

Extracting crop irrigation fields using remote sensing time series and deep learning

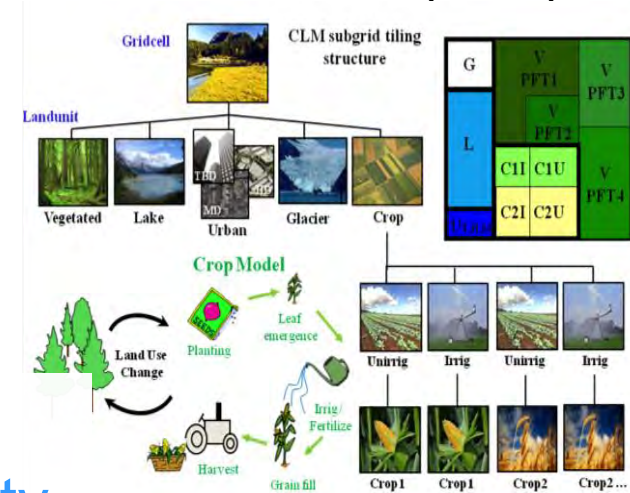
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University of Illinois at Urbana–Champaign



Remote Sensing

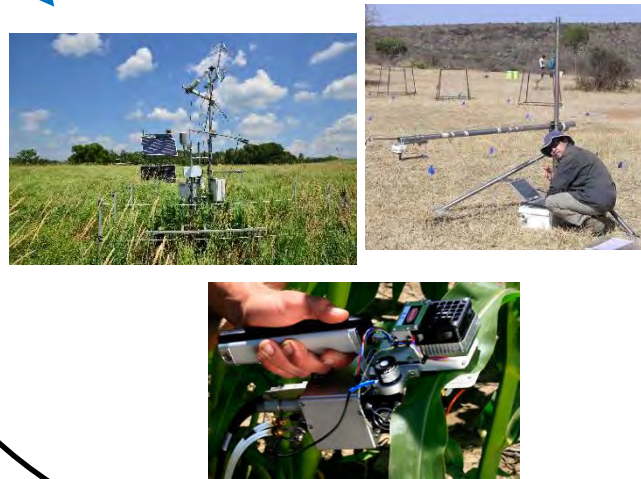


Numerical Modeling & Parallel Computing



Monitoring Food Production and Security

Field Studies



Irrigation mapping of croplands



Why irrigation?

- ~70% of global water uses
- 33–40% of global food production from irrigated croplands
- Irrigation influences
 - Crop yields
 - Energy exchange
 - Underwater recharge
 - Regional climate

