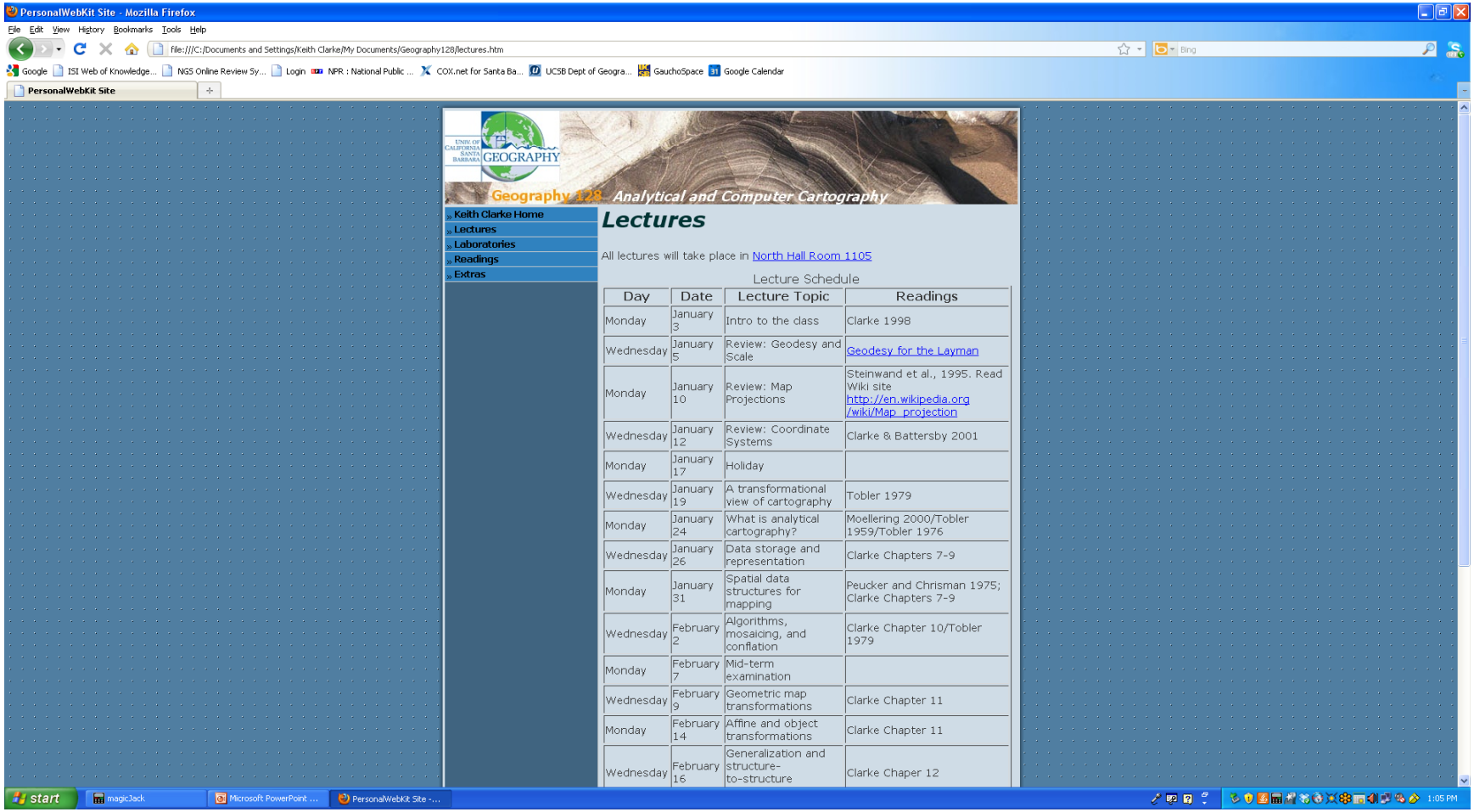
Winter 2017 Geography 128

Analytical and Computer Cartography

Professor Keith C. Clarke

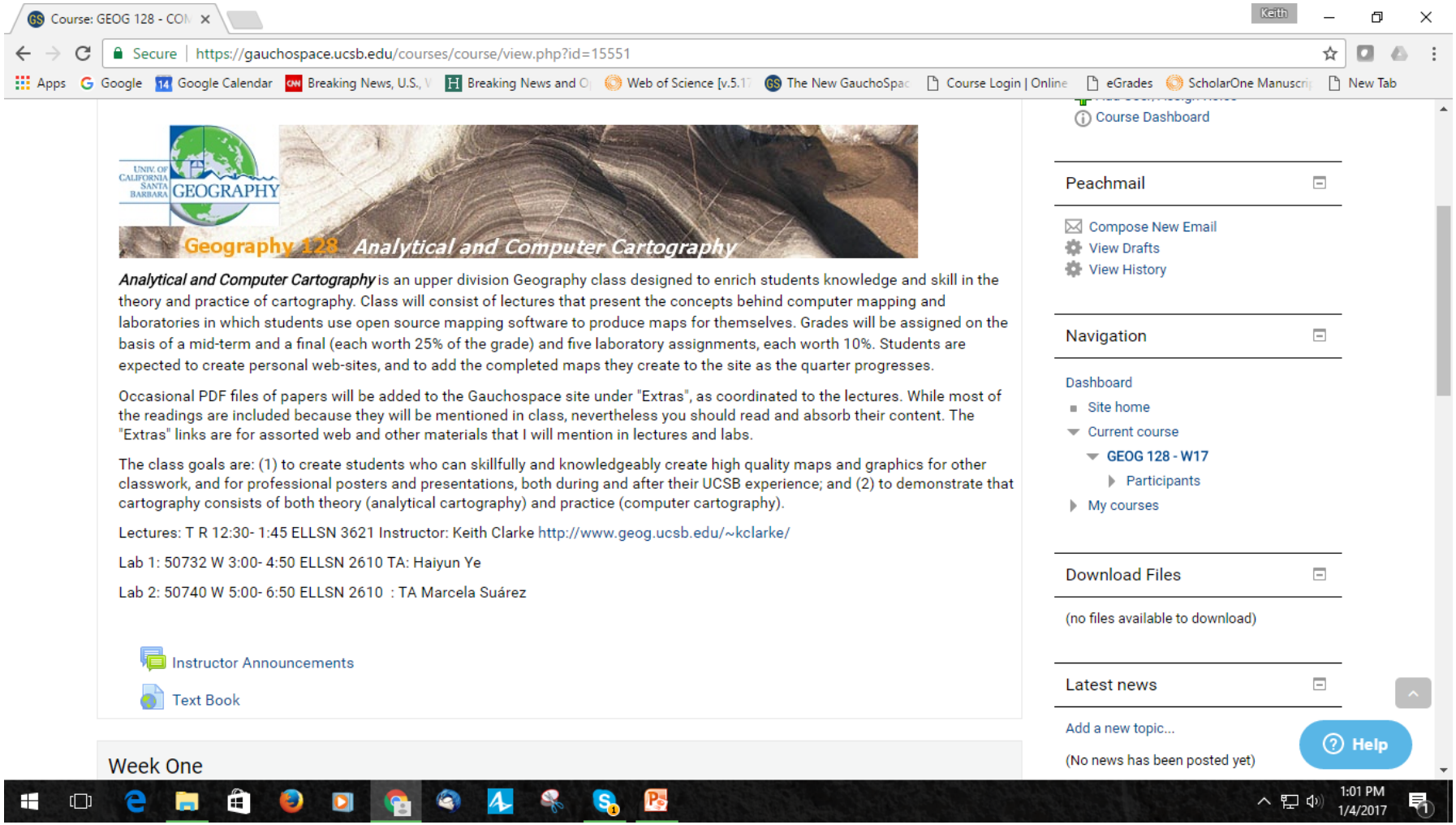
Old Class web site

http://www.geog.ucsb.edu/~kclarke/Geography128/Geog128.html



Day	Date	Lecture Topic	Readings
Monday	January 3	Intro to the class	Clarke 1998
Wednesday	January 5	Review: Geodesy and Scale	Geodesy for the Layman
Monday	January 10	Review: Map Projections	Steinwand et al., 1995. Read Wiki site http://en.wikipedia.org/wiki/Map_projection
Wednesday	January 12	Review: Coordinate Systems	Clarke & Battersby 2001
Monday	January 17	Holiday	
Wednesday	January 19	A transformational view of cartography	Tobler 1979
Monday	January 24	What is analytical cartography?	Moellering 2000/Tobler 1959/Tobler 1976
Wednesday	January 26	Data storage and representation	Clarke Chapters 7-9
Monday	January 31	Spatial data structures for mapping	Peucker and Chrisman 1975; Clarke Chapters 7-9
Wednesday	February 2	Algorithms, mosaicing, and conflation	Clarke Chapter 10/Tobler 1979
Monday	February 7	Mid-term examination	
Wednesday	February 9	Geometric map transformations	Clarke Chapter 11
Monday	February 14	Affine and object transformations	Clarke Chapter 11
Wednesday	February 16	Generalization and structure-to-structure	Clarke Chaper 12

Gauchospace Site



What you will learn

- The cartographic side of Geographic Information Science
- What AC is, where it came from, and where its going
- Aspects of cartographic transformations
- Some extra details on 3D representation
- Several Open Source mapping packages
- How to build a map portfolio

The class

- Lectures 2x a week, video posted on old site
- Labs once a week
- 5 labs, 2 weeks per lab
- Labs are far more self-help based than 176. Use your intelligence!
- Web site
- Papers will be distributed on Gauchospace
- Gauchospace site

