Advanced Latex Automation

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October 17, 2015

This presentation has approximately five lines of math in it.
This presentation has approximately 300 lines of code in it.

All of the automation is written in python.
Consider your tools and their limitations.

There are three examples in ascending order of difficulty.

Matrices and Tables

Matrix syntax and table syntax are identical. Consider a file `A.tex`.

```
3.000 & 5.000 & 2.000 \\
1.000 & 6.000 & 2.000 \\
1.000 & 1.000 & 1.000 \\
```

The contents of `A.tex` can be made into a table.

C_1	C_2	C_3
3.000	5.000	2.000
1.000	6.000	2.000
1.000	1.000	1.000

```
\begin{tabular}{c c c}
$C_1$ & $C_2$ & $C_3$ \\
\midrule
\input{pieces/A.tex}
\end{tabular}
```

Simple Problem

Given a linear system A and a resulting output b, find the input x which maps to b through A.

$$Ax = b \tag{1}$$
$$x = A^{-1}b \tag{2}$$

$$\begin{pmatrix} 3.000 & 5.000 & 2.000 \\ 1.000 & 6.000 & 2.000 \\ 1.000 & 1.000 & 1.000 \end{pmatrix} \begin{pmatrix} -1.143 \\ -1.286 \\ 5.429 \end{pmatrix} = \begin{pmatrix} 1.000 \\ 2.000 \\ 3.000 \end{pmatrix} \tag{3}$$

Latex Source for Linear System, Slide 6

```latex
\subsection{Simple Problem}
\begin{frame}
\label{slide/linear_system}
\frametitle{Simple Problem}
Given a linear system $A$ and a resulting output
$b$, find the input $x$ which maps to $b$
through $A$.
\begin{gather}
A x = b \\
x = A^{-1} b \\[2em]
% Notice that A is now a matrix.
\begin{pmatrix}\input{pieces/A.tex}\end{pmatrix}
\begin{pmatrix}\input{pieces/x.tex}\end{pmatrix}
=
\begin{pmatrix}\input{pieces/b.tex}\end{pmatrix}
\end{gather}
\end{frame}
```

Simple Problem Python Code

```python
def simple_problem(outdir):
  A = np.matrix([
    [3, 5, 2],
    [1, 6, 2],
    [1, 1, 1],
    ])
  b = np.matrix([1,2,3]).T
  x = np.linalg.solve(A, b)

  pairs = [(A,"A"), (b,"b"), (x,"x")]
  for v, name in pairs:
    np.savetxt(
      os.path.join(outdir, "{}.tex".format(name)),
      v,
      fmt="%5.3f",
      delimiter=" & ",      # These two lines
      newline=" \\\\\n",    # enable latex inputs.
      )
```

Fourier Synthesis

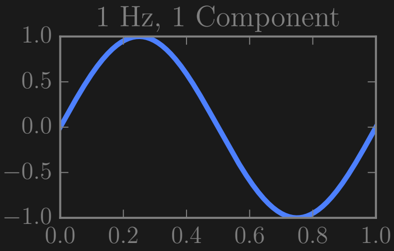
Given a `freq` and a set of `components`, find the sum of the harmonic sinusoids.

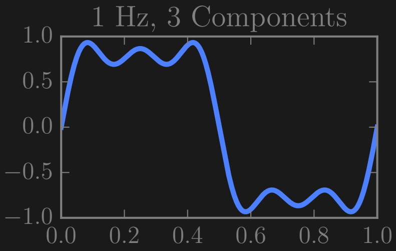
```python
def fourier(freq, components, tlims=[0,1]):
    """
    freq is a number
    components is a list of numbers
    """
    t = np.linspace(*tlims, num=1000)
    y = 0*t
    for n in components:
        y += 1.0/n * np.sin(2*np.pi*(freq*n)*t)
    return t, y
```

