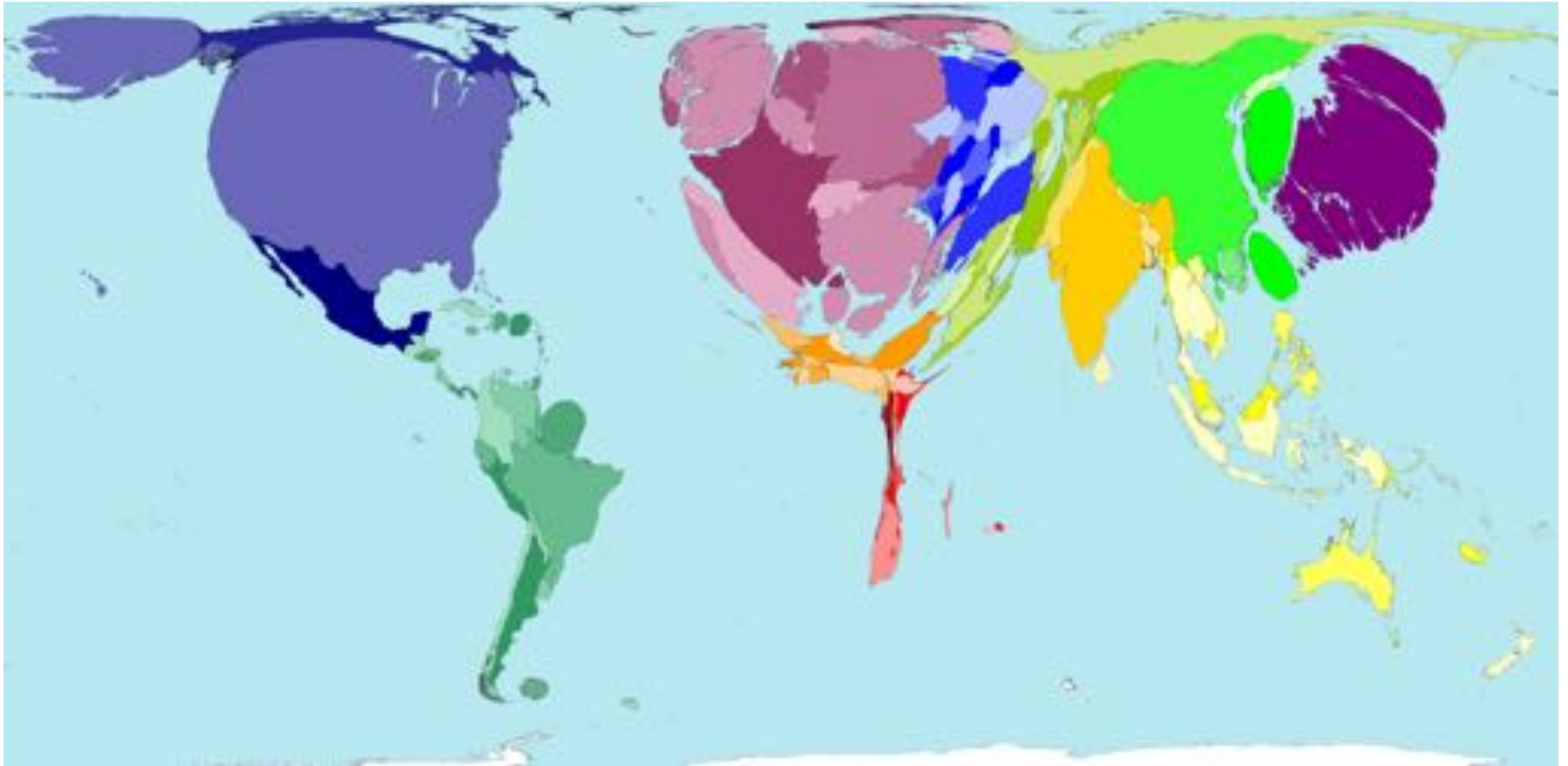
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Global Wealth Distribution: circa 1960



