Designing Interactive Systems I
Lecture 11: Responsiveness, Notations

Prof. Dr. Jan Borchers
Media Computing Group
RWTH Aachen University

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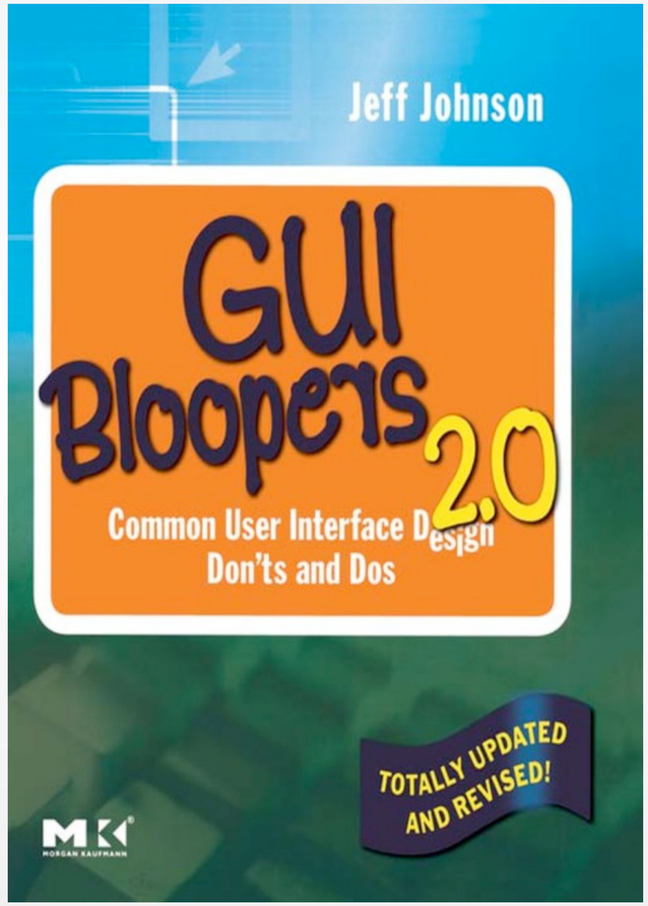
http://hci.rwth-aachen.de/dis

Responsiveness and Performance

Responsiveness

- See also: Jeff Johnson, *GUI Bloopers 2.0*
- Key usability problem of interactive systems
  - Bad responsiveness opens Gulf of Evaluation
- Examples for bad responsiveness:
  - A screen pointer that doesn't keep up
  - Delayed response to button-clicks
  - Sliders and scrollbars that lag
  - Applications that go "dead" during disk operations
  - Multiple screen repaints



Reasons for Poor Responsiveness

- Importance not widely known
  - UI designers think of other things first
  - UI designers rarely specify responsiveness
  - Programmers tend to equate it with performance
- This kind of tuning is always difficult
  - "We'll get it in the next release," and so on
- Developers treat human input like machine input
- Simple, naïve implementations
- GUI tools and platforms are inadequate
  - Limitations of online apps (which everybody knows about)

Example: Scrollbar

- Does text move as you scroll (good) or after you let go (bad)?
- If designer doesn't specify, developer will make a decision
- That will usually be the technically simplest
  - Since developers are not trained in user interface theory and concepts
  - Just as UI designers are generally not trained in implementing large software products in C++

Some Eternal Facts

- Responsiveness ≠ performance!
- Processing resources will always be limited
  - We still look at hourglass as much as 15 years ago
  - UIs are real-time systems with deadlines based on human cognition
  - Software does not need to do everything instantly, or in a given order, or even at all

Three Human Deadlines

- 0.1 seconds
  - Perception of cause and effect (recall CMN model)
  - E.g., delay between moving mouse and pointer following, or between mouse click and inverting button
- 1 second
  - Turn-taking in conversation, minimum reaction time for unexpected events
  - E.g., you have 1s max to show progress indicator, open window, or finish system-initiated operations (like auto-save)
- 10 seconds
  - Typical human attention span
  - Max. time for one step of a task
    - E.g., entering a check into a banking program, or completing one step of a wizard
  - Max. time to finish giving input for a task
    - E.g., from selecting "Print" menu entry to sending off the print job

Design Techniques for Responsiveness

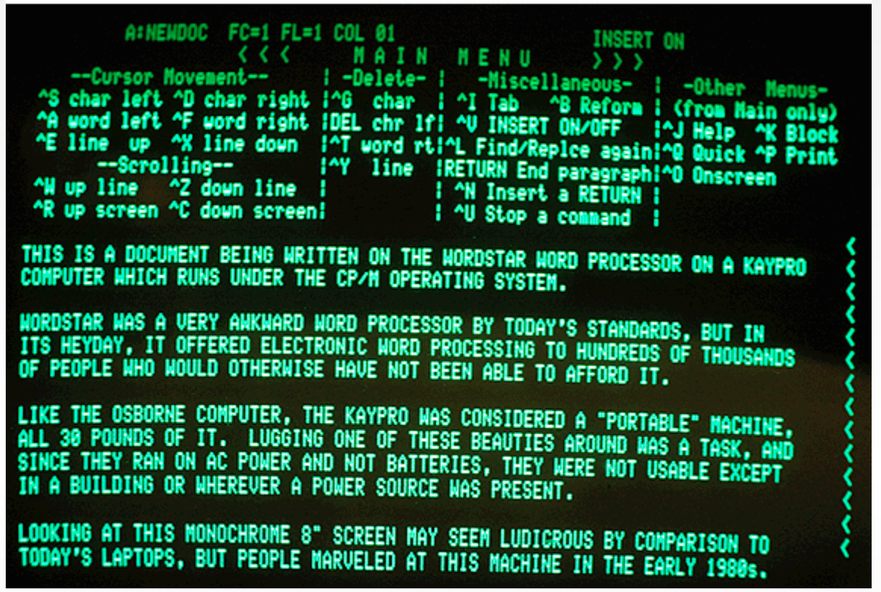
- Meet human-time deadlines
  - Rely on the three deadlines and recognize the differences
  - Acknowledge user input immediately, and display busy and progress indicators
  - Use them as frequently as you can, you never know when it will take longer
  - Example "Progress bar":
    - Make it real, show total items remaining, overall progress, and estimated total time remaining
    - Only useful if it advances roughly linearly! (no hanging at 99% please)
    - Estimated time should always go down, never up
    - "Less than a minute" is better than "47 seconds" (why?)

Design Techniques for Responsiveness

- Display important information first
  - Example: How to draw a clock
- Work in parallel
  - Delegate work that isn't time-critical to background processes
  - Work ahead by preparing likely requests
- Optimize Queueing
  - Create a logical order by looking at all pieces first, then prioritize

Design Techniques for Responsiveness

- Manage time dynamically
  - Adjust the strategy if not keeping up
  - Decrease quality or quantity to keep up
- Example: WordStar
  - Ran on a 1 MHz computer, killed by IBM PC
  - Written by an amateur, but he accommodated by making the system responsive
  - WordStar never dropped characters typed
  - Characters typed were always on screen instantly
  - Instead stopped updating other areas of the screen



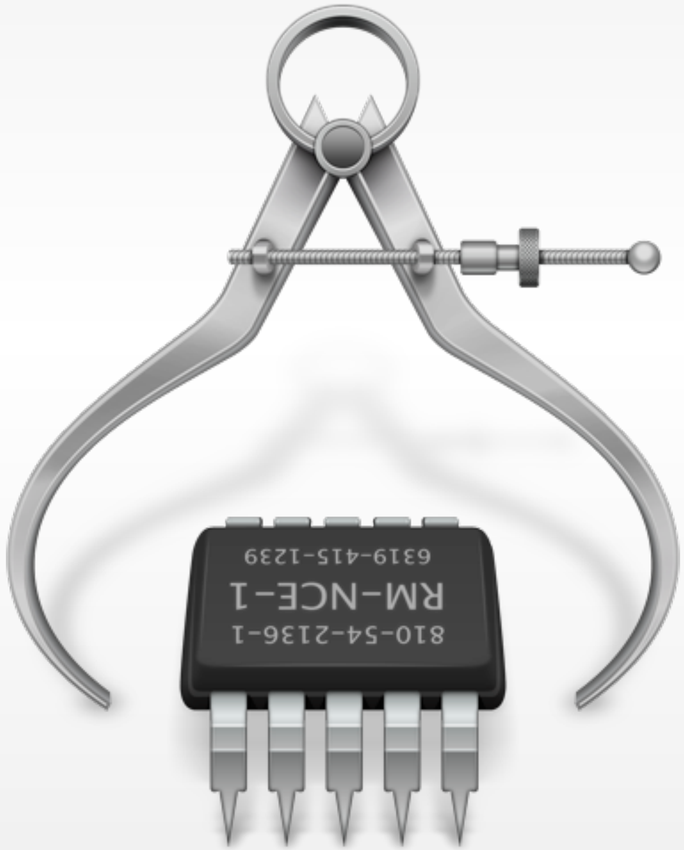
Design Techniques for Responsiveness

- Test under different conditions
  - Test under heavy loads
  - Test on slower systems, like your customers have
  - Test over slower net connections

The Top 5 Performance Hits

Hard Disk Access

Large Memory Footprint



Interlocking Threads

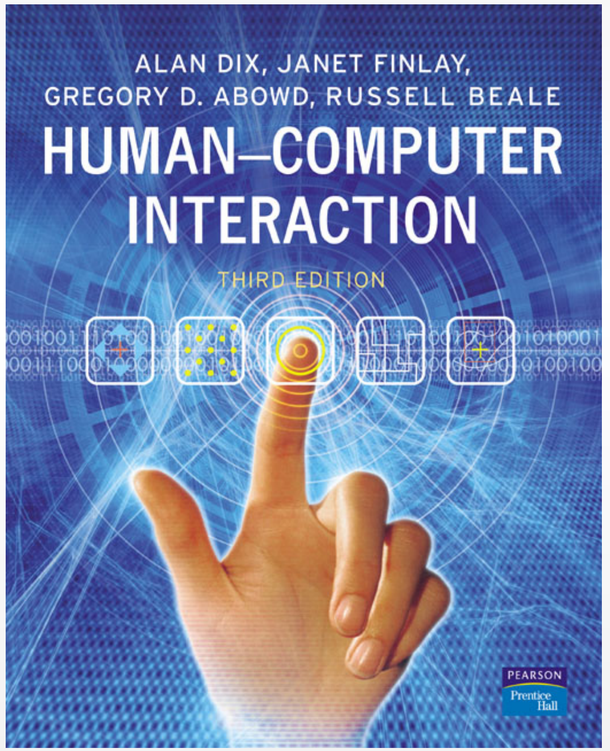
Unsuitable Data and Control Structures

Reinventing the Wheel

Reinventing the Wheel

Interaction Design Notations

- Alan Dix et al.: Human-Computer Interaction, 3rd ed. (2003), Chapter 16



Back to BASICs

```
Print "Please enter a number”

INPUT n

Print "The square of",n,"is",n*n
```

- What are the problems with using such a notation to specify a dialog?

Why UI Specification Languages

- In normal programming languages, UI and algorithms are mixed up
- System and user decisions are hard to distinguish
- Error checking on inputs dominates and complicates code
- First step: bundling I/O in classes/procedures
- Second step: Use a more efficient, readable language to specify the dialog
  - A priori to design the dialog
  - As part of the implementation (executable spec.)

Specifying User Interfaces

- Problem: Describe the proposed design of a user interface
- Approach: natural/semi-formal/formal languages
- Many standard computer science techniques apply
- The more modern the UI, the harder to describe textually, depending on modality and UI style

Grammars

- Mostly BNF-like

```
expr ::= empty | atom expr | '(' expr ')' expr
```

- E.g., Shneiderman's multiparty grammar

```
<Session>          ::=   <U: Opening> <C: Responding>
<U: Opening>       ::=   LOGIN <U: Name>
<U: Name>          ::=   <U: string>
<C: Responding>    ::=   HELLO [<U: Name>]
```

- Great for command-line UIs, e.g., banking ATMs, Unix commands
- Less suitable for GUIs

Grammars

- Regular expressions
  - **`select-line click click* double-click`**
- E.g., Unix "copy" command synopsis:

```
cp [-R [-H | -L | -P]] [-f | -i | -n] [-pv] source_file target_file
cp [-R [-H | -L | -P]] [-f | -i | -n] [-pv] source_file ... target_dir
```

recursion policies

overwrite policies

- Short and precise, but hard to read, requires additional information about semantics