Your instructors

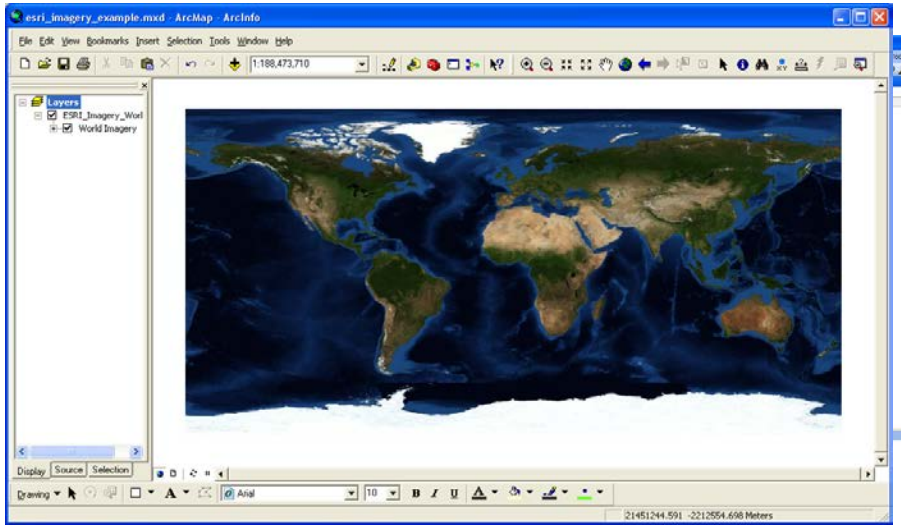
Keith Clarke, Professor

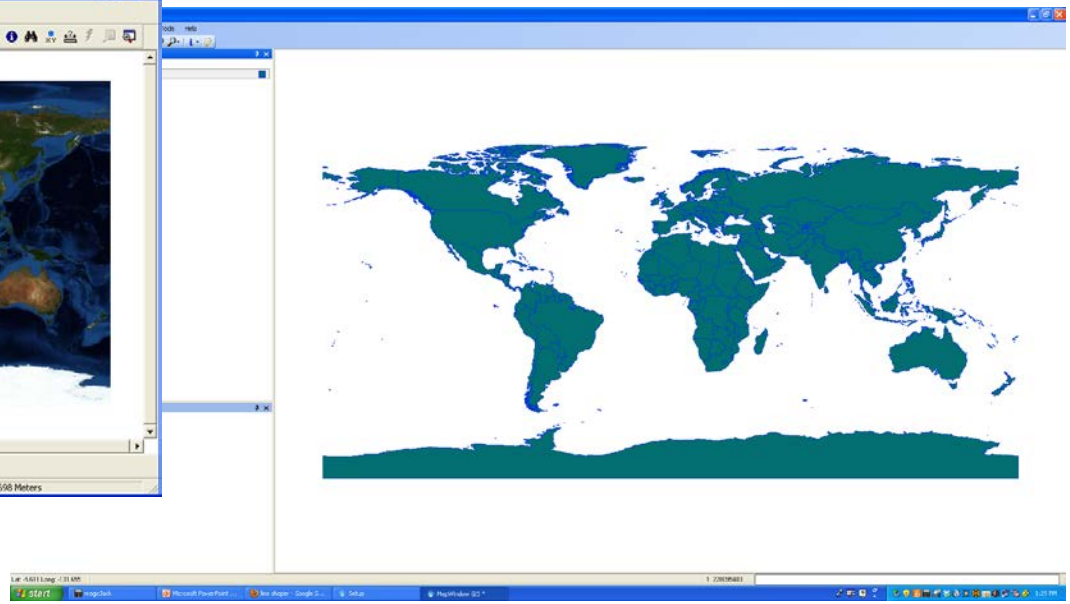
Marcela Suarez, TA

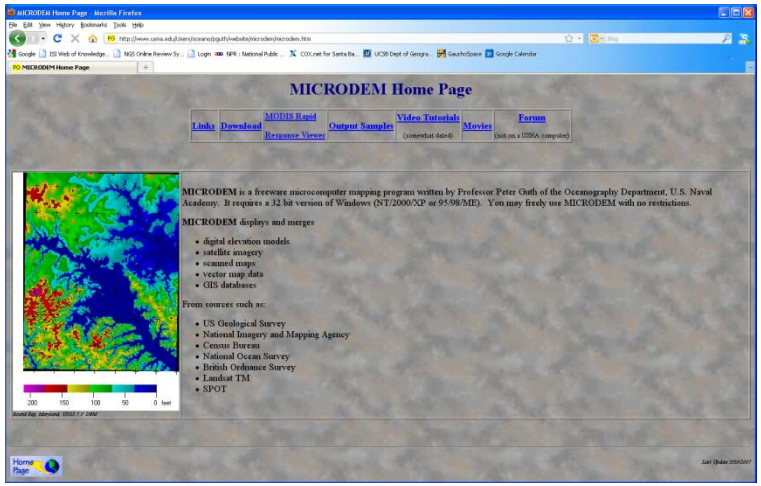
Haiyun Ye, TA

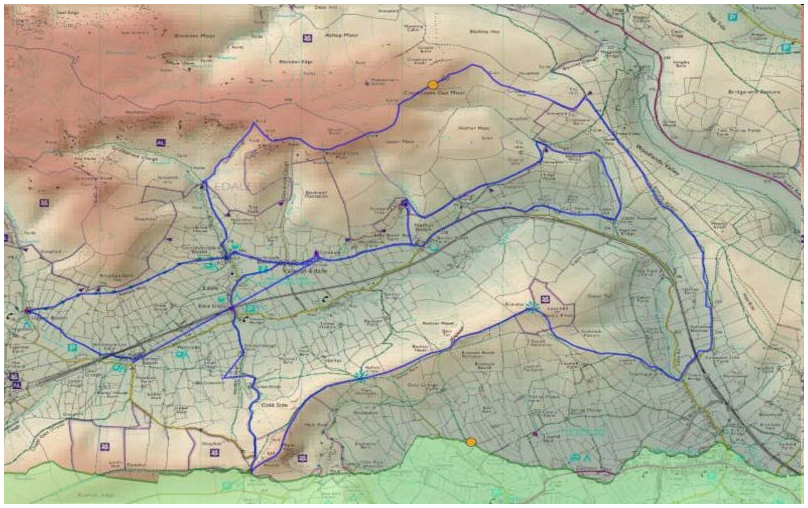
The lab work

ArcGIS/Open source/Freeware

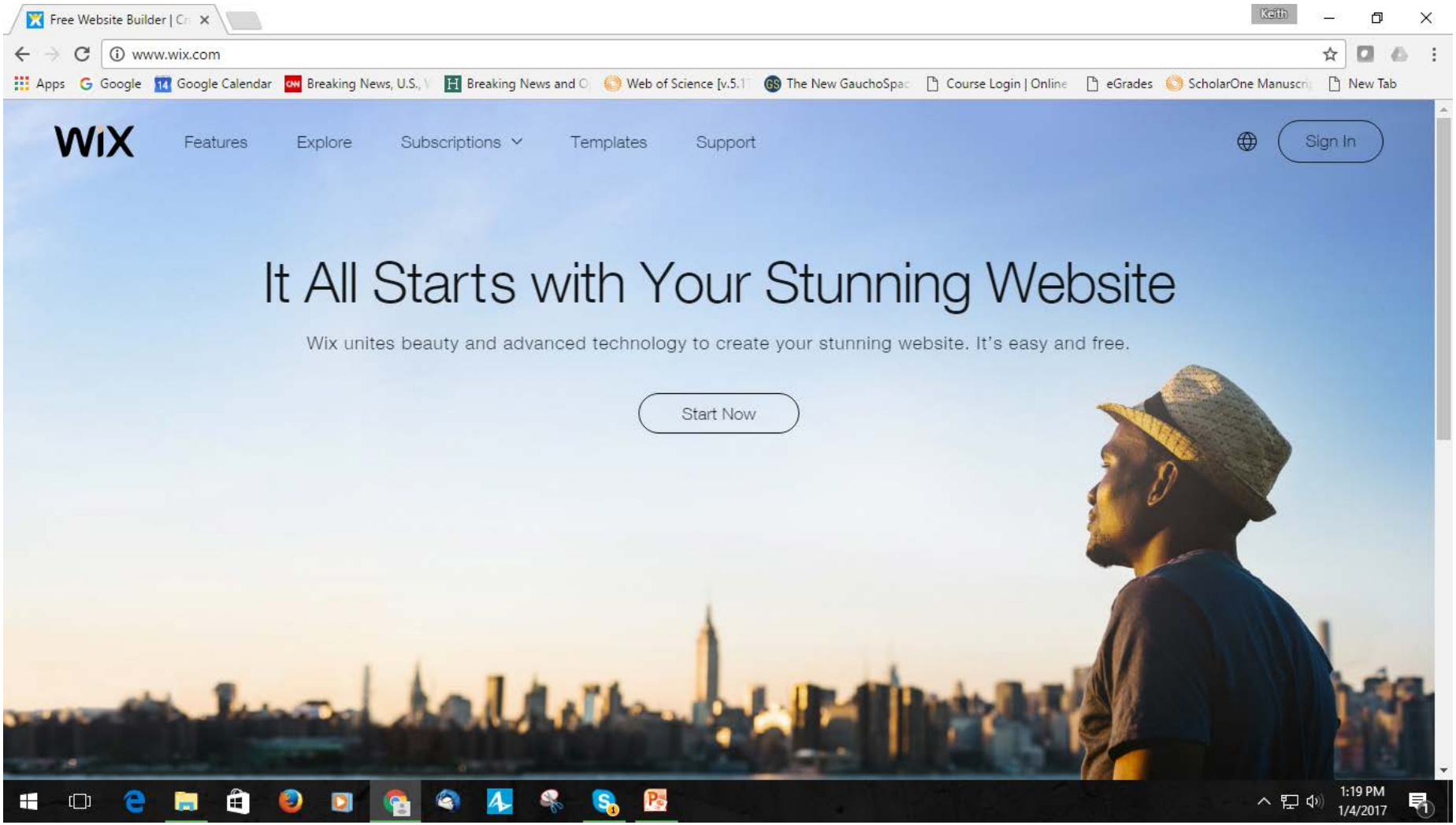








Portfolio of maps



Many Choices

Website Builder	Score	Features We Like	Ease Of Use	Best Deal	
web.com	9.9 Read Reviews	✓ Free Domain ✓ Unlimited Hosting ✓ Access to Pro Web Designers ✓ 10,000 Design Templates ✓ Comprehensive SEO package	●●●●●	Everything you need for $1.95/month	Visit Site
SiteBuilder.	9.4 Read Reviews	✓ Free Domain ✓ 10,000 Design Templates ✓ Drag & Drop Builder ✓ Powerful SEO Tools	●●●●●	Free Domain with all packages	Visit Site
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The Class

- Taught as *Analytical Cartography* (Geog 482) at the University of Michigan by Waldo Tobler late 1960s on
- Topic of paper by Tobler in 1976, published the curriculum (more detailed than actual class!)