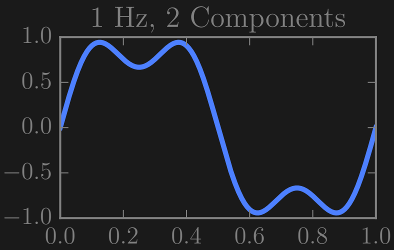
Synthesis of Rectangular Waves

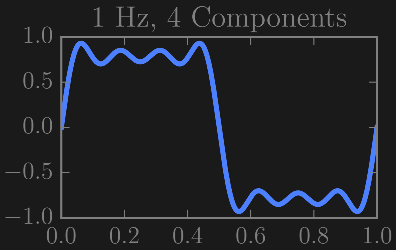
```python
def make_plots():
  freqs = [1,2,3,4,5]
  components = [1,3,5,7,9]
  for freq, num in product(freqs, range(1,6)):
    print(freq, num)

    t, y = fourier(freq, components[:num])

    fig = plt.figure(figsize=[3,2])
    plt.plot(t, y, c=[.3,.5,1], lw=2.5)
    plt.title("{} Hz, {} Component{}".format(
      freq, num, "" if num == 1 else "s"))
    plt.tight_layout()
    plt.savefig("../img/fouriers/{}_{}.pdf".format(
      freq, num))
    plt.close()
```

Closeup of 1Hz Waves

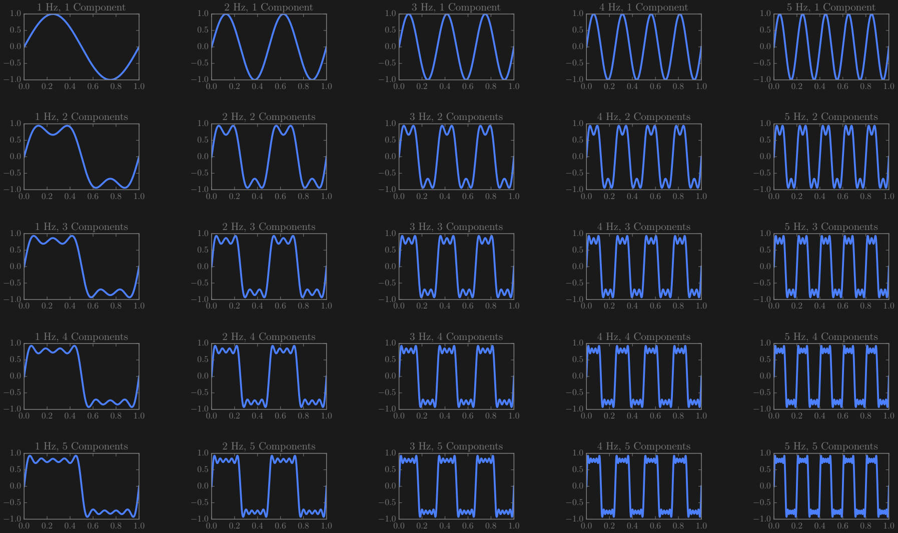








Varying Frequency and Harmonics



Using the Grid

```
if __name__ == "__main__":
  grid(
    indir="../img/fouriers",
    outfile="../tex/pieces/grid.tex",
    C=5, # five columns, all images
    )
  grid(
    indir="../img/fouriers",
    outfile="../tex/pieces/closeup.tex",
    N=4, # four images total
    C=2, # across two columns
    )
```

Writing the Grid

```python
def grid(indir, outfile, C=5, N=None):
  with open(outfile, "w") as fout:

    # print the header
    fout.write(template(header).format(cols=C))

    # print something for each file
    for f in sorted(os.listdir(indir))[:N]:
      fout.write(template(texstring).format(
        name=os.path.join(indir,f),
        ))

    # print the footer
    fout.write(template(footer).format())
```

Pythong String Formatting

```python
string1 = "hello {firstname} {lastname}".format(
  firstname="Ebrahim",
  lastname="Amiri",
  )
string2 = "hello {{{firstname}}} {{{lastname}}}".format(
  firstname="Ittiphong",
  lastname="Leevongwat",
  )
names = [(string1,"amiri"), (string2,"leev")]
for s,n in names:
  outname = "../tex/pieces/{}.tex".format(n)
  with open(outname,"w") as fout:
    fout.write(s)
```

Notice the curly brace differences in `string1` and `string2`. Output is at the top of the next slide. Compare against the standard `printf` function.

