



# Dual Attention Network for Product Compatibility and Function Satisfiability Analysis

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AAAI '18

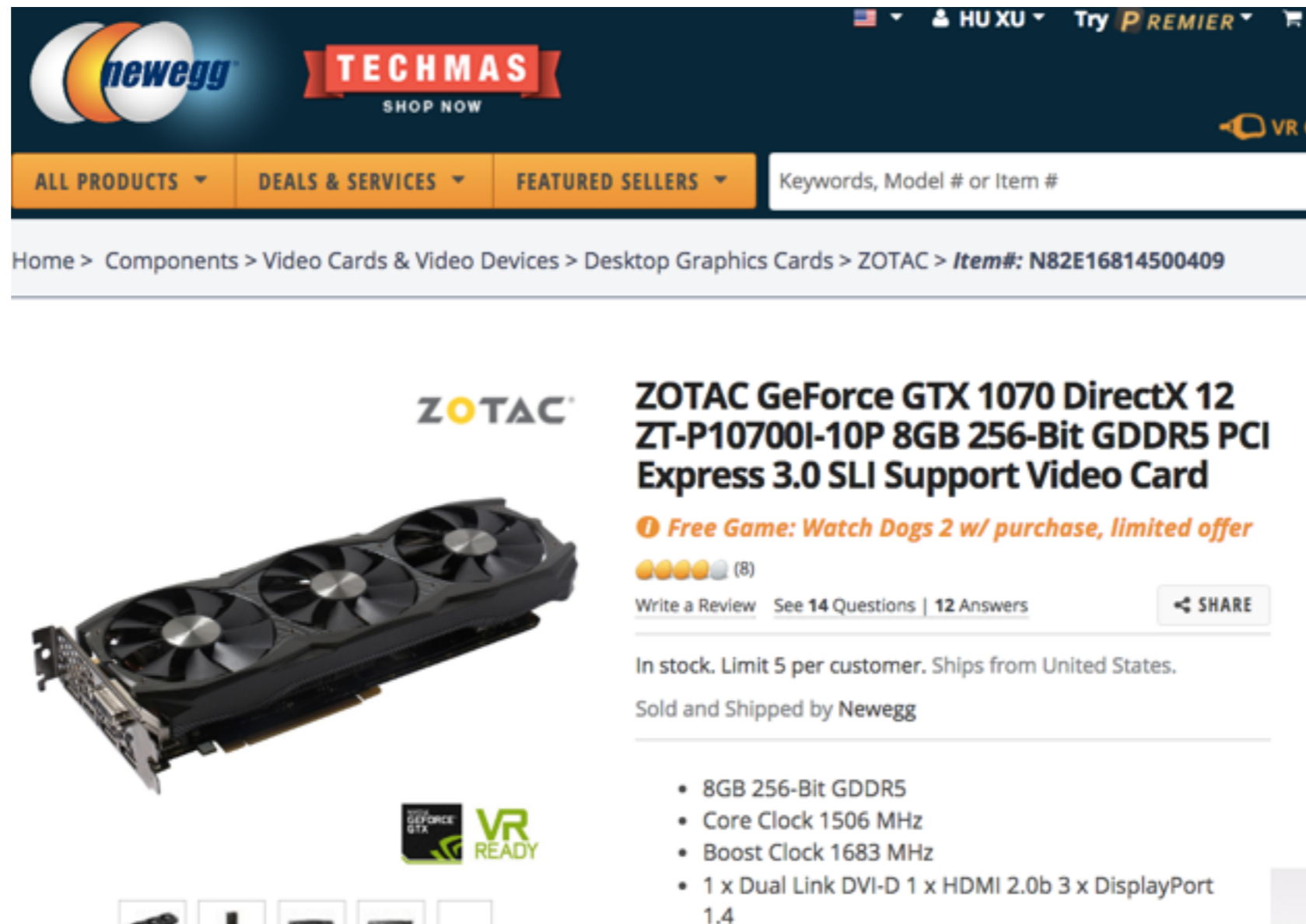
I have a case and want to add a new GPU (a complementary entity).



This is how a compatible GPU should look like.



I found a 1070 GPU with a good price on Newegg.



The screenshot shows the Newegg website interface. At the top, there's a navigation bar with the Newegg logo, a 'TECHMAS SHOP NOW' banner, and user account information for 'HUXU' with a 'Try PREMIER' option. Below this is a menu with 'ALL PRODUCTS', 'DEALS & SERVICES', and 'FEATURED SELLERS', followed by a search bar. The breadcrumb trail reads: 'Home > Components > Video Cards & Video Devices > Desktop Graphics Cards > ZOTAC > Item#: N82E16814500409'.

