



The Duckietown Book



The last version of this book and other documents are available at this URL:
<https://duckietown.github.io/duckuments/>

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PART 1

The Duckietown project

CHAPTER 1

What is Duckietown?

Duckietown is a robotics education and outreach effort.

The most tangible goal of the project is to provide a low-cost educational platform for learning autonomy, consisting of the Duckiebots, an autonomous robot, and the Duckietowns, the infrastructure in which the Duckiebots navigate.

However, we focus on the *learning experience* as a whole, by providing a set of modules teaching plans and other guides, as well as a curated role-play experience.

We have two targets:

1.

For **instructors**, we want to create a “class-in-a-box” that allows to offer a modern and engaging learning experience. Currently, this is feasible at the advanced undergraduate and graduate level, though in the future we would like to present the platform as multi-grade experiences.

2.

For **self-guided learners**, we want to create a “self-learning experience”, that allows to go from zero knowledge of robotics to graduate-level understanding.

In addition, the Duckietown platform has been used as a research platform.

TODO: add references to papers submitted/published with it.

While we are at the early phases of the project, many people have been using the materials in the past year.

Why the duckies?

Compared to other educational robotics projects, the presence of the duckies is what makes this project stand out. Why the duckies?

We want to present robotics in an accessible and friendly way.

TODO: copy usual discussion from somewhere else.

TODO: add picture of kids with Duckiebots.

Duckietown has been recently incorporated as a non-profit foundation.

1.1. Learn about the platform

The best way to get a sense of how the platform looks is to watch these videos. They show off the capabilities of the platform.

TODO: add 4 “cool” videos currently in the home page

This video is part of the Red Hat documentary:

TODO: add Red Hat video

1.2. Learn about the educational experience

These papers present a more formal description of the technical side of the project as well as the educational side.

This paper [1] describes the course design for Duckietown: learning objectives, teaching methods, etc.

This video is a Duckumentary about the first version of the class, during Spring 2016. The Duckumentary was shot by Chris Welch.

TODO: Duckumentary about the release.

1.3. Learn about the platform

The paper [2] describes the Duckiebot and its software. With 29 authors, we made the record for a robotics conference.

CHAPTER 2

Duckietown history and future

2.1. The beginnings of Duckietown

Duckietown started as an MIT class during Spring 2016.

2.2. Duckietown around the world

1) Duckietown High School

2.3. Coming up

In 2017, the class will be offered contemporaneously at:

- ETH Zurich
- University of Montreal
- University of Chicago

as well as:

CHAPTER 3

First steps

3.1. How to get started

If you are an instructor, please jump to [Chapter 4](#).

If you are a self-guided learner, please jump to [Chapter 5](#).

If you are a company, and interested in working with Duckietown, please jump to [Chapter 6](#).

3.2. How to keep in touch

TODO: add link to Facebook

TODO: add link to Mailing list

TODO: add link to Slack?

3.3. How to contribute

TODO: If you want to contribute to the software...

TODO: If you want to contribute to the hardware...

TODO: If you want to contribute to the documentation...

TODO: If you want to contribute to the dissemination...

CHAPTER 4

Duckietown for instructors

CHAPTER 5

Duckietown for self-guided learners

TODO: to write

CHAPTER 6

Introduction for companies

TODO: to write

CHAPTER 7

Frequently Asked Questions

7.1. General questions

What is Duckietown?

Duckietown is a low-cost educational and research platform.

Is Duckietown free to use?

Yes. All materials are released according to an open source license.

Is everything ready?

Not quite! Please [sign up to our mailing list](#) to get notified when things are a bit more ready.

How can I start?

See the next section, Getting started.

How can I help?

If you would like to help actively, please email duckietown@mit.edu.

7.2. FAQ by students / independent learners

I want to build my own Duckiebot. How do I get started?

TODO: to write

7.3. FAQ by instructors

How large a class can it be? I teach large classes.

TODO: to write

What is the budget for the robot?

TODO: to write

I want to teach a Duckietown class. How do I get started?

Please get in touch with us at duckietown@mit.edu. We will be happy to get you started and sign you up to the Duckietown instructors mailing list.

7.4. FAQ by researchers

TODO: to write

PART 2

How to contribute

Contributing to this documentation

8.1. Where the documentation is

All the documentation is in the repository `duckietown/duckuments`.

The documentation is written as a series of small files in Markdown format.

It is then processed by a series of scripts to create this output:

- a [publication-quality PDF](#);
- an [online HTML version, split in multiple pages and with comments boxes](#).

8.2. Editing links

The simplest way to contribute to the documentation is to click any of the “✎” icons next to the headers.

They link to the “edit” page in Github. There, one can make and commit the edits in only a few seconds.

8.3. Comments

In the multiple-page version, each page also includes a comment box powered by a service called Disqus. This provides a way for people to write comments with a very low barrier. (We would periodically remove the comments.)

8.4. Installing dependencies for compiling the documentation

Let `DUCKUMENTS` be the base directory for the documentation.