Survey based approaches

Irrigated or non-irrigated

Area

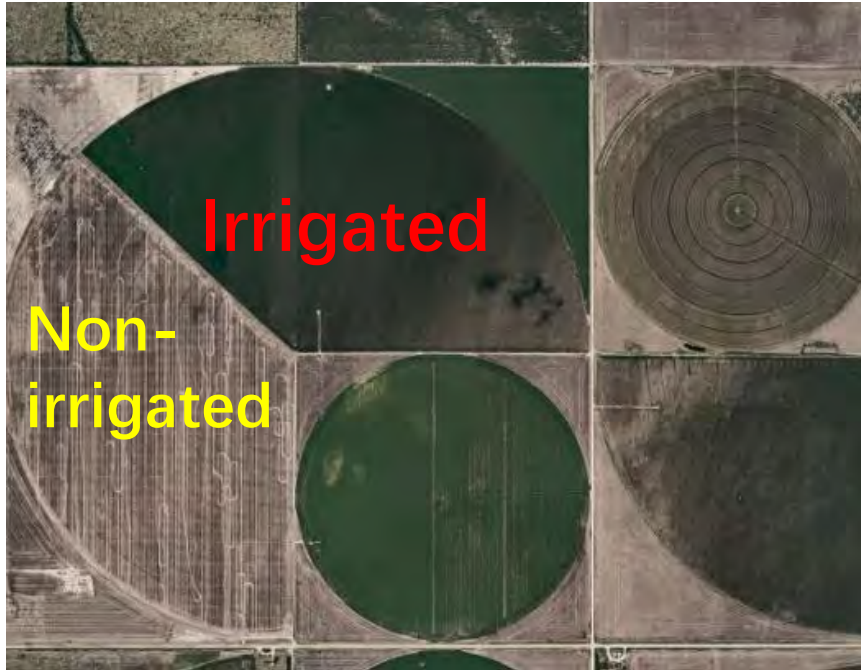
County	County ANSI	watershed_cod	Commodity	Data Item	Domain	Domain Category	Value
BUFFALO	019	00000000	CORN	CORN, GRAIN, IRRIGATED - ACRES HARVESTED	TOTAL	NOT SPECIFIED	166,800
BUFFALO	019	00000000	CORN	CORN, GRAIN, NON-IRRIGATED - ACRES HARVESTED	TOTAL	NOT SPECIFIED	31,700
BUFFALO	019	00000000	SOYBEANS	SOYBEANS, IRRIGATED - ACRES HARVESTED	TOTAL	NOT SPECIFIED	70,500
BUFFALO	019	00000000	SOYBEANS	SOYBEANS, NON-IRRIGATED - ACRES HARVESTED	TOTAL	NOT SPECIFIED	16,800
CUSTER	041	00000000	CORN	CORN, GRAIN, IRRIGATED - ACRES HARVESTED	TOTAL	NOT SPECIFIED	168,700
CUSTER	041	00000000	CORN	CORN, GRAIN, NON-IRRIGATED - ACRES HARVESTED	TOTAL	NOT SPECIFIED	57,300
CUSTER	041	00000000	SOYBEANS	SOYBEANS, IRRIGATED - ACRES HARVESTED	TOTAL	NOT SPECIFIED	62,600
CUSTER	041	00000000	SOYBEANS	SOYBEANS, NON-IRRIGATED - ACRES HARVESTED	TOTAL	NOT SPECIFIED	17,900
DAWSON	047	00000000	CORN	CORN, GRAIN, IRRIGATED - ACRES HARVESTED	TOTAL	NOT SPECIFIED	178,900



USDA survey

- **Expensive** to conduct survey
- **County level** resolution (no spatial information)
- **Questionable** data quality

Satellite imagery based approaches



Challenges:

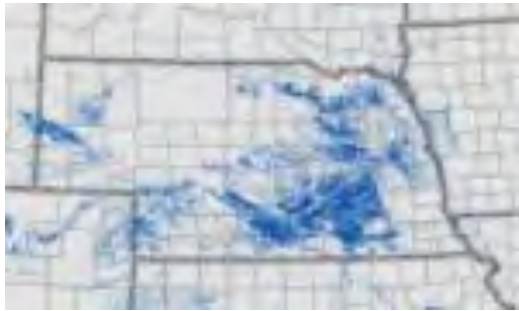
- Unstructured information
- Large-scale data
- Variations in Irrigated/non-irrigated fields
 - Climate
 - Geolocation
 - Agricultural activities

Satellite imagery:

- contains detailed information for irrigation mapping
- becoming cheaper and more accurate

