

# CS4043 Advanced Programming

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# Syllabus

## 1 Course Overview

- Premise
- Note on Programming Languages
- Job Market

## 2 UI/UX

- Overview
- UI
- Tkinter



## 1 Course Overview

- Premise
- Note on Programming Languages
- Job Market

## 2 UI/UX

- Overview
- UI
  - Tkinter

# Course Overview

## Marks Breakdown

- Mid-Term: 30 %
- Final Examination: 40%
- Assignments: 30%

## Assignment Notes

- Use Linux based tools
- If C/C++ (Use GCC)
- Marking Scheme (Typical):
- No assignment submission through email
- I May run through similarity index.

# Complex Software

## Production Process

- ① Customers & Line of Business
- ② Software Development Lifecycles (Design → Develop → Testing → Deploy)

## Deployment Platforms

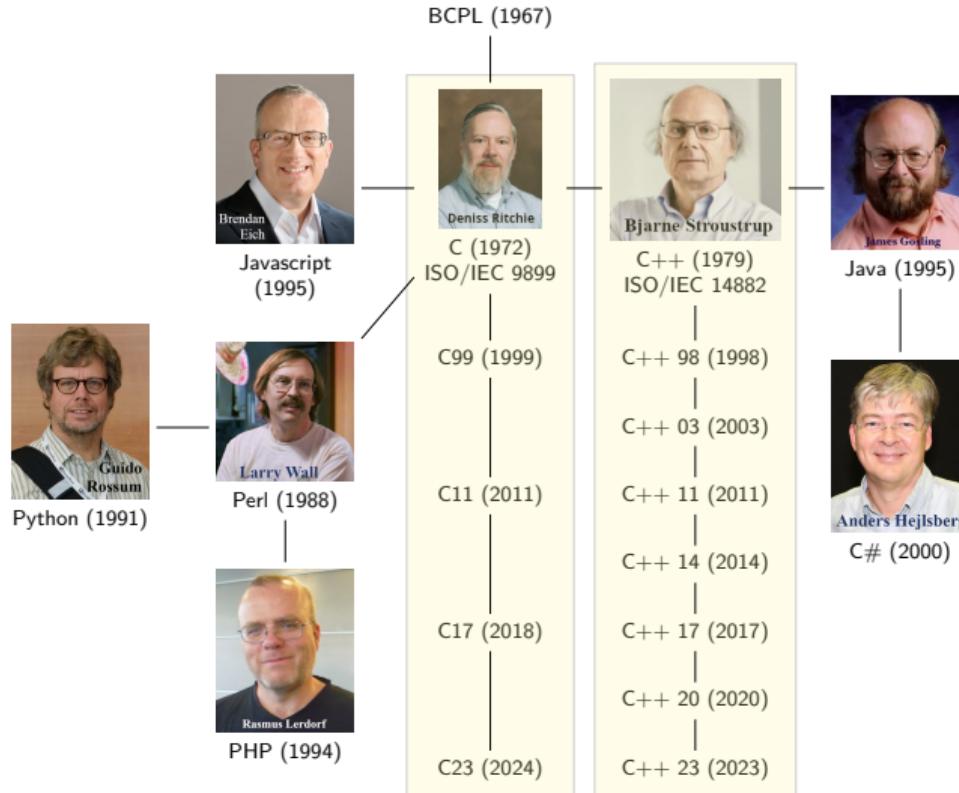
- Standalone Systems
  - Mobile Apps
  - Distributed Software
  - Big Data & Cloud
  - Internet of Things
  - ... Metaverse
- 
- Software Complex than ever (Programming Languages, Data Sources, Integrated Data Types, Software Design, Algorithms, Performance, Group based Development, Security, ...)
  - Solution: Embrace innovation in Programming Languages, Data Handling Methods, Undertake high level design choices, Software Development Frameworks, Development Methodologies, Execution Environments, ... All qualities of a **Software Architect** (job role appears with slight variations in names)

# Complex Software (cont.)

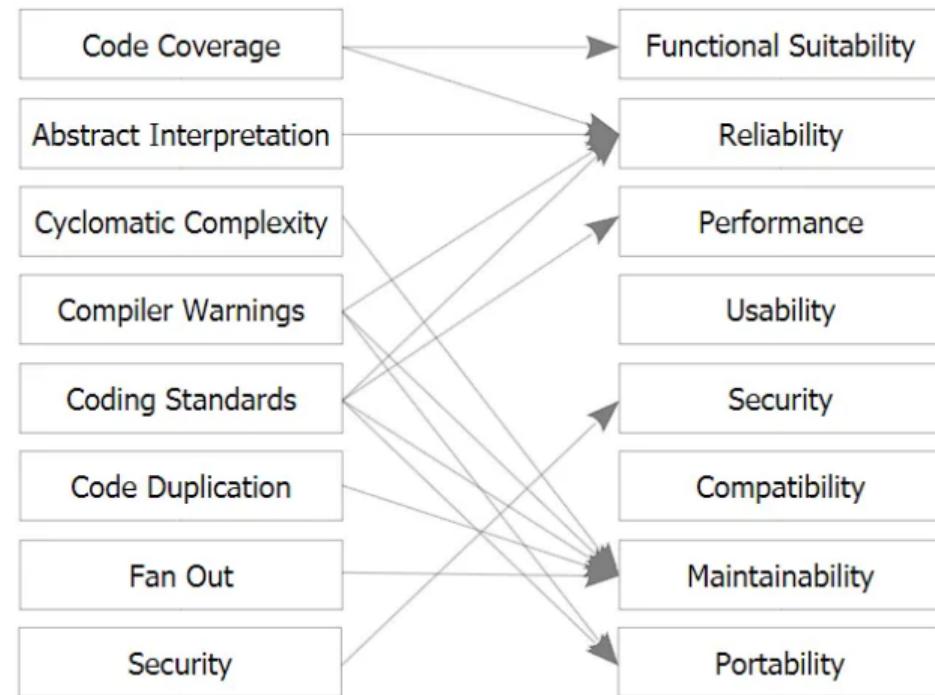
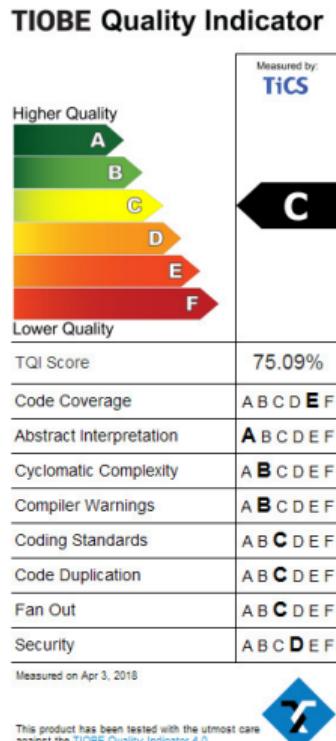