The main product listing is for the 'ZOTAC GeForce GTX 1070 DirectX 12 ZT-P10700I-10P 8GB 256-Bit GDDR5 PCI Express 3.0 SLI Support Video Card'. It features a large image of the graphics card with the ZOTAC logo above it. A promotional banner offers a 'Free Game: Watch Dogs 2 w/ purchase, limited offer'. Below the image are several small thumbnail icons. To the right of the image, there's a rating of 4.5 stars from 8 reviews, a 'Write a Review' link, and a 'SHARE' button.

Product details include: 'In stock. Limit 5 per customer. Ships from United States.' and 'Sold and Shipped by Newegg'. A list of specifications is provided:

- 8GB 256-Bit GDDR5
- Core Clock 1506 MHz
- Boost Clock 1683 MHz
- 1 x Dual Link DVI-D 1 x HDMI 2.0b 3 x DisplayPort 1.4

A 'VR READY' logo is also visible below the main image.

Unfortunately, the GPU (an incompatible entity) is too long to fit in... and non-refundable.



**ZOTAC GeForce GTX 1070 DirectX 12 ZT-P10700I-10P 8GB 256-Bit GDDR5 PCI Express 3.0 SLI .**

In stock. Limit 5 per customer. Ships from United States.

[Overview](#)

[Specifications](#)

[Warranty & Returns](#)

[Reviews](#)

### Warranty, Returns, And Additional Information

#### Warranty

Limited Warranty period (parts): 2 years

Limited Warranty period (labor): 2 years

[Read full details](#)

#### Manufacturer Contact Info

[Manufacturer Product Page](#)

Website: <http://www.zotac.com/us>

Support Phone: 1-909-594-4300

#### Return Policies

We want to ensure your holiday shopping this year is hassle-free. That's why we're automatically extending our return policies on almost every product! For purchases placed between November 1, 2016 and December 24, 2016 you will have until January 31, 2017 to return your product. There's nothing additional that you have to do!

Return for refund within: **non-refundable**

Return for replacement until: January 31, 2017

This item is covered by Newegg.com's [Extended Holiday Replacement-Only Return Policy](#).



In the end, I damaged my case a little...



because the case is cheaper than GPU.



# A Quiz on Complementary Entity



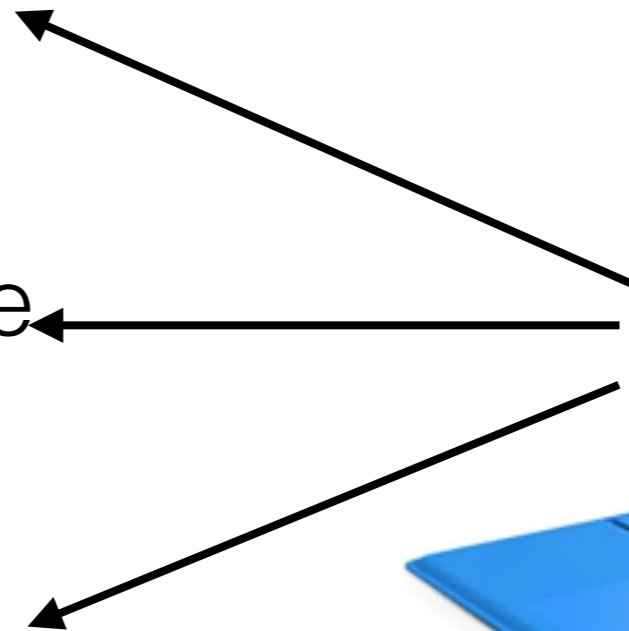
photoshop



Google Play app store



fallout 4





# Answer on their Compatibility



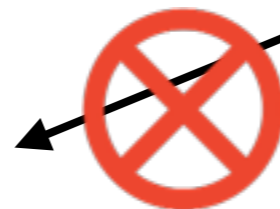
photoshop



Google Play app store



fallout 4



# Answer

Microsoft Surface Pro 4 (128 GB, 4 GB RAM, Intel Core i5)	
Q:	Can the M processor <b>handle</b> <u>photoshop</u> ?
A:	It <i>does</i> run Photoshop <i>very well</i> on our internal test unit.
Q:	Does the surface pro 4 <b>support</b> the <u>Google Play app store</u> ?
A:	<i>No</i> , it does not support Google Play.
Q:	can this <b>run</b> <u>fallout 4</u>
A:	It <i>struggles</i> graphically with Fallout 4 on low graphics settings.



Product QA is a great place for customers to resolve their compatibility concerns.

A more general problem

# A problem about the entity “Youtube video”

Youtube video



# A problem about the entity “Youtube video”

**play** Youtube video

**edit** Youtube video



# A problem about the entity Youtube video



**play** Youtube video



**edit** Youtube video



They mean totally different **functions** on the same entity.

Whether a product can **satisfy** customers' **needs on functions** is even more important.

# More QAs about Functions

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Microsoft Surface Pro 4 (128 GB, 4 GB RAM, Intel Core i5)

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Q: Can the M processor **handle** photoshop?