Irrigation mapping of cropland

Previous remote sensing based approaches



- Low resolution (500m)
- Low coverage
- Low accuracy

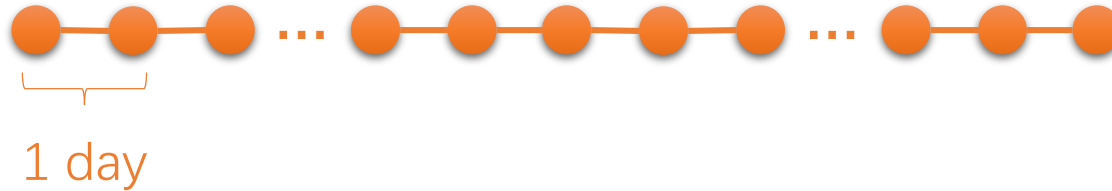
Our remote sensing based approaches



- High resolution (30m)
- High coverage
- High accuracy

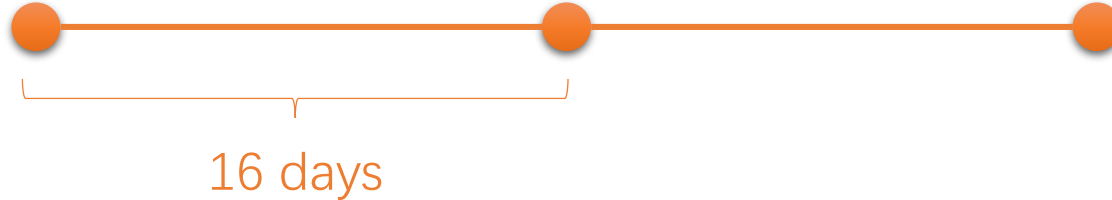
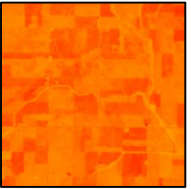
High resolution: fusion of MODIS and Landsat data

MODIS
(500m)



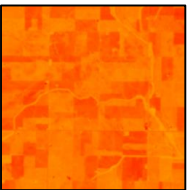
Low spatial resolution
High temporal resolution

Landsat
(30m)

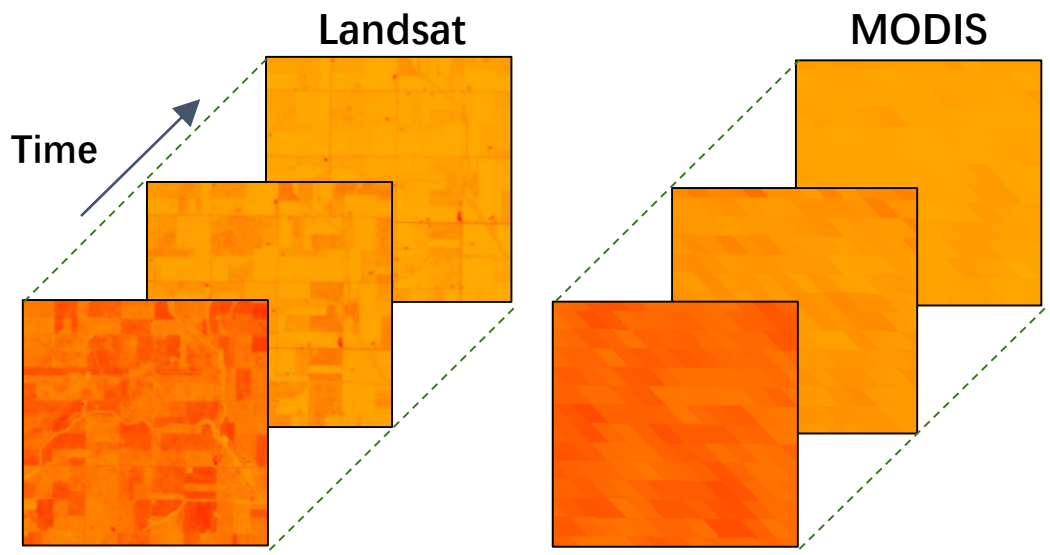


High spatial resolution
Low temporal resolution

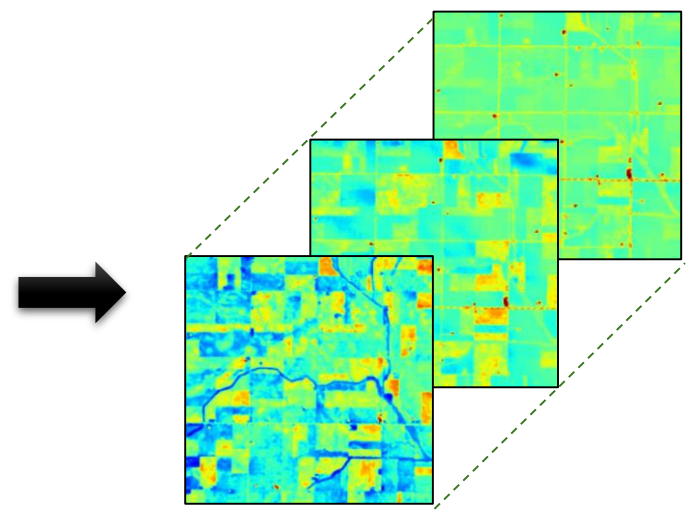
Our fused
data
(30m)



