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Temporal Distance Map:

A Warped Isochrone Map Depicting Accurate Travel Times

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Dr. Mark V. Albert

Director of UNT Biomedical AI Lab

Dr. Albert's professional goal in life is to leverage machine learning to automate the collection and inference of clinically useful health information to improve clinical research. His projects in wearable sensor analytics have improved the measurement of health outcomes for individuals with Parkinson's disease, stroke, and transfemoral amputations with a variety of additional populations and contexts including children with cerebral palsy as well as healthy toddler activity tracking. Current projects include video-based activity tracking and mobile robotic platforms, all in an effort to improve measures of clinical outcomes to justify therapeutic interventions.

Elijah Nacar

Undergraduate Student

Elijah Nacar is an undergraduate researcher currently enrolled in the Texas Academy of Mathematics and Science at the University of North Texas,

Devak Nanda

Undergraduate Student

Devak Nanda is an undergraduate researcher currently enrolled in the Texas Academy of Mathematics and Science at the University of North Texas,

Current Projects (UNT Biomedical AI Lab)

People:

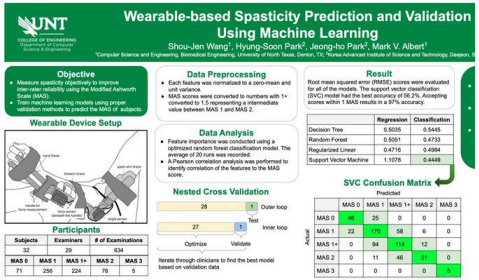
- Dr. Mark V. Albert
- 8 PHD Students
- 5 MS Students
- 11 Undergraduates
- 1 Affiliated Lab
- 4 Capstone Groups for Fall 2020

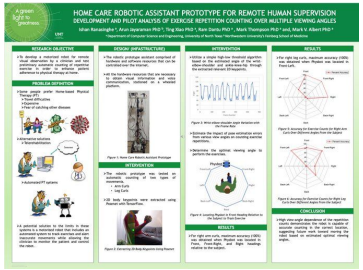
Mission Statement:

We use machine learning to advance medicine, with a history in wearable device analytics to aid clinicians in the treatment of mobility disorders, as well as broadly using AI to improve health outcomes.

Populations	Applications	ML Techniques
Parkinson's Disease	Activity Recognition	Tons of ML predictive and unsupervised models
Incomplete spinal cord injury	Fall Detection and Real-time response	Deep learning (CNN w Keras & Tensorflow)
Transfemoral amputees	Assessing quality of activities	Kubernetes/Docker orchestration & Parallelisation
Cerebral Palsy	Posture recognition	Hidden Markov Models
Toddlers	Computational Neuroscience	

A Few of Our Projects:





Tweet from the Lab::