Results!

`pieces/amiri.tex`	`hello Ebrahim Amiri`
`pieces/leev.tex`	`hello {Ittiphong} {Leevongwat}`

this slide's source

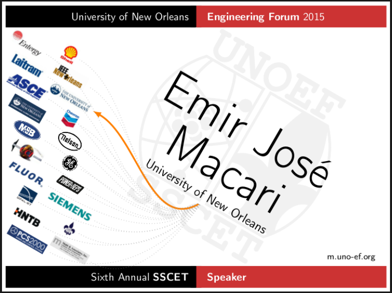
```latex
\newcommand{\pageme}[1]{%
  \begin{minipage}[t][1em]{\linewidth}
  #1 \end{minipage}}    % verbatim
\begin{frame}[fragile] % troubles...
  \frametitle{Results!}
  \begin{tabular}{r | m{0.7\linewidth}}
  \verb|pieces/amiri.tex| & \pageme{%
  \verbatiminput{pieces/amiri.tex}} \\
  \verb|pieces/leev.tex| & \pageme{%
  \verbatiminput{pieces/leev.tex}} \\
  this slide's source &
  \snippet{tex/template_results}
  \end{tabular}
\end{frame}
```

That **template()** Function

Define the sequence `[=[var]=]` as an indication that we want to insert the python variable `var` into a latex string.

```
header = r"""\begin{multicols}{[=[cols]=]}"""
footer = r"""\end{multicols}"""
texstring = r"""
\includegraphics[width=\linewidth]{[=[name]=]}
"""

def template(x):
  y = x.replace("{","{{")
  y = y.replace("}","}}")
  y = y.replace("[=[","{")
  y = y.replace("]=]","}")
  return y
```