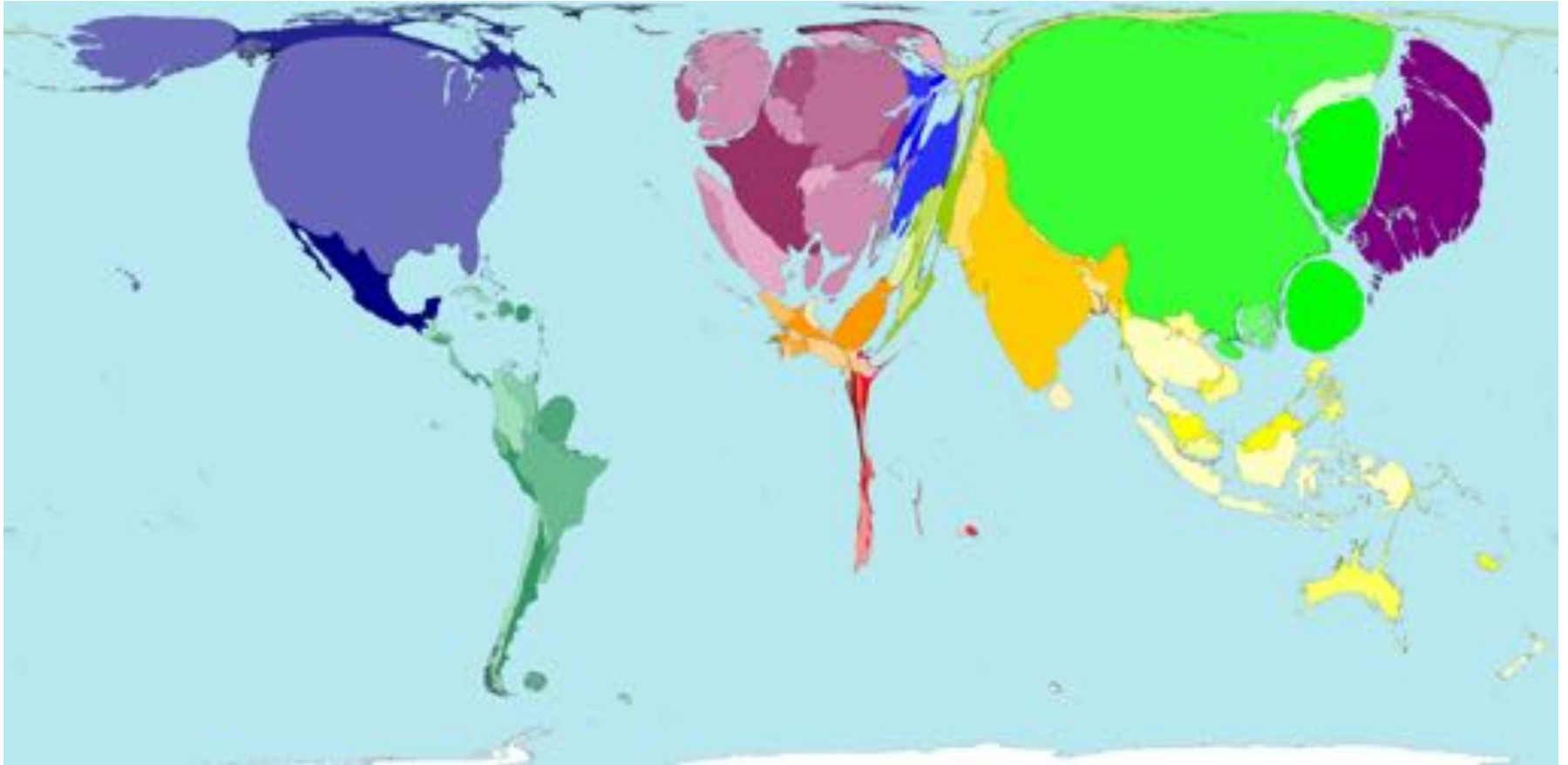
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Global Wealth Distribution: circa 1990