- Adopted by Keith Clarke at Hunter College in 1982, after taking the class at Michigan
- Led to *Analytical and Computer Cartography* 1990 textbook. 2 editions
- Moved the class to UCSB in 1996, taught in several other universities, including CUG Wuhan
- Many subsequent additions to the literature

Geog 482

COURSE OUTLINE

Analytical Cartography. Geography 482. 3 credits. Prof. Waldo R. Tobler University of Michigan, Ann Arbor, Michigan 48109, U.S.A.

Week I. Introduction. Relation to mathematical geography, geodesy, photogrammetry, remote sensing. Replacement of map data storage by computer data storage. Technological change and the need for theoretical approach. Historical perspective.

Week II. Computer Graphics. Turing's theorem in relation to cartography. Output devices: lines, halftones, color. Sources of programs and algorithms. Dynamic cartography and computer movie making. Interactive graphics in cartography and geography.

Week III. Geographical Matrices. Triagonal, quadrilateral, hexagonal, and Escher types. Notation, neighborliness property, topological invariance. The varieties of geographical data: nominal, binary, scalar, complex, colored, N-valued, and infinite-valued matrices. Isomorphism to the surface of the earth.

Week IV. Geographical Matrix Operators. Functions of matrices: algebraic, logical, differentiable, invertible; linear, local, spatially invariant (translationally and rotationally). Parallel processing, windows, edge effects. Finite difference calculations.

Week V. Response Functians. Fourier and other orthogonal series. Operations in the frequency domain. Two-dimensional transforms.

Week VI: Sampling and Resolution. Fourier interpretations of aliasing, band limited functions, Nyquist limit, comb functions. The sampling theorem, random plane sampling, invisible distributions.

Week VII. Quantization and Coding. Analogue and digital processing. Quantization error, reduction of. Information theory: how many aerial photographs are there? Huffman coding, higher order statistics, spatial autocorrelation functions. Television and choropleth maps.

Week VIII. Map Generalization. Textual, acoustical, visual abstractions: smoothing and reconstruction, spread functions and inverses. Information loss. Point, line, network, binary to N-valued matrix generalization. Digital implementation, optical data processing. How the brain works: Limulus, frog, cat, human.

Week IX. Pattern Recognition. Preprocessing, enhancement, feature extraction; discrimination and classification (linear, Gaussian); signal-to-noise ratios; perceptrons.

Week X. Generalized Spatial Partitionings. Census tracts and the like, *ad nausium.* Point functions versus interval functions, a false dichotomy. Spatial resolution redefined. Generalized neighbors in a point set: epsilon neighborhood, K^{th} surround, minimal triangulation, Gabriel contiguity, Thiessen polygons. Higher order neighbors. Interval sets associated with a point set; point sets associated with an interval set. Higher dimensional cases.

