Finite Statemachines

Specify and Implement dynamic Behaviour

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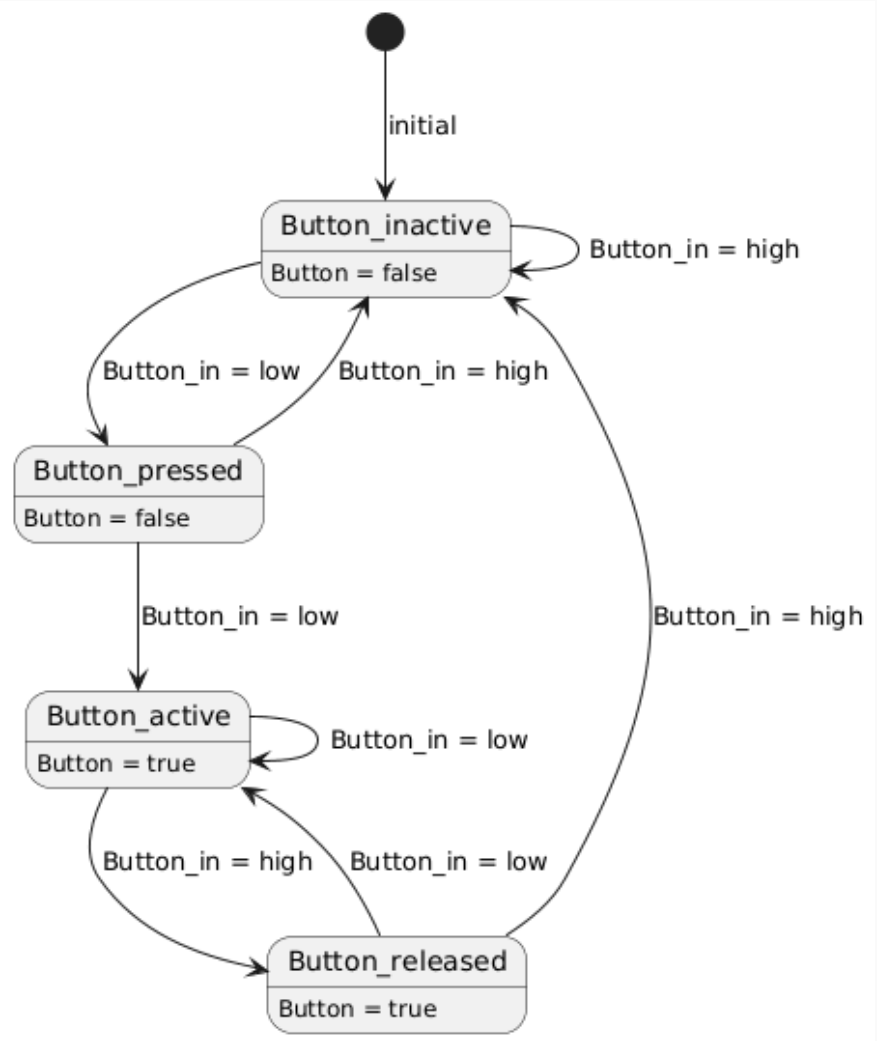
Example

Example Button Debounce

Button Debounce Statemachine

- Button Inactive - Button is registered as released
- Button pressed - latch event after first pressed
- Button active - Button is registered as pressed
- Button released - latch event after first release



Theory

Definition

Definition of a Statemachine

A finite-state machine (FSM) is a mathematical model of computation. It is an abstract machine that can be in exactly one of a finite number of states at any given time. The FSM can change from one state to another in response to some inputs; the change from one state to another is called a transition.

