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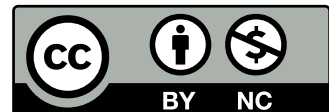
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Submitted in Partial Fulfillment of the Requirements

for the Degree of Doctor Of Philosophy

in the Santa Clara University at

Santa Clara University, MONTH YEAR

Santa Clara, California

Acknowledgments

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Abstract

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If you've just opened up this template, you should check out Chapter 1 for a quick introduction.

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Keywords: your, keywords, go, here

Contents

List of Figures

List of Tables

List of Algorithms

List of Theorems

List of Acronyms

SCU Santa Clara University

lidar light detection and ranging sensor *(also commonly known as 'lidar' or a 'laser range scanner')*

Chapter 1

Introduction

This thesis template should provide you with enough LaTeX code to get writing immediately on your thesis, without having to learn too much LaTeX up front. You may wish to save snippets from the template, or the entire template somewhere separate before you overwrite too much of it if you're unfamiliar with LaTeX, so you can refer back to the source and the PDF it produces if you get stuck. You can cite like this [1]

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1.1 Section in Introduction

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1.1.1   Subsection in Introduction

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List of References

[1] B. Douillard, "Laser and vision based classification in urban environments," PhD thesis, The University of Sydney, January 2009.

Appendix A

An Example Appendix

As an appendix, this should contain some content that's not really required for the argument in the main body of the thesis, but is clearly relevant and supports the work.

A.1 Code Listings

The `listings` package allows you to include code listings or other formatted text with some parsing to make them more readable than simply calling \input{} on the code file.

Listing A.1 – MATLAB script for interactive radians to degrees converter

```python
from __future__ import print_function
import argparse
import torch
import torch.nn as nn
import torch.nn.functional as F
import torch.optim as optim
from torchvision import datasets, transforms
from torch.optim.lr_scheduler import StepLR


class Net(nn.Module):
    def __init__(self):
        super(Net, self).__init__()
        self.conv1 = nn.Conv2d(1, 32, 3, 1)
        self.conv2 = nn.Conv2d(32, 64, 3, 1)
        self.dropout1 = nn.Dropout(0.25)
        self.dropout2 = nn.Dropout(0.5)
```

```python
        self.fc1 = nn.Linear(9216, 128)
        self.fc2 = nn.Linear(128, 10)

    def forward(self, x):
        x = self.conv1(x)
        x = F.relu(x)
        x = self.conv2(x)
        x = F.relu(x)
        x = F.max_pool2d(x, 2)
        x = self.dropout1(x)
        x = torch.flatten(x, 1)
        x = self.fc1(x)
        x = F.relu(x)
        x = self.dropout2(x)
        x = self.fc2(x)
        output = F.log_softmax(x, dim=1)
        return output


def train(args, model, device, train_loader, optimizer, epoch):
    model.train()
    for batch_idx, (data, target) in enumerate(train_loader):
        data, target = data.to(device), target.to(device)
        optimizer.zero_grad()
        output = model(data)
        loss = F.nll_loss(output, target)
        loss.backward()
        optimizer.step()
        if batch_idx % args.log_interval == 0:
            print('Train Epoch: {} [{}/{} ({:.0f}%)]\tLoss: {:.6f}'.format(
                epoch, batch_idx * len(data), len(train_loader.dataset),
                100. * batch_idx / len(train_loader), loss.item()))
            if args.dry_run:
                break


def test(model, device, test_loader):
    model.eval()
    test_loss = 0
    correct = 0
    with torch.no_grad():
        for data, target in test_loader:
            data, target = data.to(device), target.to(device)
            output = model(data)
            test_loss += F.nll_loss(output, target, reduction='sum').item()  # sum up batch loss
```

```python
                pred = output.argmax(dim=1, keepdim=True)  # get the index of the max log-probability
                correct += pred.eq(target.view_as(pred)).sum().item()

    test_loss /= len(test_loader.dataset)

    print('\nTest set: Average loss: {:.4f}, Accuracy: {}/{} ({:.0f}%)\n'.format(
        test_loss, correct, len(test_loader.dataset),
        100. * correct / len(test_loader.dataset)))


def main():
    # Training settings
    parser = argparse.ArgumentParser(description='PyTorch MNIST Example')
    parser.add_argument('--batch-size', type=int, default=64, metavar='N',
                        help='input batch size for training (default: 64)')
    parser.add_argument('--test-batch-size', type=int, default=1000, metavar='N',
                        help='input batch size for testing (default: 1000)')
    parser.add_argument('--epochs', type=int, default=14, metavar='N',
                        help='number of epochs to train (default: 14)')
    parser.add_argument('--lr', type=float, default=1.0, metavar='LR',
                        help='learning rate (default: 1.0)')
    parser.add_argument('--gamma', type=float, default=0.7, metavar='M',
                        help='Learning rate step gamma (default: 0.7)')
    parser.add_argument('--no-cuda', action='store_true', default=False,
                        help='disables CUDA training')
    parser.add_argument('--no-mps', action='store_true', default=False,
                        help='disables macOS GPU training')
    parser.add_argument('--dry-run', action='store_true', default=False,
                        help='quickly check a single pass')
    parser.add_argument('--seed', type=int, default=1, metavar='S',
                        help='random seed (default: 1)')
    parser.add_argument('--log-interval', type=int, default=10, metavar='N',
                        help='how many batches to wait before logging training status')
    parser.add_argument('--save-model', action='store_true', default=False,
                        help='For Saving the current Model')
    args = parser.parse_args()
    use_cuda = not args.no_cuda and torch.cuda.is_available()
    use_mps = not args.no_mps and torch.backends.mps.is_available()

    torch.manual_seed(args.seed)

    if use_cuda:
        device = torch.device("cuda")
    elif use_mps:
        device = torch.device("mps")
```

```
else:
    device = torch.device("cpu")

train_kwargs = {'batch_size': args.batch_size}
test_kwargs = {'batch_size': args.test_batch_size}
```