Week XI. Generalized Geographical Operators. Expansion of matrix operators to irregular point sets, to interval data, in such a manner as to include matrix as a special case. Generalized two-dimensional sampling theorem and reconstructions from sampled data.

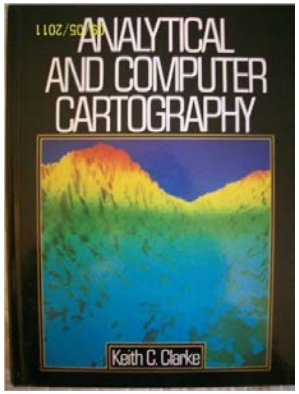
Week XII. Geographical Coding. Information theoretical content of Latitude / Longitude, street address, ZIP code, telephone number, Public Land Survey, and the like.

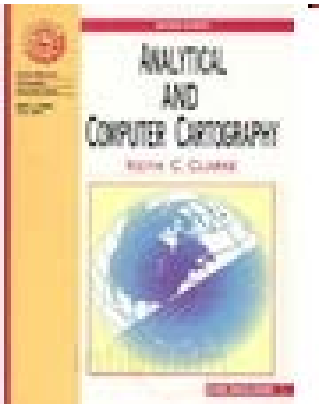
Topological and metrical properties of place naming schemes. Gaussian coordinates. A variety of plane coordinate schemes. Formulae for working on sphere and ellipsoid.

Week XIII. Geographical Code Conversions. Complete-partial, redundant-optimal, invertible & non-invertible codes. Blum geometry and skeletal invariants. Point-point, point-interval, interval-interval conversions and their inverses. Polygonal and skeletal approaches; error measures. Street address, Latitude Longitude, and so forth.

Week XIV. Map Projections. The classical theory: Ptolemy, Mercator, Lambert, Euler, Gauss, Airy, Chebyshev, Tissot. Finite and differential measures of distortion. Applicability to "mental maps." Simplifying computations by using map projections. Some new ways of inventing projections. Computation of cartograms.

Week XV. Geographical Information Systems. Band width requirements; dollar requirements; hardware and software. Input schemes, manipulation algorithms, output schemes. Historical overview and examples: TIROS-ERTS, CATS-PJ-BATS, CLI-MLADS-DIME. Analytical approaches to using geographical data: optimization techniques, sensitivity testing, regionalization, spatial trend analysis, dynamic simulation, growth models, regional forecasting.





Curriculum

- Week 1:
  - Review: Geodesy and Scale
  - Review: Map Projections
- Week 2:
  - Review: Coordinate Systems
  - A transformational view of cartography
- Week 3:
  - What is Analytical Cartography?
  - Data storage and representation

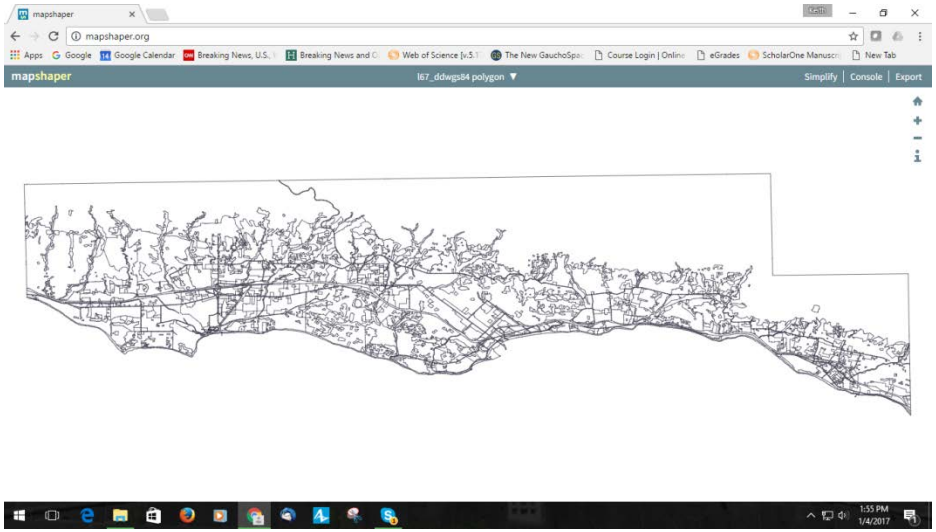
- Week 4:
  - Spatial Data Structures for Mapping
  - Algorithms, mosaicing, and conflation
- Week 5:
  - Mid-Term
  - Geometric map transformations
- Week 6:
  - Open Source Cartography
  - Generalization and structure-to-structure transformations