Templating Examples from UNOEF

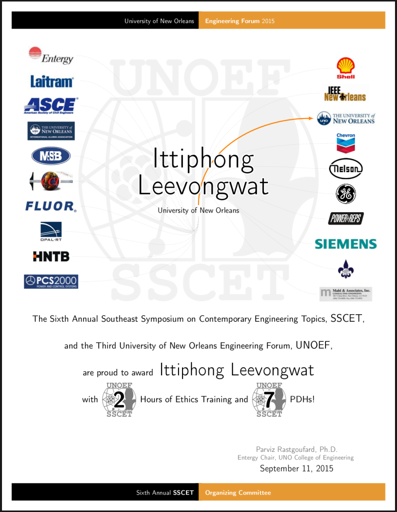

University of New Orleans Engineering Forum 2015

Emir José Macari

University of New Orleans

m.uno-ef.org

Sixth Annual SSCET Speaker


University of New Orleans Engineering Forum 2015

Ittiphong Leevongwat

University of New Orleans

The Sixth Annual Southeast Symposium on Contemporary Engineering Topics, SSCET,

and the Third University of New Orleans Engineering Forum, UNOEF,

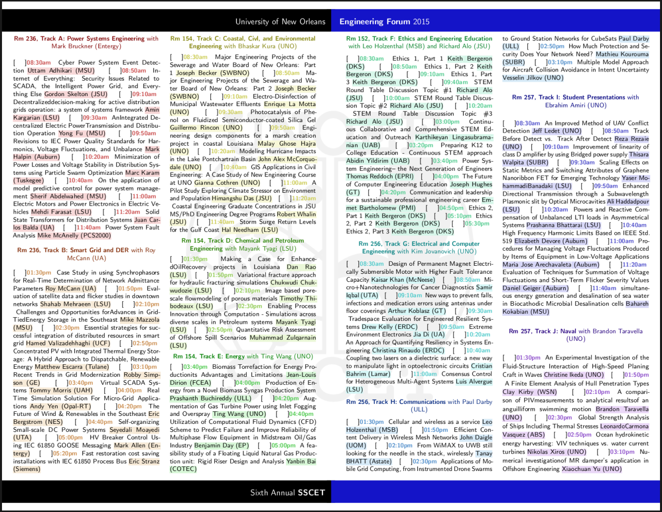
are proud to award Ittiphong Leevongwat

with 2 Hours of Ethics Training and 7 PDHs!

Parviz Rastgoufard, Ph.D.
Entergy Chair, UNO College of Engineering
September 11, 2015

Sixth Annual SSCET Organizing Committee

Templating Examples from UNOEF



University of New Orleans **Engineering Forum** 2015

Rm 236, Track A: Power Systems Engineering with Mark Bruckner (Entergy)

[ ]08:30am Cyber Power System Event Detection Uttam Adhikari (MSU) [ ]08:50am Internet of Everything: Security Issues Related to SCADA, the Intelligent Power Grid, and Everything Else Gordon Skelton (JSU) [ ]09:10am Decentralizeddecision-making for active distribution grids operation: a system of systems framework Amin Kargarian (LSU) [ ]09:30am AnIntegrated Decentralized Electric PowerTransmission and Distribution Operation Yong Fu (MSU) [ ]09:50am Revisions to IEC Power Quality Standards for Harmonics, Voltage Fluctuations, and Unbalance Mark Halpin (Auburn) [ ]10:20am Minimization of Power Losses and Voltage Stability in Distribution Systems using Particle Swarm Optimization Marc Karam (Tuskegee) [ ]10:40am On the application of model predictive control for power system management Sherif Abdelwahed (MSU) [ ]11:00am Electric Motors and Power Electronics in Electric Vehicles Mehdi Farasat (LSU) [ ]11:20am Solid State Transformers for Distribution Systems Juan Carlos Balda (UA) [ ]11:40am Power System Fault Analysis Mike McAnelly (PCS2000)

Rm 236, Track B: Smart Grid and DER with Roy McCann (UA)

[ ]01:30pm Case Study in using Synchrophasors for Real-Time Determination of Network Admittance Parameters Roy McCann (UA) [ ]01:50pm Evaluation of satellite data and flicker studies in downtown networks Shahab Mehraeen (LSU) [ ]02:10pm Challenges and Opportunities forAdvances in Grid-TiedEnergy Storage in the Southeast Mike Mazzola (MSU) [ ]02:30pm Essential strategies for successful integration of distributed resources in smart grid Hamed Valizadehhaghi (UCF) [ ]02:50pm Concentrated PV with Integrated Thermal Energy Storage: A Hybrid Approach to Dispatchable, Renewable Energy Matthew Escarra (Tulane) [ ]03:10pm Recent Trends in Grid Modernization Robby Simpson (GE) [ ]03:40pm Virtual SCADA Systems Tommy Morris (UAH) [ ]04:00pm Real Time Simulation Solution For Micro-Grid Applications Andy Yen (Opal-RT) [ ]04:20pm The Future of Wind & Renewables in the Southeast Eric Bergstrom (NES) [ ]04:40pm Self-organizing Small-scale DC Power Systems Seyedali Moayedi (UTA) [ ]05:00pm HV Breaker Control Using IEC 61850 GOOSE Messaging Mark Allen (Entergy) [ ]05:20pm Fast restoration cost saving installations with IEC 61850 Process Bus Eric Stranz (Siemens)

Rm 154, Track C: Coastal, Civl, and Environmental Engineering with Bhaskar Kura (UNO)