Definition

Parameters of a Statemachine:

- states s
- transitions t
- event σ

$$s \in \mathbf{S}$$

Definition of State

The state of a system is defined by the smallest possible number of its changeable internal parameters.
e.g.:

- velocity
- position
- temperature

Definition

Parameters of a Statemachine:

- states s
- transitions t
- event σ

$$t \in \mathbf{T}$$

Definition of Transition

A Transition is a change from one set of paramaters of a system to another one. e.g.:

- acceleration
- heat

Definition

Parameters of a Statemachine:

- states s
- transitions t
- event σ

$$\sigma \in \mathbf{\Sigma}$$

Definition of Event

A Event is a change of inputs of a system. e.g.:

- push of gas pedal
- expiration of time

Definition

Finite

A finite Statemachine only implements a limited set of states **S**. This implicates a limited set of transitions **T** and a limited set of Events **E**

A Statemachine can be described as a set functions t operating on its internal state s. The output y depends on the internal state s, additionaly it may depend on the input σ.

$$s_{n+1} = t(s_n, \sigma) \tag{1}$$

$$\lambda = g(s_n, \sigma) \tag{2}$$

Facts

- Statemachines, as per Definition, do not imply any timing behaviour.
- Every Memory implicitly holds state, thus implements a statemachine.
- The amount of states is proportional to the complexity of the statemachine.
- Every slightly complex component implements a statemachine.

Design of Statemachines

When to use a statemachine?

- Simple Behaviour that can be clustered
- Strict Deterministic control
- Ressource/Device Control

When not to use a statemachine?

- If a combinational logic is an alternative
- If a mathematical formula can be used instead (filters)
- Multiple Statemachines should never implement the same state

Senior Experience

State should be avoided.

Designtips

- Decide about timing (cyclic, synchronous, asynchronous)
- Number of states shall be reduced
- Hierarchical Statemachines are a good way to reduce states
- Statemachines that are directly or indirectly linked shall be avoided
- Make states explicit (no rotation direction as variable, no global variables)
- If a component implies state implement it as a statemachine (init, running, error)
- shall invalid transitions be neglected or treated as errors?

Senior Experience

Do not hide difficulties. Put them in a place to handle them.

Questions

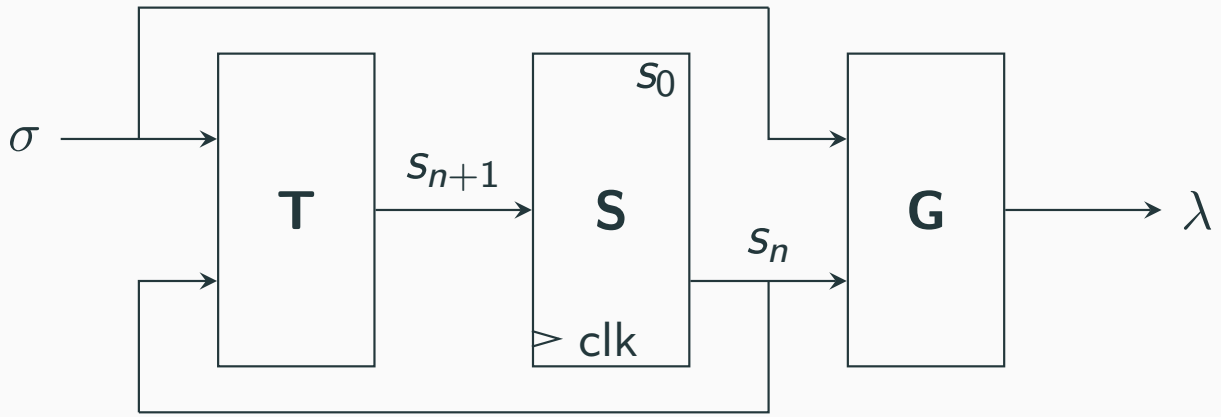
- How many states does a Integer(8-Bit) hold?
- How many states can a microcontroller with 2 KBytes of RAM and 16KBytes of ROM have?
- What is the maximum amount of transitions in a state machine with 4 States?