# Programming Languages

# Programming Languages (cont.)



## TIOBE Index (ISO 25010)



# TIOBE Index (ISO 25010) (cont.)

Feb 2022	Feb 2021	Change	Programming Language	Ratings	Change
1	3	▲	Python	15.33%	+4.47%
2	1	▼	C	14.08%	-2.26%
3	2	▼	Java	12.13%	+0.84%
4	4		C++	8.01%	+1.13%
5	5		C#	5.37%	+0.93%
6	6		Visual Basic	5.23%	+0.90%
7	7		JavaScript	1.83%	-0.45%
8	8		PHP	1.79%	+0.04%
9	10	▲	Assembly language	1.60%	-0.06%
10	9	▼	SQL	1.55%	-0.18%
11	13	▲	Go	1.23%	-0.05%
12	15	▲	Swift	1.18%	+0.04%
13	11	▼	R	1.11%	-0.45%
14	16	▲	MATLAB	1.03%	-0.03%
15	17	▲	Delphi/Object Pascal	0.90%	-0.12%
16	14	▼	Ruby	0.89%	-0.35%
17	18	▲	Classic Visual Basic	0.83%	-0.18%
18	20	▲	Objective-C	0.81%	-0.08%
19	19		Perl	0.79%	-0.13%
20	12	▼	Groovy	0.74%	-0.76%

Jun 2024	Jun 2023	Change	Programming Language	Ratings	Change
1	1		Python	15.39%	+2.83%
2	3	▲	C++	10.03%	-1.33%
3	2	▼	C	9.23%	-3.14%
4	4		Java	8.40%	-2.88%
5	5		C#	6.65%	-0.06%
6	7	▲	JavaScript	3.32%	+0.51%
7	14	▲	Go	1.93%	+0.93%
8	9	▲	SQL	1.75%	+0.28%
9	6	▼	Visual Basic	1.66%	-1.67%
10	15	▲	Fortran	1.53%	+0.53%
11	11		Delphi/Object Pascal	1.52%	+0.27%
12	19	▲	Swift	1.27%	+0.33%
13	10	▼	Assembly language	1.26%	-0.03%
14	12	▼	MATLAB	1.26%	+0.14%
15	8	▼	PHP	1.22%	-0.52%
16	13	▼	Scratch	1.17%	+0.15%
17	20	▲	Rust	1.17%	+0.26%
18	18		Ruby	1.11%	+0.17%
19	29	▲	Kotlin	1.01%	+0.50%
20	22	▲	COBOL	0.96%	+0.22%

By the Way ...



## Frameworks vs Libraries

- Both provide reusable abstractions of code, wrapped in well defined API
- Libraries: Flow of control dictated by caller (software calls library)
- Frameworks: Flow of control dictated by Framework (Framework drives software)

### Framework Examples

- General Software: .NET, Android SDK, ...
- GUI Based: Gnome, QT, ...
- Web Based: ASP.Net, ...
- Concurrency: Hadoop Map/Reduce, ...
- ...

## Jobs (Pakistan) 2022-2023 Source: P@sha

 1 JavaScript Fullstack (MEAN/MERN)	 2 .NET	 3 React Native (Hybrid)	 4 Android - JAVA	 5 PHP (Laravel/CodeIgnitor/Yii/Zend/Drupal)	 6 Python	 7 Flutter (Hybrid)
 7 iOS - Objective C & SWIFT	 9 AWS Developer- Associate	 10 Java	 11 MICROSOFT SQL	 12 Unity	 13 Selenium	 13 Microsoft Certified: Azure Fundamentals
 15 Postgres	 16 Redis/ElasticSearch AWS	 16 Agile Certified Practitioner PMI-ACP	 18 Professional Scrum Master™ PSM	 19 Ruby on Rails	 20 Salesforce	

Figure 1: P@sha Top In-Demand Technologies &amp; Tools

# Jobs (Pakistan) 2022-2023 Source: P@sha (cont.)

## Hiring Resources (Next 6-8 Months)

Following are future top 20 in-demand technologies & tools nationwide keeping in mind the current technology trends.

A total of **19,451 resources** will be hired in next 6-8 months for the **42 technology tracks** mentioned in the survey.

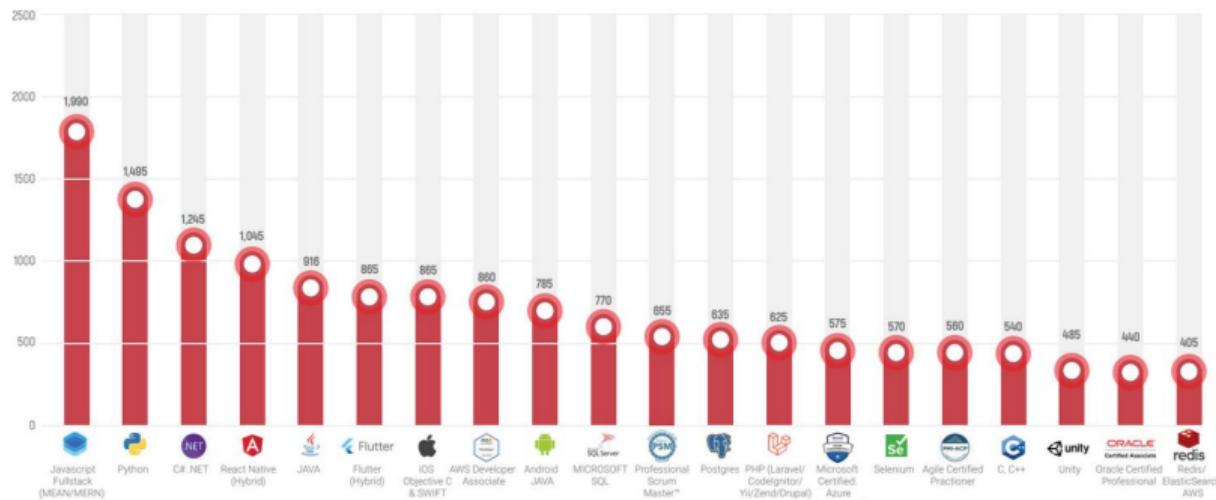


Figure 2: Next 6-8 Months Job Market

## Jobs (Pakistan) 2022-2023 Source: P@sha (cont.)


Figure 3: Participating Companies List A

## Jobs (Pakistan) 2022-2023 Source: P@sha (cont.)

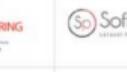
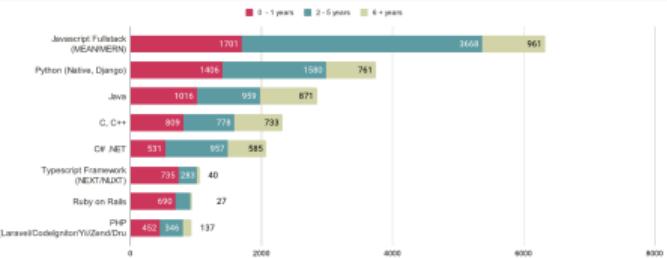
							
