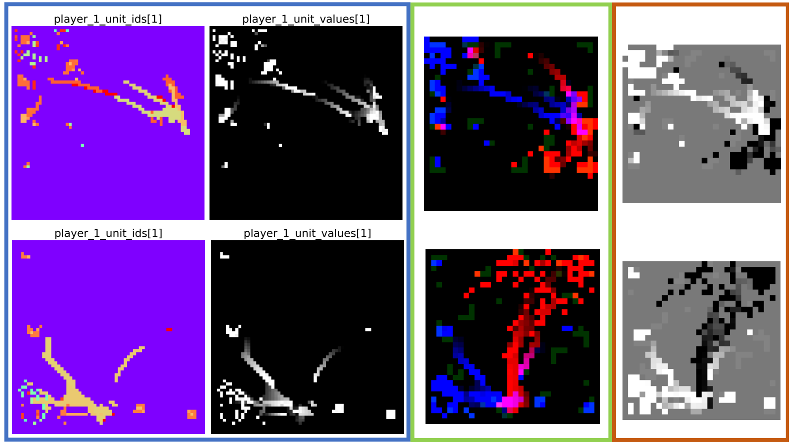
StarCraftImage:

A Dataset For Prototyping Spatial Reasoning Methods for Multi-Agent Environments



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Poster Session: THU-PM-133

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DEVCOM ARMY RESEARCH LABORATORY

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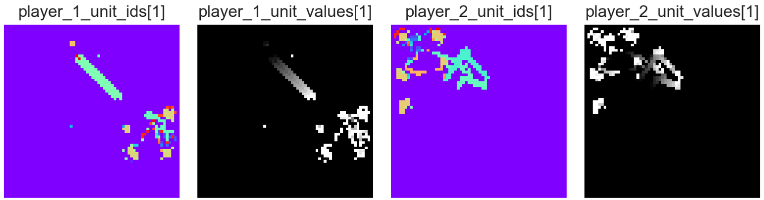
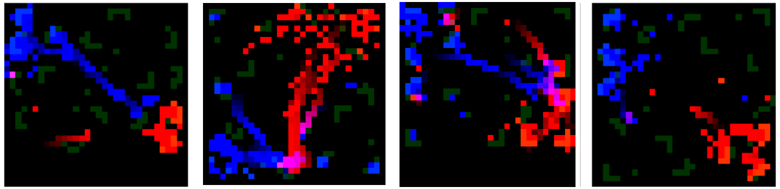
StarCraftImage is an easy-to-use image dataset with intelligent (and adversarial) multi-agent behavior

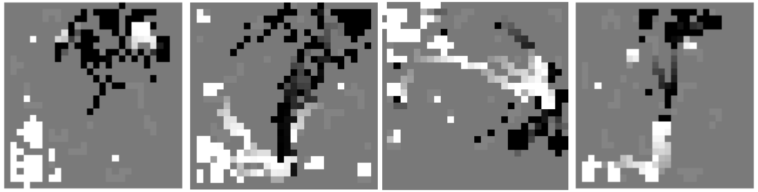
- StarCraft II game states were extracted from 60K publicly available match recordings
- StarCraftImage contains 3.6M images that summarize unit locations in a 10 second window
- The dataset contains intelligent (and adversarial) multi-agent behavior along with rich metadata
- **StarCraftCIFAR10** and **StarCraftMNIST** exactly match CIFAR10 and MNIST formats
  (only URL change from PyTorch MNIST/CIFAR10 datasets)



A **StarCraftHyper** hyperspectral Image (Flattened To RGB Image)



Four 32x32 RGB Images from **StarCraftCIFAR10**



Four 28x28 Grayscale Images from **StarCraftMNIST**

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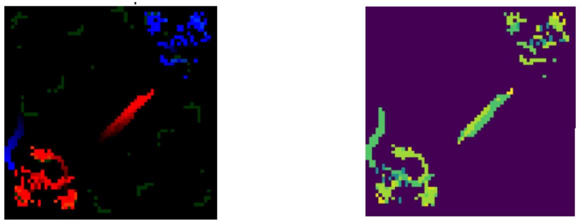
StarCraftImage is applicable to many spatial reasoning tasks

- **Unit Identification** - Given a RGB image, predict unit ID information
  (image colorization)
- **Multi-Object Tracking** - Predict unit movement in the next 10 seconds
  (next window prediction)
- **Global Reasoning** - Predict which player will win
  (classification)
- **Missing Data Imputation** - Apply noise simulation (e.g., a sensor network) and predict de-noised image