Download the `duckuments` repo in that directory:

```
$ git clone git@github.com:duckietown/duckuments.git $DUCKUMENTS
```

Cd into directory:

```
$ cd $DUCKUMENTS
```

Create a virtual environment usign `venv` (the command `virtualenv` might be used as well, depending on the distribution):

```
$ venv deploy
```

Activate the virtual environment:

```
$ source $DUCKUMENTS/deploy/bin/activate
```

Install some dependencies:

```
$ sudo apt-get install libxm12-dev bibxslt1-dev python-dev
$ sudo apt-get install libffi6 libffi-dev
```

Clone this external repository:

```
$ cd $DUCKUMENTS
$ git clone -b duckuments git@github.com:AndreaCensi/mcdp.git
```

Install it and its dependencies:

```
$ cd $DUCKUMENTS/mcdp
$ python setup.py develop
```

Install these other dependencies:

```
$ cd $DUCKUMENTS
$ pip install numpy matplotlib
```

Ensure the latest version (>6) of nodejs is installed, and:

```
$ sudo apt-get install node-less
$ npm install MathJax-node jsdom@9.3 less
```

Install PrinceXML from [this page](#).

8.5. Troubleshooting installation problems

1) Installing (nodejs) packages

The only pain point in the installation procedure has been the installation of nodejs packages using npm. For some reason, they cannot be installed globally (npm install -g).

Do not use sudo for installation. It will cause problems.

If you use sudo, you probably have to delete a bunch of directories, such as: RBR00T/node_modules, /.npm, and /.node_modules, if they exist.

8.6. Compiling the documentation

Make sure you have deployed and activated the virtual environment. Then:

```
$ cd $DUCKUMENTS
$ make duckuments-dist
```

This creates the directory duckuments-dist, which contains another checked out copy of the repository, but with the branch gh-pages, which is the branch that is published by Github using the “Github Pages” mechanism.

At this point, please make sure that you have these two .git folders:

```
$DUCKUMENTS/.git
$DUCKUMENTS/duckuments-dist/.git
```

To compile the docs, go in the DUCKUMENTS directory and run make compile:

```
$ cd $DUCKUMENTS
$ make all split
```

This creates the following files:

- duckuments-dist/master/duckiebook.html is a single-page HTML of everything.
- duckuments-dist/master/duckiebook.pdf is the PDF version.
- duckuments-dist/master/duckiebook/index.html is the first page of the version with each chap-

ter on a different page.

8.7. Deploying the documentation

To deploy the documentation, jump into the `DUCKUMENTS/duckuments-dist` directory.

Run the command `git branch`. If the out does not say that you are on the branch `gh-pages`, then one of the steps before was done incorrectly.

```
$ cd $DUCKUMENTS/duckuments-dist
$ git branch
...
* gh-pages
...
```

Now, after triple checking that you are in the `gh-pages` branch, you can use `git status` to see the files that were added or modified, and simply use `git add`, `git commit` and `git push` to push the files to Github.

Features of the documentation writing system

9.1. Embedded LaTeX

You can use *LaTeX* math, environment, and references. For example, take a look at

$$x^2 = \int_0^t f(\tau) \, d\tau$$

or refer to [Proposition 1](#).

Proposition 1. (Proposition example) This is an example proposition: $2x = x + x$.

The above was written as in [Figure 1](#).

```
You can use  $\LaTeX$  math, environment, and references.
For example, take a look at

\[\quad x^2 = \int_0^t f(\tau) \, \text{d}\tau\quad\]

or refer to \[Proposition example\].

\begin{proposition}[Proposition example]\label{prop:example}
This is an example proposition:  $2x = x + x$ .
\end{proposition}
```

Figure 1. Use of LaTeX code.

TODO: other LaTeX features supported

9.2. Other interesting features

TODO: to write

PART 3

Modeling

TODO:

CHAPTER 10

Kinematics of Duckiebot

TODO:

[1] [Jacopo Tani](#), [Liam Paull](#), [Maria Zuber](#), [Daniela Rus](#), [Jonathan How](#), [John Leonard](#), and [Andrea Censi](#). **Duckietown: an innovative way to teach autonomy**. In *EduRobotics 2016*. Athens, Greece, December 2016.  [pdf](#)

[2] [Liam Paull](#), [Jacopo Tani](#), [Heejin Ahn](#), [Javier Alonso-Mora](#), [Luca Carlone](#), [Michal Cap](#), [Yu Fan Chen](#), [Changhyun Choi](#), [Jeff Dusek](#), [Daniel Hoehener](#), [Shih-Yuan Liu](#), [Michael Novitzky](#), [Igor Franzoni Okuyama](#), [Jason Papis](#), [Guy Rosman](#), [Valerio Varricchio](#), [Hsueh-Cheng Wang](#), [Dmitry Yershov](#), [Hang Zhao](#), [Michael Benjamin](#), [Christopher Carr](#), [Maria Zuber](#), [Sertac Karaman](#), [Emilio Frazzoli](#), [Domitilla Del Vecchio](#), [Daniela Rus](#), [Jonathan How](#), [John Leonard](#), and [Andrea Censi](#). **Duckietown: an open, inexpensive and flexible platform for autonomy education and research**. In *IEEE International Conference on Robotics and Automation (ICRA)*. Singapore, May 2017.  [pdf](#)