Biomed AI Lab presentations this Sep & Oct 2020

1. Nallapareddy H, Mummidisetty C, Botonis O, Harari Y, Jayaraman A, Albert MV. **Automated pre-fall detection for fall mitigation using a wearable airbag belt.** Biomedical Engineering Society conference (BMES 2020) Oct 14-17, 2020.
2. Meyarian A, Namdari H, Yuan X, Roeske J, Albert MV. **Phantom Tumor Tracking in Dual-energy Fluoroscopy using a Kalman Filter.** Biomedical Engineering Society conference (BMES 2020) Oct 14-17, 2020.
3. Tabashum T, Xiao T, Gaynes B, Chawla J, Colleatta D, Albert MV. **Automated Pupil Tracking For Parkinson's Disease Biomarker Detection By Integrating Kalman Filters In A Robust User Interface.** Biomedical Engineering Society conference (BMES 2020) Oct 14-17, 2020.
4. Xiao T, Tabashum T, Olness G, Mahbub I, Berman D, Tasneem NT, Albert MV. **"Mobile Diarization Dashboard Application and Remote Vocalization Sensor Prototype for Evaluating Communication Rehabilitation Effectiveness."** American Congress of Rehabilitation Medicine (ACRM) conference 2020.
5. Ranasinghe I, Jayaraman A, Xiao T, Thompson M, Dantu R, Albert MV **"Home Care Robotic Assistant Prototype for Remote Human Supervision: Development and Pilot Analysis of Exercise Repetition Counting over Multiple Viewing Angles"** American Congress of Rehabilitation Medicine (ACRM) conference 2020.
6. Wang SJ, Park JH, Park HS, Albert MV **"Wearable-based Spasticity Prediction and Validation Using Machine Learning"** American Congress of Rehabilitation Medicine (ACRM) conference 2020.
7. Namdari H, Comerica SS, Wang SJ, Lu X, Kalahe J, Du J, Albert MV. **"Using machine learning for material properties prediction in glass production"** ACM Tapia Conference, September 16-19, 2020
8. Yuan C, Bansal R, Nelson P, Akula K, Sidorova A, Narayanan A, Albert MV. **"Multi-agent hierarchical reinforcement learning of strategy and tactics in competitive play."** ACM Tapia Conference, September 16-19, 2020
9. Behpour S, Urs N, Albert MV. **"Towards an 'innate learning' efficient coding model using spontaneous neural activity."** ACM Tapia Conference, September 16-19, 2020
10. Rafiq RB, Modave F, Guha S, Albert MV **"Validation methods to promote real-world applicability of machine learning in medicine."** ACM Tapia Conference, September 16-19, 2020
11. Zelman S, Dow M, Tabashum T, Albert MV, Xiao T. **"Automatic counting methods applied to unspecified repetitive physical activities."** ACM Tapia Conference, September 16-19, 2020
12. Olness G, Mahbub I, Albert MV, Berman D, Xiao T, Fletcher A. **Wireless Smart System of Vocalization Sensors for Convergent Evidence of Post-Discharge Communicative Participation in Everyday Life Contexts.** Launchpad competition at American Congress of Rehabilitation Medicine (ACRM) conference 2020.
13. O'Brien M, Rafiq RB, Moudy S, Albert MV (organizer). **"Best Practices for Validating Machine Learning in Medicine"** Workshop in the Tapia Conference, September 16-19, 2020.

"Want to see how AI can improve medical care? Over the next month we'll be posting about the 13 different presentations from our lab at 3 national conferences representing diversity in computing, rehabilitation, and biomedical engineering (ACM Tapia, ACRM, and BMES)! Stay tuned!"

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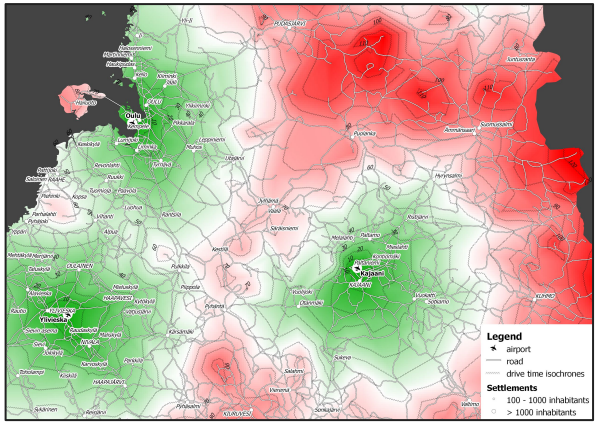
Introduction

Background & Purpose

- Travel Time is poorly represented on physical maps
- Most research has began utilizing isochrone maps
- Isochrones depict contours that delineate distance
- We sought to create a tool that would morph the static image of a location to order to substitute distance on the map as the region's travel time