Unit Identification: StarCraftCIFAR10 → StarCraftHyper

Next Window Prediction: StarCraftHyper → StarCraftHyper

Applying a simulated sensor network to StarCraftImage

Game replays are rich data sources for ML but require significant overhead to use

- StarCraft II (SCII) is a real-time strategy game
    - Replay packs with thousands of human-played SCII matches provide intelligent (and adversarial) multi-agent behaviors
    - The PySC2 API enables direct access to the entire game state
- However, extracting ML-ready representations of games requires many hours of engineering work
- Our goal: Create a multi-agent spatial reasoning dataset that is as easy to use as MNIST and CIFAR10

Source: https://news.blizzard.com/en-gb/starcraft2/20112699/patch-3-3-new-co-op-content-and-features

Extracting StarCraftImage

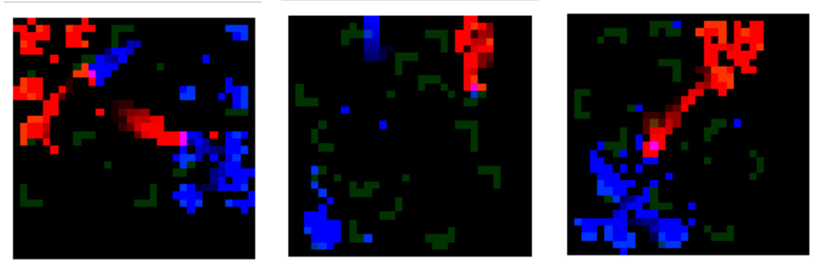
- We use PySC2 to replay an SCII match and extract all unit information at each frame

- We summarize 10 second windows into a single image

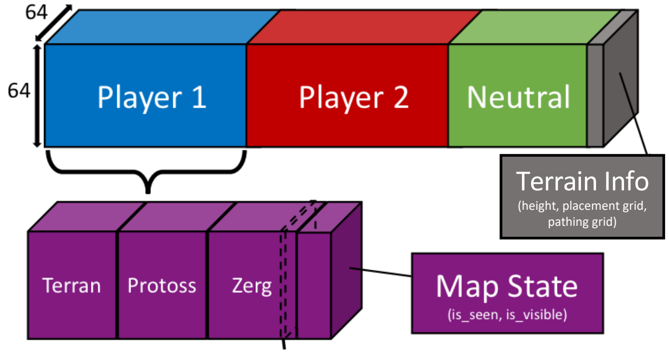
- Hyperspectral images (**StarCraftHyper**) consist of 384 channels each representing a different unit type
  (e.g., channel 51 is Player 1's Terran Battlecruiser units)

- Values at each channel show when the last time a unit was seen during the 10 second window
  (this produces a ghosting effect)

- Map state information such as visibility and creep (Zerg-specific) are included



Three images, each summarizing 10 seconds of a StarCraft II match



Value Matrix:

153	155	0	0	0	240	0	0
0	157	0	0	0	241	242	0
0	158	159	0	0	0	244	245
0	0	160	0	0	0	0	0
0	0	162	163	0	0	0	0
0	0	0	165	169	170	0	0
0	0	0	0	0	173	0	0
0	0	0	0	0	175	0	0

Values are "last seen" time stamp in window [0, 255] where 0 := not seen

Logical View of Hyperspectral Images for StarCraftImage

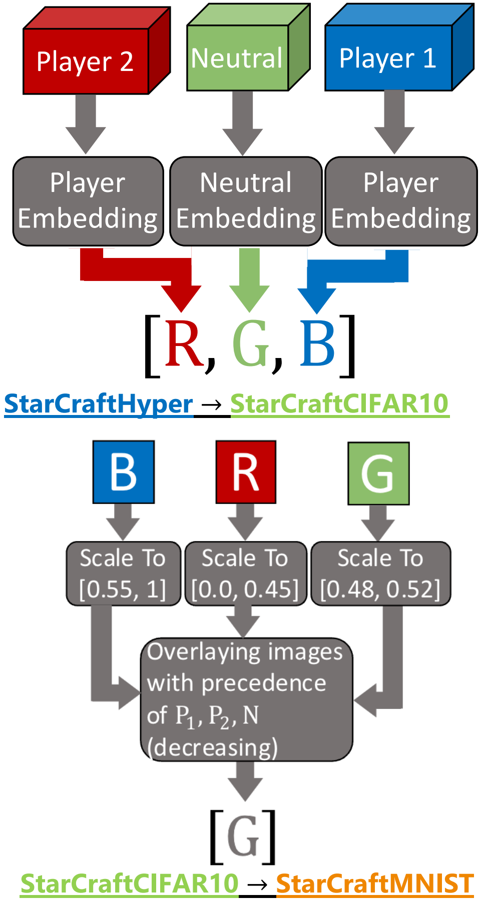
Simplifying to StarCraftMNIST and StarCraftCIFAR10