Questions

- How many states does a Integer(8-Bit) hold? **256**
- How many states can a microcontroller with 2KBytes of RAM and 16KBytes of ROM have? $\mathbf{2^{18000}}$
- What is the maximum amount of transitions in a state machine with 4 States? **16**

Implementation

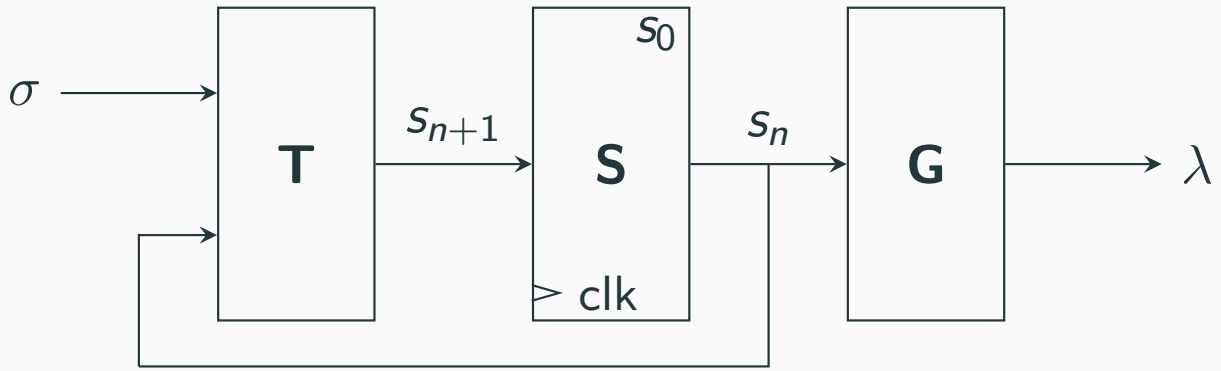
Mealy Machine



$$s_{n+1} = t(s_n, \sigma) \tag{3}$$

$$\lambda = g(s_n, \sigma) \tag{4}$$

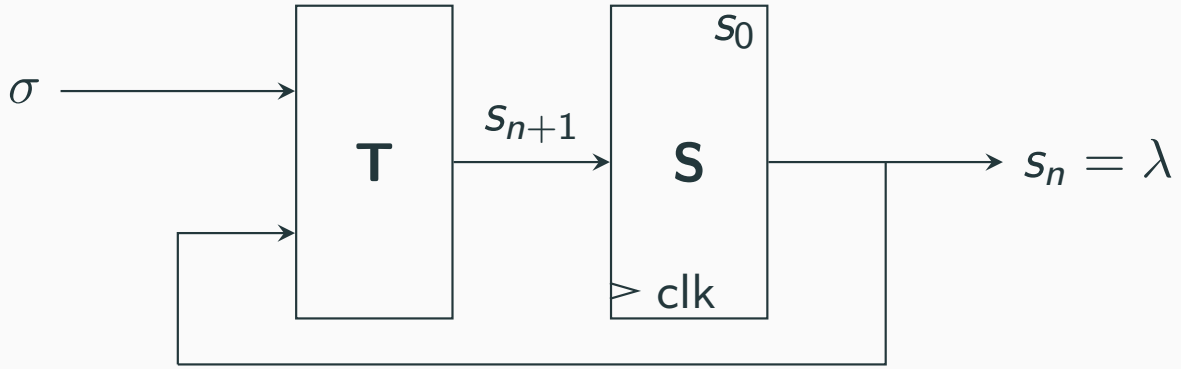
Moore Machine



$$s_{n+1} = t(s_n, \sigma) \tag{5}$$

$$\lambda = g(s_n) \tag{6}$$

Medvedev Machine



$$s_{n+1} = t(s_n, \sigma) \tag{7}$$

$$\lambda = s_n \tag{8}$$

Implementation in Software

Procedure

- Define statemachine
- choose a statemachine implementation that fits your needs
- define the sets matching the process variables ($\mathbf{S}$, $\mathbf{\Sigma}$, $\mathbf{T}$, $\mathbf{\Lambda}$)

Experience

To properly engineer something you need to understand your components and tools to a certain level.

Remark

Finding that level Depends on the problem.

Titleformats

Metropolis titleformats

metropolis supports 4 different titleformats:

- Regular
- Smallcaps
- allsmallcaps
- ALLCAPS

They can either be set at once for every title type or individually.

Small caps

This frame uses the `smallcaps` titleformat.

Potential Problems

Be aware, that not every font supports small caps. If for example you typeset your presentation with pdfTeX and the Computer Modern Sans Serif font, every text in smallcaps will be typeset with the Computer Modern Serif font instead.

all small caps

This frame uses the `allsmallcaps` titleformat.