							
							
							
							
							
							

Figure 4: Participating Companies List B

# Jobs (Pakistan) 2023-2024 Source: P@sha

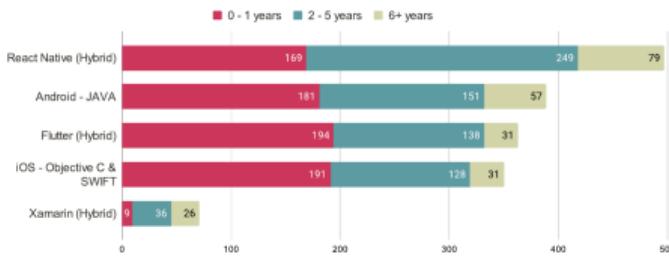
## Resources Required Web Engineering Job Roles

A total of **20,250 resources** are required in the 'Web Engineering' roles with the highest demand for **Javascript Fullstack (MEAN/MERN)**.



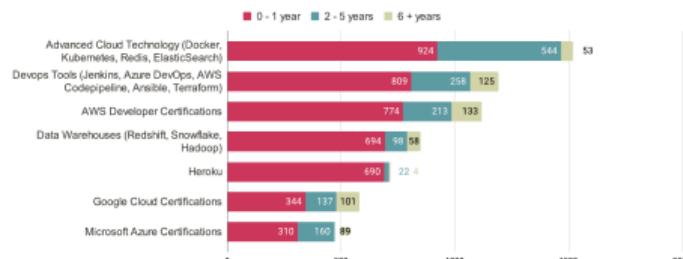
## Resources Required Mobile Development Job Roles

A total of **1,670 resources** are required in the 'Mobile Development' roles with the highest demand for **React Native (Hybrid)**.



## Resources Required Cloud Infrastructure - Tool / Certification

A total of **6,540 resources** are required in the 'Cloud Infrastructure - Tool / Certification' roles with the highest demand for **Advanced Cloud Technology (Docker, Kubernetes, Redis, ElasticSearch)**.



## Resources Required Automation & Software Testing - Tool / Certification

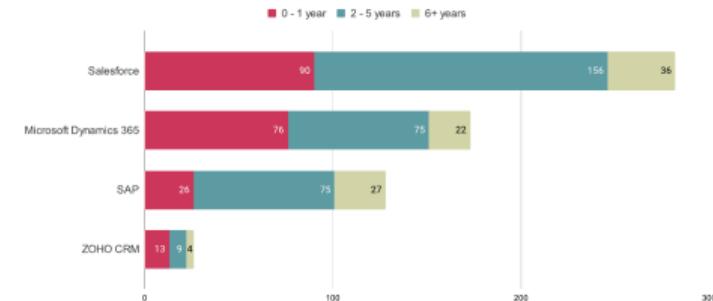
A total of **2125 resources** are required in the 'Automation & Software Testing - Tool/Certification' roles with the highest demand for **Selenium**.



# Jobs (Pakistan) 2023-2024 Source: P@sha (cont.)

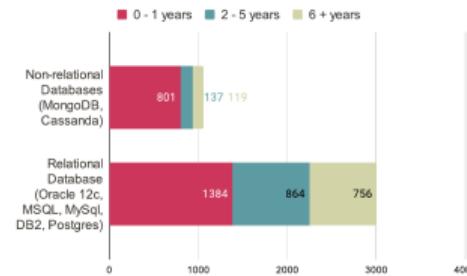
## Resources Required CRM Tool

A total of **609 resources** are required in the 'CRM Tool' roles with the highest demand for **Salesforce**.



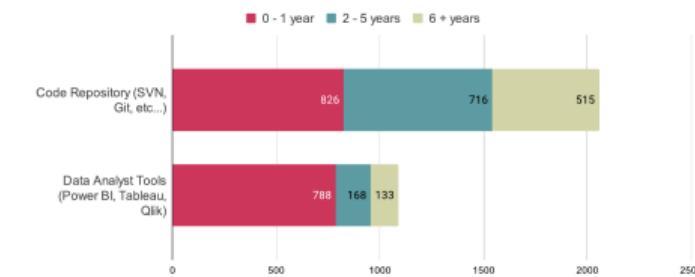
## Resources Required Database Job Roles

A total of **4061 resources** are required in the 'Database' roles with the highest demand for **Relational Database**.



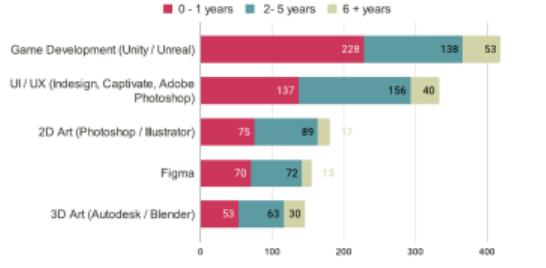
## Resources Required Programming and Data Analyst

A total of **3146 resources** are required in the programming and data analyst domain with the highest demand for **Code Repository (SVN, Git, etc...)**