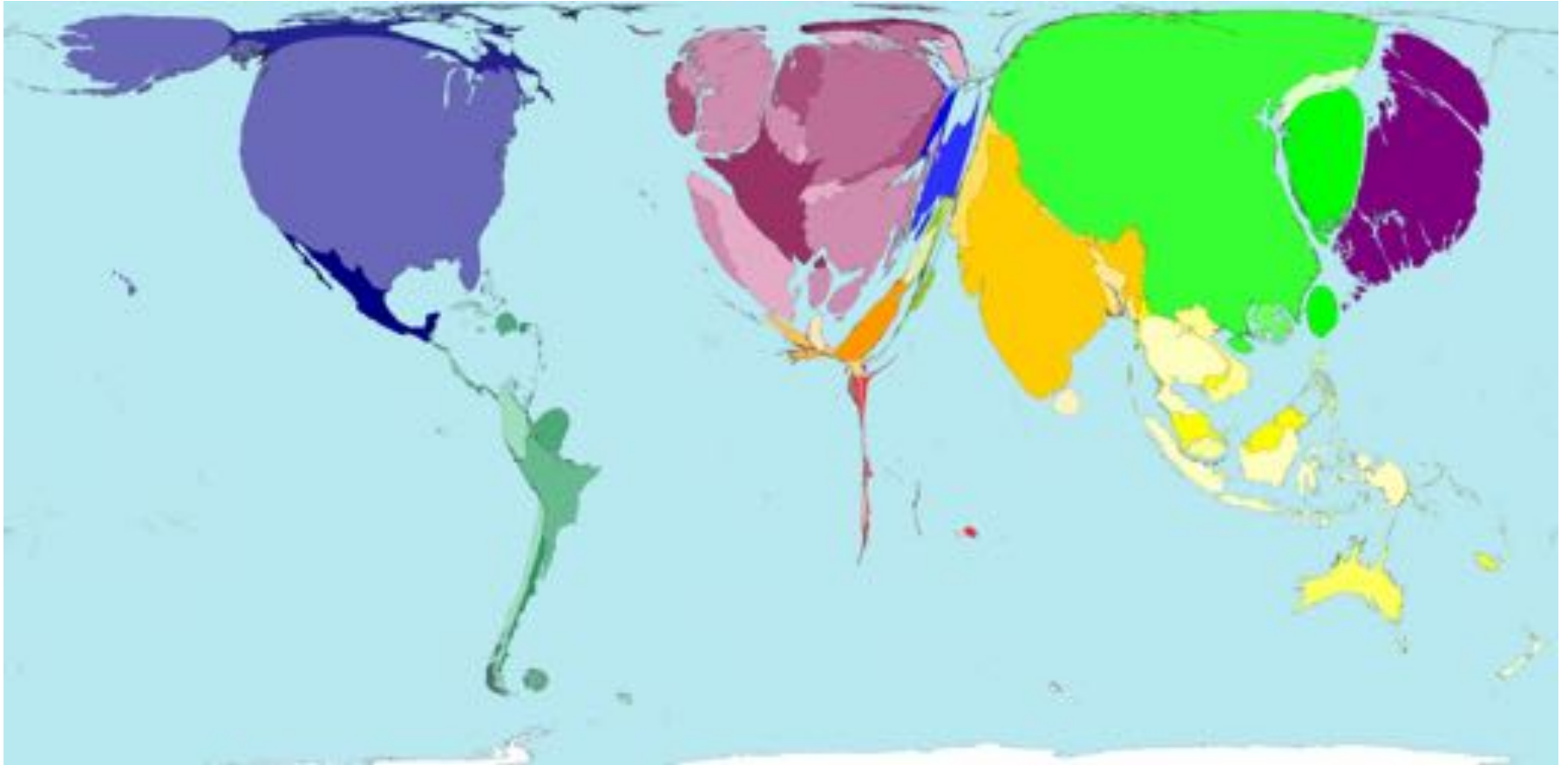
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Global Wealth Distribution: circa 2015



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Global Economic Growth since 1975



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Computing for Developing Regions

Create technologies that empower underserved communities to overcome global challenges



HCI for Development (HCI4D)

Human-Computer Interaction (HCI) + Information and Communication Technologies for Development (ICTD)

Global problems

Poverty
Education
Gender equality
Infant mortality
Maternal health
Human rights
Conservation

Technology constraints

Computers
Cell phones
Mobile devices
Networks
Connectivity
Energy and power
Transport

Diverse challenges

Culture
Gender
Politics
Language
Literacy
Social structures
Communication

Technology alone is not enough!