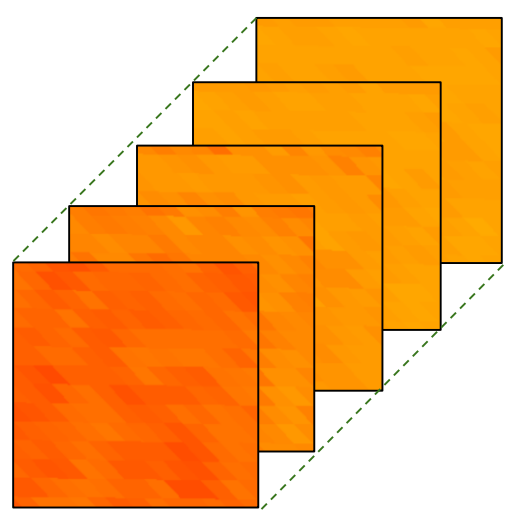
High spatial resolution
High temporal resolution



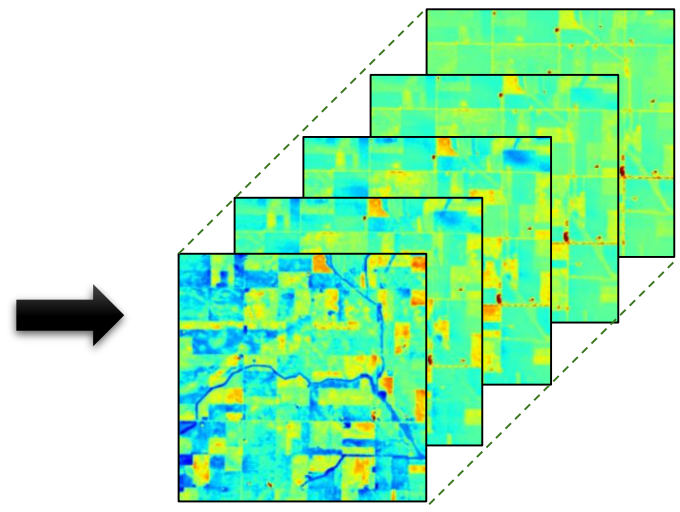
Input: Time series of Landsat-MODIS pairs