## Resources Required Animation, Graphic, Games – 3D Engine/Tool

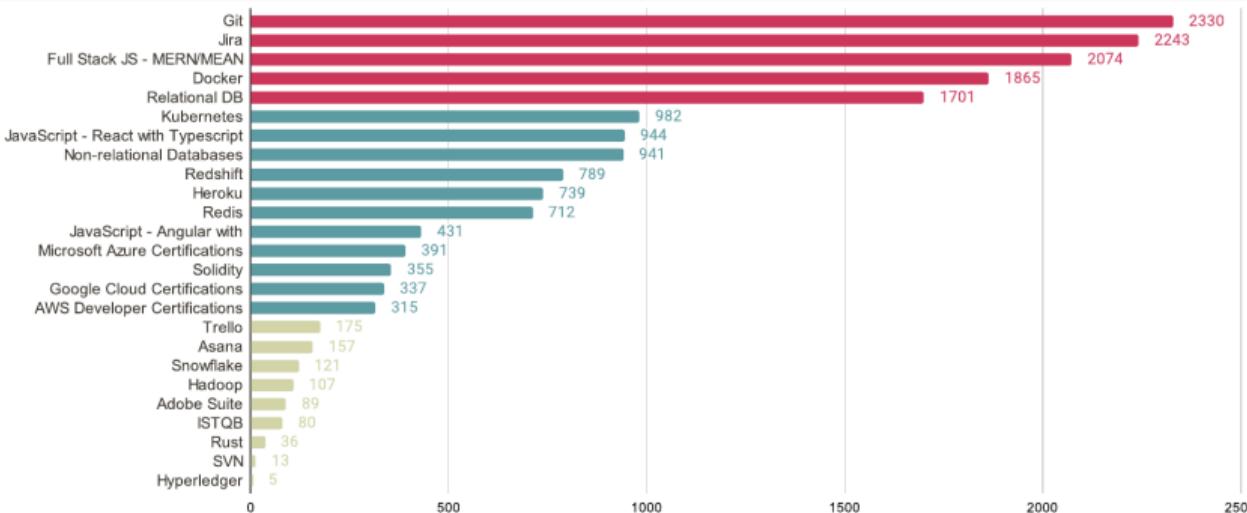
A total of **1234 resources** are required in the 'Animation, Graphic, Games – 3D Engine/Tool' with the highest demand for **Game Development (Unity/Unreal)**.



## Jobs (Pakistan) 2023-2024 Source: P@sha (cont.)

## Resources Required Major tools & technologies for the Upskilling of Employees

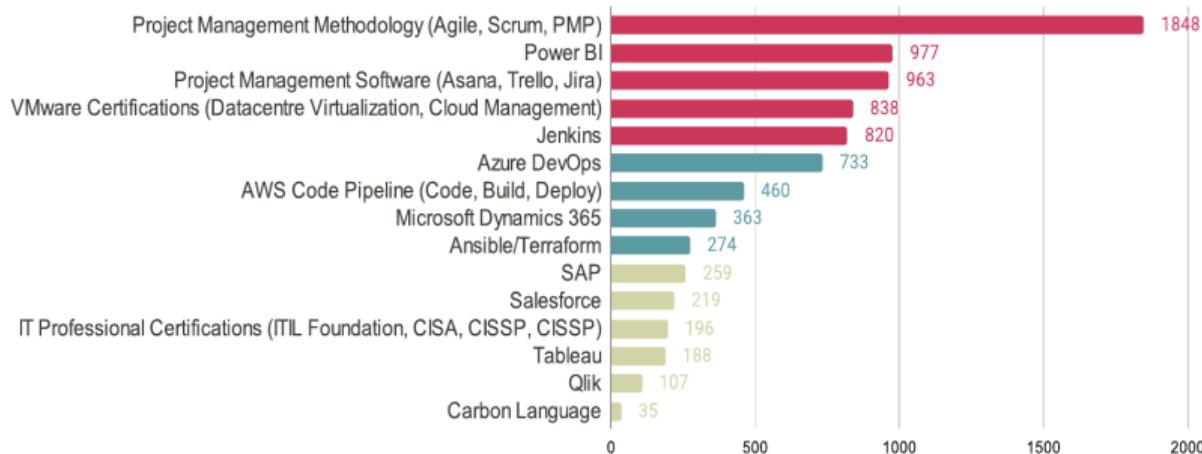
A total of **17,932 resources** are required in following tools & technologies for upskilling of employees with highest demand for **Git**.



# Jobs (Pakistan) 2023-2024 Source: P@sha (cont.)

## Resources Required - Major tools & technologies for the Reskilling of Employees

A total of **8,280** resources are required in following tools & technologies for reskilling of employees with highest demand for '**Project Management Methodology (Agile, Scrum, PMP)**'



# Homework Task 1

## Task Juggler

Use Task Juggler to create a Financial Proposal, and Project Gantt Chart for your Final Year Project

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# UI/UX Overview

## UI

- UID: Design of **UI's** for machines and softwares, with focus on maximizing **usability** and **user experience**
- UI: Visual elements of a product, adaptable to different views (mobile, tablet, computer, ...)
- *Makes the interface beautiful*
- UI Designer: Typography, Colors, Styles, Branding, Spacing/Layouts, Number of items, Icons, Images, ...

## UX

- UXD: Study user behaviour (usability, usefulness) and understanding user motivations (desirability) in the interaction with a product, with goal of maximizing digital experiences.
- *Makes the UI useful*
- UX Designer: Interaction design, Wireframes/Prototypes, Information architect, user research, personas, scenarios, ...

## UI/UX Overview (cont.)



# UI/UX Overview (cont.)

## Don Norman

American Researcher

Overview

Books

Videos



N Nielsen Norman Group

Don Norman, co-founder and board member of Nielsen ...

Don Norman, Ph.D., is co-founder and board member of Nielsen Norman Group: User Experience Research, Training, and...

Age

88 years

25 Dec 1935

Known for

The Design of Everyday Things; Cognitive er-...



# UI/UX Overview (cont.)

## Jakob Nielsen

Danish consultant

Overview

Books

Videos



Age

66 years  
5 Oct 1957

Parents >  
Gerhard Nielsen, Helle Höpfner Nielsen

NN Nielsen Norman Group

Jakob Nielsen, Ph.D. and Principal at Nielsen Norman Group

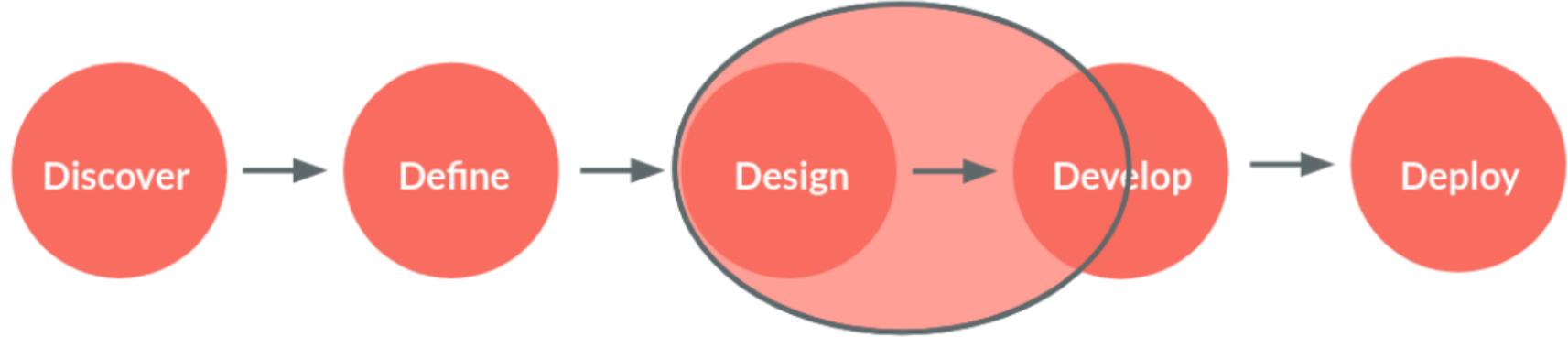
Biography: Jakob Nielsen, Ph.D., is a usability advocate and retired principal of the Nielsen Norman Group: User...