Research Directions

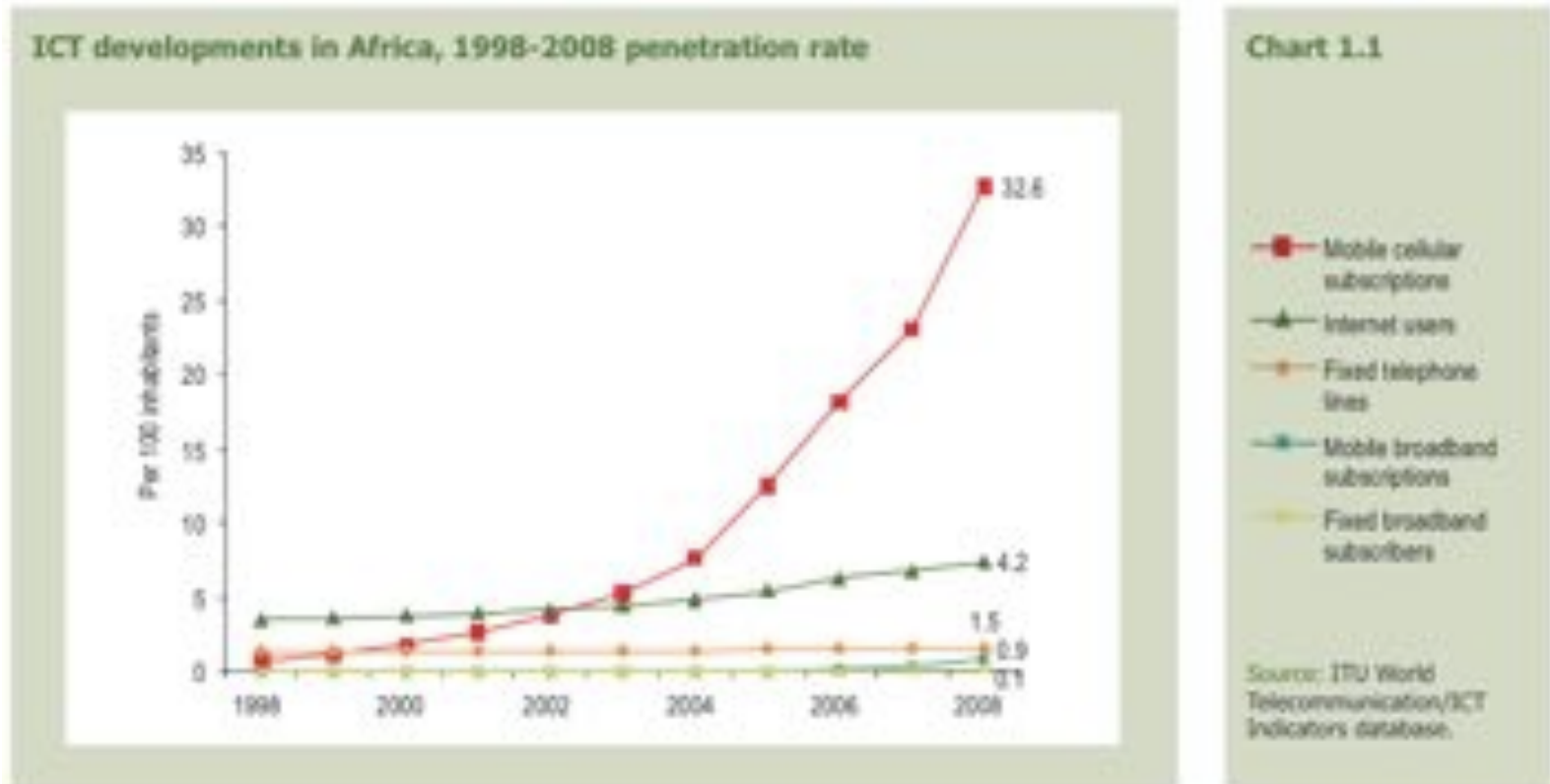
Individuals



Intermediaries



What devices make sense?



A billion mobile subscriptions in Africa by 2015!

Why target mobile devices?

Portable

Battery-powered

Familiar

Intuitive touchscreen

Built-in sensors

Network interfaces

Storage capacity



Built-in sensors provide many opportunities



Can we just use the same apps and systems that we use in the US?



Internet users in 2010 as a percentage of a country's population

Source: Percentage of Individuals using the Internet 2000-2011, International Telecommunications Union.



Many other constraints

No or intermittent electricity

Low levels of education

Low levels of literacy

Unfamiliar with technology

Linguistic challenges

Social and cultural challenges

Poverty

Political challenges

Many more....

