

CS 5150 Software Engineering  
9. Usability and User Interfaces

William Y. Arms

# The Importance of the User Experience

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**A computer system is only as good as the experience it provides to its users.**

- If a system is hard to use:
  - ⇒ users may fail to find important results, or mis-interpret what they do find,
  - ⇒ users may give up in disgust.
- Appropriate functionality, easy navigation, elegant design, and fast response times make a measurable difference to a system's effectiveness.
- **Usability** is more than **user interface design**.

**Good support for users is more than a cosmetic flourish.**

- Developing good user interfaces needs **skill** and **time**.

# Terminology

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## User experience (UX)

The **user experience** is the total of all the factors that contribute to the usability (or otherwise) of a computer and its systems.

## Human computer interaction (HCI)

**Human computer interaction** is the academic discipline that studies how people interact with computers.

At Cornell, the Information Science and Communication departments offer a series of courses in Human Computer Interaction and have major research programs in this area.

# Development Processes for User Interfaces

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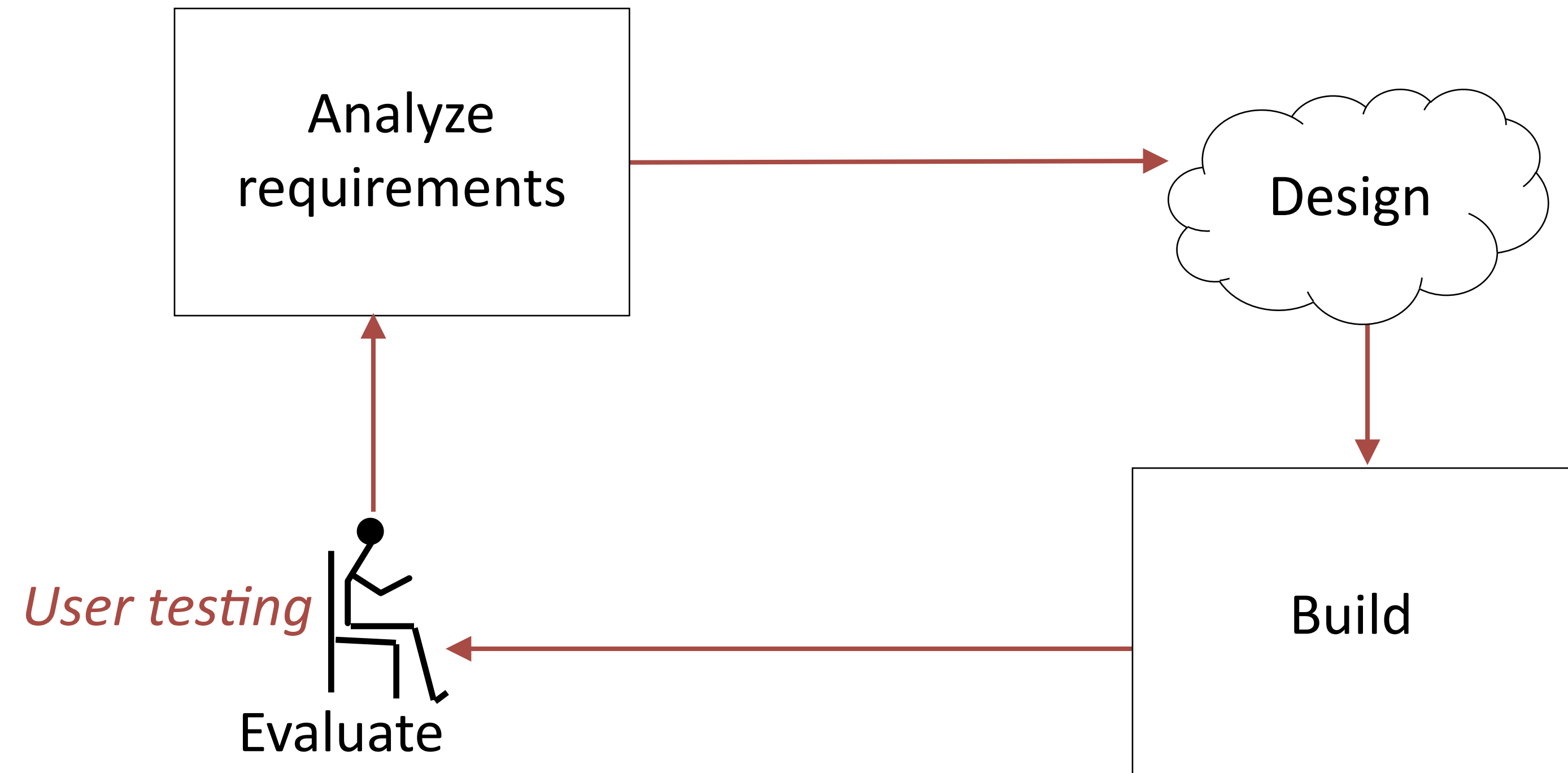
It is almost impossible to specify an interactive or graphical interface in a textual document.