[ ]08:30am Major Engineering Projects of the Sewerage and Water Board of New Orleans: Part 1 Joseph Becker (SWBNO) [ ]08:50am Major Engineering Projects of the Sewerage and Water Board of New Orleans: Part 2 Joseph Becker (SWBNO) [ ]09:10am Electro-Disinfection of Municipal Wastewater Effluents Enrique La Motta (UNO) [ ]09:30am Photocatalysis of Phenol on Fluidized Semiconductor-coated Silica Gel Guillermo Rincon (UNO) [ ]09:50am Engineering design components for a marsh creation project in coastal Louisiana Malay Ghose Hajra (UNO) [ ]10:20am Modeling Hurricane Impacts in the Lake Pontchartrain Basin John Alex McCorquodale (UNO) [ ]10:40am GIS Applications in Civil Engineering: A Case Study of New Engineering Course at UNO Gianna Cothren (UNO) [ ]11:00am A Pilot Study Exploring Climate Stressor on Environment and Population Himangshu Das (JSU) [ ]11:20am Coastal Engineering Graduate Concentrations in JSU MS/PhD Engineering Degree Programs Robert Whalin (JSU) [ ]11:40am Storm Surge Return Levels for the Gulf Coast Hal Needham (LSU)

Rm 154, Track D: Chemical and Petroleum Engineering with Mayank Tyagi (LSU)

[ ]01:30pm Making a Case for EnhancedOilRecovery projects in Louisiana Dan Rao (LSU) [ ]01:50pm Variational fracture approach for hydraulic fracturing simulations Chukwudi Chukwudozie (LSU) [ ]02:10pm Image based pore-scale flowmodeling of porous materials Timothy Thibodeaux (LSU) [ ]02:30pm Enabling Process Innovation through Computation - Simulations across diverse scales in Petroleum systems Mayank Tyagi (LSU) [ ]02:50pm Quantitative Risk Assessment of Offshore Spill Scenarios Muhammad Zulqarnain (LSU)

Rm 154, Track E: Energy with Ting Wang (UNO)

[ ]03:40pm Biomass Torrefaction for Energy Productionits Advantages and Limitations Jean-Louis Dirion (FCEA) [ ]04:00pm Production of Energy from a Novel Biomass Syngas Production System Prashanth Buchireddy (ULL) [ ]04:20pm Augmentation of Gas Turbine Power using Inlet Fogging and Overspray Ting Wang (UNO) [ ]04:40pm Utilization of Computational Fluid Dynamics (CFD) Scheme to Predict Failure and Improve Reliability of Multiphase Flow Equipment in Midstream Oil/Gas Industry Benjamin Day (EP) [ ]05:00pm A feasibility study of a Floating Liquid Natural Gas Production unit: Rigid Riser Design and Analysis Yanbin Bai (COTEC)

Rm 152, Track F: Ethics and Engineering Education with Leo Holzenthal (MSB) and Richard Alo (JSU)

[ ]08:30am Ethics 1, Part 1 Keith Bergeron (DKS) [ ]08:50am Ethics 1, Part 2 Keith Bergeron (DKS) [ ]09:10am Ethics 1, Part 3 Keith Bergeron (DKS) [ ]09:40am STEM Round Table Discussion Topic #1 Richard Alo (JSU) [ ]10:00am STEM Round Table Discussion Topic #2 Richard Alo (JSU) [ ]10:20am STEM Round Table Discussion Topic #3 Richard Alo (JSU) [ ]03:00pm Continuous Collaborative and Comprehensive STEM Education and Outreach Karthikeyan Lingasubramanian (UAB) [ ]03:20pm Preparing K12 to College Education - Continuous STEM approach Abidin Yildirim (UAB) [ ]03:40pm Power System Engineering– the Next Generation of Engineers Thomas Reddoch (EPRI) [ ]04:00pm The Future of Computer Engineering Education Joseph Hughes (GT) [ ]04:20pm Communication and leadership for a sustainable professional engineering career Emmet Bartholomew (PMI) [ ]04:50pm Ethics 2, Part 1 Keith Bergeron (DKS) [ ]05:10pm Ethics 2, Part 2 Keith Bergeron (DKS) [ ]05:30pm Ethics 2, Part 3 Keith Bergeron (DKS)