Example problem domains

Healthcare

- Low-cost diagnostics
- Telemedicine
- Healthcare informatics

Agriculture

- Supply chain efficiencies
- Crafts
- Crop quality information
- Geophysical sensing

Education

- Low cost computing
- Computer sharing
- Distance education

Governance

- Information organization
- Manpower costs
- Healthcare informatics

Design

- Text-free interfaces
- Assistive technology

Financial services

- Microfinance information

Global Health Challenges

Basic Health Care

- Life Expectancy: Zambia 43 yrs, Germany 79 yrs
- Infant Mortality: Niger 109, Italy 5

Control of Major Diseases

- HIV/Aids: Namibia 20%, Canada 0.3%
- Malaria: 500M infections, 2M deaths per year

Improved Health Practices

- 1.1 B people lack access to safe drinking water

Education

Literacy Rates

- Mali 19%, Pakistan 49%, Laos 69%

School Attendance, Primary Enrolment

- Somalia 17%, Sudan 60%, Congo 88%,
- India 116%, Rwanda 120%, Cambodia 134%

Teacher Absenteeism

Language Study

Vocational Training

Livelihood

“The reason most poor people are poor is because they don’t have enough money”

180 Million Smallholder Farmers in Sub-Saharan Africa earning under 1\$ a day

Costs of being poor

- Many goods more expensive for poor

In Africa the informal sector accounts for 20% of the GDP and employs 60% of the urban workforce

UN Millennium Development Goals

Eradicate extreme poverty and hunger

Achieve universal primary education

Promote gender equality and empower women

Reduce child mortality

Improve maternal health

Combat HIV/AIDS, malaria and other diseases

Ensure environmental sustainability

Develop a global partnership for development

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HCI4D version 1.0

Technology will save the world!

 [Agenda](#) [Events](#) [Reports](#) [Projects](#) [About](#) [Login to TopLink](#) [中文](#) [日本語](#) 

[Global Agenda](#) > [Global Economic Imbalances](#) > [Global Governance](#) > [Inequality](#)

How technology can help us eliminate, not alleviate, poverty

THE BLOG

Technology to End Extreme Poverty

🕒 09/24/2012 10:48 am ET | Updated Nov 24, 2012

Example: One Laptop per Child

Originally the \$ 100 Laptop

Later OLPC, finally XO (\$399 for 2)

Technological Innovation

Learning approach

Constructivism

Take laptops home, play with them

Critiques

“Little or no sustained and scaled effects on teaching, learning, and achievement” (Bain and Weston)



Problems with OLPC

Technology centric approach – no focus on humans

Did not fit people's actual needs

Did not pay attention to local contexts and challenges

Did not provide on the ground support

Did not plan for sustainability

The Failure of OLPC:

<http://hackeducation.com/2012/04/09/the-failure-of-olpc>

HCI4D version 2.0

Amplification theory

- Technology can only amplify human intent (Toyama)

Technology on it's own won't do anything

People have to want to change the situation, solve the problem



Digital Green



Problem: Teach poor farmers better farming practices

Solution: Digital Green

Mediation / Mediator

Highly formatted, targeted video content

Contextual content: local presenter, not “well-dressed” scientist

Supporting organizations on the ground

Outcomes: 55% adoption of new practice over 8% in old system

Why it works

Pays attention to local culture and context

Specifically designed to suit the needs of target population

Gives people the tools to solve their own problems

Provides support through organizations on the ground

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My Research Approach

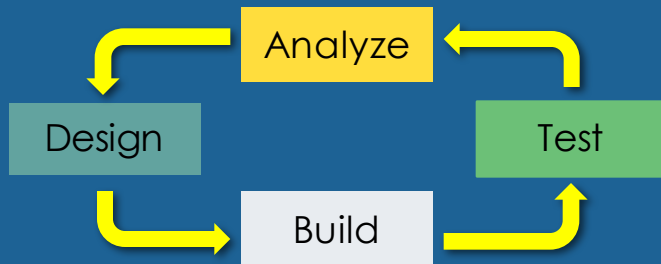
Analyze the entire ecosystem
Many stakeholders, different needs



Technology hand-off
Broad impact



Iteratively design, build, test
Create robust and usable systems



Longitudinal deployments
Partner with organizations



What do we build?