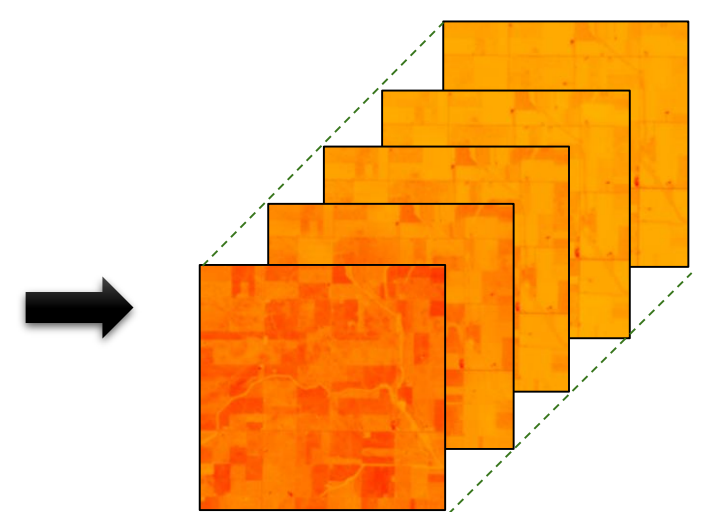
Time series of Landsat-MODIS difference



Input: Daily time series of MODIS

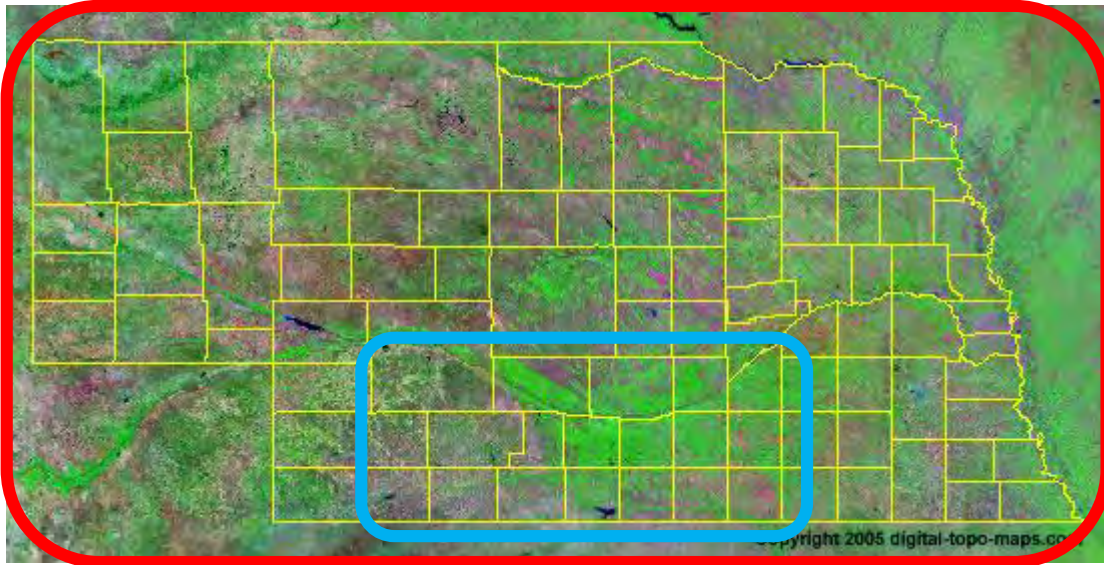


Predicted daily time series of Landsat-MODIS difference



Output: Daily time series of predicted images

High coverage: Blue Waters enables large-scale prediction



Previous works:

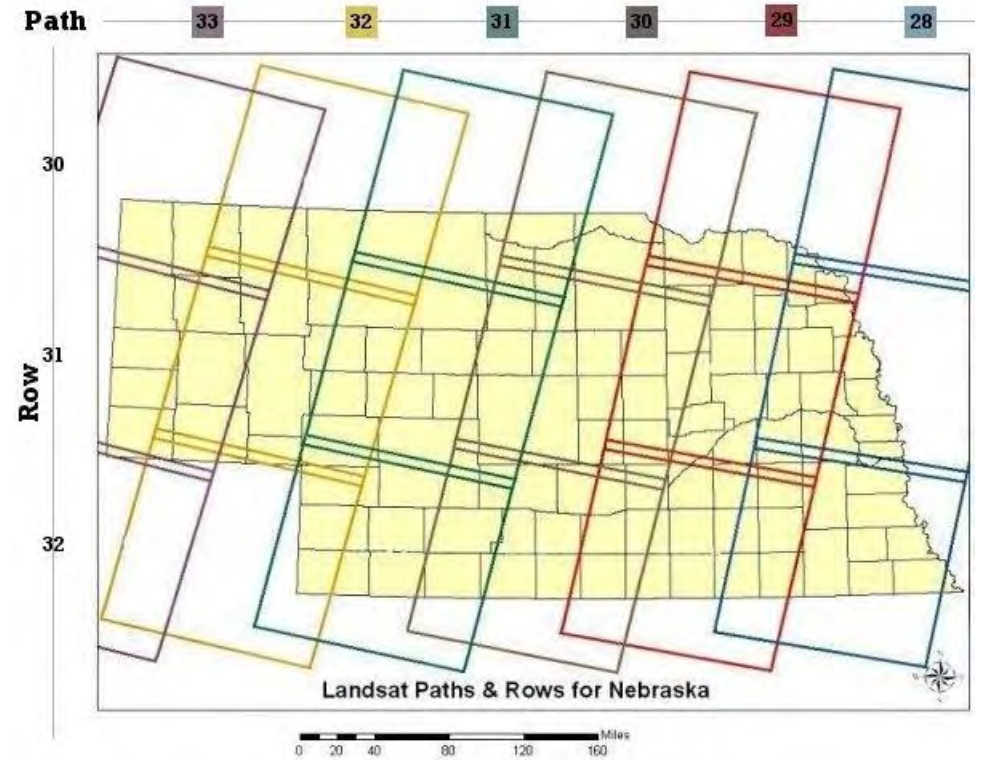
South Nebraska; One year

Our work:

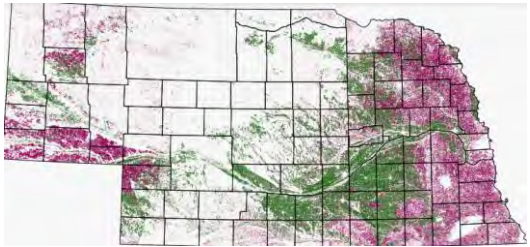
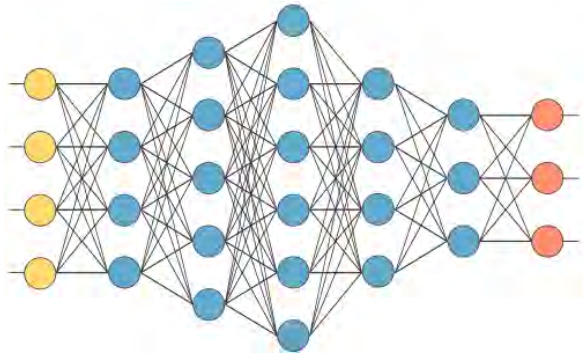
Whole Nebraska; 2002 to 2015

Data processed: >50TB

CPU/GPU used: >5K node hours for each year of data



High accuracy: Irrigation mapping based on deep learning

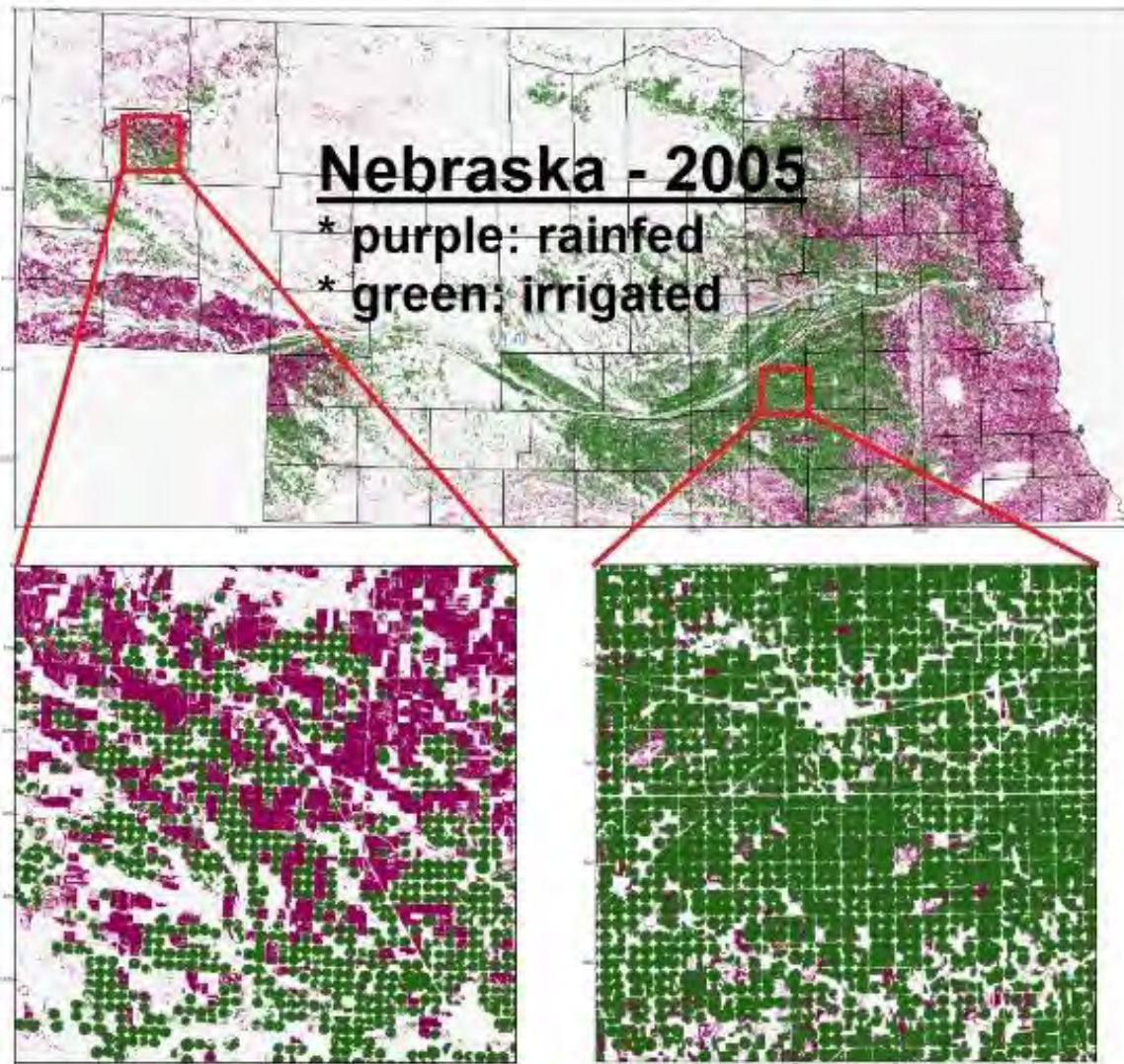


Plain map