A number of languages are supported with basic syntax highlighting and formatting.

A.2   Multi-Page Tables

The `supertabular` package allows tables to span multiple pages using the `supertabular` environment (in place of `tabular`). This has already been used in the Nomenclature Section in the front matter, allowing the notation to span multiple pages if necessary. Table A.1 shows an example of a table spanning two pages. Note that such tables are no longer floating elements (i.e. there's no `table` environment anymore), and the header/footer for the whole table, and ones repeated on each new page, can be defined through `supertabular` macros rather than as part of the table to copy headers across each page.

Table A.1 – This table is especially long, so it's been turned into a `supertabular` environment allowing it to span multiple pages.

first	×	second	=	RHS
1	×	1	=	1
1	×	2	=	2
1	×	3	=	3
1	×	4	=	4
1	×	5	=	5
1	×	6	=	6
1	×	7	=	7
1	×	8	=	8
2	×	1	=	2

first	**×**	**second**	**=**	**RHS**
2	×	2	=	4
2	×	3	=	6
2	×	4	=	8
2	×	5	=	10
2	×	6	=	12
2	×	7	=	14
2	×	8	=	16
3	×	1	=	3
3	×	2	=	6
3	×	3	=	9
3	×	4	=	12
3	×	5	=	15
3	×	6	=	18
3	×	7	=	21
3	×	8	=	24

A.3   Landscape Tables

If your table is especially wide, it may be better to switch it to the landscape orientation. One way of doing this is with the `rotating` package, which implements (among other things) two new environments: `sidewaystable` and `sidewaysfigure`[1]. The way this package achieves this is most useful for *printed results*, as it only rotates the environment on the page (but does not convert the page into landscape orientation)—for electronic viewing of a PDF, it may be useful to rotate the whole page since it's not often easy for the reader to rotate their screen (assuming the sideways content takes up the whole page). One advantage of this package's implementation of sideways environments is that it supports `twoside`

---

[1]I find `sidewaysfigure` less useful, as it tends to be easy enough to rotate the figure before inclusion, but if the caption/figure are complex it may be useful to have them oriented in the same way

page layout, and will rotate the sideways environment such that the bottom is towards the outside of the double-page layout in such cases.