Production Rules

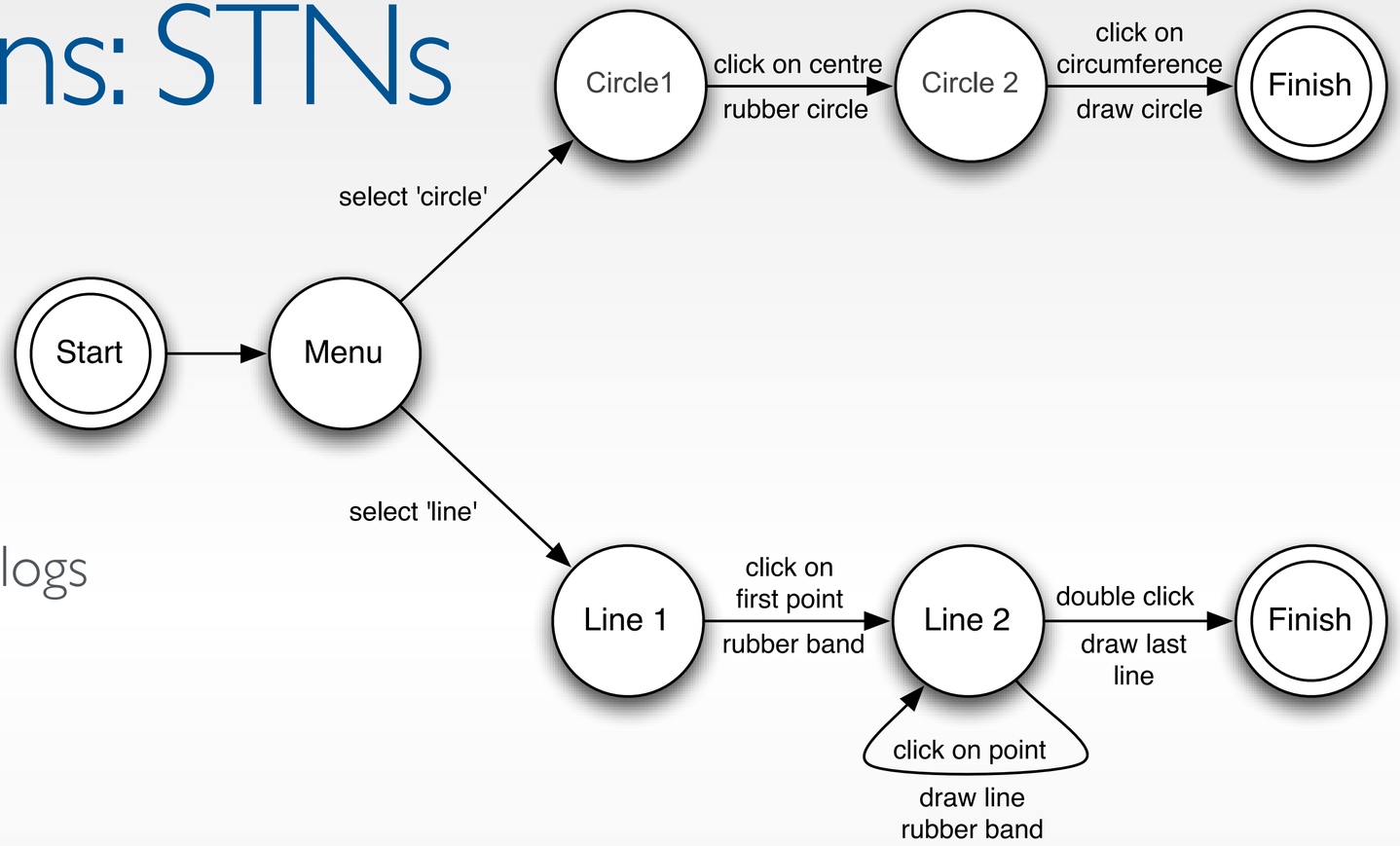
- Unordered list of rules: `if condition then action`
  - Condition based on state or pending events
  - Every rule always potentially active
- Good for concurrency
- Bad for sequence

Event-based Production Rules

```
select-line → first

click first → rest

click rest → rest

double-click rest → < draw line >
```

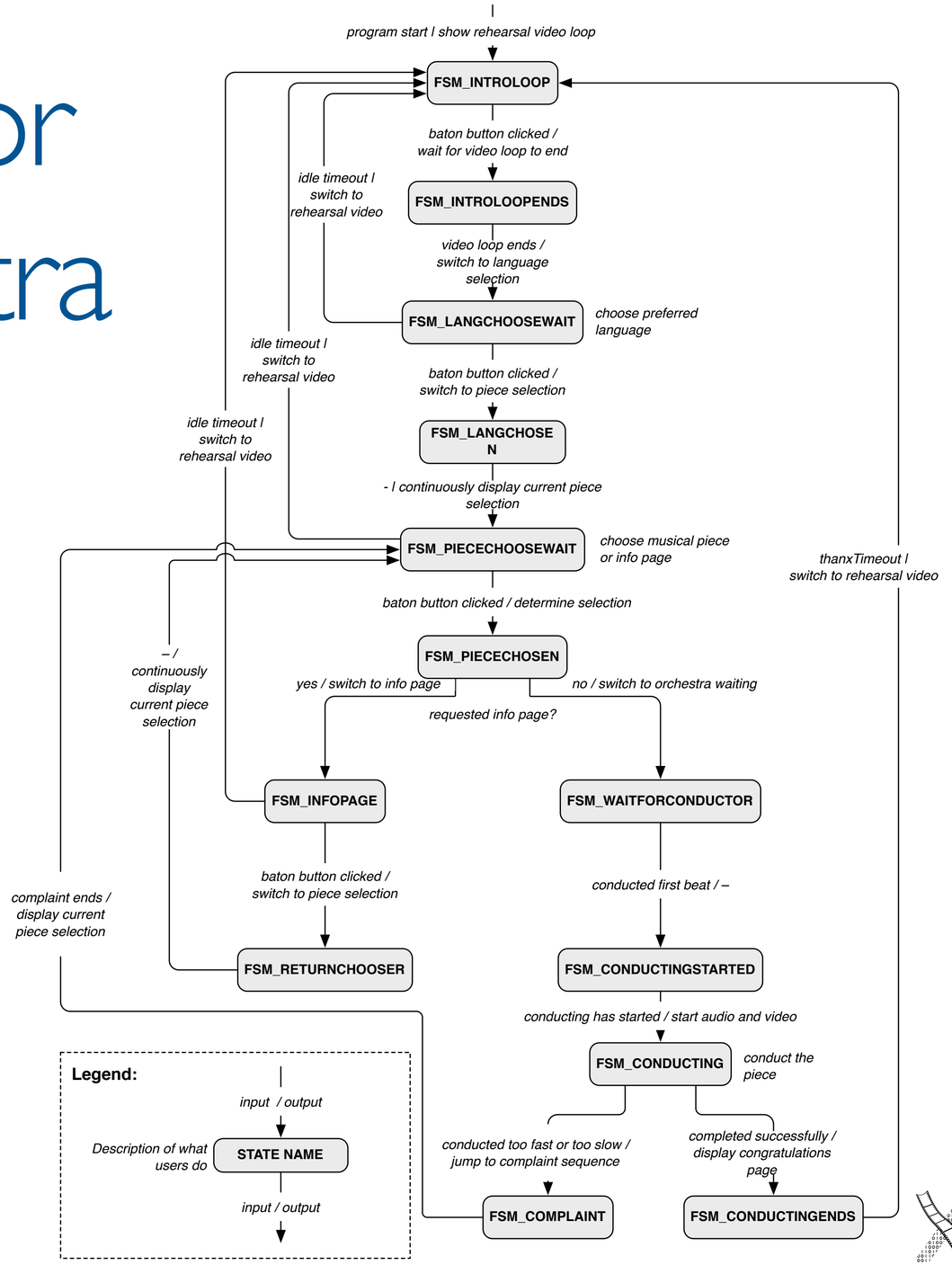
- Note:
  - Events added to list of pending events
  - ‘first’ and ‘rest’ are internally generated events
- Bad at state!