Camera-based systems
computer vision, machine-learning



Text-based systems
social computing, crowdsourcing



Voice-based systems
machine-learning, NLP



More....
sensors, web systems. VR and AR

Case Study

Improve data collection by
automatically digitizing data
from paper forms

Paper forms are widely used for data collection in low-resource settings

The image shows a paper form used for data collection, featuring a grid layout. The form contains handwritten text in various languages, including English and Hindi, and numerical data. The grid is divided into columns and rows, with some cells containing numbers like 60, 150, and 160. The form is slightly tilted and shows signs of use.

Querying, accessing, and analyzing
paper-based data is difficult



Manual data entry is time consuming and error prone



Data entry is a huge bottleneck for many organizations

How can we improve paper-digital workflows in global development?

Key Idea

Ease the data entry bottleneck by using a mobile device to automatically digitize paper-based data on the device

Challenges and Constraints

Handle forms in very poor condition

Range of applications and data types

Robust performance

Perform computation locally

Usable by different stakeholders



Make it easy to design digitizable forms

Designers create form in browser

The screenshot shows the ODK Scan web interface for form design. The top menu bar includes: ODK Scan, File, Edit, Add, Copy, Delete Field, Undo Delete, Change Position, and Align Field. Below the menu is a toolbar with 'Page 1', 'Add', and 'Remove' buttons. The main area is divided into two panels. The left panel, titled 'Form Properties', contains settings for a field named 'given_bcg'. It includes fields for Name, Label, Bubble size (set to Small), Bubble type (set to Select One), Number of columns (set to 1), Number of rows (set to 1), Grid values (Row: 1, Col: 1), Include Border? (Yes/No), Verify Field? (Yes/No), Order Of Fields, and Top, Bottom, Left, and Right Margins. An 'Update Field' button is at the bottom. The right panel shows a preview of the form titled 'VACCINES GIVEN AT BIRTH'. It features a header with the Nigerian coat of arms and the title. Below the header is a section for 'Date of next vaccination (at 6 weeks)' with a date picker. The main section is a table with columns: Vaccine name, Vaccine given, Date given, and Nurse initials. It lists BCG, OPV, and HEPB vaccines. Below the table is a section for 'Additional vaccines received (e.g. via campaigns)' with a similar table structure. A blue arrow points from the ODK Scan interface to the right.

Automatically generate files

Printable
form image

The image shows a printable form titled 'VACCINES GIVEN AT BIRTH'. It includes a header with the Nigerian coat of arms and the title. Below the header is a section for 'Date of next vaccination (at 6 weeks)' with a date picker. The main section is a table with columns: Vaccine name, Vaccine given, Date given, and Nurse initials. It lists BCG, OPV, and HEPB vaccines. Below the table is a section for 'Additional vaccines received (e.g. via campaigns)' with a similar table structure. A blue arrow points from the ODK Scan interface to the right.

Form
description

```
{
  "type": "select1",
  "name": "given_bcg",
  "label": "given_bcg",
  "verify": "yes",
  "classifier": {
    "classifier_height": 20,
    "classifier_width": 20,
    "training_data_uri": "bubbles",
    "classification_map": {
      "empty": false
    }
  },
  "default_classification": true,
  "advanced": {
    "flip_training_data": false
  }
},
{
  "param": "yes_no",
  "grid_values": [
    "yes"
  ]
},
{
  "segments": [
    {
      "segment_x": 150,
      "segment_y": 200
```

Database
table definition

The diagram shows a database table definition. It features a green arrow pointing to a grid representing a table. The grid has 4 columns and 10 rows. The columns are labeled: 'nextvaccination_at6weeks_image0', 'nextvaccine_nextvaccination_at6weeks', 'bcg_datagiven_image0', 'bcg_datagiven', 'opv0_datagiven_image0', 'opv0_datagiven', 'hepb0_datagiven_image0', 'hepb0_datagiven', 'given_addtvacc_2_image0', 'given_addtvacc_2', 'nurse_notes_image0', and 'nurse_note_nurse_notes'. The rows are labeled with 'begin screen' and 'end screen'.