Rm 256, Track G: Electrical and Computer Engineering with Kim Jovanovich (UNO)

[ ]08:30am Design of Permanent Magnet Electrically Submersible Motor with Higher Fault Tolerance Capacity Kaisar Khan (McNeese) [ ]08:50am Micro+Nanotechnologies for Cancer Diagnostics Samir Iqbal (UTA) [ ]09:10am New ways to prevent falls, infections and medication errors using antennas under floor coverings Arthur Koblasz (GT) [ ]09:30am Tradespace Evaluation for Engineered Resilient Systems Drew Kelly (ERDC) [ ]09:50am Extreme Environment Electronics Jia Di (UA) [ ]10:20am An Approach for Quantifying Resiliency in Systems Engineering Christina Rinaudo (ERDC) [ ]10:40am Coupling two lasers on a dielectric surface: a new way to manipulate light in optoelectronic circuits Cristian Bahrim (Lamar) [ ]11:00am Consensus Control for Heterogeneous Multi-Agent Systems Luis Alvergue (LSU)

Rm 256, Track H: Communications with Paul Darby (ULL)

[ ]01:30pm Cellular and wireless as a service Leo Holzenthal (MSB) [ ]01:50pm Efficient Content Delivery in Wireless Mesh Networks John Daigle (UOM) [ ]02:10pm From WiMAX to UWB still looking for the needle in the stack, wirelessly Tanay BHATT (Astate) [ ]02:30pm Applications of Mobile Grid Computing, from Instrumented Drone Swarms to Ground Station Networks for CubeSats Paul Darby (ULL) [ ]02:50pm How Much Protection and Security Does Your Network Need? Mathieu Kourouma (SUBR) [ ]03:10pm Multiple Model Approach for Aircraft Collision Avoidance in Intent Uncertainty Vesselin Jilkov (UNO)

Rm 257, Track I: Student Presentations with Ebrahim Amiri (UNO)

[ ]08:30am An Improved Method of UAV Conflict Detection Jeff Ledet (UNO) [ ]08:50am Track Before Detect vs. Track After Detect Reza Rezaie (UNO) [ ]09:10am Improvement of linearity of class D amplifier by using Bridged power supply Thisara Walpita (SUBR) [ ]09:30am Scaling Effects on Static Metrics and Switching Attributes of Graphene Nanoribbon FET for Emerging Technology Yaser MohammadiBanadaki (LSU) [ ]09:50am Enhanced Directional Transmission through a Subwavelength Plasmonic slit by Optical Microcavities Ali Haddadpour (LSU) [ ]10:20am Powers and Reactive Compensation of Unbalanced LTI loads in Asymmetrical Systems Prashanna Bhattarai (LSU) [ ]10:40am High Frequency Harmonic Limits Based on IEEE Std. 519 Elizabeth Devore (Auburn) [ ]11:00am Procedures for Managing Voltage Fluctuations Produced by Items of Equipment in Low-Voltage Applications Maria Jose Arechavaleta (Auburn) [ ]11:20am Evaluation of Techniques for Summation of Voltage Fluctuations and Short-Term Flicker Severity Values Daniel Geiger (Auburn) [ ]11:40am simultaneous energy generation and desalination of sea water in Biocathodic Microbial Desalination cells Bahareh Kokabian (MSU)

Rm 257, Track J: Naval with Brandon Taravella (UNO)

[ ]01:30pm An Experimental Investigation of the Fluid-Structure Interaction of High-Speed Planing Craft in Waves Christine Ikeda (UNO) [ ]01:50pm A Finite Element Analysis of Hull Penetration Types Clay Kirby (WSN) [ ]02:10pm A comparison of PIVmeasurements to analytical resultsof an anguilliform swimming motion Brandon Taravella (UNO) [ ]02:30pm Global Strength Analysis of Ships Including Thermal Stresses LeonardoCarmona Vasquez (ABS) [ ]02:50pm Ocean hydrokinetic energy harvesting: VIV techniques vs. water current turbines Nikolas Xiros (UNO) [ ]03:10pm Numerical investigationof MR damper's application in Offshore Engineering Xiaochuan Yu (UNO)