- **Requirement** benefit from sketches, comparison with existing systems, etc.
- **Designs** should include graphical elements and benefit from a mock-up or other form of prototype.
- User interfaces must be **tested with users**. Expect to change the requirements and design as the result of testing.
- **Schedules** should include user testing and **time to make changes**.

Whatever process you use to develop a software system, the development of the user interface is always iterative.

# The Analyze/Design/Build/Evaluate Loop

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# Tools for Usability Requirements and Evaluation

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	Initial	Mock-up	Prototype	Production
Client's opinions	✓	✓	✓	
Competitive analysis	✓			
Expert opinion	✓	✓	✓	
Focus groups	✓	✓		
Observing users		✓	✓	✓
Measurements			✓	✓



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# Tools for Usability Requirements: Focus Group

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## A focus group is a group interview

- Interviewer
- Potential users
  - Typically 5 to 12
  - Similar characteristics (e.g., same viewpoint)
- Structured set of questions
  - May show mock-ups
  - Group discussions
- Repeated with contrasting user groups



# Accessibility Requirements

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## Accessibility

Software designers must be prepared to users with with disabilities (e.g., poor eyesight, lack of hearing, poor manual dexterity), or limited knowledge of English, etc.

Requirements about accessibility are most likely to arise in the user interface.

You may have a legal requirement to support people with disabilities.

### Example of requirements specification:

The system must comply with Section 508 of the US Rehabilitation Act. See: <http://www.section508.gov/>

# Equipment Requirements

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There may also be requirements to support computers with poor performance, limited screen sizes, bad network connections, etc.

Be explicit about the equipment assumptions that you make and how to handle failures. Do user testing with both good and bad equipment.

## Example

MacMail has a requirement that operations terminate cleanly if the network connection is lost, but its behavior is erratic if the network connection becomes extremely slow, e.g., it will not quit.

# Mental Models and Computer Models

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## **Mental Model**

The mental model is the user's view of the system and the user experience that it provides.

## **Computer Model**

The computer model is the software architecture that implements the user experience.

The Model-View-Controller is a widely used software architecture for interactive software systems.

# Mental Models

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The user experience is more than user interface design.

mental model	user interface
	interface functions
	data and metadata
	computer systems and networks