YouTube • NNgroup  
The NN/g UX Podcast

EPISODE 1  
What is UX,  
anyway?  
16:53



# UI/UX Design Process



## Design

- Iterate (Information Architecture: Personas & User Research, Storyboards, Wireframes)
- Prototype (Visual Design & Layout, Interaction Design, Accessibility)
- Test (Usability Testing, A/B Testing)

## UI/UX Design Process (cont.)

## Develop (Front-end)

- Responsive Layouts
  - Behavior (React/Angular)
  - ...

# Sophie March



**Bio**

Sophie March is a 28-year-old marketing executive based in Beijing. She has been in China for five years, initially working as a translator for a local company before transitioning into marketing. Sophie is known for her creative and analytical skills, often coming up with innovative solutions to complex problems. She is also a avid traveler and enjoys exploring the city's rich history and diverse culture.

**Goals - Interest**

- Traveling and experiencing new cultures while staying safe and healthy.
- Learning more about Chinese culture and history, particularly the ancient dynasties and their impact on modern society.
- Developing her skills in digital marketing and learning new software and techniques.
- Volunteering at local charities to give back and make a positive impact.
- Exploring traditional Chinese medicine approaches to staying fit.

**Pain Points - Concerns**

- Sophie is acutely aware of the challenges faced by women in business, particularly in a non-native country like China. She is concerned about how to balance work and personal life effectively.
- The high cost of living in Beijing is a significant concern, especially given her relatively modest salary.
- The social dynamics of different cultures and their impact on professional relationships can sometimes pose a challenge.
- Balancing work, family, and personal interests can be overwhelming at times.

**Motivations**

- Curiosity
- Adventure
- Creativity
- Health & Fitness

**Personality**

- Intense
- Idealistic
- Positive
- Passionate

**Brands**

**Dr. Martens**

## Top of Form Validation



## Inline Validation



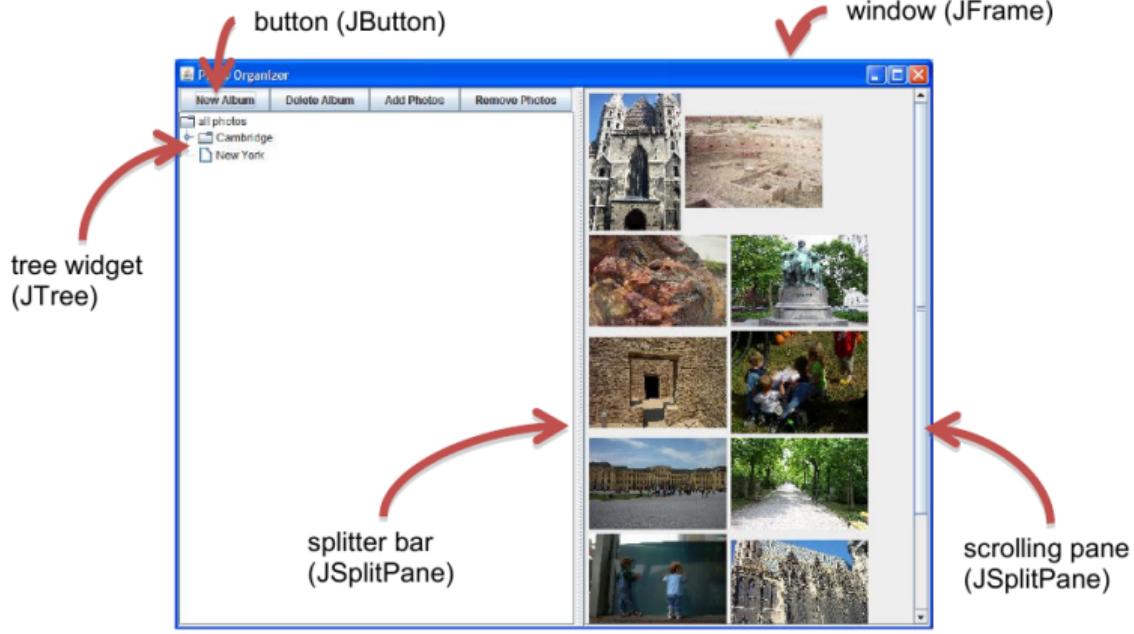
# UI/UX Design Process (cont.)

## UI Frameworks

- Python: Tkinter, PyQt, PyGTK, wxPython, ...
- C/C++: TCL/TK, GTK (Gnome), QT, WxWidgets, NCurses, Flutter (Google), ...
- Java: Swing, JavaFX, ...

## Visual Elements in a Tree (View Tree)

- GUI's composed of View Objects; Each occupying certain portion of screen (covering a rectangular area = bounding box)
- View Objects arranged into a hierarchy of Containment (views inside other views)
  - Examples of Containers: Window, Panel, Toolbar, etc.
  - Child views are nested inside parent's bounding box
- Primitive Views (Do not contain other Views)
  - Buttons, Trees, Textbox, Thumnail, etc.
- View Objectives can be composited / grouped / joined together



## Visual Elements in a Tree (View Tree) (cont.)

```
1  <?xml version="1.0" encoding="UTF-8"?>LF
2  <ui version="4.0">LF
3  <class>Dialog</class>LF
4  <widget class="QDialog" name="Dialog">LF
69 <resources/>LF
70 <connections>LF
71 <connection>LF
72   <sender>buttonBox</sender>LF
73   <signal>accepted()</signal>LF
74   <receiver>Dialog</receiver>LF
75   <slot>accept()</slot>LF
76   <hints>LF
77     <connection>LF
78       <sender>buttonBox</sender>LF
79       <signal>rejected()</signal>LF
80       <receiver>Dialog</receiver>LF
81       <slot>reject()</slot>LF
82     <hints>LF
83       <hint type="sourcelabel">LF
84         <hint type="destinationlabel">LF
85           <x>286</x>LF
86           <y>274</y>LF
87         </hint>LF
88       </hints>LF
89     </connection>LF
90   </connections>LF
91 </ui>
```