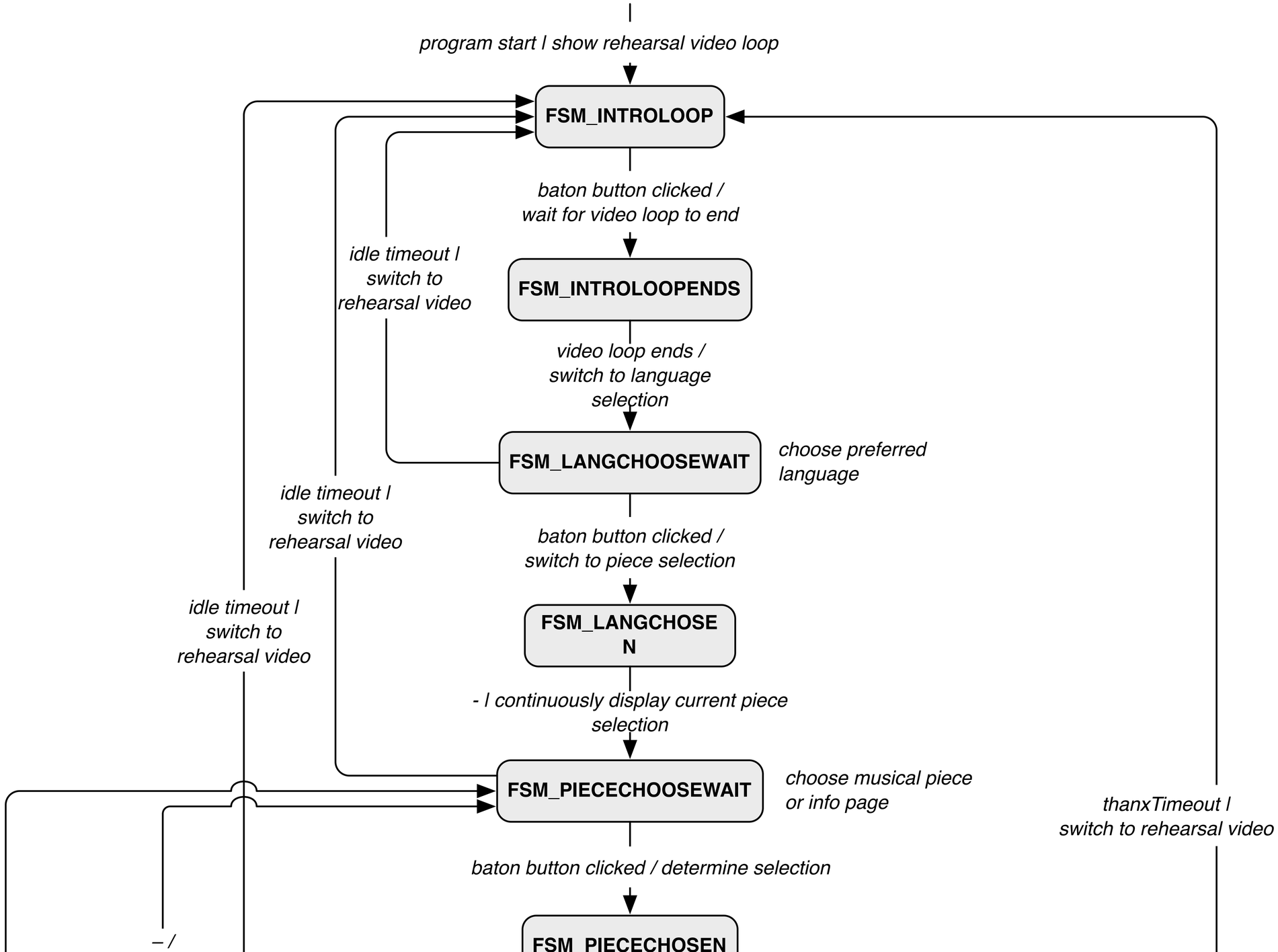
Graph Notations: STNs

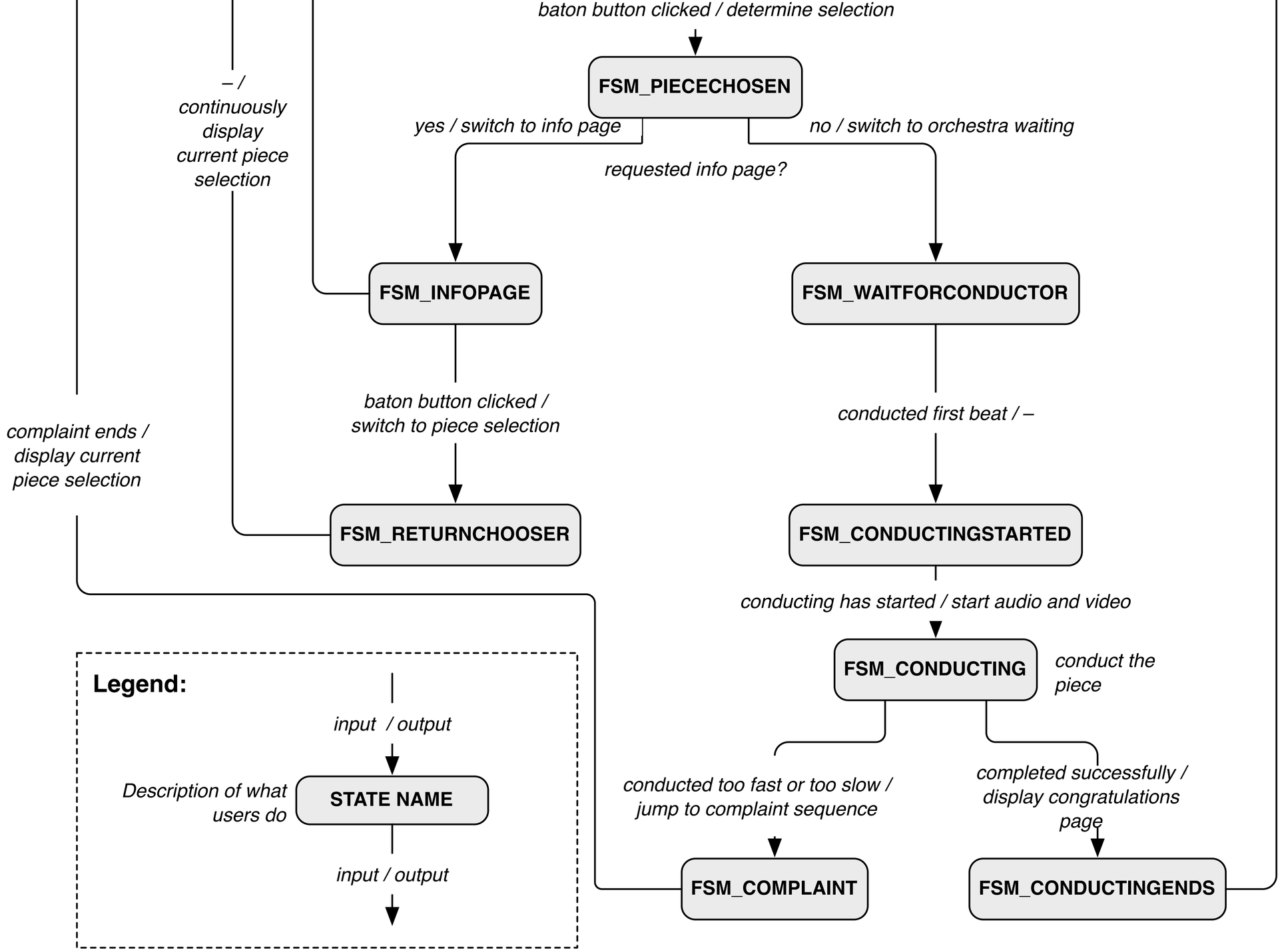


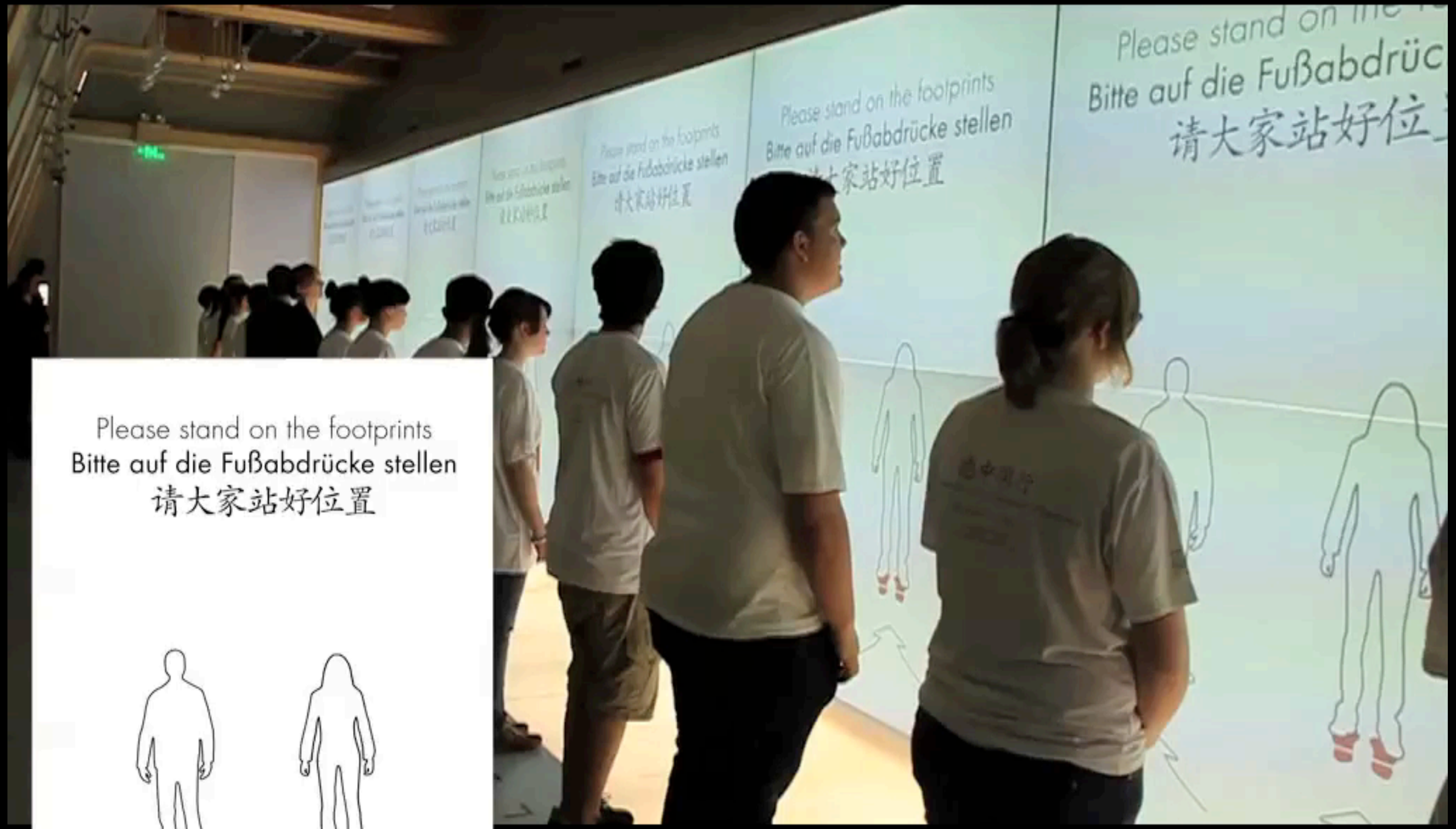
- State Transition Networks (STNs)
  - Most common tool to specify dialogs
  - Established format (since 1960s)
- Consisting of:
  - States (usually the system waiting for some user action)
  - Transitions (which have a user action and a system response associated with them)
- Describes sequences of user actions and system responses

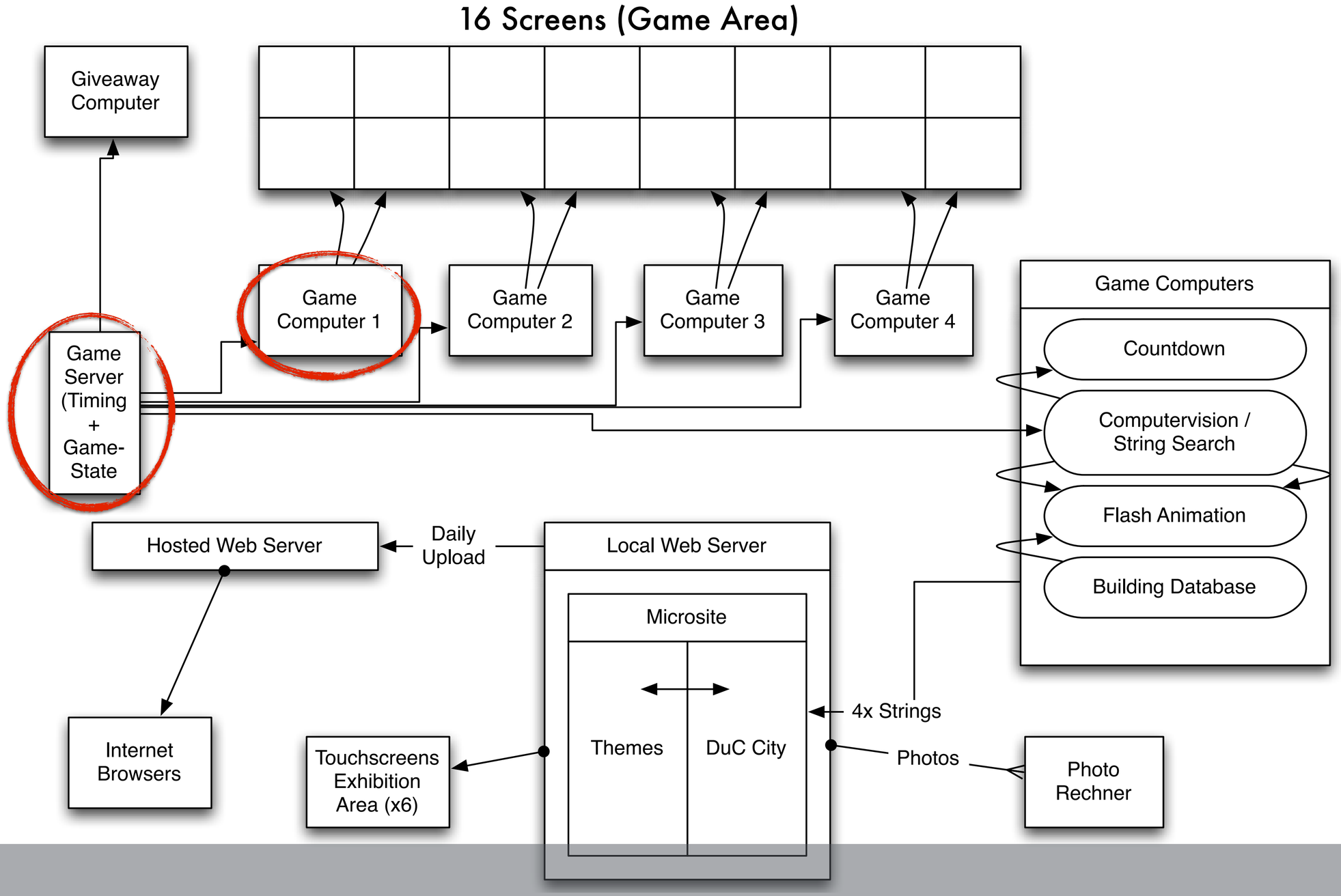
Example: STN for Personal Orchestra Dialog



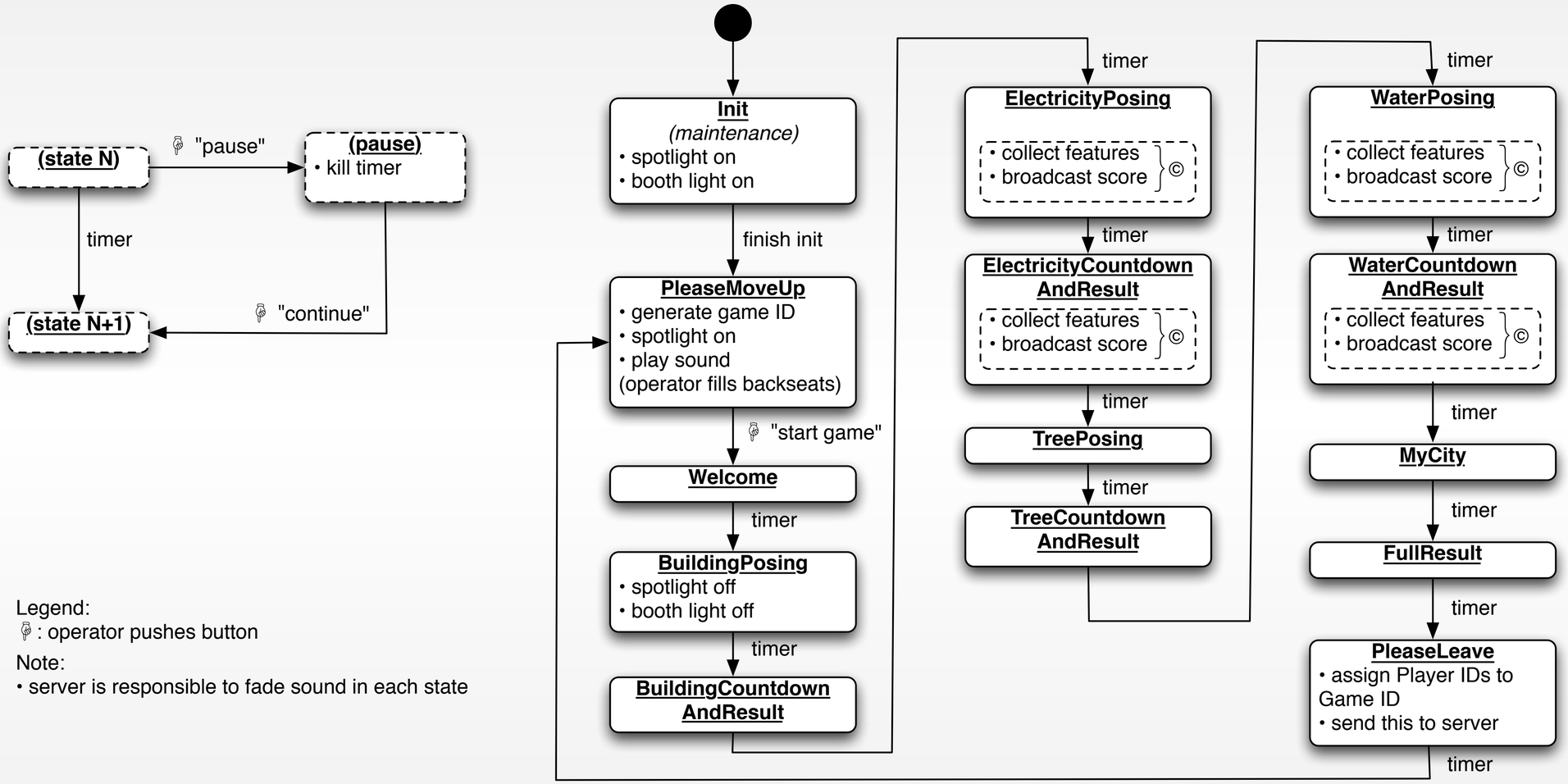

program start / show rehearsal video loop
FSM_INTROLOOP
baton button clicked /
wait for video loop to end
idle timeout /
switch to
rehearsal video
FSM_INTROLOOPENDS
video loop ends /
switch to language
selection
FSM_LANGCHOOSEWAIT
choose preferred
language
idle timeout /
switch to
rehearsal video
baton button clicked /
switch to piece selection
idle timeout /
switch to
rehearsal video
FSM_LANGCHOSE
N
- / continuously display current piece
selection
FSM_PIECECHOOSEWAIT
choose musical piece
or info page
thanxTimeout /
switch to rehearsal video
baton button clicked / determine selection
– /
FSM_PIECECHOSEN


baton button clicked / determine selection
FSM_PIECECHOSEN
yes / switch to info page
no / switch to orchestra waiting
requested info page?
– / continuously display current piece selection
FSM_INFOPAGE
FSM_WAITFORCONDUCTOR
baton button clicked / switch to piece selection
conducted first beat / –
complaint ends / display current piece selection
FSM_RETURNCHOOSER
FSM_CONDUCTINGSTARTED
conducting has started / start audio and video
FSM_CONDUCTING
conduct the piece
conducted too fast or too slow / jump to complaint sequence
completed successfully / display congratulations page
FSM_COMPLAINT
FSM_CONDUCTINGENDS
Legend:
input / output
Description of what users do
STATE NAME
input / output


Please stand on the footprints
Bitte auf die Fußabdrücke stellen
请大家站好位置
Please stand on the footprints
Bitte auf die Fußabdrücke stellen
Please stand on the
Bitte auf die Fußabdrüc