# Mental Model

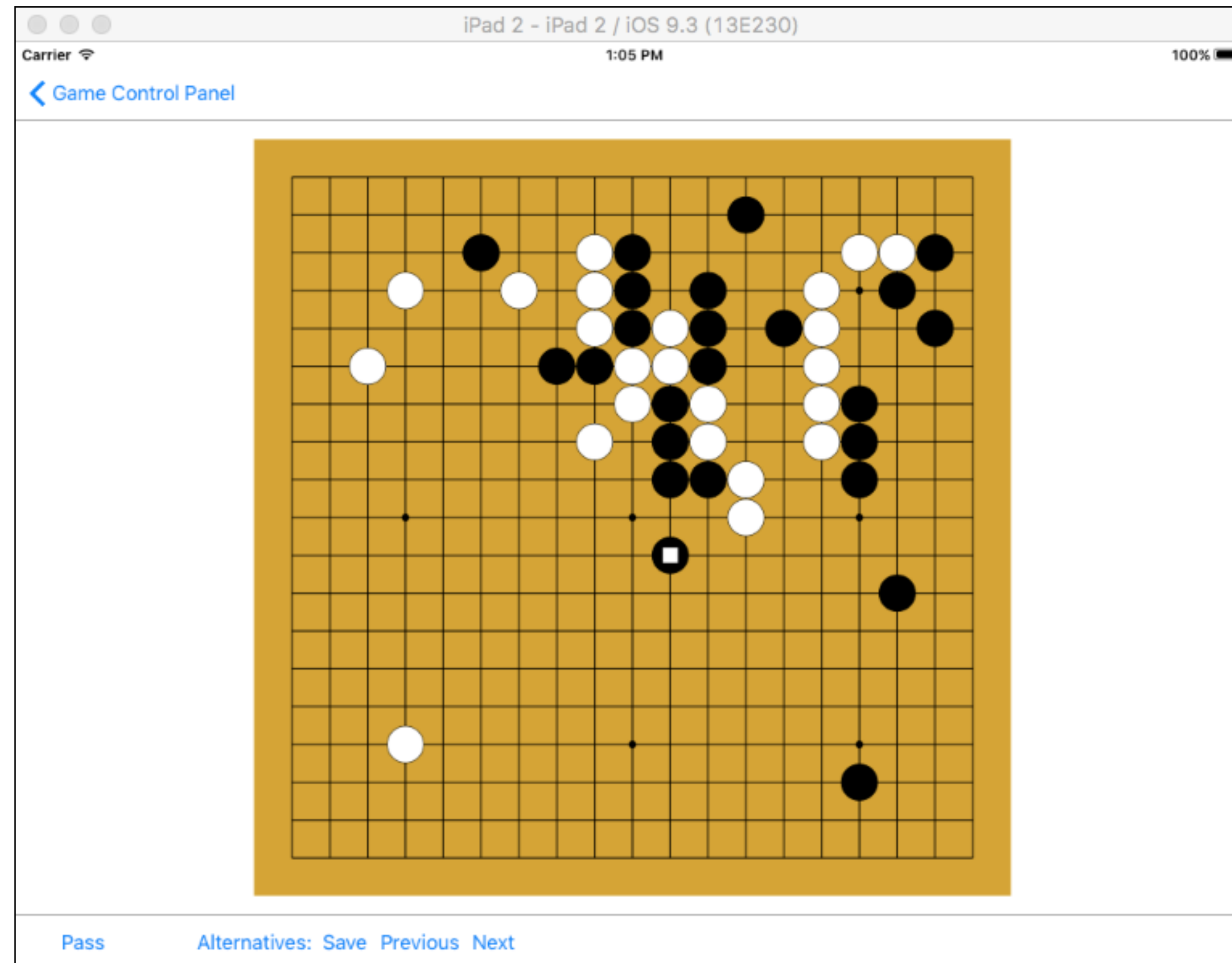
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A **mental model** is what a user thinks is true about a system, not necessarily what is actually true.

- A mental model should be similar in structure to the system that is represented.
- A mental model allows a user to predict the results of his/her actions.
- A mental model is simpler than the represented system. It includes only enough information to allow reasonable predictions.

A mental model is also called a **conceptual model**.

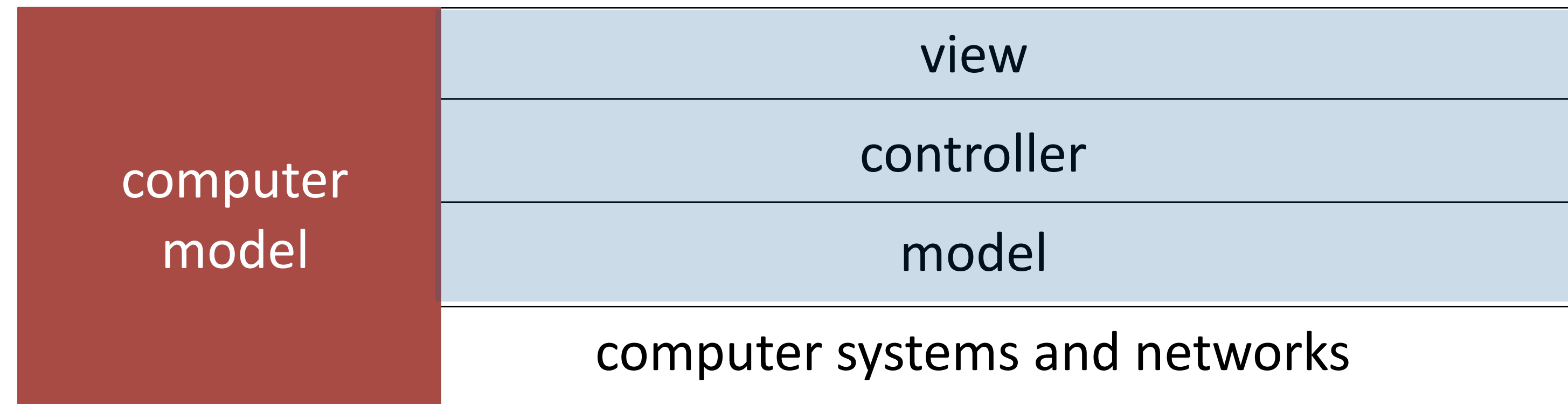
# Example: Game Program - Undo Move



# Computer Models

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Many modern development environments have a computer model that follows one of the many variations of the Model-View-Controller architecture.



# Mental Models and Computer Models

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The **mental model** is the user's model of what the system provides.

