

# Final topics to review

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## 1 Matlab commands

- `plot()`
- `subplot()`
- the `.` operator
- the `*` operator
- the `/` operator
- the `+` and `-` operators
- the `^` operator
- the `:` operator
- the left matrix divide `ldivide (\)`
- `shading interp`
- `colormap()`
- `pcolor`
- `contour`
- `surf`
- `meshgrid`
- `mean()`

- median()
- std()
- corrcoef()
- cov()
- whos
- clear
- load
- save
- matlab .mat files, ASCII files, tabular data
- matlab functions
- making a comment (the percent sign operator)
- the transpose operator ( ' )
- tic and toc command

## 2 Topics, up to midterm

- What is modeling and why do we do it?
- The difference between the model and reality
- Greek letters and mathematical symbols (don't try to memorize EVERYTHING, but it wouldn't hurt to know or have written down those items we've used so far or discussed in class)
- Scalars
- Vectors (column vectors and row vectors)
- Matrices
- Summation ( $\Sigma$ )
- Product ( $\Pi$ )

- Transpose of a matrix
- Matrix addition/subtraction/multiplication/etc
- special matrices - identity matrix, zeros, diagonal matrices
- data files (ASCII, binary, text)
- analog vs. digital signals
- discrete vs. continuous signals
- aliasing
- filtering (low pass/high pass)
- two specific low pass filters (moving average 'box' filter, recursive filter), causality issues for each filter
- high pass filter from low pass
- domain and range of a function
- sampling frequency
- resolution
- digital precision
- nyquist frequency
- nyquist rate
- AC/DC components of a signal (not the band)
- what is data visualization?
- color space (RGB, CMY, HSV)
- luminance equation
- false color representation
- colormaps
- color gamuts
- redundant encoding of information
- Supersampling/subsampling

- Hertz
- mean, median, mode, standard deviation, covariance, correlation, variance, trace
- the normal distribution, skew, etc
- linear least squares
- nonlinear least squares
- correlation coefficient
- least square error
- solving  $Ax=b$  (conceptually, not specific steps)
- Inverse of a matrix (qualitative, anything presented)
- interpolation and extrapolation (LERP, SLERP, BERP, TERP)

### 3 Topics, from midterm on

- Lagrange
- Splines concepts - focus on what was presented in class (specifically natural cubic splines)
- Uncertainty
- Error
- Mean-squared error
- Norm-based error
- Simple error
- Difference between model and reality
- Minimization
- Optimization
- Gradient descent concept/algorithm (understand general approach, math details not as central)

- Cost/reward
- Artificial Neural Networks
- Threshold Logic Unit
- Double-edged sword of ANN's
- Neuron Activation
- Perceptrons
- Learning and training
- Perceptron learning rule (aka Perceptron learning algorithm)
- Limitations of a single neuron
- Linearly separable problems
- Binary classification
- Feedforward vs. Feedback systems
- Supervised learning
- Unsupervised learning
- Reinforcement learning
- Typical neural network topologies and applications as presented
- Overfitting
- Generalization
- Regularization strategies and definition
- Validation sets
- Conjugate Gradient descent algorithm concepts/applications
- Associative memory and Hopfield networks
- Synchronous vs. Asynchronous updates of Hopfield network weights
- Different activation functions : Threshold, linear, tanh, sigmoid - uses and general form, meaning, purpose
- Stability of memories, lyapunov functions, failures of ANN's

- What is Intelligence?
- What is artificial intelligence?
- Some AI task domain problems
- Main AI questions to consider
- Physical Symbol System Hypothesis, and Physical Symbol systems
- Knowledge
- Why consider AI concepts/models?
- Turing Test
- AI search
- States, problem space, search space, initial, goal and failure states
- operators
- problem domains
- generate and test searches
- random searches
- breadth and depth first searches
- general concept of heuristic search and other searches in the reading
- relation of search to optimization

## 4 Source material

Focus on topics mentioned in class (ie if there is a massive reading, questions may come from that reading, but topics will be relevant to the lecture)

- Lecture slides
- Lecture notes
- Homeworks
- Handouts from the handouts section of web site

- Readings
- Material from Discussion Sections