6.1800 Spring 2024
Lecture #1: Complexity, modularity, abstraction
plus an intro to client/server models
we care about you as people more than we care about any deadline

if you need help, ask for it. we need to balance the needs of a large group of students and the needs of the staff, but we will work with you to help as much as we can. in particular, as long as you reach out to your TA ahead of time, we will give you a 24-hour extension on any assignment, no questions asked.
what is a system?
“a set of interconnected components that has an expected behavior observed at the interface with its environment.”

what makes building systems difficult?
complexity

why do we care?
complexity limits what we can build
why do we care?
complexity \textbf{limits} what we can build

how do we mitigate complexity?
with design principles such as \textbf{modularity} and \textbf{abstraction}

how do we enforce modularity?
\textit{one} way is to use a \textbf{client/server model}

the browser is the client in this example

\begin{minipage}{0.45\textwidth}
\textbf{Class Browser}
(on machine 1)
\begin{verbatim}
def main():
    html = browser_load_url(URL) ...

def browser_load_url(url):
    msg = url # could reformat
    send request
    wait for reply
    html = reply # could reformat
    return html
\end{verbatim}
\end{minipage}
\begin{minipage}{0.05\textwidth}
\end{minipage}
\begin{minipage}{0.45\textwidth}
\textbf{Class Server}
(on machine 2)
\begin{verbatim}
def server_load_url():
    ... return html

def handle_server_load_url(url):
    wait for request
    url = request
    html = server_load_url(URL)
    reply = html
    send reply
\end{verbatim}
\end{minipage}

\textit{stub}

\textit{stub}
```python
def main():
    html = browser_load_url(URL)
...

def browser_load_url(url):
    msg = url # could reformat
    send request
    wait for reply
    html = reply # could reformat
    return html

def server_load_url():
    ...
    return html

def handle_server_load_url(url):
    wait for request
    url = request
    html = server_load_url(URL)
    reply = html
    send reply
```

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**Diagram Description**

- **Client**: Class Browser (on machine 1)
  - `def main()`: Calls `browser_load_url(URL)`
  - `def browser_load_url(url)`: Sends request, waits for reply, returns HTML

- **Server**: Class Server (on machine 2)
  - `def server_load_url()`: Returns HTML
  - `def handle_server_load_url(url)`: Receives request, loads HTML, sends reply

- **Network Flow**
  - Client loads `view.html?item` from the server.
  - Server receives request, loads HTML, sends reply.

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    html = browser_load_url(URL)
...

def browser_load_url(url):
    msg = url # could reformat
    send request
    wait for reply
    html = reply # could reformat
    return html

load("buy.html?item&ccNo=XX")

problem: we just bought two copies of item

there are ways to deal with this issue — for example, giving each request a unique ID, and keeping track of those IDs on the server
problem: we just bought two copies of item

def main():
    html = browser_load_url(URL)
...

def browser_load_url(url):
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there are ways to deal with this issue — for example, giving each request a unique ID, and keeping track of those IDs on the server — but then new problems arise: for example, what happens if the server crashes in the middle of handling a request?
**scalability:** how does our system behave as we increase the number of machines, users, requests, data, etc.?

**fault-tolerance/reliability:** how does our system deal with failures (☠️)? machines crashing, network links breaking, etc.

**security:** how does our system cope in the face of targeted attacks (😈)?

**performance:** how do we define our performance requirements, and know if our system is meeting them? what do we do if performance is subpar ((#)?)

**who is impacted** by our design and implementation choices? who makes those choices?
http://mit.edu/6.1800

has all of the class material, due dates, deadlines, etc.

<table>
<thead>
<tr>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
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</thead>
<tbody>
<tr>
<td>feb 5</td>
<td>feb 6</td>
<td>feb 7</td>
<td>feb 8</td>
<td>feb 9</td>
</tr>
<tr>
<td><strong>LEC 1</strong>: Modularity, Abstraction, and the Impact of Systems</td>
<td><strong>REC 1</strong>: We Did Nothing Wrong</td>
<td><strong>LEC 2</strong>: Naming</td>
<td><strong>REC 2</strong>: DNS</td>
<td><strong>TUT 1</strong>: Intro to 6.1800 Communication</td>
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*First day of classes*
http://mit.edu/6.1800

has all of the class material, due dates, deadlines, etc.

Canvas

for submitting assignments and seeing your grades, and the occasional class-wide (or section-wide) announcement. everything on Canvas will be linked from the class website

we’ve already sent out one announcement about a scheduling form — please fill it out today if you haven’t already!
http://mit.edu/6.1800

has all of the class material, due dates, deadlines, etc.

Canvas

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Piazza

for questions that are relevant to the entire class. important information from Piazza will also end up on the website (e.g., some of your assignments will have FAQs)

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if you need help, ask for it. we need to balance the needs of a large group of students and the needs of the staff, but we will work with you to help as much as we can. in particular, as long as you reach out to your TA ahead of time, we will give you a 24-hour extension on any assignment, no questions asked.
**complexity** limits what we can build, but can be mitigated with design principles such as **modularity** and **abstraction**

one way to **enforce modularity** is with a **client/server model**, where the two modules reside on different machines and communicate with RPCs; network/server failures are still an issue

you will see these principles applied over and over in this class

a student once told me that I say “modularity” in almost every lecture, which seems correct

**next lecture:** naming, which allows modules to communicate

**after that:** operating systems, which enforce modularity on a single machine