The **computer model** may be quite different from the user's mental model.

## **Example: the desktop metaphor**

- Files and folders on a desk top

## **Example: web search**

- mental model — one vast collection of pages, which are searched on request
- computer model — a central index, which is searched on request



# Mental Models v. Computer Model

"All the News That's Fit to Print"

# The New York Times

Late Edition

Today, periodic rain, afternoon storms, heavy mist, high 62. Tonight, rain, cloudy, mild, low 55. Tomorrow, clouds, some sunshines, high 58. Weather map, Page D10.

VOL. CLXVI ... No. 57,432

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NEW YORK, WEDNESDAY, NOVEMBER 30, 2016

\$2.50



Bodies were recovered on Tuesday after a plane crash in Colombia killed dozens, including members of a Brazilian soccer team.

## Cabinet Choice Wrote Remake Of Health Law

Plan Could Aid Doctors but Limit Consumers

By ROBERT FEAR

WASHINGTON — In choosing Representative Tom Price of Georgia to be his health secretary, President-elect Donald J. Trump has signaled an undiminished determination to repeal President Obama's signature domestic achievement, the Affordable Care Act, and replace it with a health law that would be far less comprehensive.

And Mr. Trump is handing Republicans and their base voters what they have clamored for since the Affordable Care Act became law in 2010 — a powerful force to reverse course.

Republicans were pleased.

"I can tell you where we're going to start: with a process to repeal and replace Obamacare," Senator Mitch McConnell of Kentucky, the majority leader, said Tuesday.

Mr. Price, an orthopedic surgeon from Atlanta's affluent northern suburbs, was one of the first lawmakers to draft a bill to replace the Affordable Care Act. His proposal would take local, state and federal health care funding fundamentally off-budget.

## MOVIE FINANCIER IS SAID TO BE PICK FOR TREASURY JOB

ROOTS ON WALL STREET

Trump Elevates Loyalist From Campaign to Pivotal Post

This article is by Julie Hirschfeld Davis, Shyamini Arapparamba and Maggie Haberman.

WASHINGTON — Steven Mnuchin, a financier with deep roots on Wall Street and in Hollywood but no government experience, is reported to be named Donald J. Trump's Treasury secretary as soon as Wednesday, people close to the transition say.

Mr. Mnuchin, 53, was the national finance chairman for Mr. Trump's campaign, and his selection would elevate a wealthy loyalist to a pivotal economic post. He began his career at Goldman Sachs, where he became a partner, before creating his own hedge fund, moving to the West Coast and entering the first rank of movie financiers by bankrolling hits like the "X-Men" franchise and "Avatar."

If confirmed, Mr. Mnuchin

## JOY, THEN GRIEF, OVER BRAZIL TEAM

OVER BRAZIL TEAM

## Despite Climate Vow, China Scrambles for Coal

Here in Jinzhong, a smoggy city in China's east, comes the story.

The **mental model** is that the photograph is embedded in the text of the document...

The New York Times

INTERNATIONAL

## Caught on Camera: Aide's 'Brexit' Notes

By KATRIN BENNHOLD

LONDON — It's official — or is it? The British strategy for its divorce from the European Union is to “have your cake and eat it,” something critics have derided as delusional.

Ever since voting to leave the bloc, Britons have been trying to figure out whether their government has an actual plan for negotiating its exit, or “Brexit,” and what that plan might be. This week, an open notepad, surreptitiously photographed in the grip of an aide leaving the aptly named Department for Exiting the European Union, has offered at least a glimpse into the fog.



From left: David Davies, secretary of state for exiting the European Union; Foreign Secretary Boris Johnson; and Prime Minister Theresa May at a cabinet meeting in London this week. Pool photo by Peter Nicholls

but in the **computer model** the photograph is an independent file, which could be changed separately.

*Based on an example by Joel Spolsky*



# User Interface Design

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mental model	user interface
	interface functions
	data and metadata
	computer systems and networks

The **user interface** is the appearance on the screen and the actual manipulation by the user

- Fonts, colors, logos, key board controls, menus, buttons
- Mouse control, touch screen, or keyboard control
- Conventions (e.g., "back", "help")

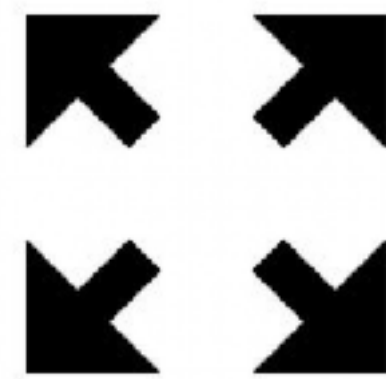
# User Interface Design

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## Example: to leave full screen