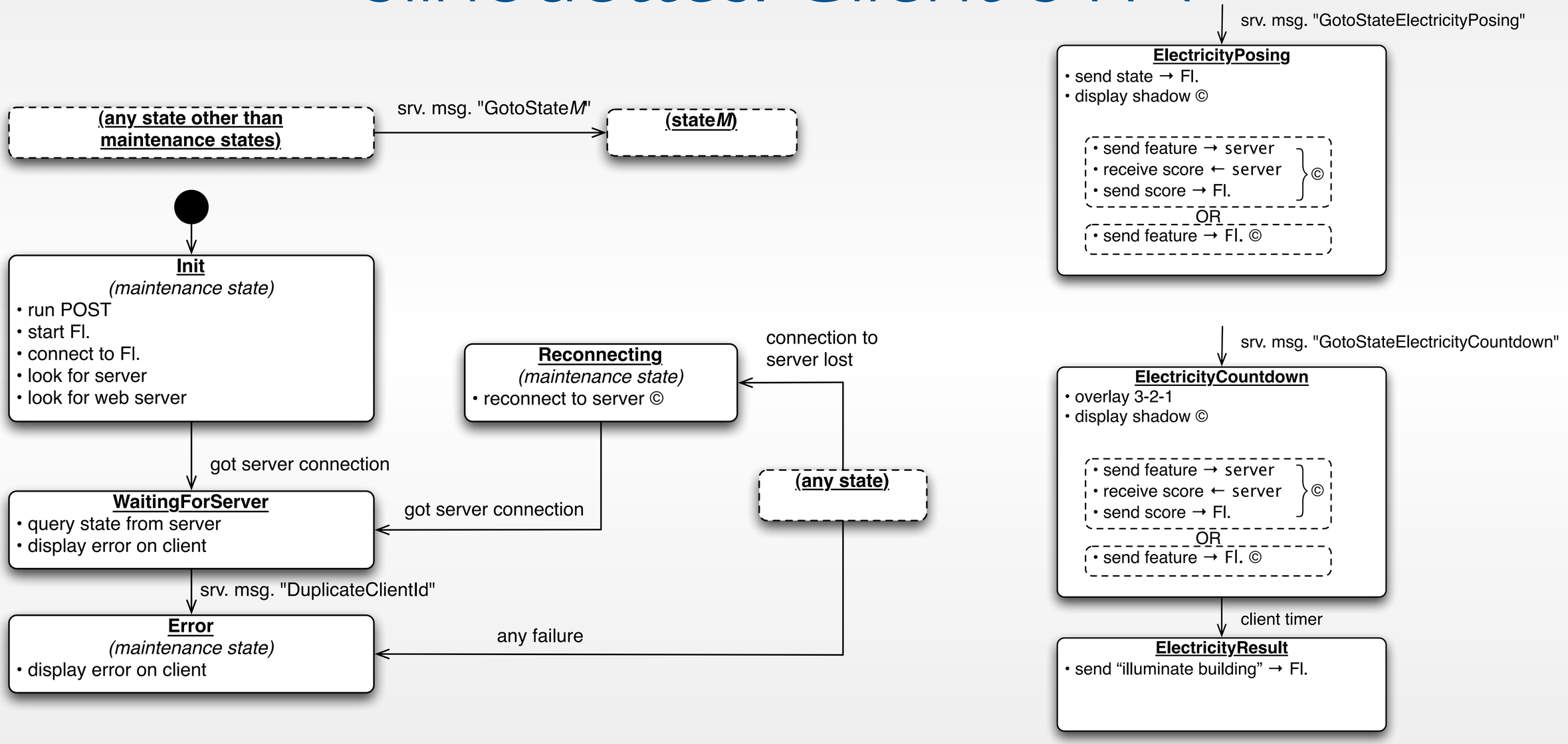

16 Screens (Game Area)
Giveaway Computer
Game Server (Timing + Game-State
Game Computer 1
Game Computer 2
Game Computer 3
Game Computer 4
Game Computers
Countdown
Computervision / String Search
Flash Animation
Building Database
Hosted Web Server
Daily Upload
Local Web Server
Microsite
Themes
DuC City
4x Strings
Photos
Photo Rechner
Internet Browsers
Touchscreens Exhibition Area (x6)

Silhouettes: Server STN



- Unconventional notation (agreed upon in the team)

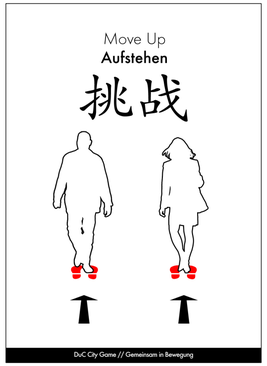
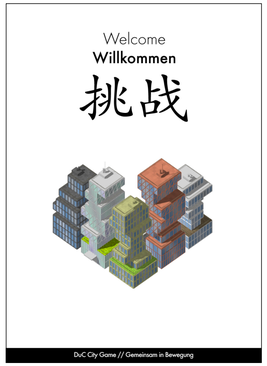
Silhouettes: Client STN



Game Storyboard

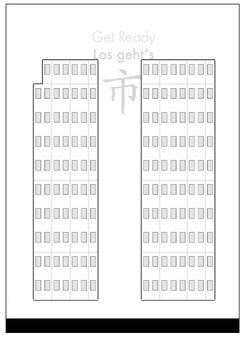
04.03.2010

media computing group

Visuals	Description	Server State/Action	Client State/Light
	Waiting people will be asked to move up to the front and take their positions on the indicated spots.	**PleaseMoveUp** • generate game ID • spotlight on • play sound (operator fill backseats)	DMX msg. - fade **in** spots on indicated footprints on the floor srv. msg. "GotoStatePleaseMoveUp" ↓ **PleaseMoveUp** • send state → Fl.
		"start game" by button push 	
 	Playing people will be presented a a welcome screen. People from the outer waiting queue will take their seats in the inside waiting booths.	**Welcome** 	DMX msg. - fade **out** spots on indicated foot prints on the floor - fade **in** light in the waiting booths srv. msg. "GotoStateWelcome" ↓ **Welcome** • send state → Fl. • display mnemonics DMX msg. - fade **out** light in the waiting booths

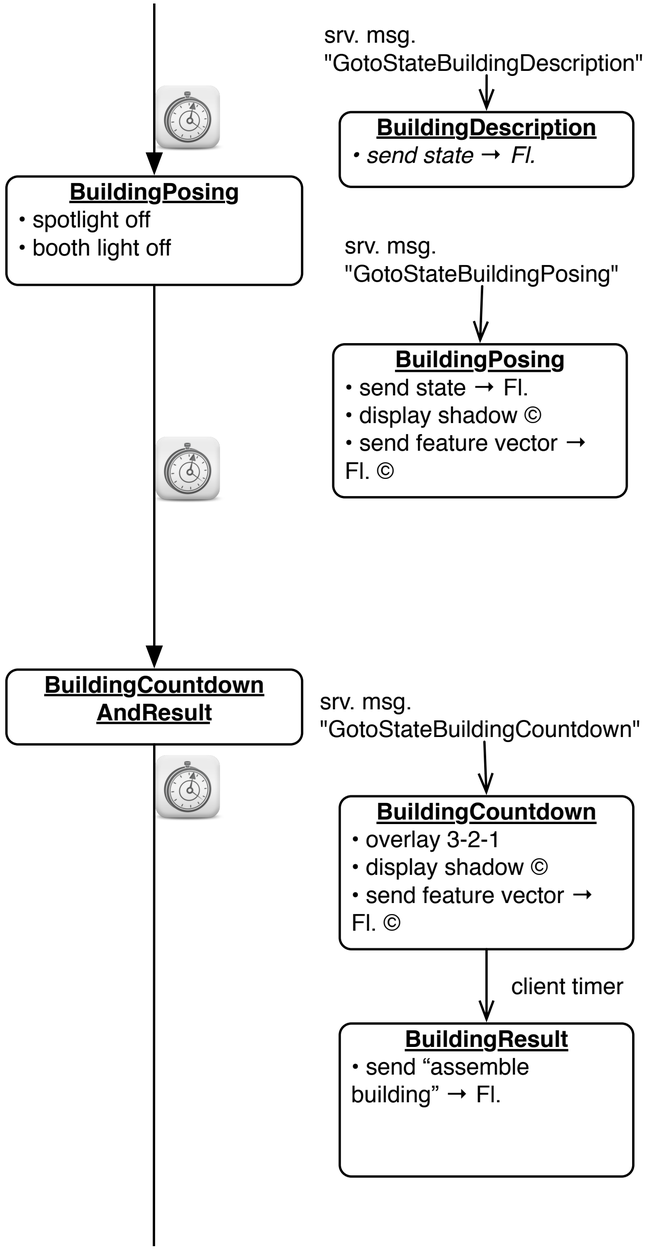
Iconic illustrations will remind the player how to create buildings by their shadows.

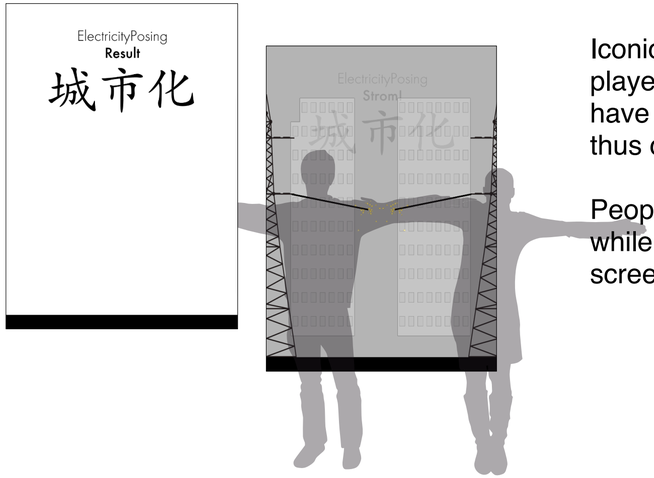
People will see their shadows while posing in front of the screens.



A countdown will indicate that shadows will be "frozen".

People will see the representation of their shadows as buildings.



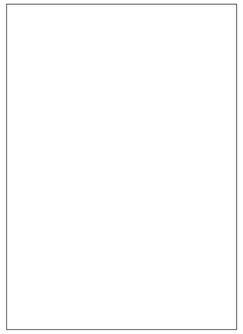


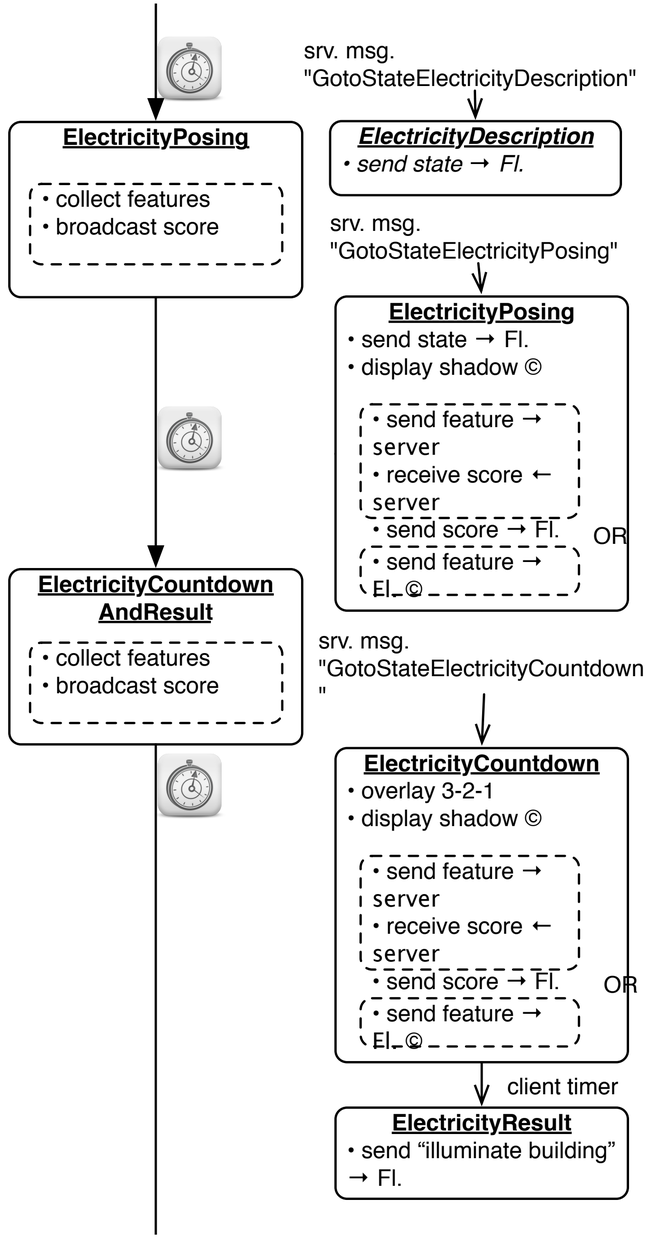
Iconic illustrations will remind the player how to pose in order to have their shadows overlap and thus create a power line.

People will see their shadows while posing in front of the screens.

A countdown will indicate that shadows will be "frozen".

People will see illuminated buildings in 4 different versions??



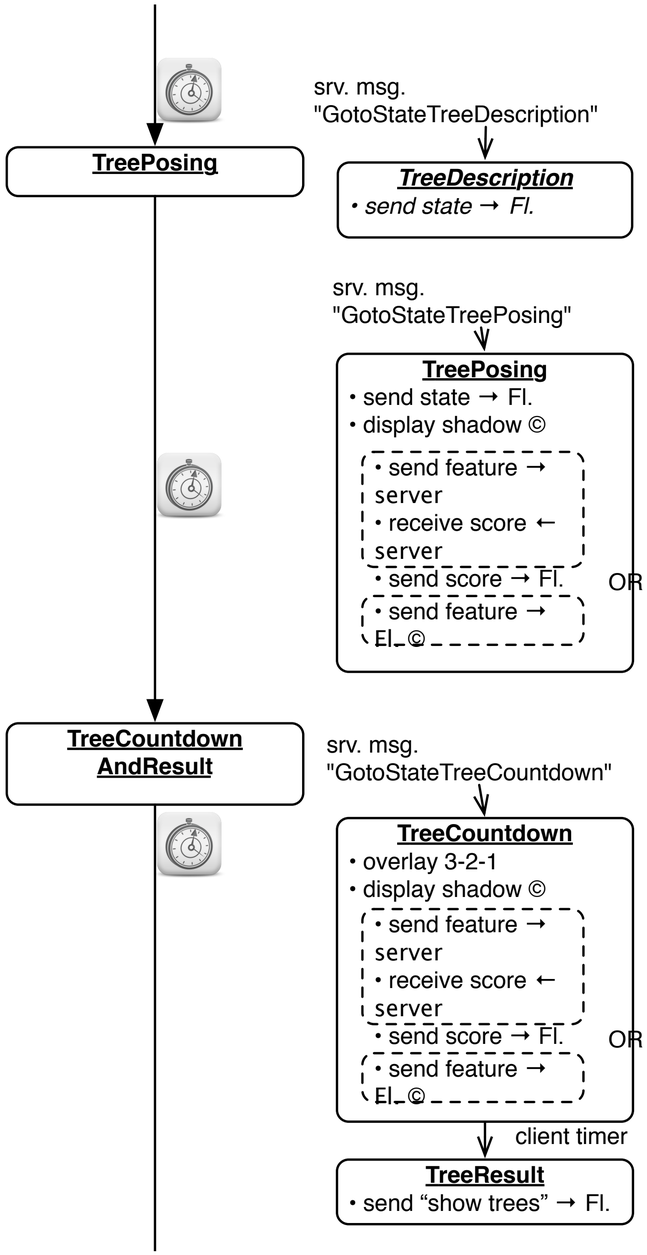


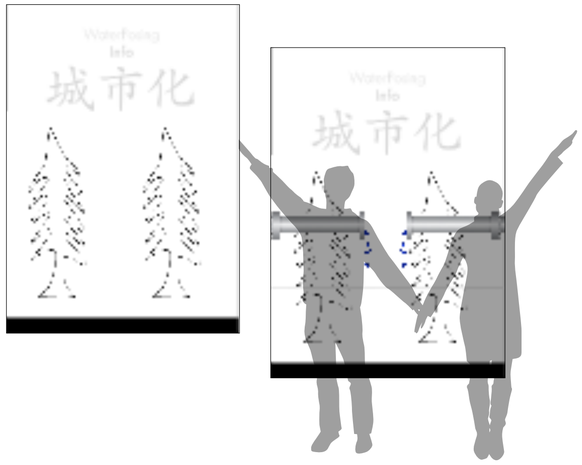
Iconic illustrations will remind the player how to create trees by their shadows.