Sixth Annual **SSCET**

Using Snippets

Sometimes, discussion revolves around code snippets. We would like to include these snippets using a simple command.

```
\subsection{Defining Latex Commands}
\begin{frame}
\frametitle{Using Snippets}
Sometimes, discussion revolves around code
snippets.  We would like to include these
snippets using a simple command.
% We want a snippet here!
\snippet{tex/using_snippets}
% Did it work?!?
This slide shows the latex source code to
generate this slide.  (Recursive logic...?)
\end{frame}
```

This slide shows the latex source code to generate this slide. (Recursive logic...?)

Snippet Command

```
% Define the snippet command
\newcommand{\snippet}[1]{\begin{small}%
\input{../code/snippets/#1}\end{small}}

% Redefine the snippet command to work better
% with beamer slides.
\let\oldsnippet\snippet
\renewcommand{\snippet}[1]{%
\begin{center}%
\begin{minipage}{.8\linewidth}%
\oldsnippet{#1}%
\end{minipage}%
\end{center}%
}
```

Pygmentize!

Pygments colors any source code with a variety of possible output formats.

pygmentize -f latex -o output.tex input.tex
pygmentize -f html -o output.html input.tex

The following is an example of calling the command line function from within python. Three optional arguments are specified.

```
    call([
      "pygmentize",
      "-f", "tex",
      "-P", "verboptions={},{},{}".format(
        "numbers=left",
        "numbersep=0.5em",
        "firstnumber={}".format(i)),
      "-o", os.path.join(snipdir, sname + ".tex"),
      inname
      ])
```

Typical Source Code with Snippet

We want to pull out the snippet of code surrounded by "**%$**", which we have defined to be the start and stop markers of **snippets**.

The code on the right is an excerpt from Slide 5, where we showed how to input a matrix from a file into a table.

```
\end{center}
The contents of \verb|A.tex| can be
made into a table. \\[1em]
\begin{minipage}{.45\linewidth}
\centering
%$ simple_table
\begin{tabular}{c c c}
$C_1$ & $C_2$ & $C_3$ \\
\midrule
\input{pieces/A.tex}
\end{tabular}
%$
\end{minipage}
\begin{minipage}{.45\linewidth}
```

Define Patterns to Match

Each file is text. Process each file sequentially line by line.

Look for comments in the code that that have a snippet name preceded by a specific pattern.

%$ snippet_name

Different languages use different comment delimiters, so define a pattern for each language of interest.

```
exts = {
  ".m" : "%$",
  ".py" : "#$",
  ".tex" : "%$",
  }
```

(Python dictionary! The variable `exts[".m"]` contains the text `"%$"`.)

Identifying Snippets

```python
def snipdef(pat, line):
  """Look for snippet definitions on a line."""
  if pat not in line:
    return None
  idx = line.index(pat)
  # If the line starts with pat, then
  # consider it to be a snippet.
  if idx == 0:
    # The snippet's name is everything
    # to the right of pat on this line.
    return line[idx+len(pat):].strip()
  return None # pattern is in line but not snippet
```

Collect Lines for Each Snippet

```python
name, ext = os.path.splitext(fname)
snippets = {} # dict of this file's snippets
with open(fname, "r") as fin:
  sname = "" # sname will be the name of snippet
  for i, line in enumerate(fin.readlines()):
    if snipdef(pat, line) is not None:
      sname = snipdef(pat, line)
      if sname: # beginning of a snippet
        if not sname in snippets:
          # +1 because the code starts
          # on the line after the label.
          # Another +1 because enumerate
          # starts with i at 0.
          snippets[sname] = (i+2, [])
    if sname and snipdef(pat, line) is None:
      snippets[sname][1].append(line)
```