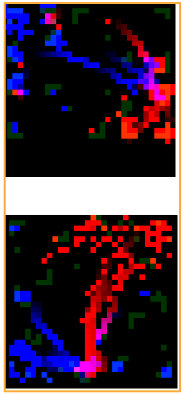
- As a simpler alternative, we further processed **StarCraftHyper** to exactly fit the formats of CIFAR10 and MNIST
  (only URL change required)

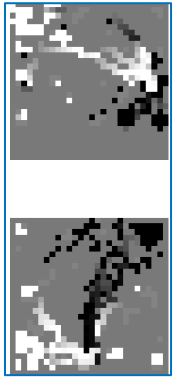
- **StarCraftCIFAR10**– Compressed player unit information into a 3 channels

- **StarCraftMNIST**– Compressed further to 28x28 grayscale image

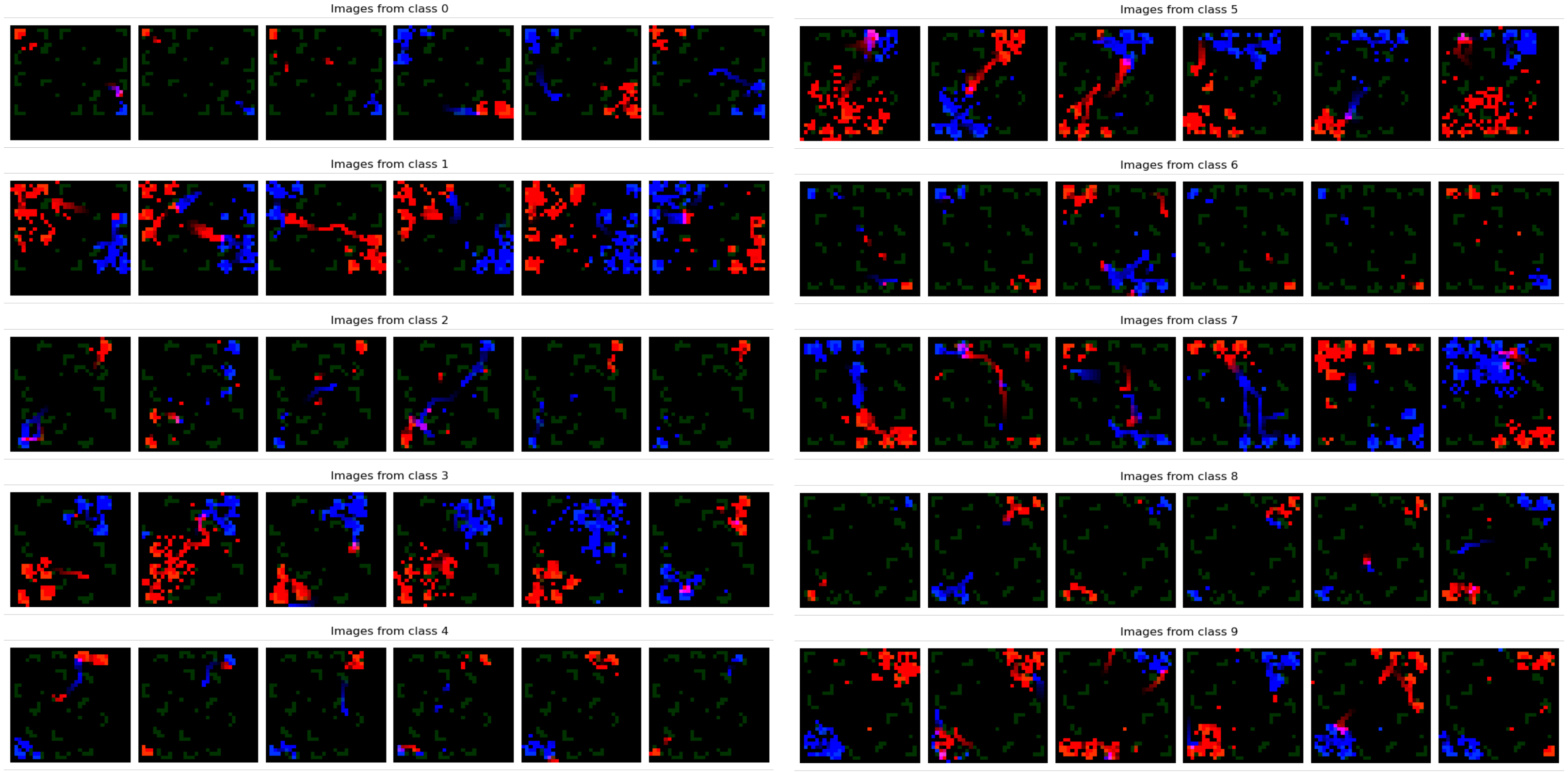
- The 10 labels are map name (5 maps) + first or second half of match
  (e.g., Class 1 = ("Odyssey", "First half"),
  Class 2 = ("Odyssey", "Second half"), ...)