Isochrone Map

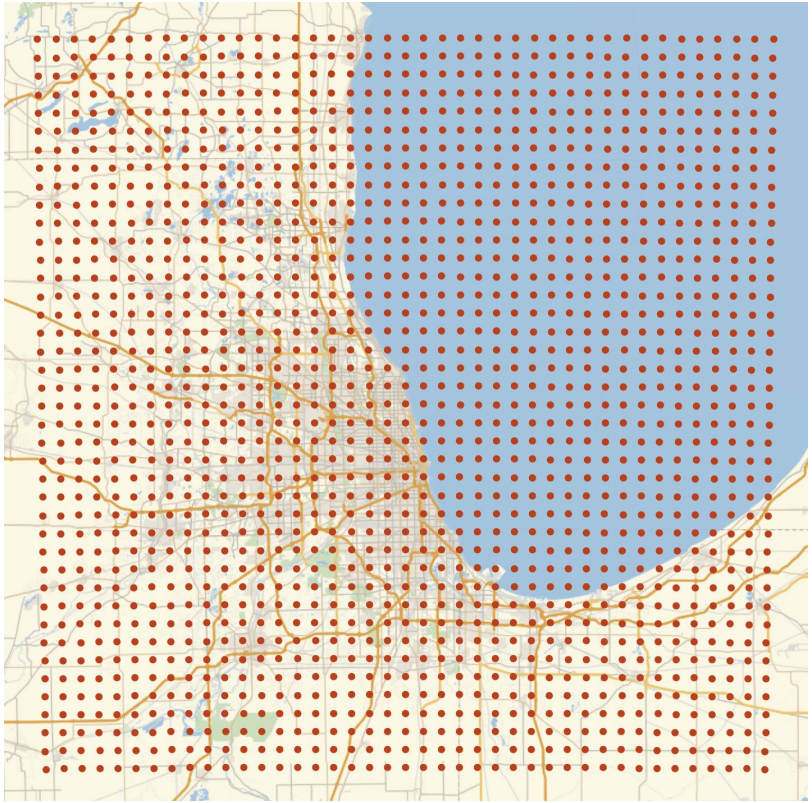


Isochrone map showing drive times around airports in northern Finland, created using GIS software (2011)

All Code and Documentation can be found here: https://github.com/Debusan13/temporal-distance-map

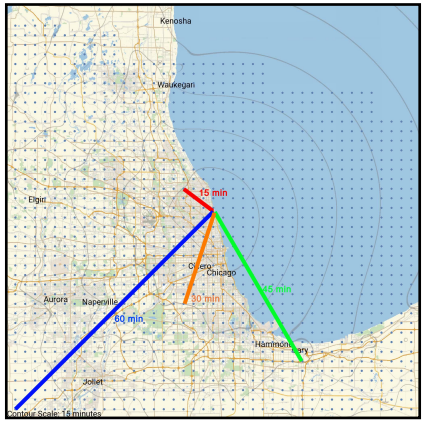
Method

1. Utilize the Bing Maps API to obtain both a static image of the location and the regions travel time from a central point
2. Overlay a mesh of points corresponding to Latitude and Longitude
3. Find travel time between the mesh of points and the central point

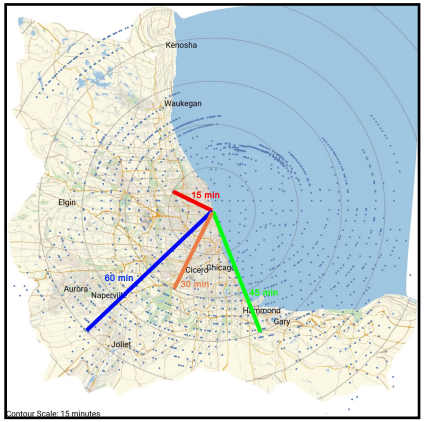


Method (Pt .2)