People will see their shadows while posing in front of the screens.

A countdown will indicate that shadows will be "frozen".

People will see the representation of their shadows as trees.



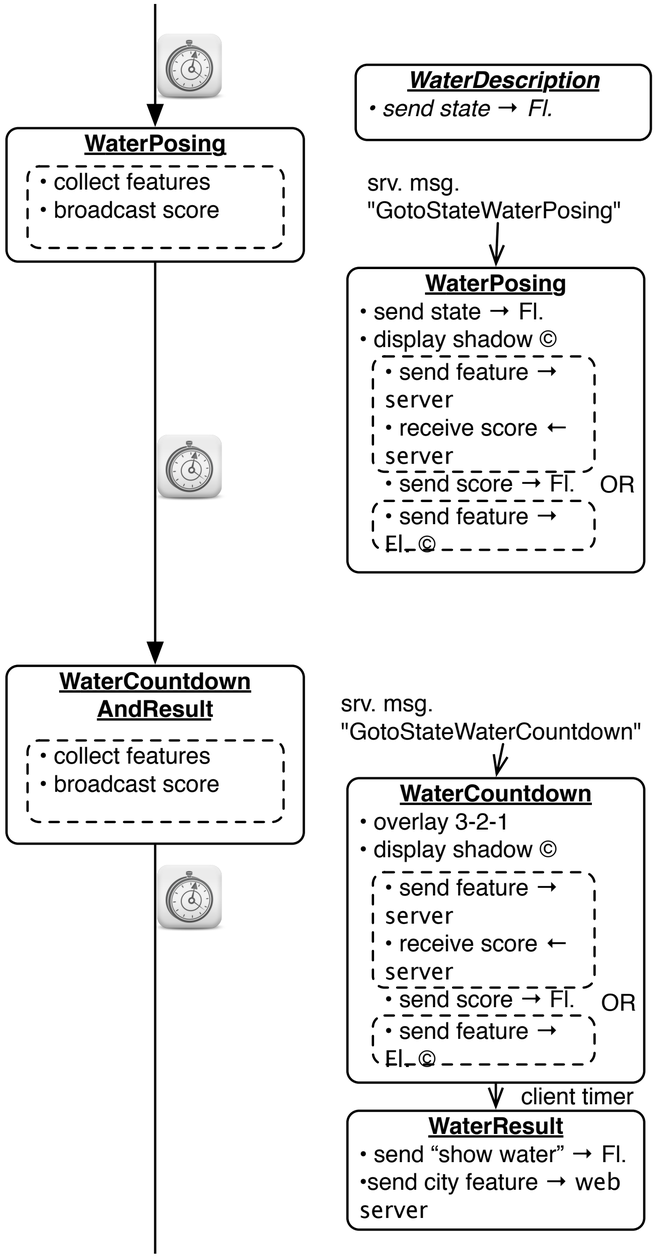


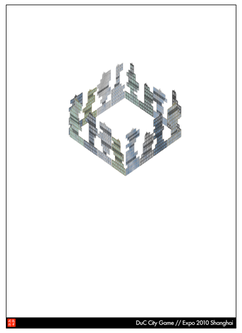
Iconic illustrations will remind the player how to pose in order to have their shadows overlap and thus create a water line.

People will see their shadows while posing in front of the screens.

A countdown will indicate that shadows will be "frozen".

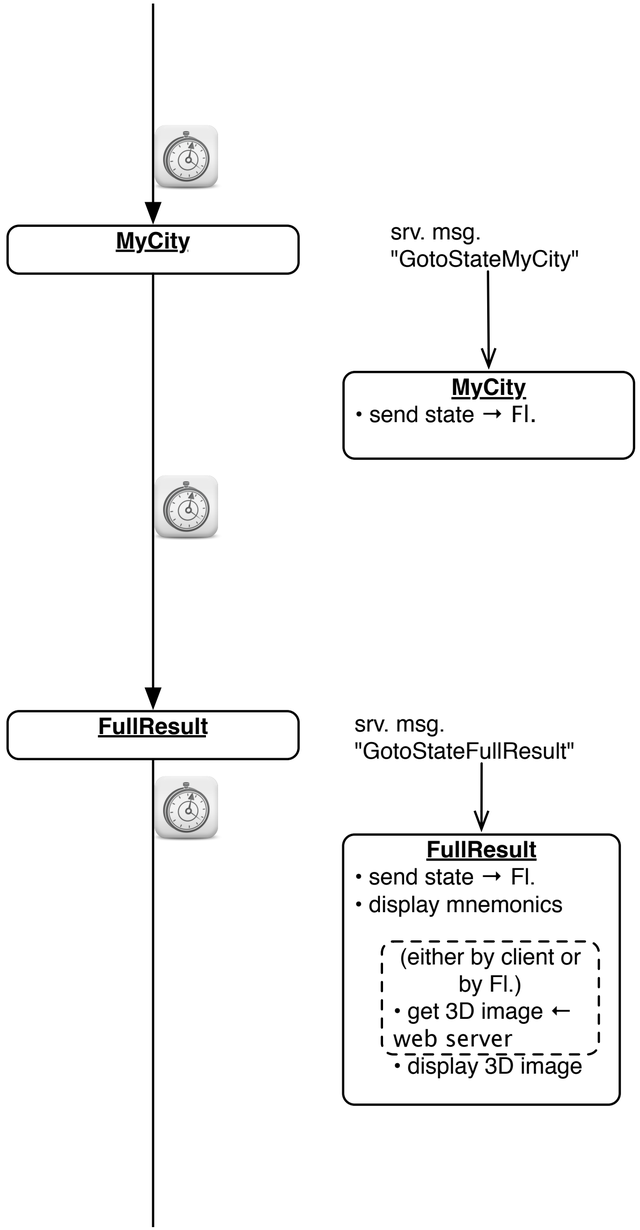
People will see the trees that they created with different green colours/trees with leaves?





People will see a animation of what will happen with their skyline.

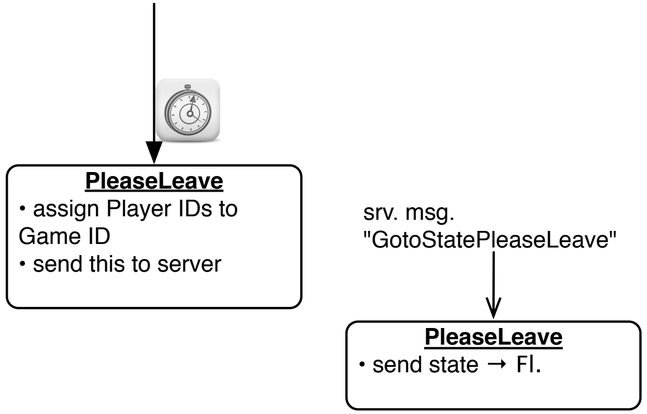
People will see their city block with the block number and the URL of the DuC Website.



PleaseLeave
Geh weg!
城市化

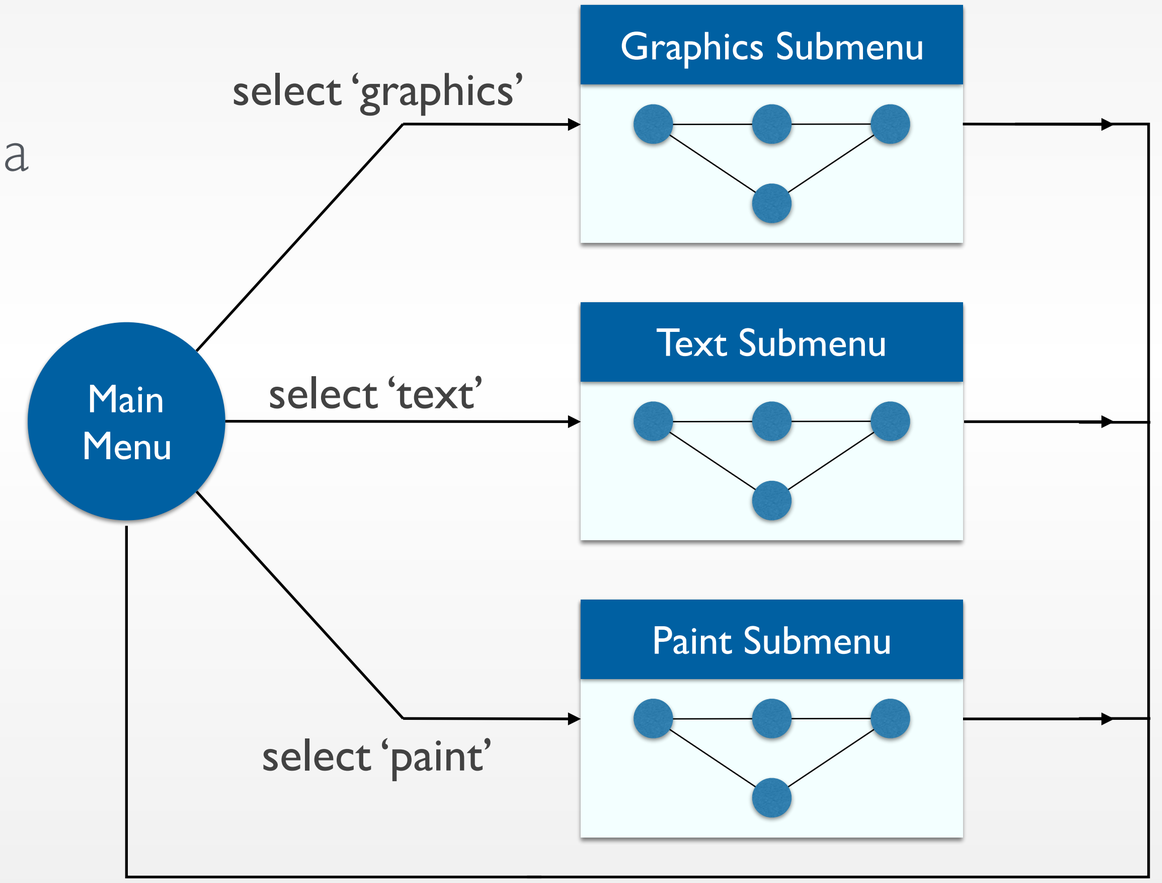
People will be asked to move out.

Beyond the playing area, visitors can deepen their understanding of city concepts at individual interactive stations before leaving the pavilion.



Hierarchical STNs

- Start and Finish states serve to glue an STN for a sub dialog (e.g., a certain menu selection) into a larger dialog (e.g., operating the application in general)
- Same expressive power as STNs, just more convenient
- The dialog structure of an entire system can be specified this way

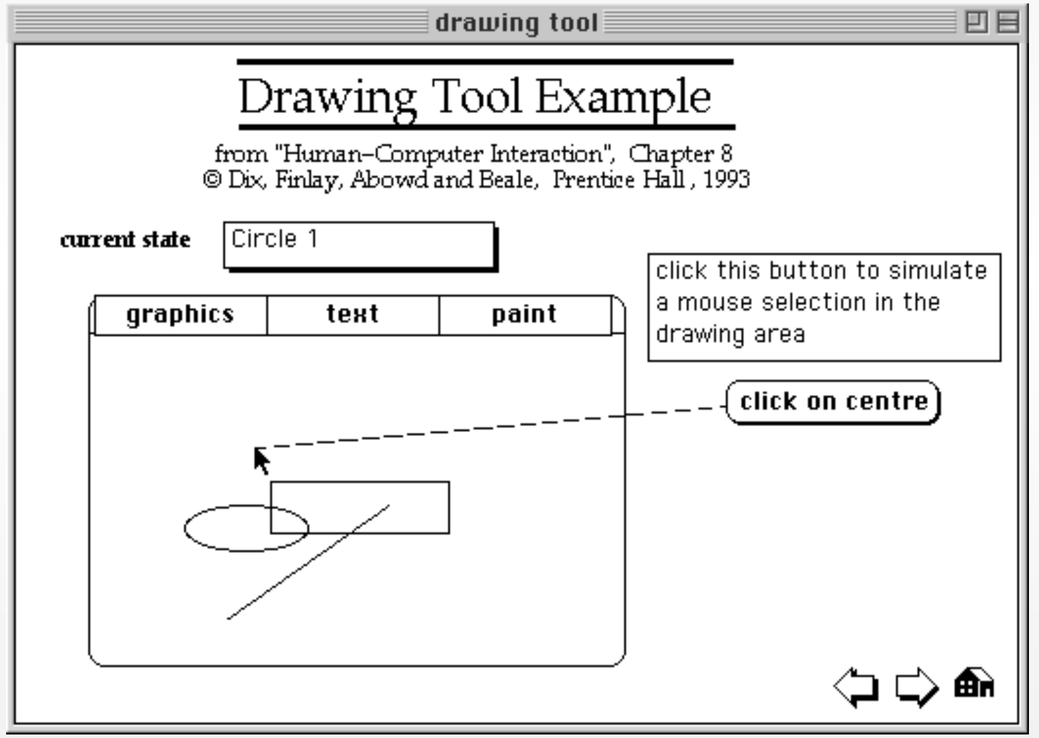


Using STNs in Prototyping

- Create a simple STN for the dialogs envisioned
- Create one UI snapshot (sketch if paper prototype) per state
  (label it with the state name)
- Include offscreen area for annotations and to include extra buttons simulating user actions that do not correspond to simple clicks on the current screen
- When walking the user through your paper prototype, consult the STN to find out how to respond to each user action

Using STNs in Prototyping

- Alternative: Let the computer "execute" the STN to run the prototype
- Use tools such as Keynote, PowerPoint
- Demo: Drawing tool prototype in HyperCard

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5 vor 12: Die Wissenschaftsnacht 2011
Fit für Informatik? Mach' den Test!
Vorkurs Informatik