Write Lines of Each Snippet

```
for sname in snippets:
  i, lines = snippets[sname]
  print " ", sname, i, "-", i+len(lines)-1

  fname = sname + ext
  inname = os.path.join(outdir, fname)

  # put snippet in outdir subfolder
  # labeled by extension
  snipdir = os.path.join(outdir,ext[1:])
  mkdir_p(snipdir)
  with open(inname, "w") as fout:
    fout.writelines(lines)
```

Call Pygmentize and Use Snippets

```
    call([
      "pygmentize",
      "-f", "tex",
      "-P", "verboptions={},{},{}".format(
        "numbers=left",
        "numbersep=0.5em",
        "firstnumber={}".format(i)),
      "-o", os.path.join(snipdir, sname + ".tex"),
      inname
      ])
```

```
% Here's this slide's source, an
% example of using snippets!
\begin{frame}
\frametitle{Call Pygmentize and Use Snippets}
\snippet{py/pygmentize}
\snippet{tex/snippet_example}
\end{frame}
```

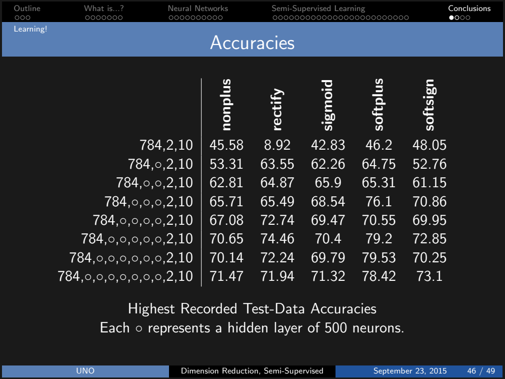
Nothing Left? :D

Parsing Logs

Parsing through source code to find keywords is similar to parsing through log files to find keywords.

Parse logs to generate tabular data in order to avoid needing to make layout decisions in advance.

Having the power to change your mind is **valuable**.



Learning!

Accuracies

	nonplus	rectify	sigmoid	softplus	softsign
784,2,10	45.58	8.92	42.83	46.2	48.05
784,∘,2,10	53.31	63.55	62.26	64.75	52.76
784,∘,∘,2,10	62.81	64.87	65.9	65.31	61.15
784,∘,∘,∘,2,10	65.71	65.49	68.54	76.1	70.86
784,∘,∘,∘,∘,2,10	67.08	72.74	69.47	70.55	69.95
784,∘,∘,∘,∘,∘,2,10	70.65	74.46	70.4	79.2	72.85
784,∘,∘,∘,∘,∘,∘,2,10	70.14	72.24	69.79	79.53	70.25
784,∘,∘,∘,∘,∘,∘,∘,2,10	71.47	71.94	71.32	78.42	73.1

Highest Recorded Test-Data Accuracies
Each ∘ represents a hidden layer of 500 neurons.

Discussion

How often do EE students/professors need to include source code? What about the **listings** package?

How severe is the penalty of making a mistake or having inconsistent documents due to copying and pasting code/figures/tables?

Reproducible Research!

Uses of Latex outside of papers/presentations?

Bonus! Check out those partially-highlighted outlines.

```
\section{Grids of Figures}
\begin{frame}
\tableofcontents[currentsection]
\end{frame}
```

Directory Listing of this Presentation

```
../tex
|-- 2015_10_17_advanced_latex.aux
|-- 2015_10_17_advanced_latex.log
|-- 2015_10_17_advanced_latex.nav
|-- 2015_10_17_advanced_latex.out
|-- 2015_10_17_advanced_latex.pdf
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|-- 2015_UNOEF_Schedule.png
|-- EmirJoseMacari_2015_08_26.png
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|   `-- summary4.tex
`-- Table_Only_2015_09_23_learning.pdf

8 directories, 100 files
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