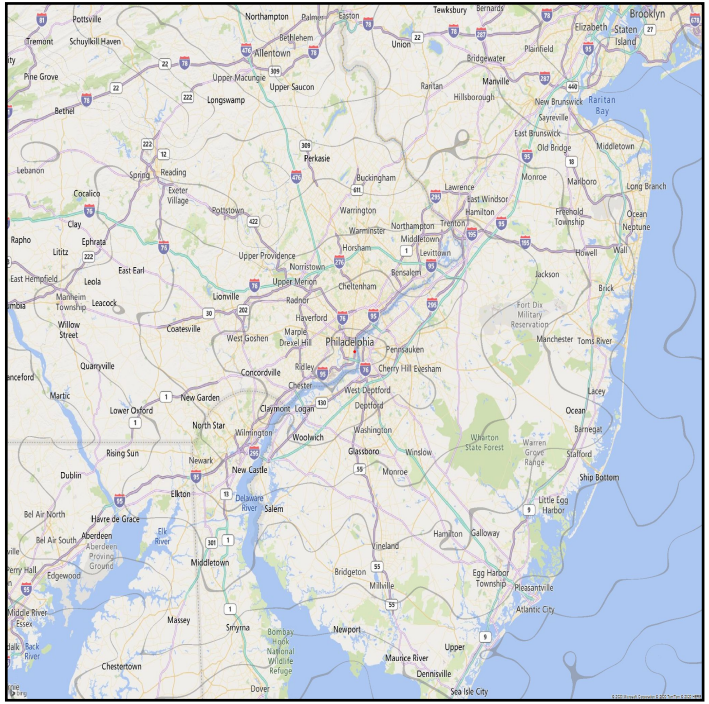
4. Transform the mesh of points to accurately represent travel time from the central point
5. Shift the pixels on the map accordingly
6. Overlay contours

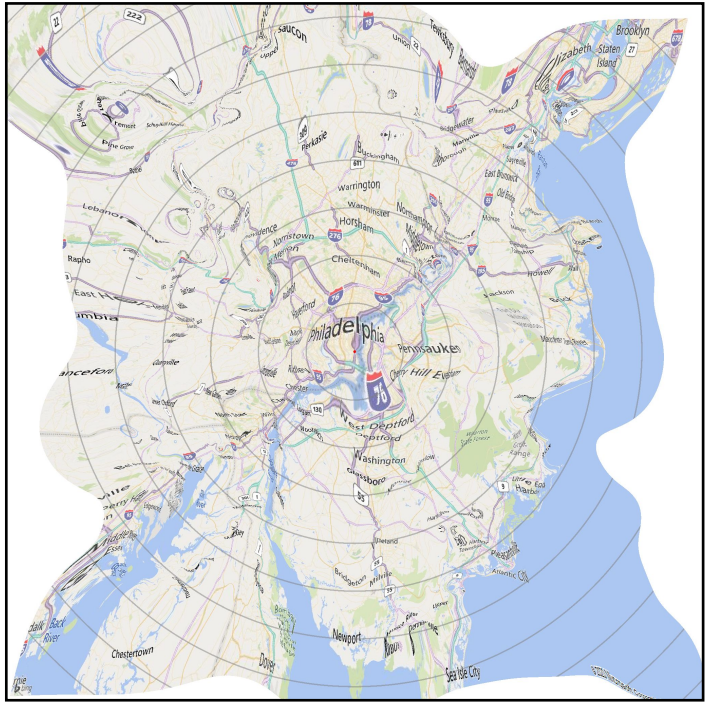


(Transformation)