Keyboard: escape key, control-F

Mouse/touch:

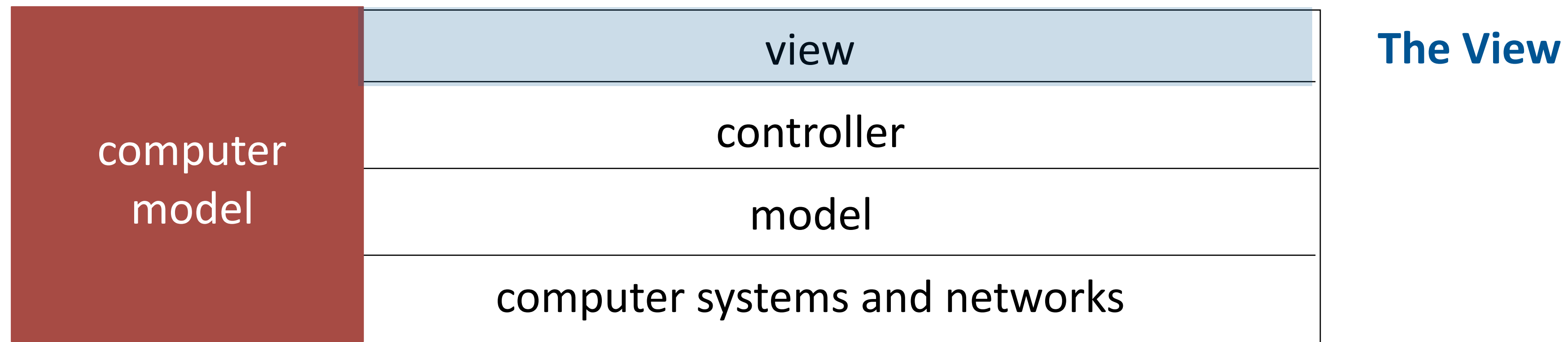


## Examples of design choices

- Screen space utilization in Adobe Reader.
- Number of snippets per page in web search.

# Model-View-Controller: The View

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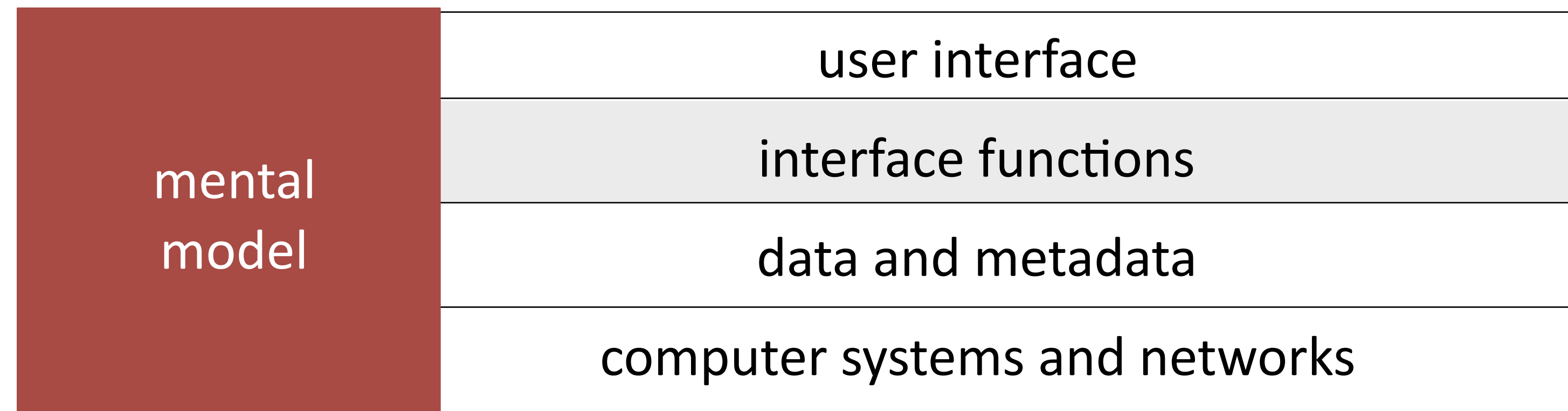
In the Model-View-Controller architecture, the user interface is called the **View**.

- Many of the interface functions are implemented by user interface widgets that are provided by the development environment.
- The development environment may also provide recommended styles for the user interface, e.g., fonts, graphical elements.