Figure 5: QT GUI as XML Tree

## Visual Elements in a Tree (View Tree) (cont.)

### View Object Properties (Layout)

- Arrangement of bounding boxes of each view object arranged on the basis of a layout.
- May involves information about position and size of view objects

### View Object Properties (Output)

- Each View Object responsible for displaying itself
- Associated with a thread
- If Tree changes, so will its child nodes

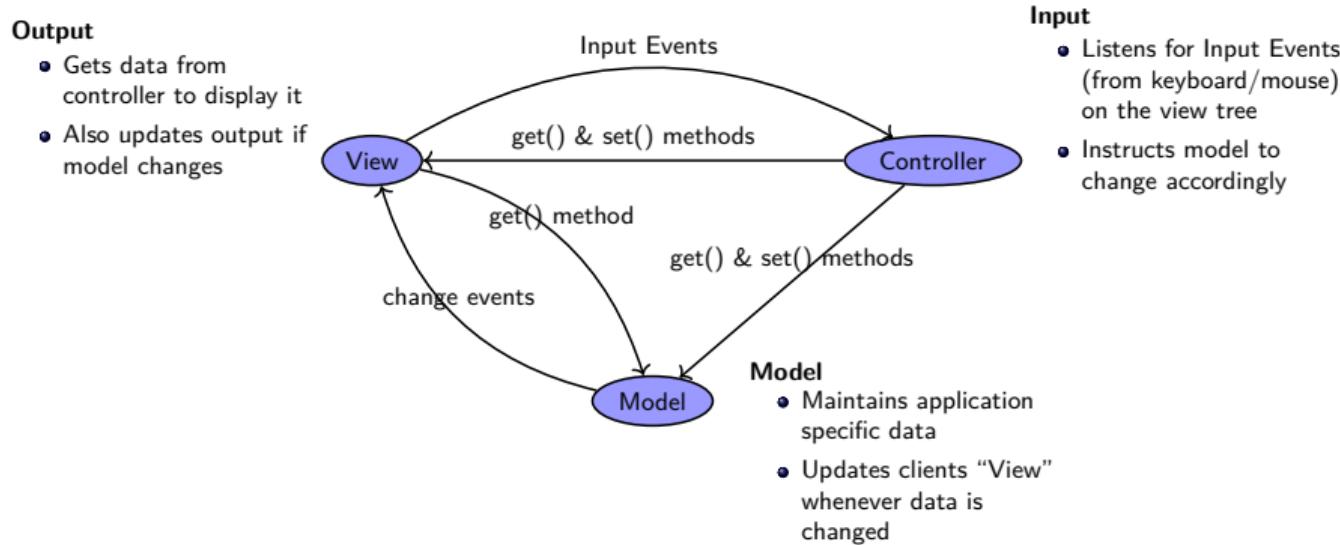
## Visual Elements in a Tree (View Tree) (cont.)

### View Object Properties (Input)

- Enabled View Objects can listen for input from Keyboard and Mouse using additional threads
  - Event Object** Contains information about an event
  - Event Source** The component where an event is generated
  - Event Listener** A listener is created which records an interest to the particular stream of events. It then listens for the event.
  - Event Handler** What to do when an event occurs (User Defined) A function is called whenever a new event occurs.

# Model View Controller (MVC)

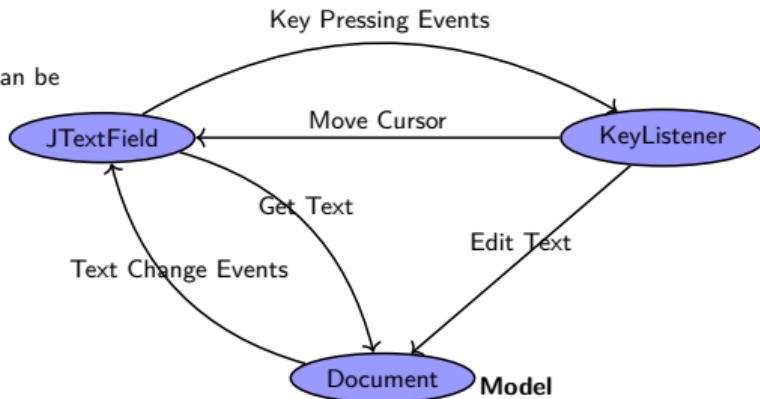
- A software architecture pattern for GUI's (initially) and Web Services
- Introduced in 1970's
- Separates GUI front-end from application back-end
  - Back-end code = Model
  - Front-end code = View, Controller



## Model View Controller (MVC) (cont.)

### Output

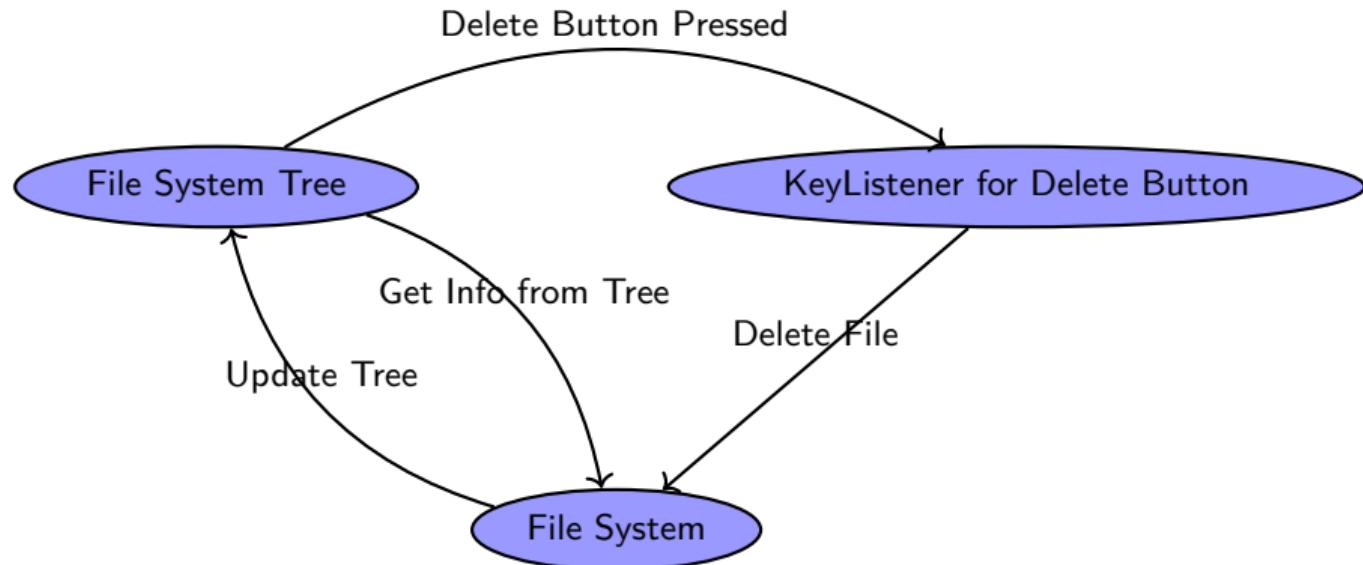
- JTextField is a Jcomponent that can be added to the view hierarchy