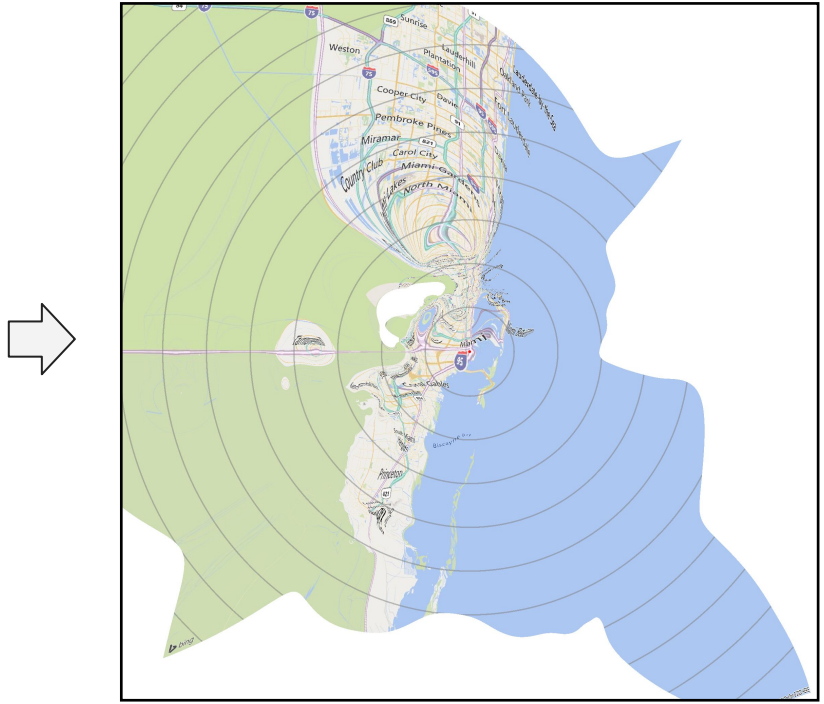


Results: Pennsport

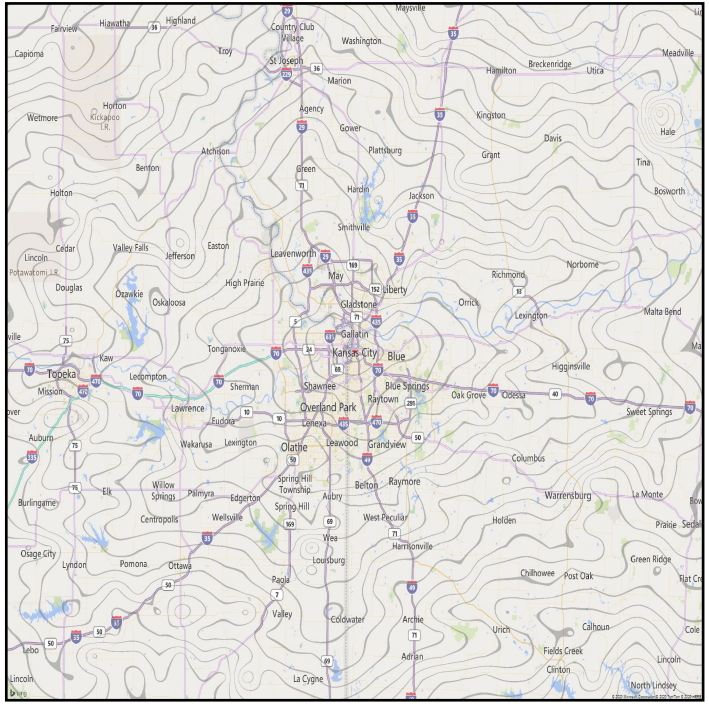


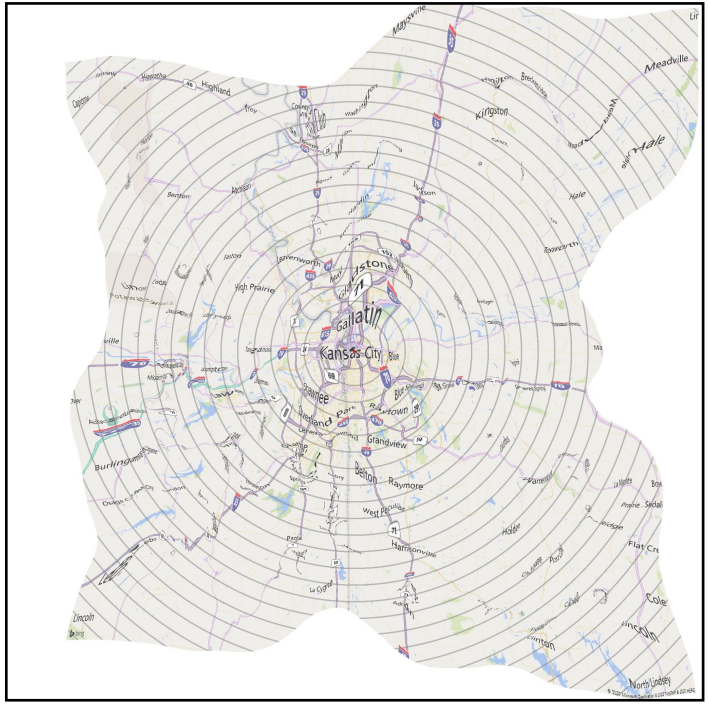


Results: Miami Bay



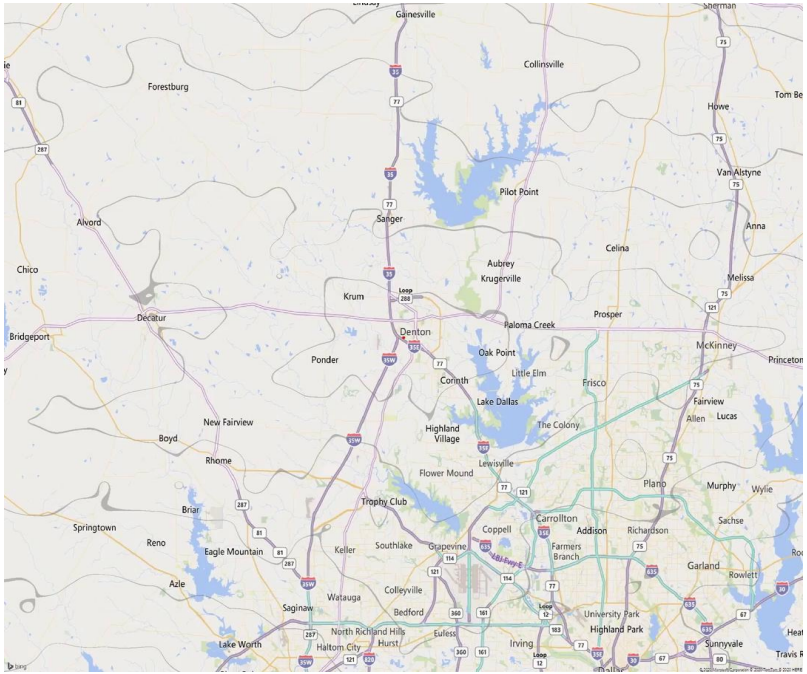
Results: Kansas City





Conclusions

- This transformation is more relevant to personal experience
- Allows the comparison of travel times at a glance
- Provides additional insight into the impact of geographic and infrastructural features



Various References

Towards a Dynamic Isochrone Map: Adding Spatiotemporal Traffic and Population Data

J. van den Berg, B. Köbben, S. van der Drift, and L. Wismans, "Towards a Dynamic Isochrone Map: Adding Spatiotemporal Traffic and Population Data. Progress in Location Based Services 2018.," Springer International Publishing., 2018. pp. 195–209.

Discusses how an isochrone map could be further developed in terms of GIS

Isochrones, Traffic and DEMOgraphics

A. Efentakis, N. Grivas, G. Lamprianidis, G. Magenschab, and D. Pfoser, "Isochrones, traffic and DEMOgraphics.," Proceedings of the 21st ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems. New York, NY, USA: Association for Computing Machinery., pp. 548–551, 2013.

Noninvasive Electrocardiographic Imaging

H. S. Oster, B. Taccardi, R. L. Lux, P. R. Ershler, and Y. Rudy, "Noninvasive Electrocardiographic Imaging.," Circulation., vol. 96 pp. 1012–1024, 1997.

The Victoria-Regina Stellar Models: Evolutionary Tracks and Isochrones for a Wide Range in Mass and Metallicity that Allow for Empirically Constrained Amounts of Convective Core Overshooting

D. A. VandenBerg, P. A. Bergbusch, and P. D. Dowler, "The Victoria-Regina Stellar Models: Evolutionary Tracks and Isochrones for a Wide Range in Mass and Metallicity that Allow for Empirically Constrained Amounts of Convective Core Overshooting.," Astrophys J., 2006.

Shows examples of how isochrone maps are being used in Geographic, Clinical, and Astrophysical Research