A: It *does* run Photoshop *very well* on our internal test unit.

---

Q: Does the surface pro 4 **support** the Google Play app store?

A: *No*, it does not support Google Play.

---

Q: can this **run** fallout 4

A: It *struggles* graphically with Fallout 4 on low graphics settings.

---

Q: Does this **connect to** a 5G home wireless network?

A: We connect to a Comcast high speed wireless router for Internet access and it seems to work well.  
*I can not speak to the specific network in the question.*

---

Q: Can you **use this for** sketching?

A: To some extent .  
*It depends upon the degree to which you intend to create .*

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# More QAs about Functions

Microsoft Surface Pro 4 (128 GB, 4 GB RAM, Intel Core i5)

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**Intrinsic Function**



# More QAs about Functions



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Microsoft Surface Pro 4 (128 GB, 4 GB RAM, Intel Core i5)

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Q: Can the M processor **handle** photoshop?

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Extrinsic Function

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Extrinsic Function

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Intrinsic Function

# Roadmaps

- Preliminary
- **Two Closely Related Problems**
- Dual Attention Network
- Experiments
- Conclusions

# Two Closely Related Problems

- Product Compatibility Analysis (PCA)
  - e.g., **Works with iphone** ? Yes, it is.
- Function Satisfiability Analysis (FSA)
  - e.g., **Works with iphone** ? Yes, it is.
- In both problems, the to-be-extracted words are from the question and the polarity is in the answer.

# Sequence Labeling

- We formalize both problems as sequence labeling problem.
- Product Compatibility Analysis (PCA)
  - The label space is {O, C, I, U} and C, I, U mean compatible, incompatible, and uncertain entity.
- Function Satisfiability Analysis (FSA)
  - The label space is {O, S, UN, U, F-S, F-UN, F-U}
  - because we want to separate function words (e.g., **works with**) and entities.
  - S, UN, U indicate function targets (e.g., iphone, or sketching) and F-S, F-UN, F-U mean function words.

# Sequence Labeling

- Product Compatibility Analysis (PCA)

- e.g., **Works with iphone ?**

- is labeled as O O C O

- Function Satisfiability Analysis (FSA)