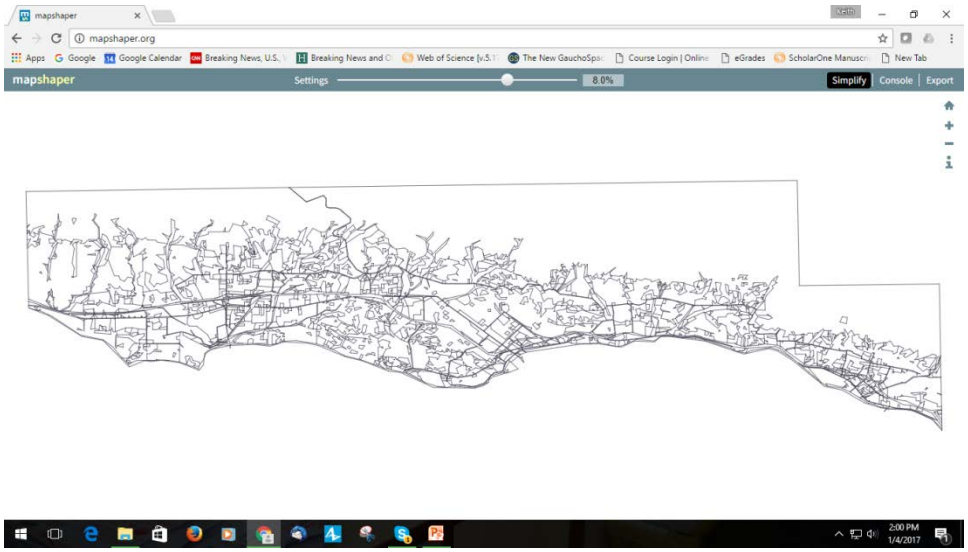
- Week 7:
  - Grids, interpolation and extrapolation
  - Cartography's institutions and past
- Week 8:
  - 3D Mapping and modeling
  - Technical Issues for 3D rendering
- Week 9:
  - The NSDI and A Digital Earth
  - Current research in Analytical Cartography
- Week 10:
  - A selective history of computer cartography, GIS and remote sensing
  - Class summary and review for final

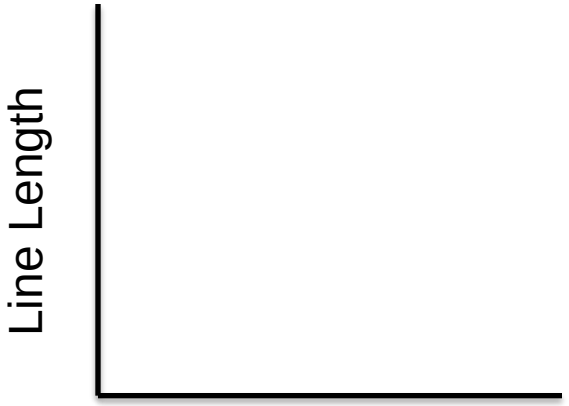
The labs

- Topics: Map projections for grids, the fractal nature of line generalization, terrain analysis and rendering, more terrain analysis
- Software: ArcGIS, MapShaper, MapWindow GIS, Excel, MicroDEM, Landserf (on UNIX server)
- Instruction template as word doc—read carefully!

For example: Map Shaper







What I expect of you

- Stay up to date with the class, readings, lectures labs
- Turn in labs on time
- Do original work
- Ask questions, come to office hours
- Use Gauchospace completely
- Try experiments
- Work hard, but work smart not too hard