Potential problems

As this titleformat also uses smallcaps you face the same problems as with the `smallcaps` titleformat. Additionally this format can cause some other problems. Please refer to the documentation if you consider using it.

As a rule of thumb: Just use it for plaintext-only titles.

ALL CAPS

This frame uses the `allcaps` titleformat.

Potential Problems

This titleformat is not as problematic as the `allsmallcaps` format, but basically suffers from the same deficiencies. So please have a look at the documentation if you want to use it.

Elements

Typography

```
The theme provides sensible defaults to
\emph{emphasize} text, \alert{accent} parts
or show \textbf{bold} results.
```

becomes

The theme provides sensible defaults to *emphasize* text, accent parts or show **bold** results.

Font feature test

- Regular
- *Italic*
- SmallCaps
- **Bold**
- ***Bold Italic***
- **SmallCaps**
- `Monospace`
- *`Monospace Italic`*
- `Monospace Bold`
- *`Monospace Bold Italic`*

Lists

Items

- Milk
- Eggs
- Potatos

Enumerations

1. First,
2. Second and
3. Last.

Descriptions

PowerPoint Meeh.

Beamer Yeeeha.

Animation

- This is important

Animation

- This is important
- Now this

Animation

- This is important
- Now this
- And now this

Animation

- This is really important
- Now this
- And now this

Figures

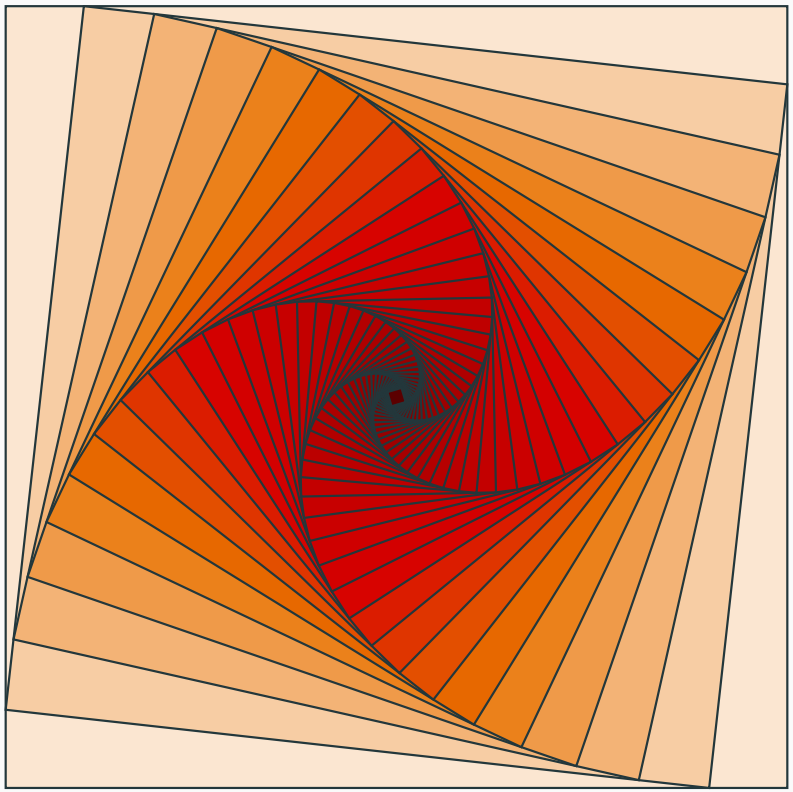


Figure 1: Rotated square from texample.net.

Tables

Table 1: Largest cities in the world (source: Wikipedia)

City	Population
Mexico City	20,116,842
Shanghai	19,210,000
Peking	15,796,450
Istanbul	14,160,467

Blocks

Three different block environments are pre-defined and may be styled with an optional background color.

Default	**Default**
Block content.	Block content.