- e.g., **Works with iphone ?**

- is labeled as F-S F-S S O

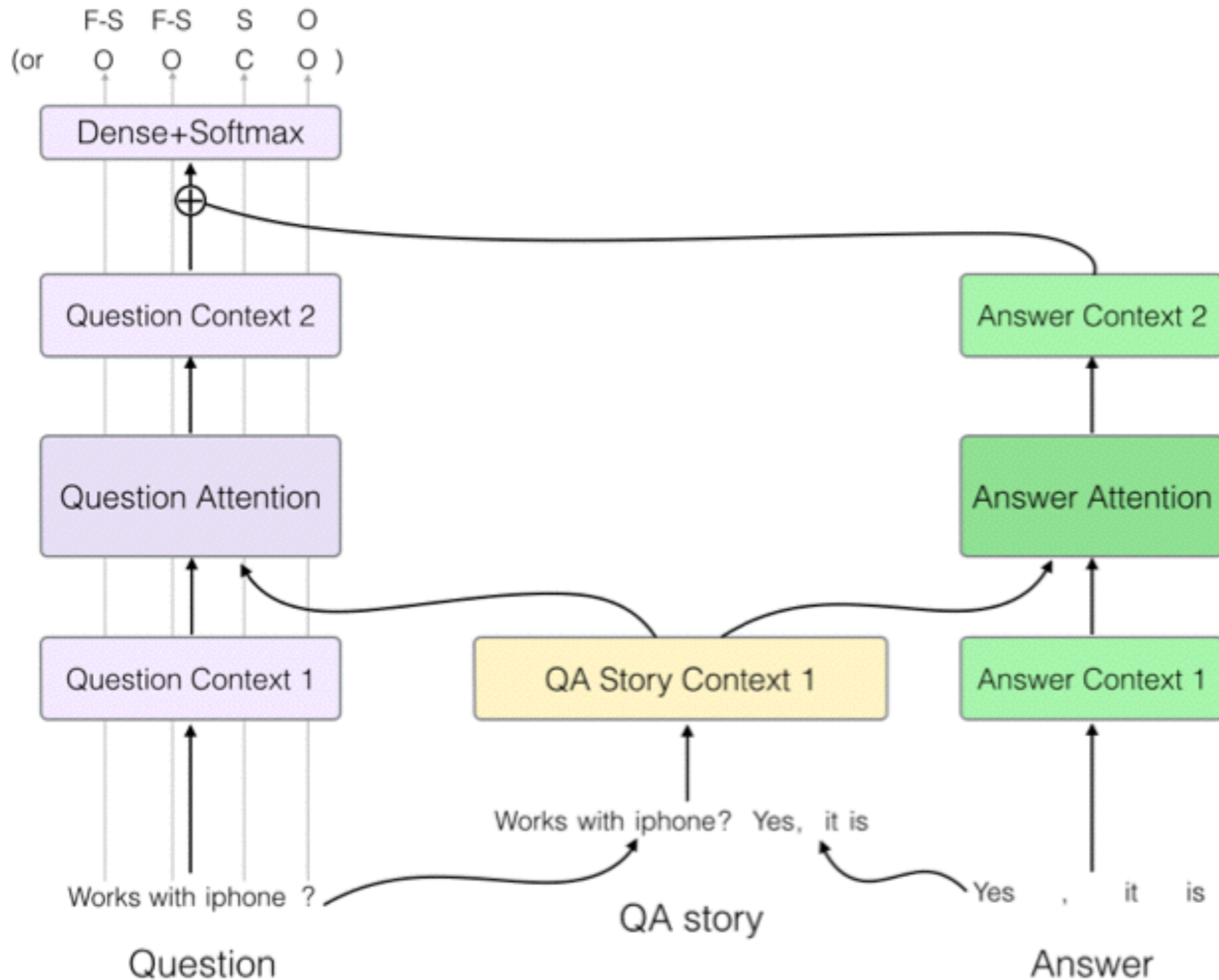
# Roadmaps

- Preliminary
- Two Closely Related Problems
- **Dual Attention Network**
- Experiments
- Conclusions

# Dual Attention Network

- The question and the answer can help each other to get better side-information.
- e.g., short question: “iphone ?”
- End-to-end model is preferred which incorporates the polarity from the answer into the word labels in the question.

# Dual Attention Network





# Roadmaps

- Preliminary
- Two Closely Related Problems
- Dual Attention Network
- **Experiments**
- Conclusions

# Experiment Setting

- Dataset:
  - We crawled 1 million electronics QAs from Amazon, combined with 8 million electronics reviews to train the word embedding.
  - We annotated 7969 QA pairs from 42 products.

Product	Satis.	Unsatis.	Uncertain
DSLR	62	9	18
E-Reader	66	35	18
Speaker	35	16	8
Tablet	76	22	27
Cellphone 1	88	2	11
Cellphone 2	63	47	30
Laptop 1	59	3	11
Laptop 2	98	88	49
Netbook	59	12	20
TV	84	38	22
TV Console	46	27	12
Gaming Console	78	29	47
Apple Watch	70	40	12
VR Headset	106	200	31
Stylus	97	24	68
Micro SD Card	168	16	46
Mouse	106	36	47
Tablet Stand	95	30	63

Table 3: Statistics of 18 selected labeled products on satisfiability. Satis.: satisfiable function needs; Unsatis.: unsatisfiable function needs; Uncertain: uncertain function needs;

# Results

Method	PCA $\mathcal{F}_1$	CER $\mathcal{F}_1$	Polar. Acc.
CRF	-	71.0	-
QA S-BLSTM	61.3	78.0	81.6
QA CoAttention	62.9	79.8	82.4
DAN (-) Ans. Attention	63.9	80.2	81.5
DAN	<b>64.8</b>	<b>80.9</b>	<b>82.5</b>

Table 4: Performance on Product Compatibility Analysis (PCA): PCA  $\mathcal{F}_1$  is the averaged  $\mathcal{F}_1$  scores over 3 types (compatible, incompatible and uncertain) of complementary entities; CER  $\mathcal{F}_1$  only evaluates the performance of Complementary Entity Recognition without considering the polarity; Polarity Accuracy only evaluates the polarity detection given successfully identified complementary entities.

# Results

Method	FSA $\mathcal{F}_1$	FNR $\mathcal{F}_1$	Polar. Acc.
CRF	-	70.2	-
QA S-BLSTM	61.1	77.0	82.2
QA CoAttention	61.7	77.4	81.3
DAN (-) Ans. Attention	62.5	78.0	83.0
DAN	<b>63.9</b>	<b>78.2</b>	<b>84.3</b>

Table 5: Performance on product Function Satisfiability Analysis (FSA): FSA  $\mathcal{F}_1$  is the averaged  $\mathcal{F}_1$  scores over 3 types (satisfiable, unsatisfiable and uncertain) of extracted function expressions; FNR  $\mathcal{F}_1$  only evaluates the performance of Function Need (function expression) Recognition without considering the polarity; Polarity Accuracy only evaluates the polarity detection given successfully identified function needs.

# Conclusions

- We introduce two closely related tasks on product QA dataset:
  - Product Compatibility Analysis
  - Product Function Satisfiability Analysis
- We propose Dual Attention Network, which performs attention on QA story to solve these problems.
- The datasets are available at
  - <https://www.cs.uic.edu/~hxu/>