# Interface Functions

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The **interface functions** determine the actions that are available to the user:

- Select part of an object
- Search a list or sort the results
- View help information
- Manipulate objects on a screen
- Pan or zoom

# Interface Functions

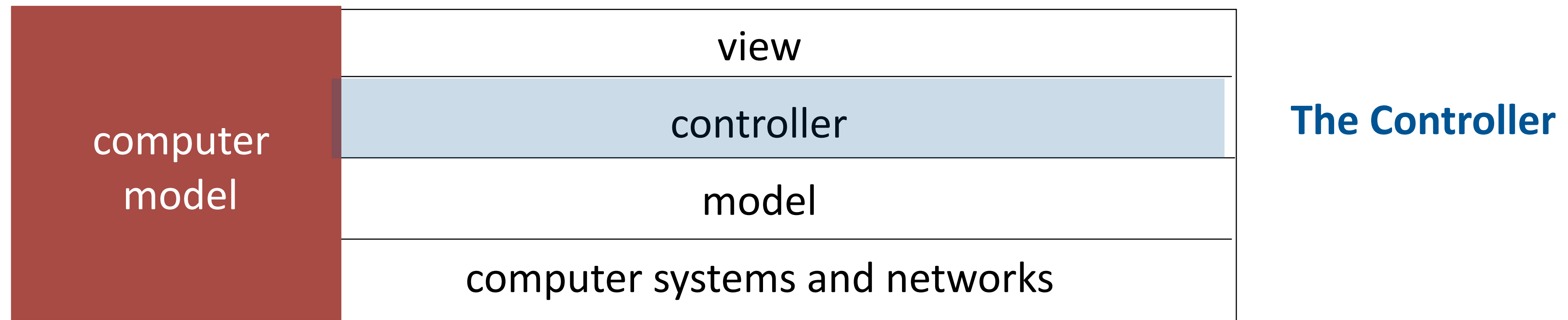
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There may be alternative **user interface designs** for the same **interface functions**, for example:

- Different versions of the MS Windows desktop have most of the same interface functions, but different user interface designs.
- Applications that run on both Windows and Macintosh computers support a one button mouse (Macintosh) or a two button mouse (Windows).

# Model-View-Controller: The Controller

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In the Model-View-Controller architecture, the interface functions are invoked by the **Controller**.

The Controller manages the flow of control of the whole user interface and connects the View to the Model.

# Data and Metadata

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mental model	user interface
	interface functions
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	computer systems and networks

The interface functions and the interface design provide an interface to the **data and metadata** stored by the computer system.

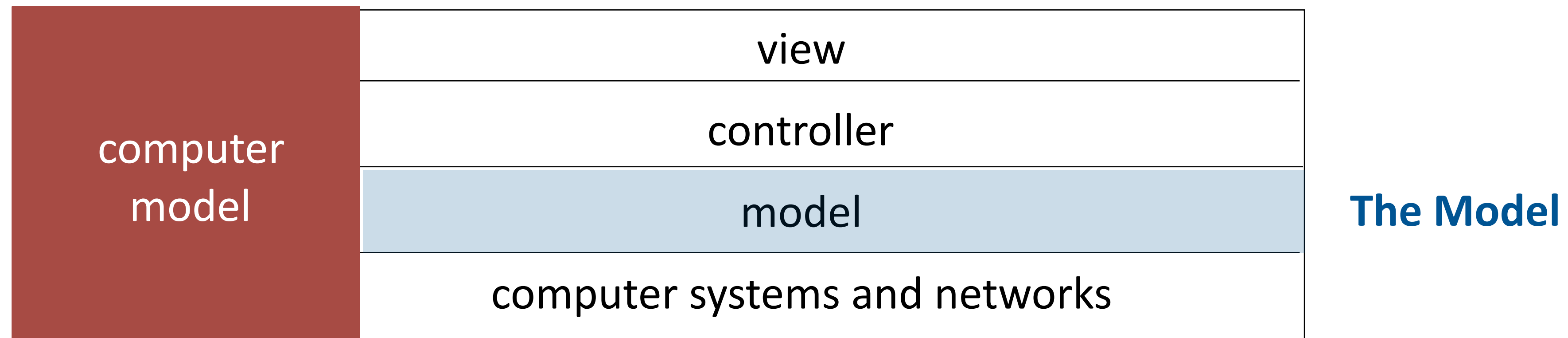
- The desktop metaphor has the concept of associating a file with an application. This requires a file type to be stored with each file:  
-> extension to filename (e.g., .txt, .pdf)

Inexperienced clients sometimes ask for interface features that require additional data or metadata.



# Model-View-Controller: The Model

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In the Model-View-Controller architecture, the data and metadata are maintained by the **Model**.