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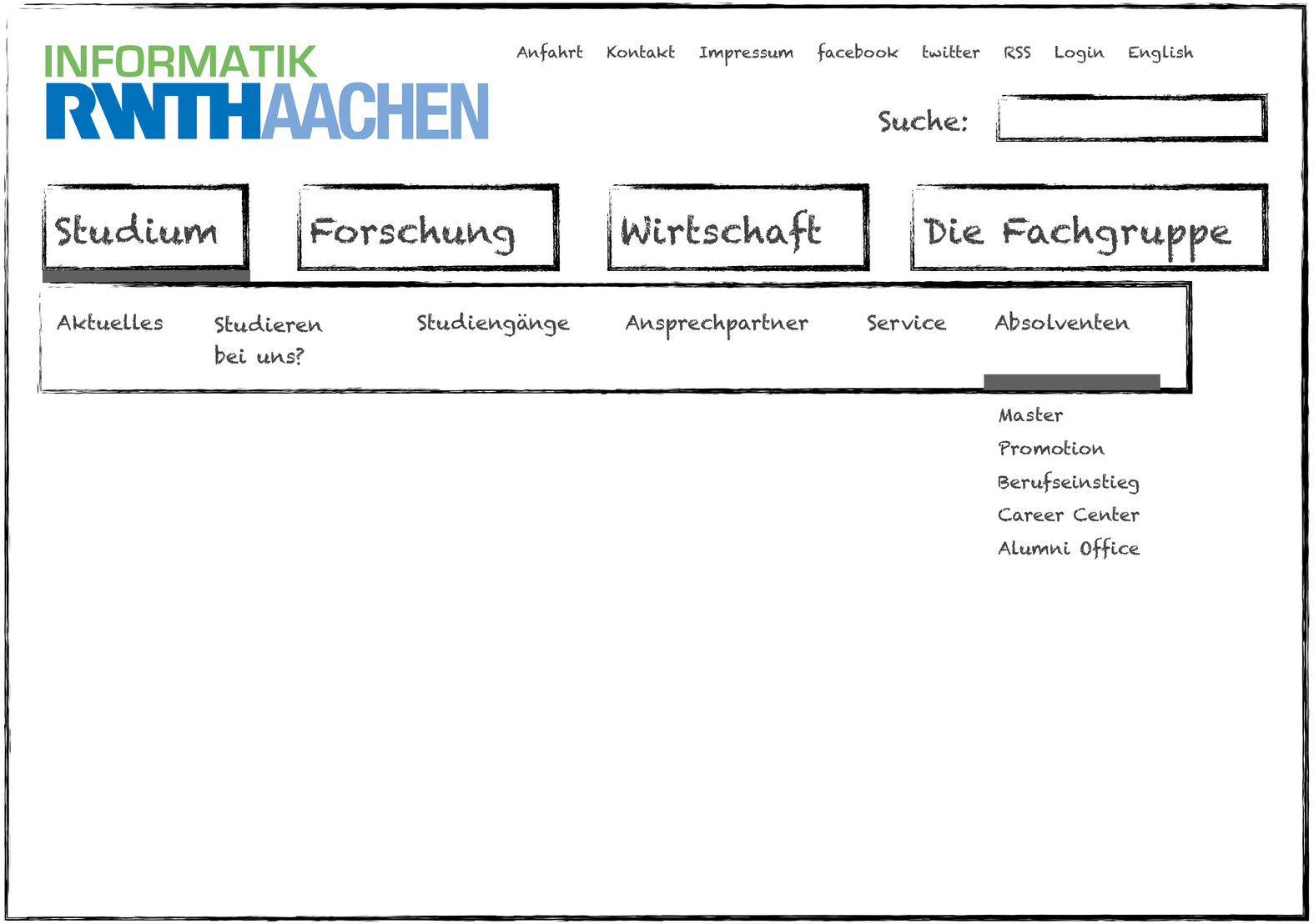
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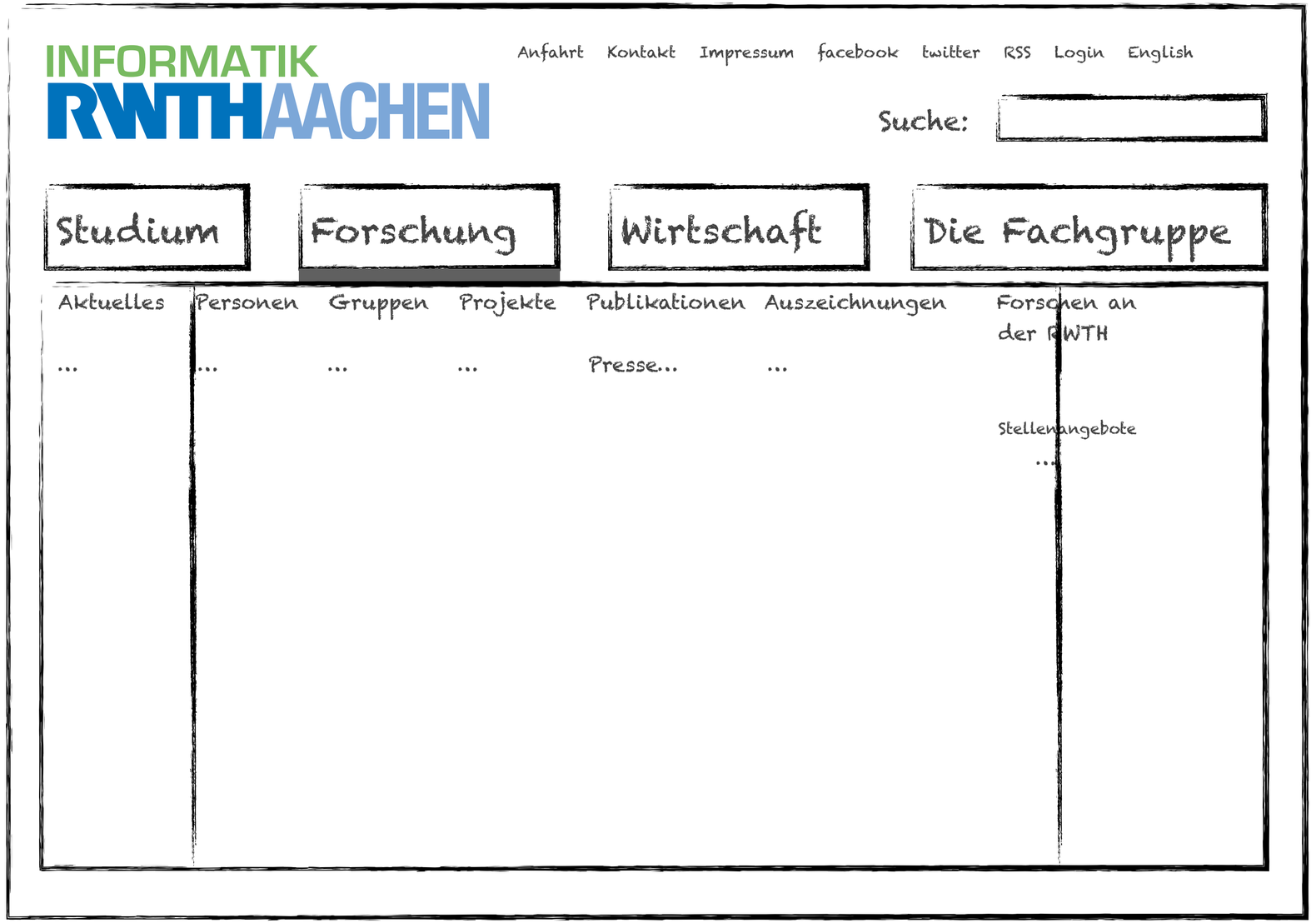
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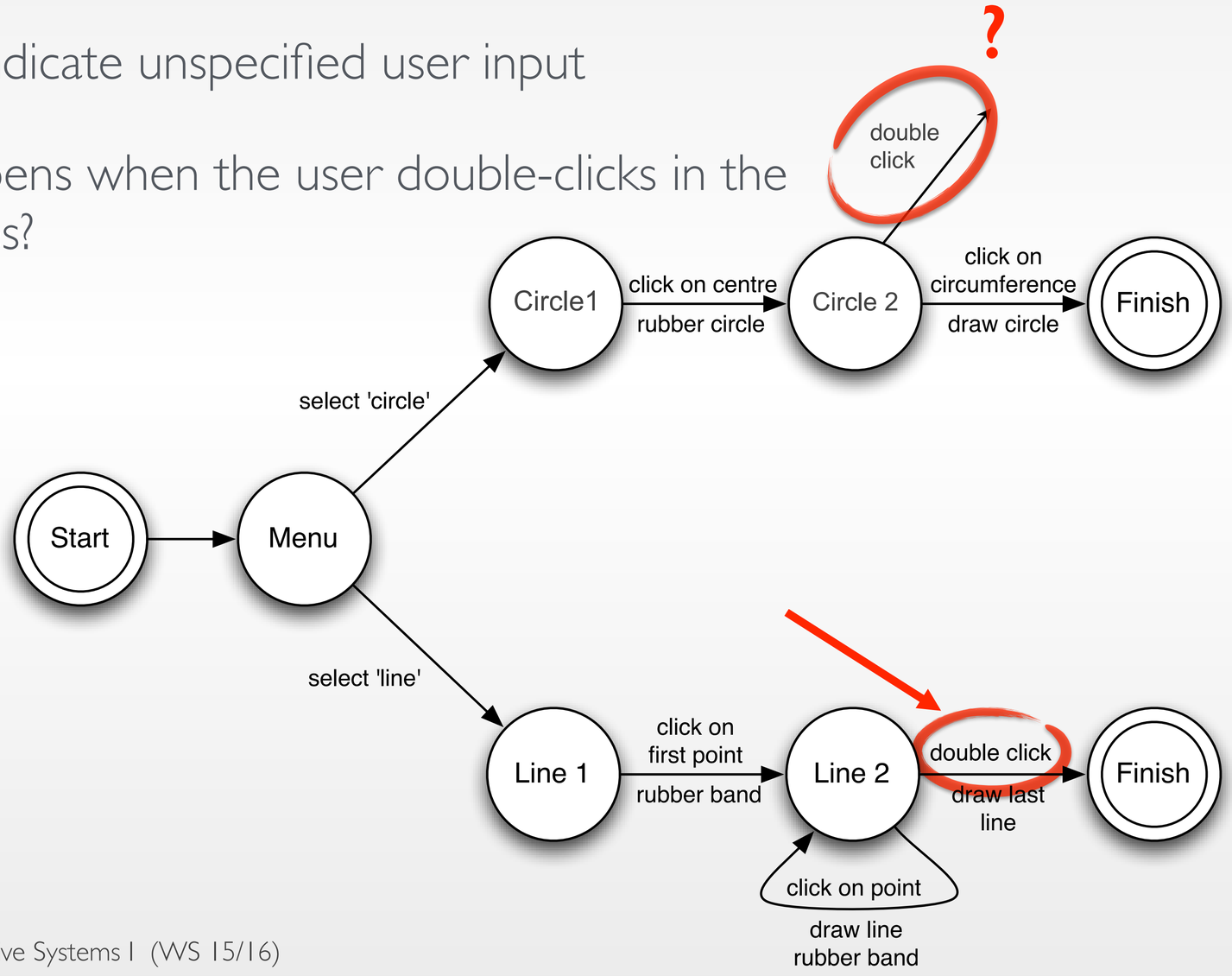
Checking STN Properties: States

- Completeness
  - Can you get anywhere from anywhere?
  - How easily?
- Reversibility
  - Can you get to the previous state?
  - But NOT undo
- Dangerous states
  - Some states you don't want to get to

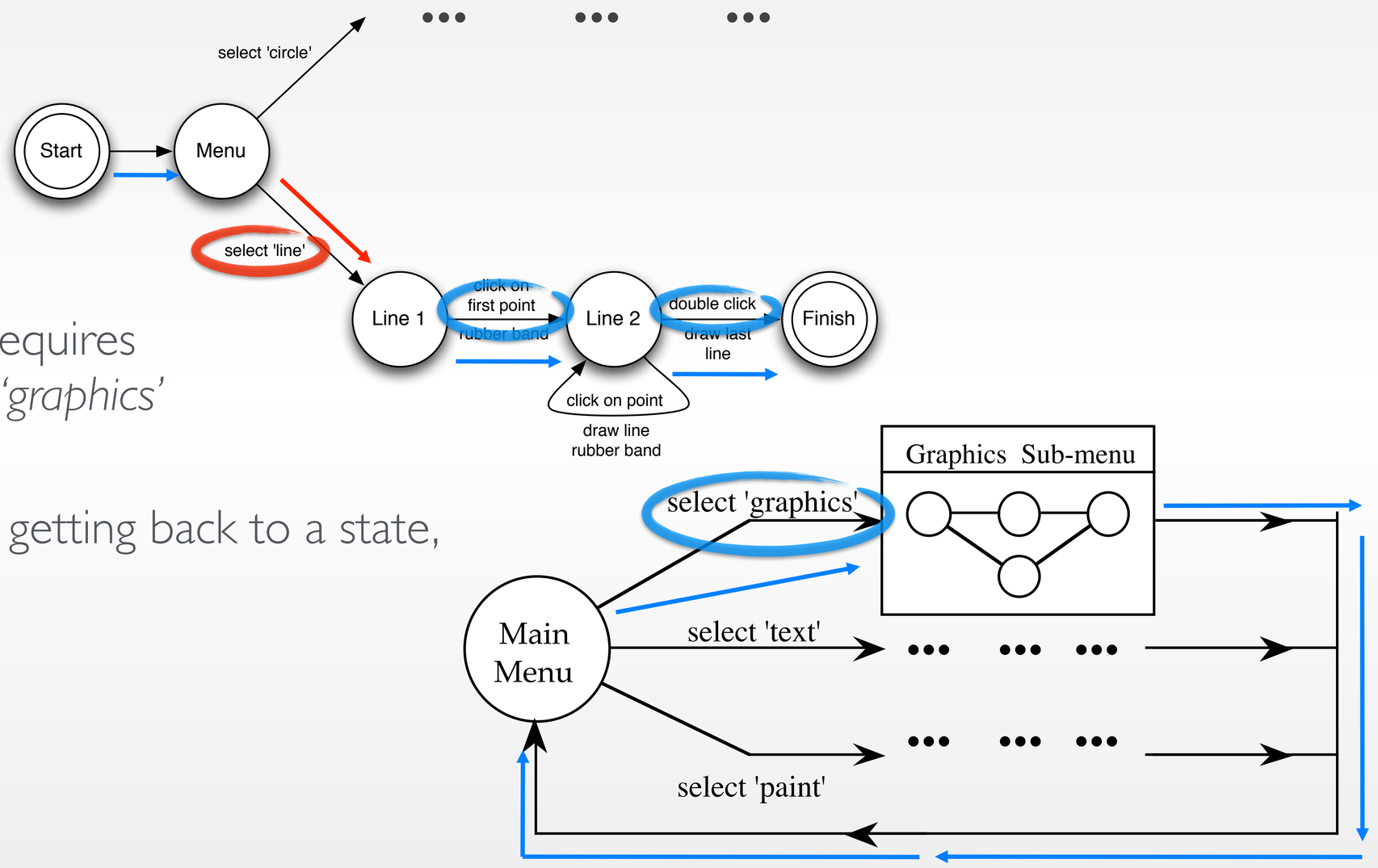
Checking Transition Properties: Completeness

- Missing arcs indicate unspecified user input
  - What happens when the user double-clicks in the Circle states?