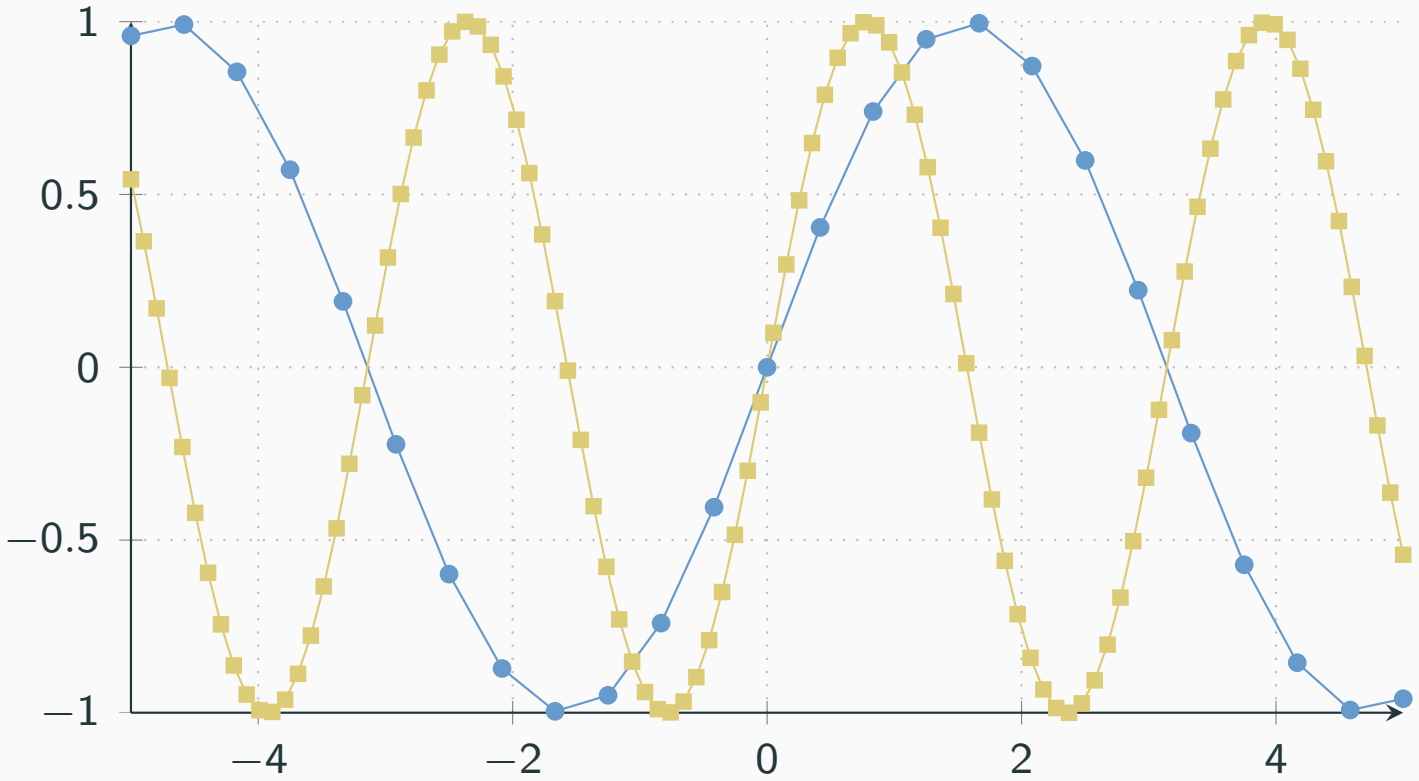
Alert	**Alert**
Block content.	Block content.

Example	**Example**
Block content.	Block content.