The Model also manages the logic of all parts of the system that are not part of the user interface.

# Computer Systems and Networks

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mental model	user interface
	interface functions
	data and metadata
	computer systems and networks

The **performance**, **reliability** and **predictability** of computer systems and networks are crucial factors.

# Principles of User Interface Design

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**User interface design is partly an art, but there are general principles**

- Consistency -- in appearance, controls, and function.
- Feedback -- what is the computer system doing? Why does the user see certain results?
- Users should be able to interrupt or reverse actions.
- Error handling should be simple and easy to comprehend.
- Skilled users should be offered shortcuts; beginners should have simple, well-defined options.




**The user should feel in control**





# Avoid the Fancy






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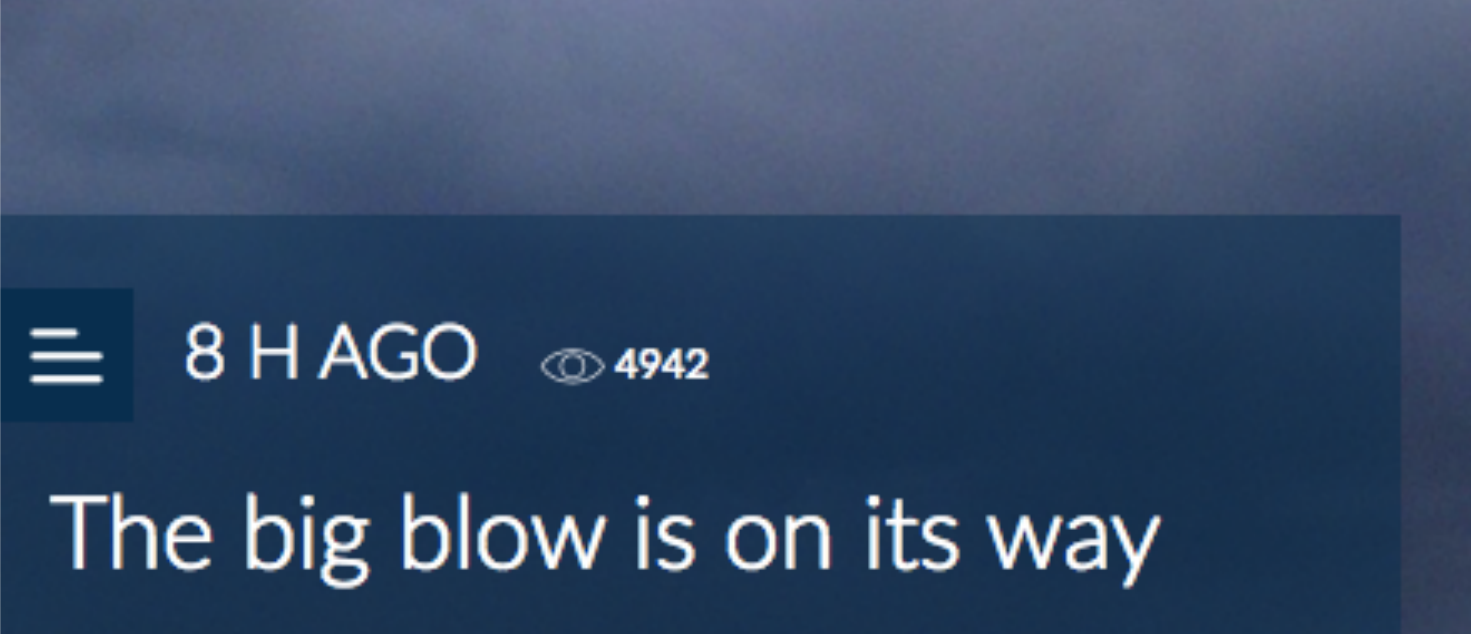


**Indian Ocean contingent grows to nine**  
The number of Vendée Globe skippers now in the Indian Ocean grew to nine overnight as French sailors Thomas Ruyant and Jean Le Cam passed the Cape of...