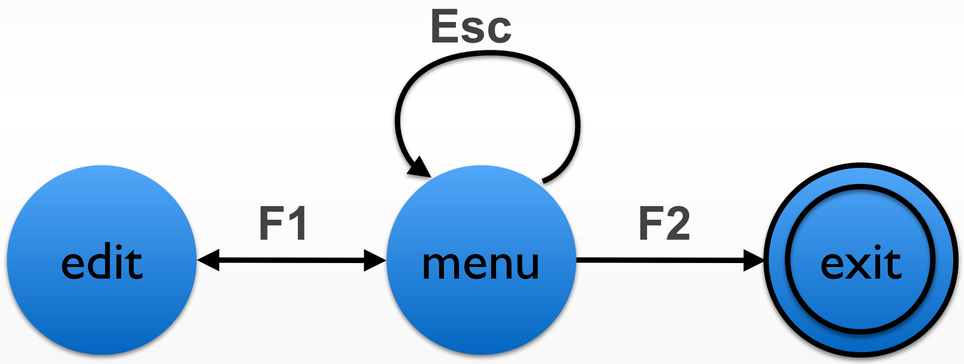
Checking Transition Properties: Reversibility

- E.g., reversing select 'line' requires *Click - double click - select 'graphics'* (3 actions)
- Note: Reverse means just getting back to a state, **not** to "undo" its effect



Dangerous States Example

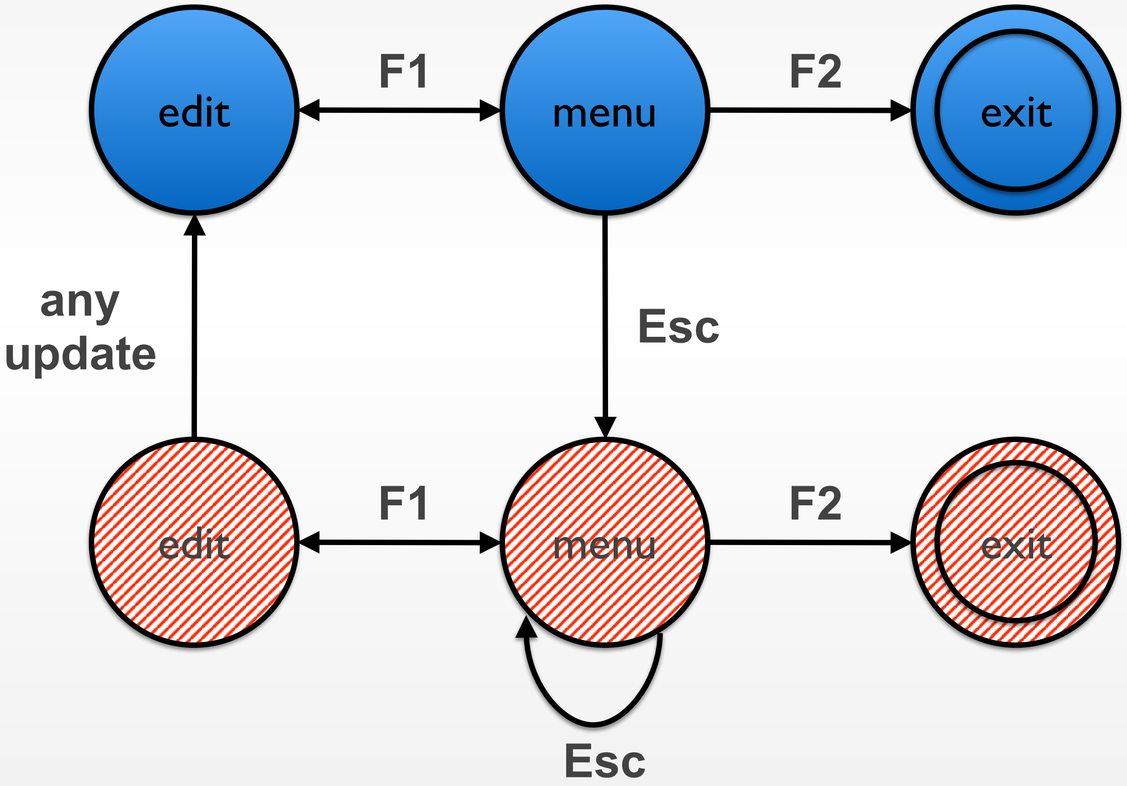
- Word processor: two modes and exit
  - F1 - changes mode
  - F2 - exit (and save)
  - Esc - no mode change



- But ... Esc resets autosave

Dangerous States Example

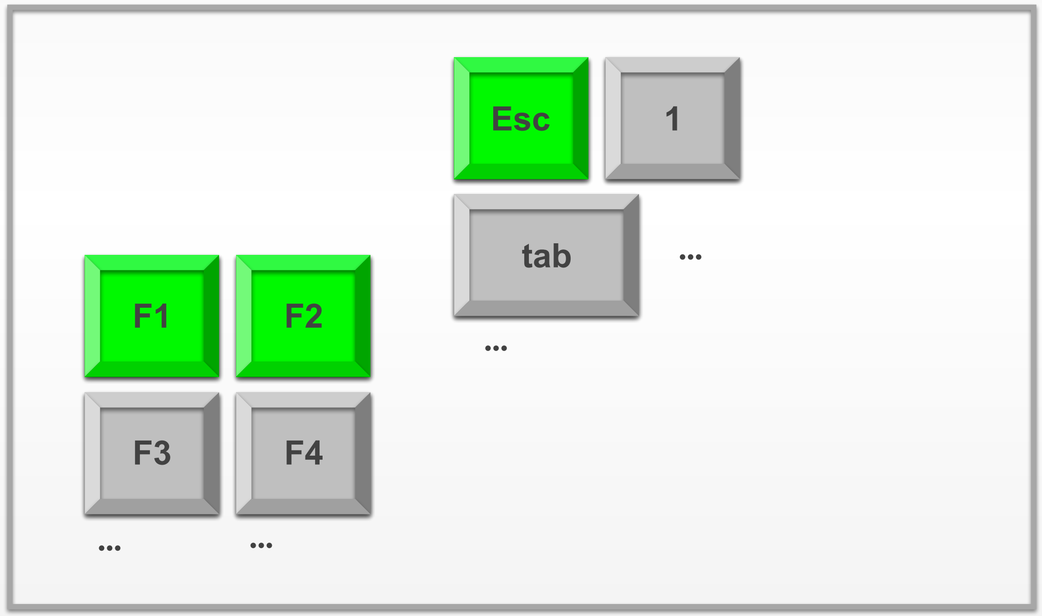
- Exit with/without save ⇒ dangerous states
- Duplicate states - semantic distinction

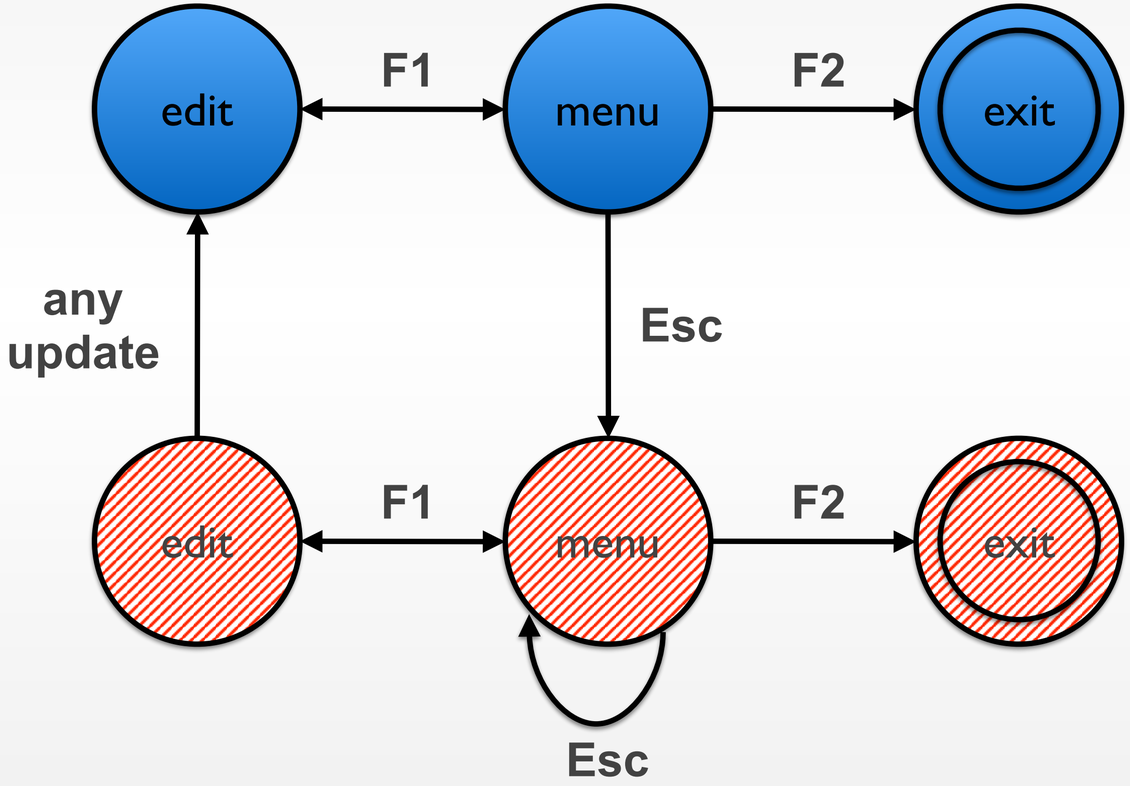


- F1-F2 - exit with save
- F1-Esc-F2 - exit with no save

Dangerous States Example: Layout Matters

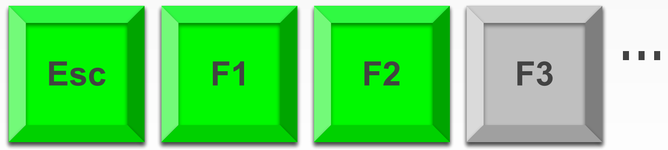
old keyboard - OK





Dangerous States Example: Layout Matters

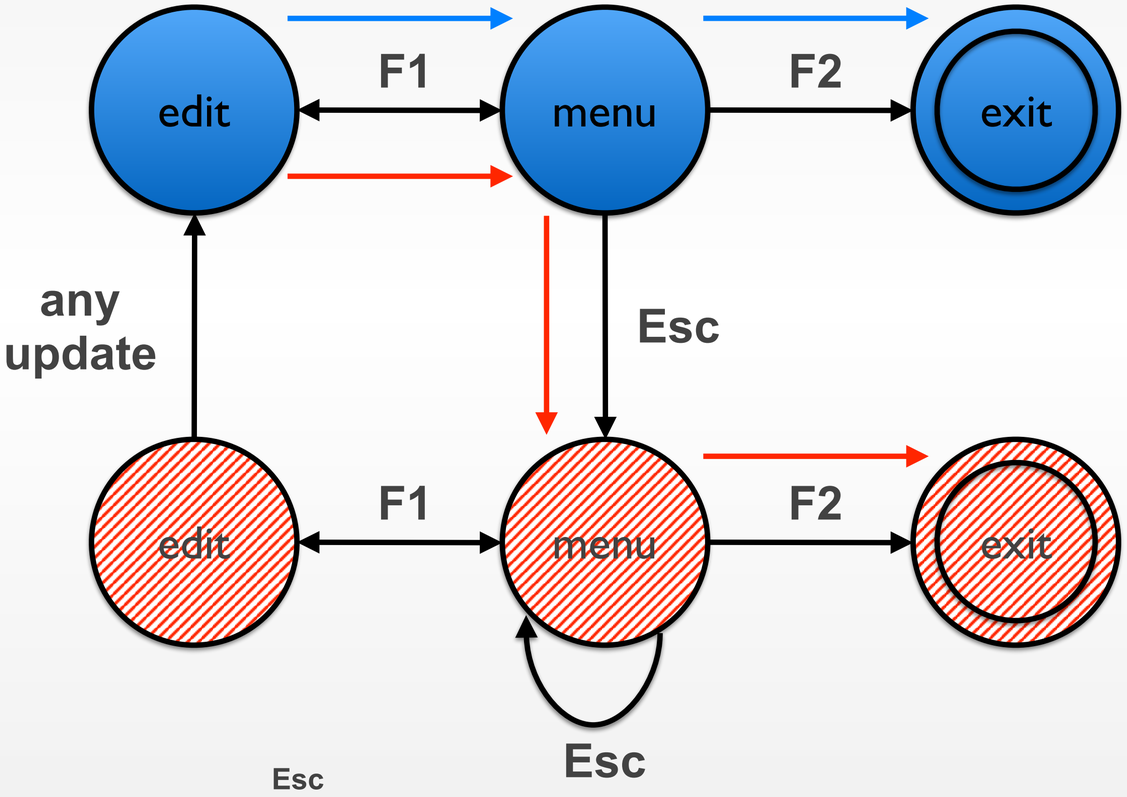
new keyboard layout



Intend F1-F2 (save)

Finger catches Esc

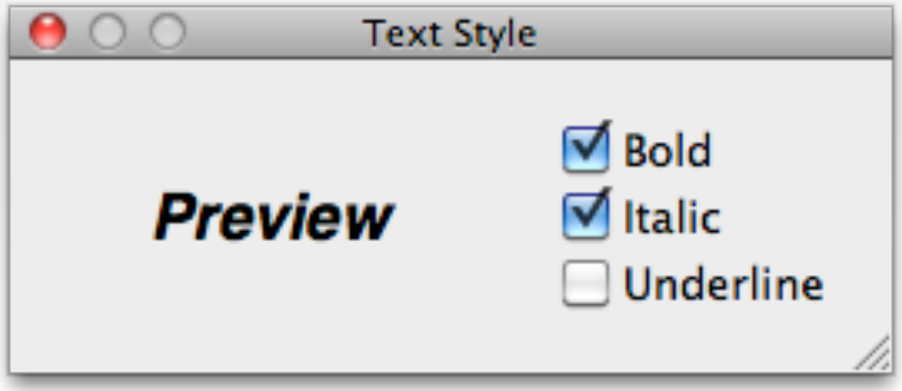
F1-Esc-F2 - disaster!