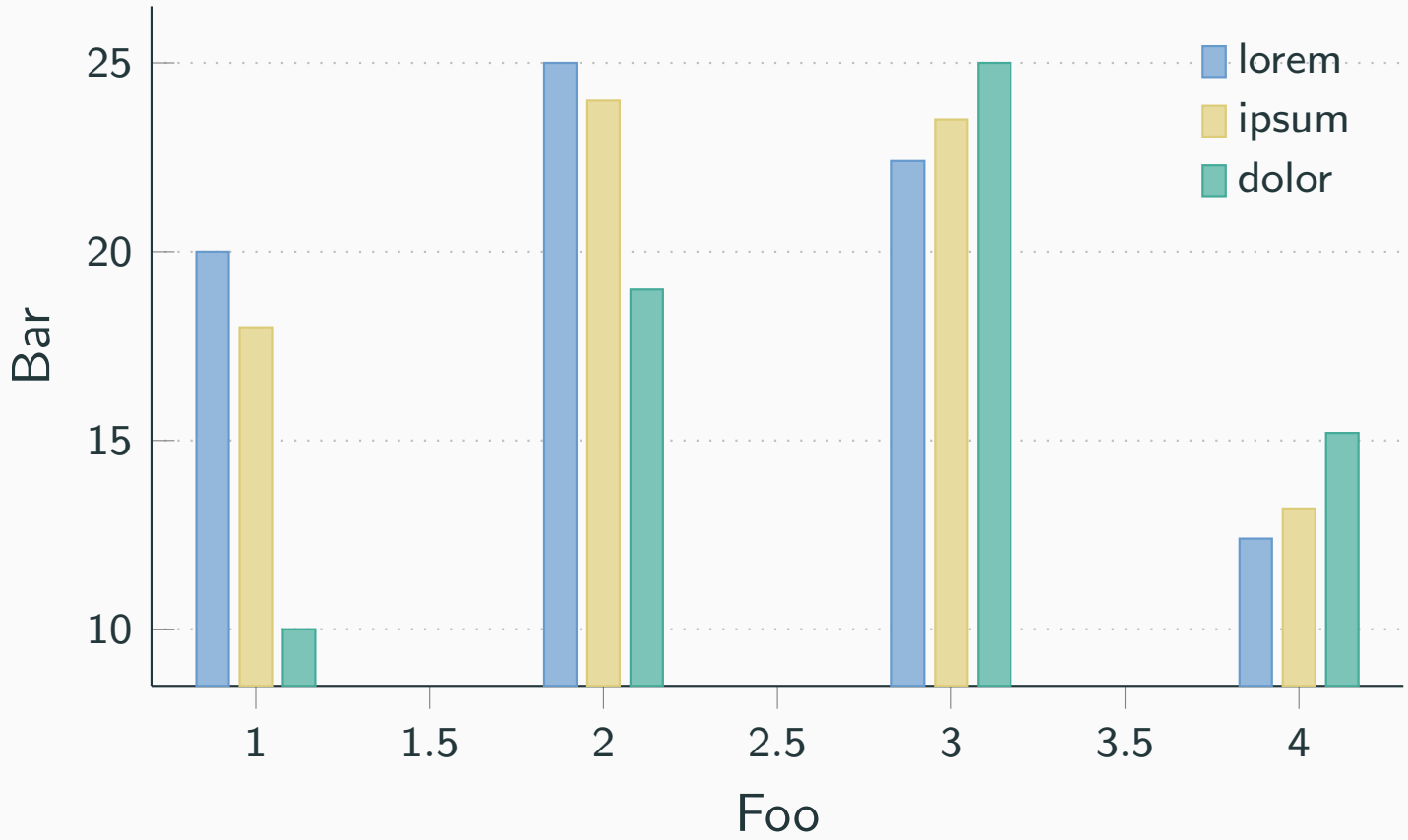
Math

$$e = \lim_{n \to \infty} \left(1 + \frac{1}{n}\right)^n$$

Line plots



Bar charts



Quotes

Veni, Vidi, Vici

Frame footer

metropolis defines a custom beamer template to add a text to the footer. It can be set via

```
\setbeamertemplate{frame footer}{My custom footer}
```

References

Some references to showcase [allowframebreaks] [**?**, **?**, **?**, **?**, **?**]

Conclusion

Summary

Get the source of this theme and the demo presentation from

`github.com/matze/mtheme`

Questions?

Backup slides

Sometimes, it is useful to add slides at the end of your presentation to refer to during audience questions.

The best way to do this is to include the `appendixnumberbeamer` package in your preamble and call `\appendix` before your backup slides.

metropolis will automatically turn off slide numbering and progress bars for slides in the appendix.

References i