### Input

- KeyListener is a listener for Keyboard Events

## Model View Controller (MVC) (cont.)



## Model View Controller (MVC) (cont.)

### Benefits of Separating Model from View

- Many views of same application data possible
- Allows for creating user interface toolkits (view toolkits, completely separate from the application data)

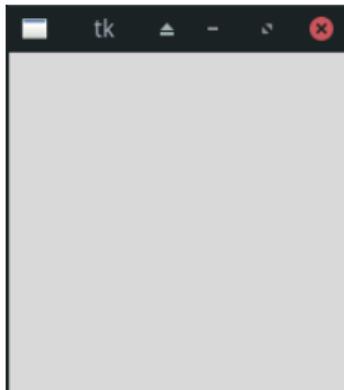
# Tkinter

- Python interface to TK (GUI tool for TCL/TK)
- Standard GUI Library in Python (bundled)
- Object Oriented Approach
- Elements represent MOTIF components (non-native components)



# Hello World

```
import tkinter
root = tkinter.Tk()
# Widget Codes
root.mainloop()
```



## Bypassing WM

```
screen_width = str(root.winfo_screenwidth())
screen_height = str(root.winfo_screenheight())

root.geometry(screen_width+"x"+screen_height+"+0+0")
print(root.winfo_geometry())
print(root.winfo_width(), root.winfo_height())

root.overrideredirect(True)
```

## Top Level

```
t1 = Toplevel(root)
t2 = Toplevel(root)
t2.transient(root)
```

## Frames

```
for relief in [RAISED, SUNKEN, FLAT, RIDGE, GROOVE, SOLID]:
    f = Frame(root, borderwidth=2, relief=relief)
    Label(f, text=relief, width=10).pack(side=LEFT)
    f.pack(side=LEFT, padx=5, pady=5)
```



## Common Widgets

```
Label(root, text="Label Text", wraplength=300,
      justify=LEFT).pack()

Button(root, text="Go1", command=go1func).pack()
Button(root, text="Go2", command=go2func()).pack()

e = StringVar()
Entry(root, width=40, textvariable=e).pack()
```

# Hello World (cont.)

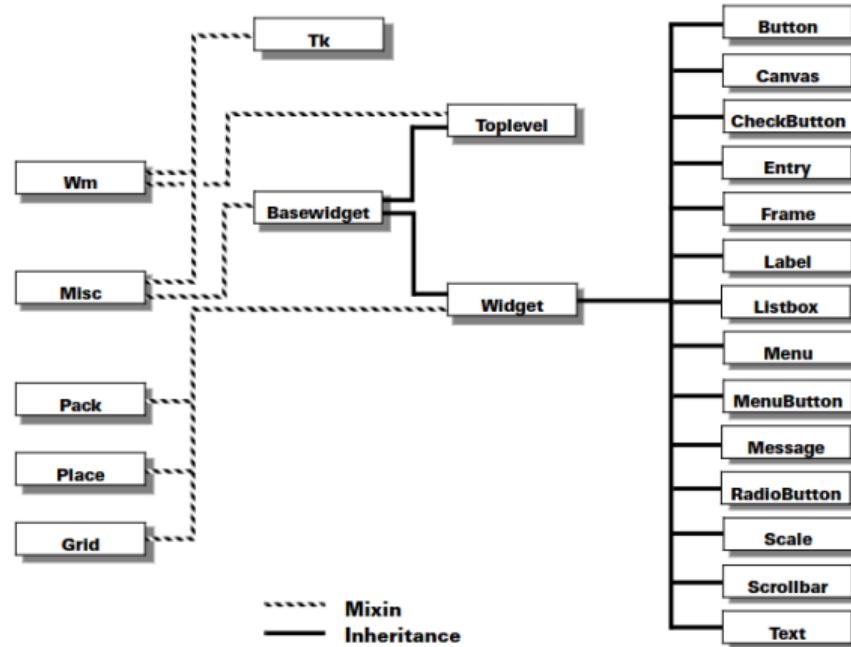
```

print(dir(root))
'''['_Misc__winfo_getint', '_Misc__winfo_parseitem', '__class__', '__delattr__', '__dict__', '__dir__', '__doc__', '__eq__', '__format__', '__ge__', '__getattr__', '__getattribute__', '__getstate__', '__gt__', '__hash__', '__init__', '__init_subclass__', '__le__', '__lt__', '__module__', '__ne__', '__new__', '__reduce__', '__reduce_ex__', '__repr__', '__setattr__', '__setitem__', '__sizeof__', '__str__', '__subclasshook__', '__weakref__', '__bind__', '__configure__', '_displayof', '_getboolean', '_getconfigure', '_getconfigure1', '_getdoubles', '_getints', '_grid_configure', '_gridconvalue', '_last_child_ids', '_loadtk', '_nametowidget', '_noarg_', '_options', '_register', '_report_exception', '_root', '_subst_format', '_subst_format_str', '_substitute', '_tclCommands', '_tkloaded', '_unbind', '_w', '_windowingsystem', 'after', 'after_cancel', 'after_idle', 'anchor', 'aspect', 'attributes', 'bbox', 'bell', 'bind', 'bind_all', 'bind_class', 'bindtags', 'cget', 'children', 'client', 'clipboard_append', 'clipboard_clear', 'clipboard_get', 'colormapwindows', 'columnconfigure', 'command', 'config', 'configure', 'deiconify', 'deletecommand', 'destroy', 'event_add', 'event_delete', 'event_generate', 'event_info', 'focus', 'focus_displayof', 'focus_force', 'focus_get', 'focus_lastfor', 'focus_set', 'focusmodel', 'forget', 'frame', 'geometry', 'getboolean', 'getdouble', 'getint', 'getvar', 'grab_current', 'grab_release', 'grab_set', 'grab_set_global', 'grab_status', 'grid', 'grid_anchor', 'grid_bbox', 'grid_columnconfigure', 'grid_location', 'grid_propagate', 'grid_rowconfigure', 'grid_size', 'grid_slaves', 'group', 'iconbitmap', 'iconify', 'iconmask', 'iconname', 'iconphoto', 'iconposition', 'iconwindow', 'image_names', 'image_types', 'info_patchlevel', 'keys', 'lift', 'loadtk', 'lower', 'mainloop', 'manage', 'master', 'mazzize', 'minsize', 'nametowidget', 'option_add', 'option_clear', 'option_get', 'option_readfile', 'overrideredirect', 'pack_propagate', 'pack_slaves', 'place_slaves', 'positionfrom', 'propagate', 'protocol', 'quit', 'readprofile', 'register', 'report_callback_exception', 'resizable', 'rowconfigure', 'selection_clear', 'selection_get', 'selection_handle', 'selection_own', 'selection_own_get', 'send', 'setvar', 'size', 'sizefrom', 'slaves', 'state', 'title', 'tk', 'tk_bisque', 'tk_focusFollowsMouse', 'tk_focusNext', 'tk_focusPrev', 'tk_setPalette', 'tk_strictMotif', 'tkraise', 'transient', 'unbind', 'unbind_all', 'unbind_class', 'update', 'update_idletasks', 'wait_variable', 'wait_visibility', 'wait_window', 'waitvar', 'winfo_atom', 'winfo_atomname', 'winfo_cells', 'winfo_children', 'winfo_class', 'winfo_colormapfull', 'winfo_containing', 'winfo_depth', 'winfo_exists', 'winfo_fpixels', 'winfo_geometry', 'winfo_height', 'winfo_id', 'winfo_interps', 'winfo_ismapped', 'winfo_manager', 'winfo_name', 'winfo_parent', 'winfo_pathname', 'winfo_pixels', 'winfo_pointerx', 'winfo_pointery', 'winfo_pointerx', 'winfo_reqheight', 'winfo_reqwidth', 'winfo_rgb', 'winfo_rootx', 'winfo_rooty', 'winfo_screen', 'winfo_screencells', 'winfo_screendepth', 'winfo_screenheight', 'winfo_screenmmheight', 'winfo_screenmmwidth', 'winfo_screenvisual', 'winfo_screenwidth', 'winfo_server', 'winfo_toplevel', 'winfo_viewable', 'winfo_visual', 'winfo_visualid', 'winfo_visualsavailable', 'winfo_vrootheight', 'winfo_vrootwidth', 'winfo_vrootx', 'winfo_vrooty', 'winfo_width', 'winfo_x', 'winfo_y', 'withdraw', 'wm_aspect', 'wm_attributes', 'wm_client', 'wm_colormapwindows', 'wm_command', 'wm_deiconify', 'wm_focusmodel', 'wm_forget', 'wm_frame', 'wm_geometry', 'wm_grid', 'wm_group', 'wm_iconbitmap', 'wm_iconify', 'wm_iconmask', 'wm_iconname', 'wm_iconphoto', 'wm_icomposition', 'wm_iconwindow', 'wm_manage', 'wm_maxsize', 'wm_minsize', 'wm_overrideredirect', 'wm_positionfrom', 'wm_protocol', 'wm_resizable', 'wm_sizefrom', 'wm_state', 'wm_title', 'wm_transient', 'wm_withdraw']'''

print(root.winfo_children())                                # [<tkinter.Label object .!label>, <tkinter.Button object .!button>]