Checking STN Properties: Other Transition Properties

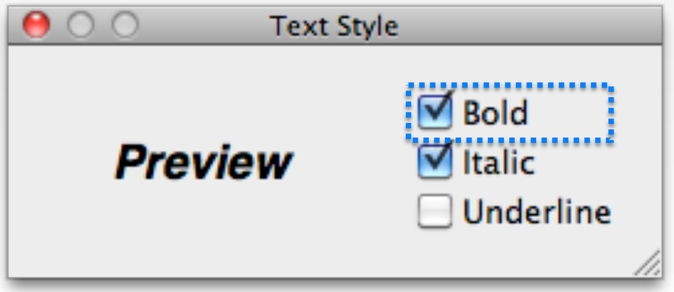
- Determinism
  - Several arcs for one action
    - Deliberate: application decides
    - Accidental: production rules
- Nested escapes
- Consistency
  - Same action, same effect?
  - Modes and visibility

In-Class Exercise: STN

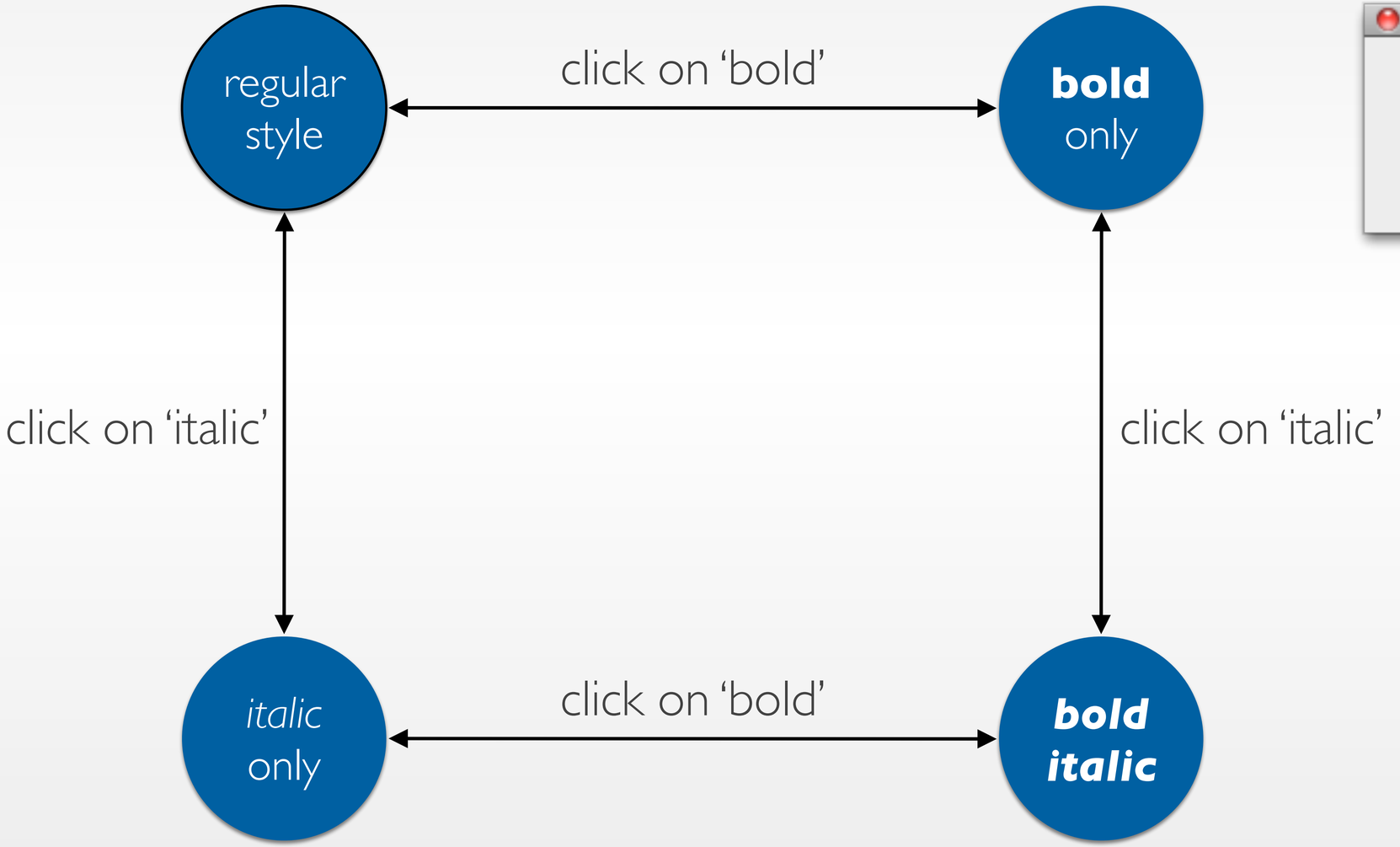


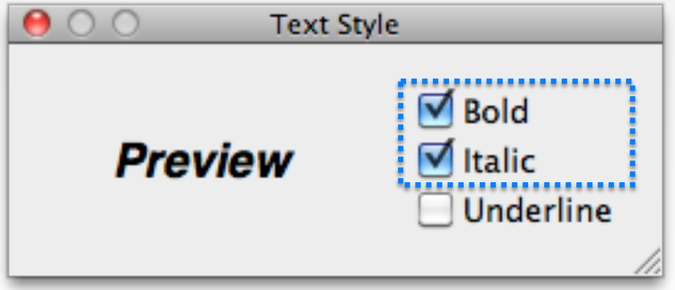
- Simple dialog to select bold, italics, and/or underline
- Draw the state diagram for:
  - Only Bold checkbox
  - Bold and italics checkboxes
  - All three checkboxes

Bold Checkbox

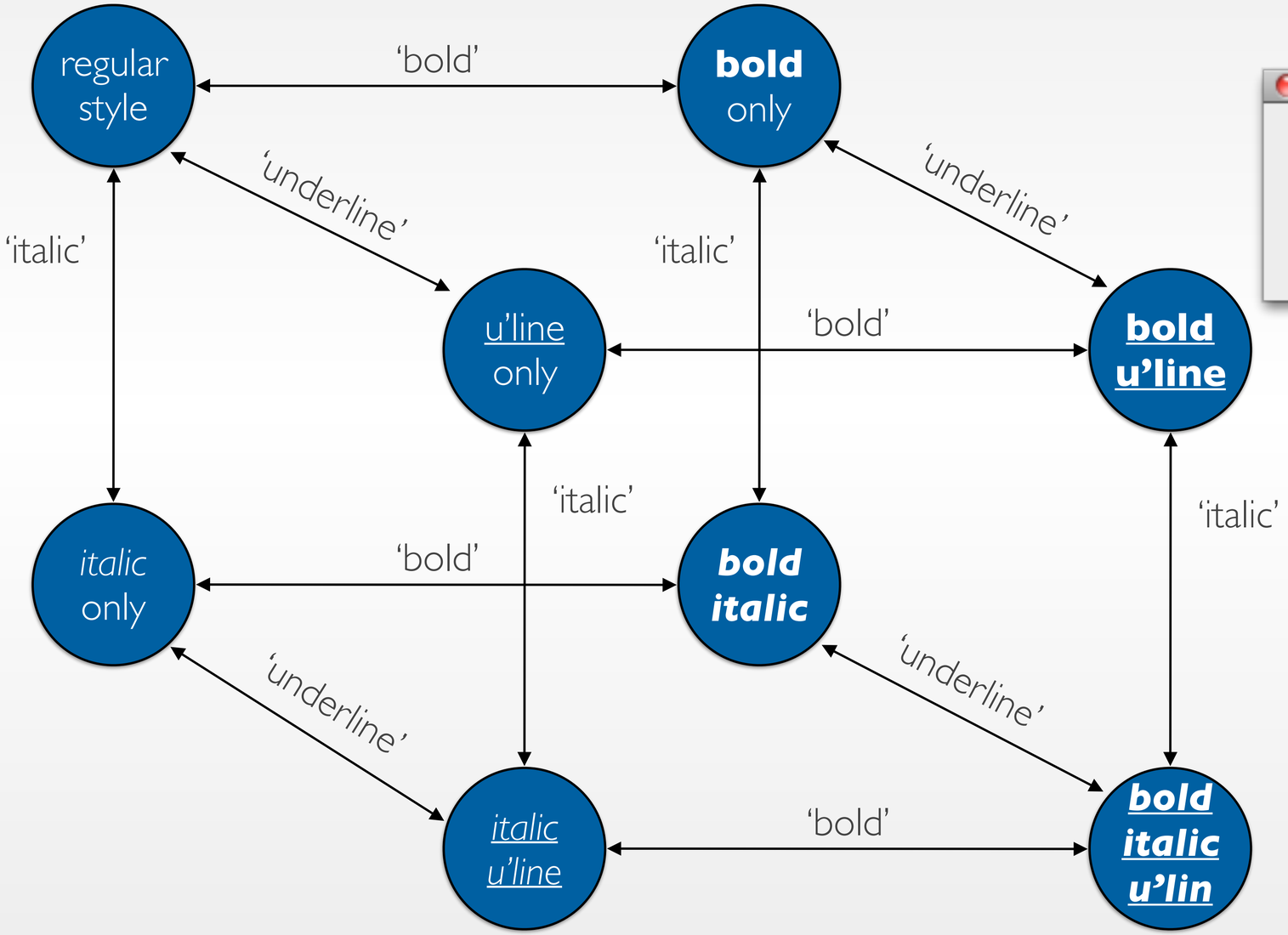


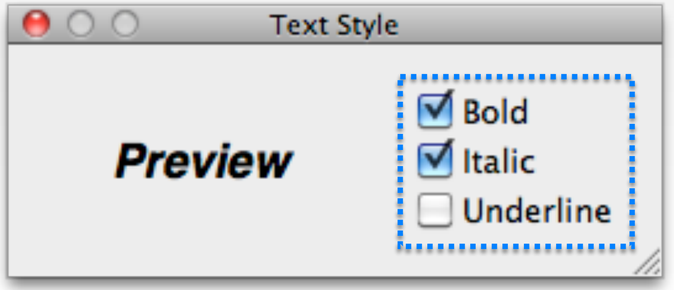
Bold & Italic Combined



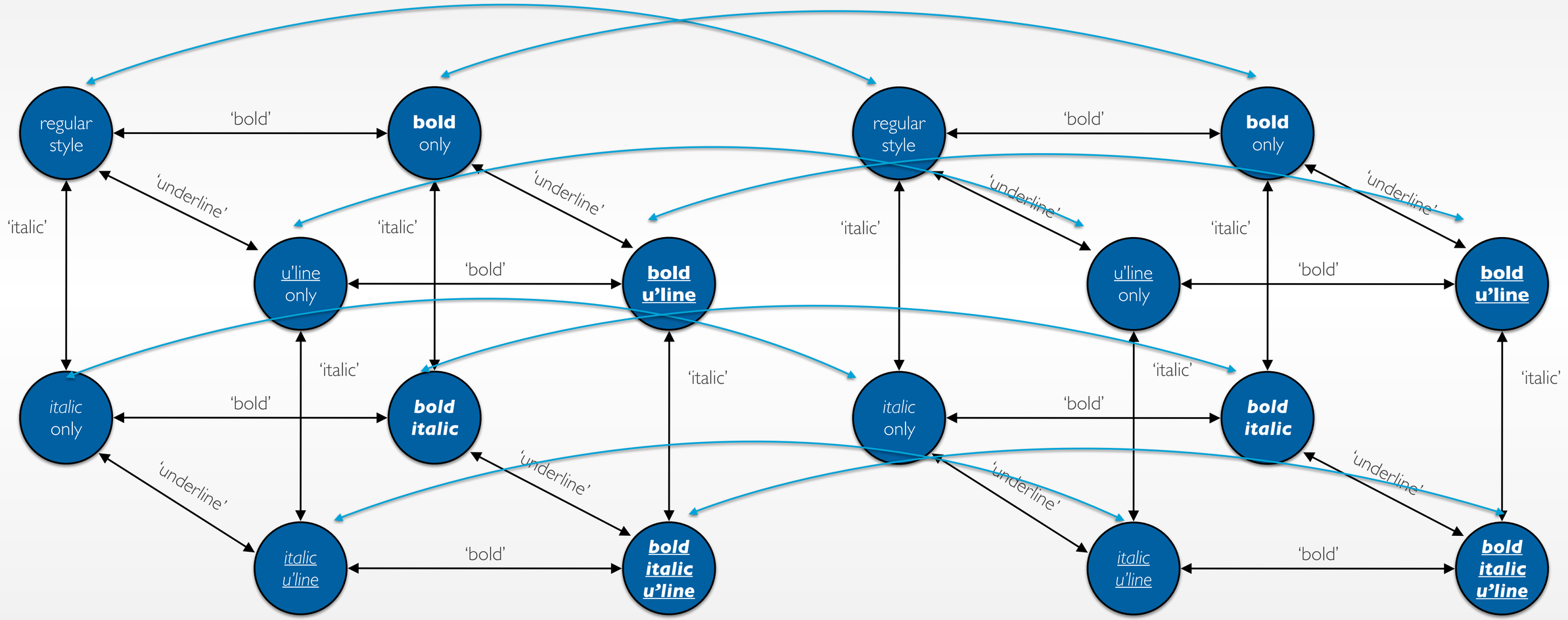


All Three Options





Adding Another Option…



Normal case

CAPITALIZED

STNs: State Explosion

- Problem: Combining two concurrent STNs with N and M states leads to new STN with N × M states
- STN hides clear structure of the dialog
- Especially problematic with modern GUIs
- Similar problems with "Escape" and "Help" options
  - ESC can be modeled as special second "Finish" exit active throughout subdialog
  - Help can be modeled as little subdialog hanging off every single state in the STN
  - Gets messy

Example: ESC & Help in STNs