Vendée Globe all news


All news




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# Interface Design: Menus

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- Easy for users to learn and use
- Certain categories of error are avoided
- Enables context-sensitive help

**Major difficulty is structure of large number of choices**

- Scrolling menus (e.g., states of USA)
- Hierarchical
- Associated control panels
- Menus plus command line

**Users prefer broad and shallow to deep menu systems**

# Information Presentation

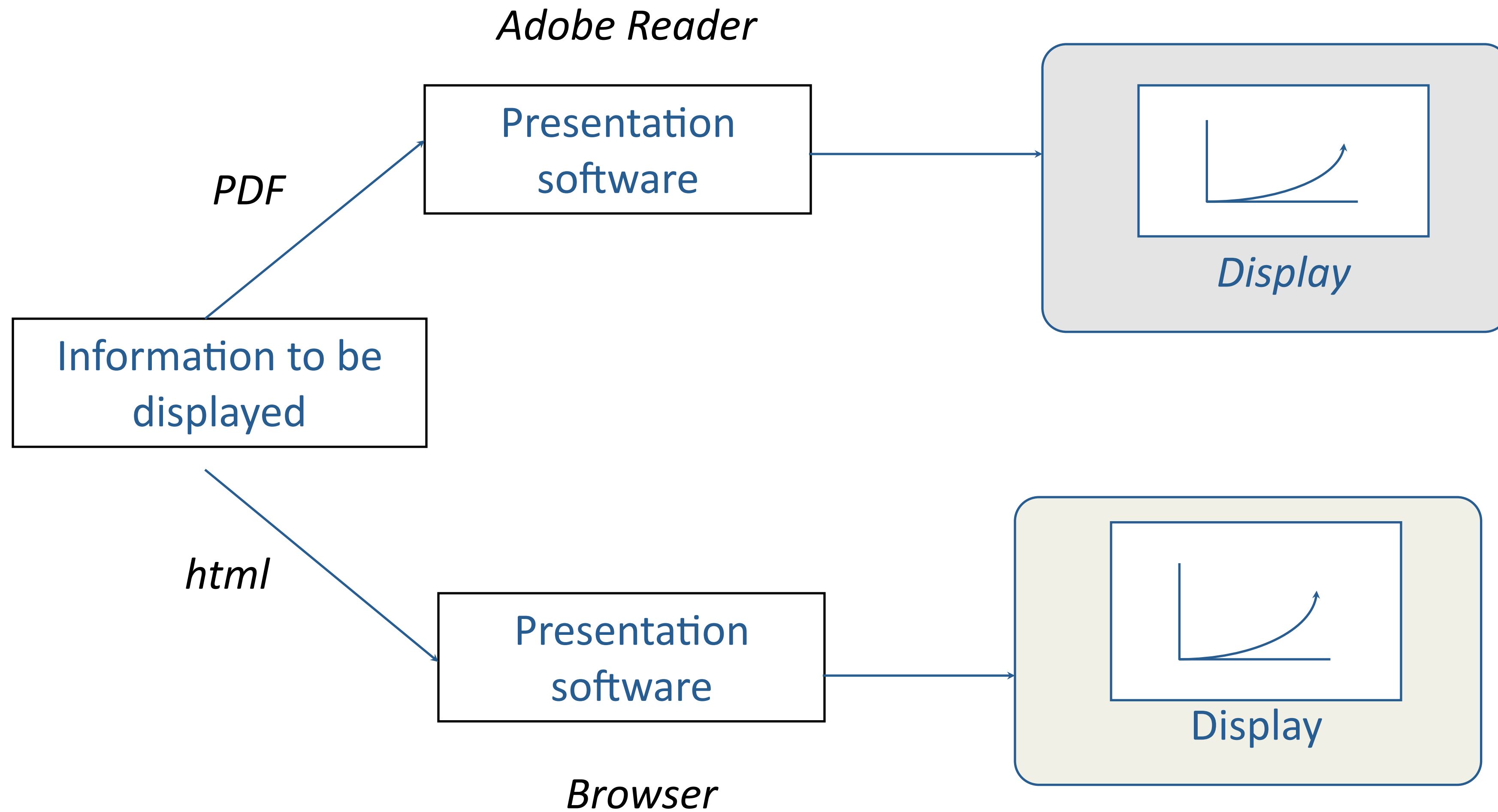
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## Simple is often better than fancy

- Text
  - precise, unambiguous
  - fast to compute and transmit
- Graphical interface
  - simple to comprehend / learn,  
*but icons can be difficult to recognize*
  - uses of color
  - variations show different cases

# Separation of Content from Presentation

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# Command Line Interfaces

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## Problems with graphical interfaces

- Not suitable for some complex interactions
- May be slow for skilled users
- Difficult to build scripts
- Only suitable for human users

## Command line interfaces

User interacts with computer by typing commands (e.g., Linux shell script)

- Allows complex instructions to be given to computer
- Facilitates formal methods of specification & implementation
- Skilled users can input commands quickly
- Unless very simple, requires learning or training
- Can be adapted for people with disabilities
- Can be multi-lingual
- Suitable for scripting / non-human clients

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**9. Usability and User Interfaces**

End of Lecture