```

# Library Structure



## Class Based GUI

```
class GUI:  
    def __init__(self, master):  
        self.root = master  
        self.root.title("Class based version")  
  
root = tkinter.Tk()  
my_gui = GUI(root)  
root.mainloop()
```

## Radio Buttons

```
var = IntVar()  
for text, value in [('Passion fruit', 0), ('Loganberries', 1), ('Mangoes in syrup', 2)]:  
    Radiobutton(root, text=text, value=value, variable=var, command=radiogo).pack()  
  
def radiogo():  
    r = var.get()
```

## Check Buttons

```
var = [IntVar() for i in range(3)]
for text, value in [('Passion fruit', 0), ('Loganberries', 1), ('Mangoes in syrup', 2)]:
    Checkbutton(root, text=text, variable=var[value], command=checkgo).pack()

def checkgo():
    r1 = var[0].get()
    r2 = var[1].get()
    r3 = var[2].get()
```

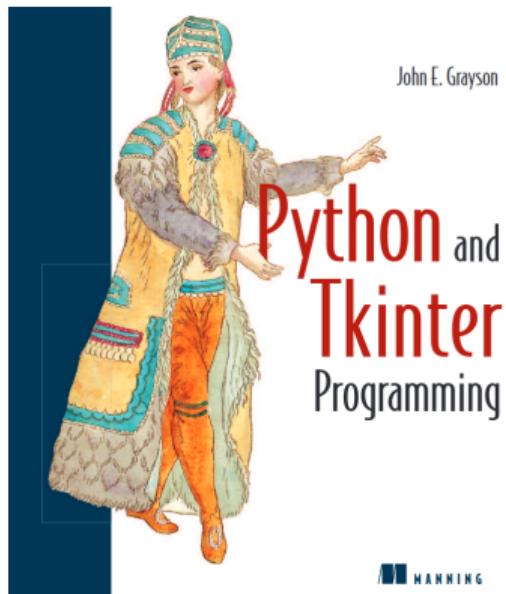
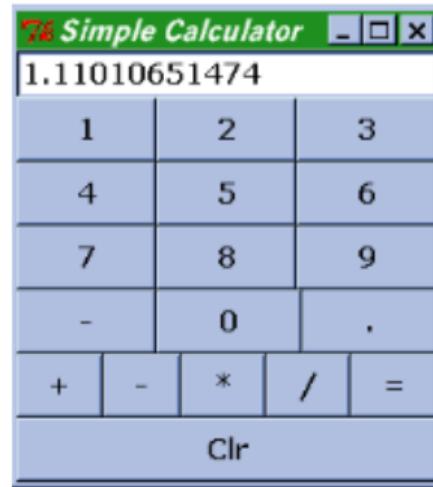


Figure 6: Reading List: Refer to Section 4.1



## Homework Task 2

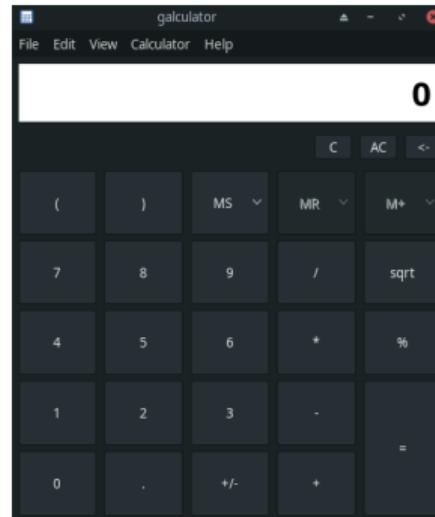


Figure 7: Modify the provided calc.py code to create this layout