10-Class Examples from StarCraftImage



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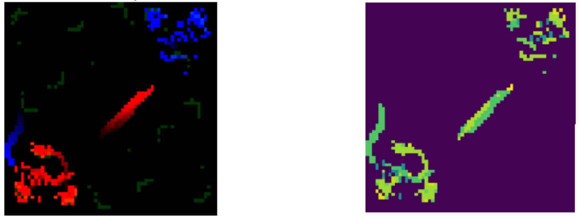
Input RGB Image　　Ground Truth Colorization



Unit Identification: StarCraftCIFAR10 → StarCraftHyper

Input Hyperspectral Image　　Ground Truth Next Window

Next Window Prediction: StarCraftHyper → StarCraftHyper

Input Image　　Sensor Visual Field　　Masked Image

Applying a simulated sensor network to StarCraftImage

Collected sample metadata allows for easy filtering and splitting for task modification

- All samples are paired with game metadata: `player_resource_counts`, `map_name`, `player_unit_races`, `player_ranking`, etc.

- Metadata can be used to split samples for task modifiers, such as domain generalization: training on $^{6}/_{7}$ maps and testing on remainder

- We found model performance on StarCraftImage tracks with real-world spatial reasoning experiment (the model ranking order is similar):

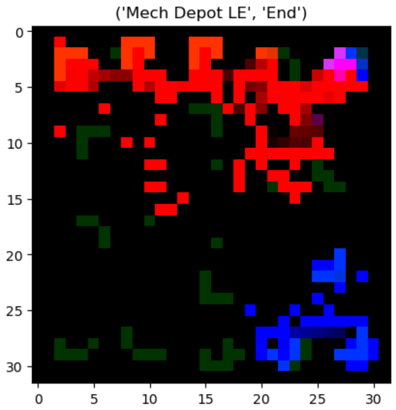
	Segformer	Lawin	Resnet-18	Resnet-34	Resnet-50
StarCraft-Image	17.9%	27.0%	56.6%	58.5%	62.5%
DOTA-Satellite	35.0%	34.1%	52.4%	52.8%	53.6%

StarCraftImage is ready to use in two lines of code

[1]:
```
from sc2image.dataset import StarCraftCIFAR10
```

[2]:
```
sc_cifar = StarCraftCIFAR10(root='./data', train=True)
```

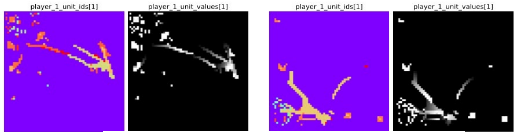
[3]:
```
import matplotlib.pyplot as plt
x, class_idx = sc_cifar[0]
plt.imshow(x)
plt.title(sc_cifar.classes[class_idx]);
```



StarCraftImage Conclusion

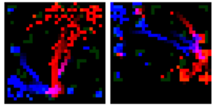
StarCraftHyper:

- 3.6+ million image samples
- Summarizes 10 seconds of human SCII match
- Hyperspectral images with full unit information



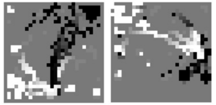
StarCraftCIFAR10:

- 60,000 32x32px RGB images
- Exactly matches the CIFAR10 format
- Difficult 10-class classification problem



StarCraftMNIST:

- 70,000 28x28px grayscale images
- Exactly matches the MNIST format
- Difficult 10-class classification problem



- Video games can serve as pseudo-realistic simulations of complex human-agent actions, but require many hours of engineering to setup for ML
- StarCraftImage is an **easy-to-use**, yet complex behaviored image-based dataset for **prototyping spatial reasoning** algorithms
- StarCraftImage has many applications (**Unit Identification**, **Multi-Object Tracking**, etc.) and possible extensions (**Simulated Partial Observations**)
- What applications will you use StarCraftImage for?
  We'd love to hear your ideas!

Q & A

StarCraftImage

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To find more information: https://starcraftdata.davidinouye.com/

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