An example of a `sidewaystable` is shown in —if you're reading this as a PDF on your computer, you'll probably find it difficult to read as it's sideways on your screen.

Table A.2 – This table is so wide that I decided it should be in the landscape orientation to allow it to fit nicely on one page. You may of course find it easier (for the reader) to reconsider the content and layout of the table, or convert it to a graphical representation, as large walls of data tend to be hard to really interpret well. Almost certainly, you'd only have such large tables in an appendix.

Item	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
SA Mission Distance (m)	1101.4	49.4	81.5	34.2	78.8	98.8	70.8	16.0	61.4	14.9	52.1	24.3	83.3	170.3	143.5	20.7	30.1	21.4	99.2
SA Traversed Distance (m)	3244.1	53.9	86.8	90.7	92.1	120.8	74.3	46.4	63.8	15.6	55.3	27.4	127.2	222.4	987.1	273.0	167.0	235.4	505.0
MA Mission Distance (m)	1083.9	59.1	81.5	34.2	78.8	98.8	70.8	16.0	61.4	14.9	52.1	24.3	83.3	170.3	143.5	20.7	30.1	21.4	81.8
MA Traversed Distance (m)	2343.1	61.8	84.6	70.7	84.6	116.6	72.5	46.3	62.6	15.5	53.5	25.8	129.4	213.4	147.1	268.2	174.5	233.8	482.3
Ratio (SA/MA)	1.38	0.872	1.03	1.28	1.09	1.04	1.03	1	1.02	1.01	1.03	1.06	0.983	1.04	6.71	1.02	0.957	1.01	1.05
SA Mission Est. Time (s)	734.3	32.9	54.4	22.8	52.5	65.9	47.2	10.7	40.9	9.9	34.8	16.2	55.5	113.5	95.7	13.8	20.1	14.3	66.2
SA Traversal Time (s)	2436.0	43.5	61.6	70.1	68.0	89.6	55.3	35.2	45.3	12.7	39.8	21.8	93.1	161.8	731.0	204.7	146.1	174.3	382.1
MA Mission Est. Time (s)	1083.9	59.1	81.5	34.2	78.8	98.8	70.8	16.0	61.4	14.9	52.1	24.3	83.3	170.3	143.5	20.7	30.1	21.4	81.8
MA Traversal Time (s)	2411.3	64.2	84.8	73.6	86.8	119.1	74.2	47.2	63.5	16.1	54.3	28.1	132.8	215.2	148.2	271.3	203.4	239.9	488.7
Ratio (SA/MA)	1.01	0.677	0.726	0.953	0.784	0.753	0.746	0.744	0.714	0.786	0.734	0.776	0.701	0.752	4.93	0.755	0.718	0.727	0.782
SA Cost (Exp. Map)	1019924.1	1540.6	49041.0	5094.7	86202.5	98847.3	0.0	7974.8	1773.9	459.0	7825.8	1120.0	4131.3	14618.2	447306.7	19380.5	109612.1	33188.1	131807.7
MA Cost (Exp. Map)	916661.5	6032.4	81939.1	7722.2	73856.9	198949.4	11654.8	6191.5	1398.9	564.8	13336.9	1123.8	6129.8	68857.2	39422.7	3213.2	172319.0	93562.5	130386.5
Ratio (SA/MA)	1.11	0.255	0.599	0.66	1.17	0.497	0	1.29	1.27	0.813	0.587	0.997	0.674	0.212	11.3	6.03	0.636	0.355	1.01
SA Cost (Ground Truth)	26891.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26891.4	0.0	0.0
MA Cost (Ground Truth)	28400.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28400.0	0.0	0.0
Ratio (SA/MA)	0.947	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.947	–	–

Map Configuration	SA Coverage (m²)	MA Coverage (m²)	Ratio (MA/SA)
Expanded Cost Map	28108	28229	1