Remote sensing time series

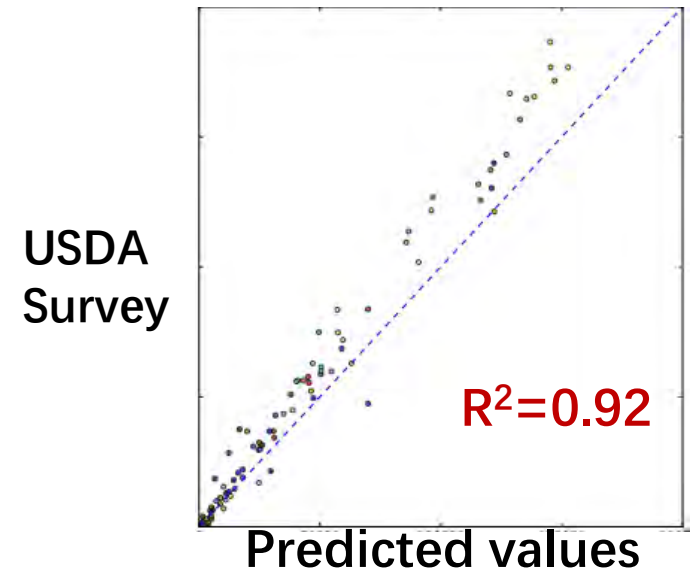
Neural network

Irrigation map

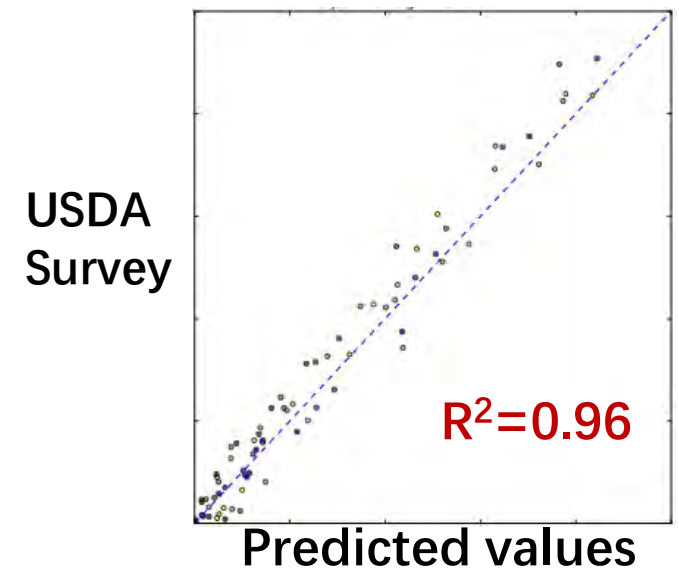


Irrigation map of 2005
 Field level accuracy: 93%

Irrigation area of corn



Irrigation area of soybean



Acknowledgements

- Prof. Kaiyu Guan (PI), Prof. Jian Peng



Thank you!