Editable
digital form

begin screen												
begin screen	read_only	nextvaccination_at6weeks_image0										TRUE
end screen	string	nextvaccine_nextvaccination_at6weeks										
begin screen												
begin screen	read_only	bcg_datagiven_image0										TRUE
end screen	string	bcg_datagiven										
begin screen												
begin screen	read_only	opv0_datagiven_image0										TRUE
end screen	string	opv0_datagiven										
begin screen												
begin screen	read_only	hepb0_datagiven_image0										TRUE
end screen	string	hepb0_datagiven										
begin screen												
begin screen	read_only	given_addtvacc_2_image0										TRUE
end screen	select_one	given_addtvacc_2										TRUE
begin screen												
begin screen	read_only	nurse_notes_image0										TRUE
end screen	string	nurse_note_nurse_notes										
begin screen												

Capture image

Sync with server

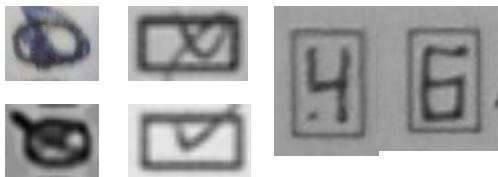


Align and segment image


Save and visualize data

[illegible]

Classify data
(~99% accuracy)



(Optionally)
enter text



Field evaluation with health workers in Mozambique

Track and report health workers' usage of medical supplies.

Use a digitizable paper
form to track usage



Digitize and report
usage data monthly



Four-month deployment in two districts

45 health workers

Two page form tracking 16 medical supplies

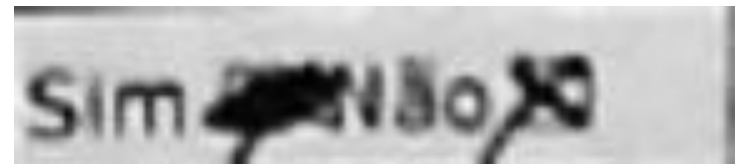
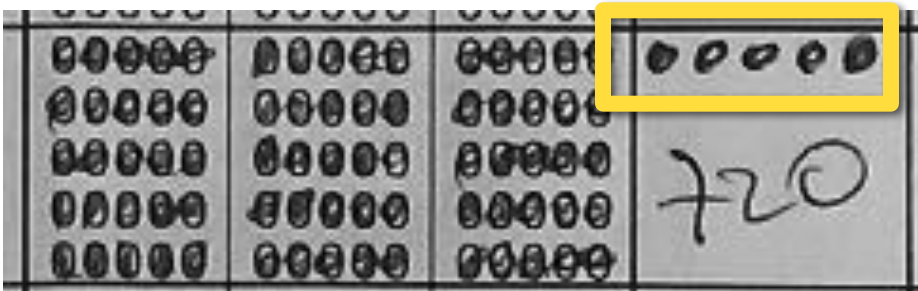
Does the system really work in the field?

Ground truth data set for ~30% of forms

Analyzed digitized data against ground truth

Data collection accuracy > 98%

Interesting Observations and Errors



Impact and Technology hand-off



Track attendance of ~10,000 students at 300 schools in Kyrgyzstan.



Digitizing patient registers collecting maternal and child health data in 4 districts in Malawi.



Digitizing patient registers at 5,000 health camps serving 650,000 people in Nigeria.

More Projects: Promoting Behavior Change

Giving pregnant women in Kenya access to medical advice and information through an hybrid computer-human communication system. 300 women, year-long randomized experiment.



A voice-based social media platform in India. 11-week deployment: 25,381 calls by 1521 callers, 5376 voice messages recorded by 516 people, around 200,000 playbacks of these messages. Impassioned adoption by blind community.



Transport tracking system to improve disease diagnosis

CM specialization project (Sean and Xiaoyang)

Collaboration with Clinton Health Access Initiative (CHAI) and Lesotho Ministry of Health



Tools to improve wildlife research and conservation



Develop mobile and sensor-based approaches to document, analyze, and track wildlife behavior.

Create tools to minimize human-wildlife conflict, fight poaching, etc.

[The Jane Goodall Institute \(Tanzania\)](#), [WILDCru \(Zimbabwe\)](#)

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Activity: Education

Literacy Rates: Mali 19%, Pakistan 49%, Laos 69%

School Attendance, Primary Enrolment

- Somalia 17%, Sudan 60%, Congo 88%,
- India 116%, Rwanda 120%, Cambodia 134%

Teacher Absenteeism

Language Study

Vocational Training

How can computing technology be used to improve education/enrolment/quality of teaching?

Propose three ideas for using technology to improve education in underserved communities (could be local or international).