CERBREC

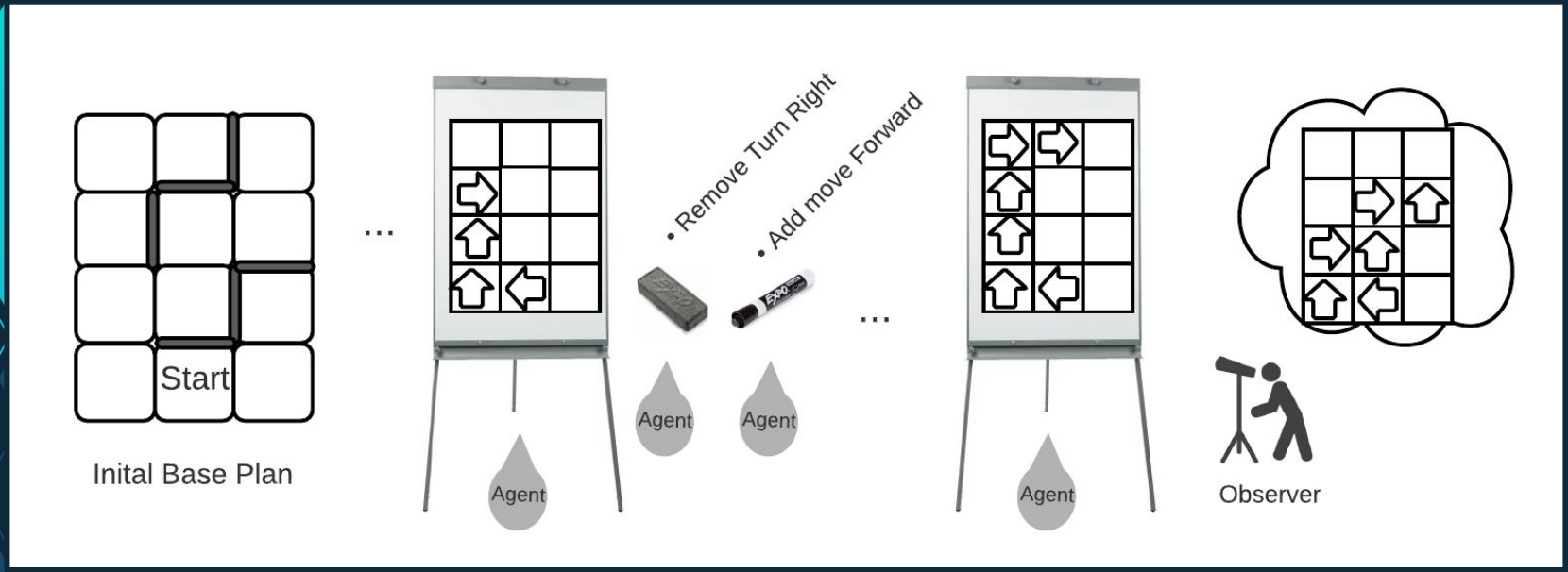
Plan-design Goal Recognition with Autoencoding Transformer for the Cerbrec Modeling Platform

Goal Reasoning Workshop ACS 2021
Presented by David R. Winer, PhD

Outline

- Plan-design Goal Recognition
- Cerbrec Modeling Platform
- Applied/Motivating Task
- Learning Approach
- Prediction Generation Approach
- Results/Conclusions
- Live demo if extra time!

Plan-design Goal Recognition (PDGR)



User File Edit Control Help

Schema Files Memory

search

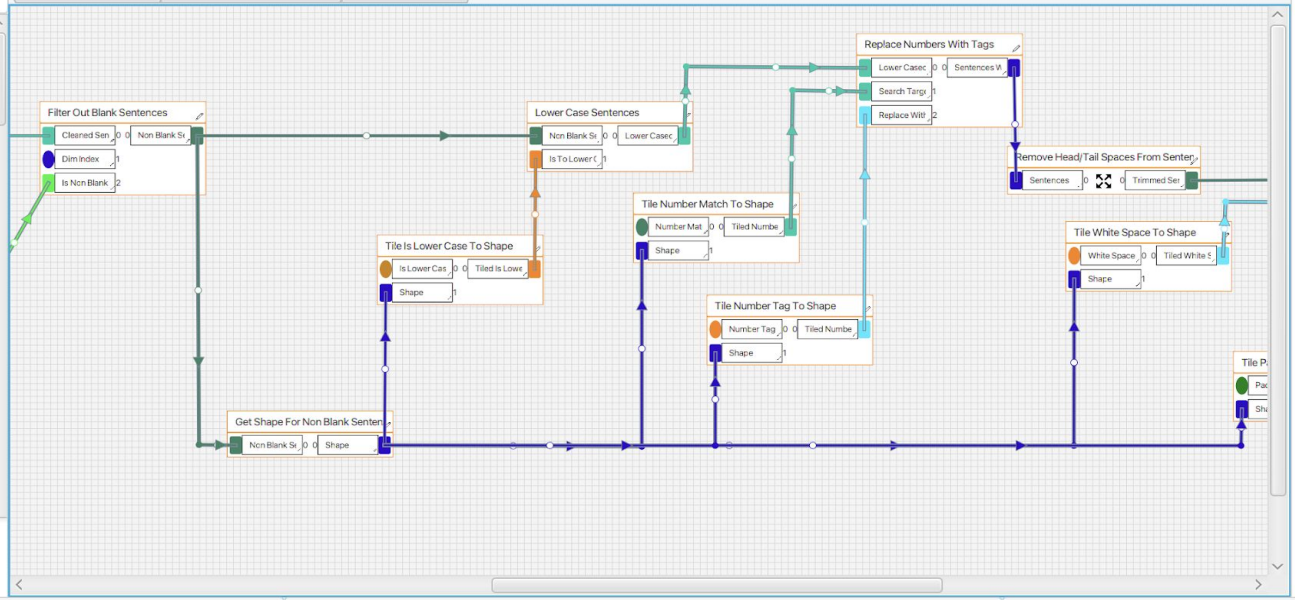
- operation_schemas
  - algebraic_operations
    - logarithm
    - differentiate_addition
    - argument_minimum
    - divide
    - argument_maximum
    - subtract
    - element_wise_multiply
    - minimum
    - absolute_value
    - sum
    - element_wise_divide
    - add
    - exponentiate
    - differentiate_multiplication

NLP Tokeni... Second Layer

Cerbrec

\+ Clear

Your Graph Name > Complaints_Classifier > NLP Tokenizer



Graph JSON Errors

```
name : Your Graph Name
schema : CerboGraph
position : 0.0, 0.0
inputs
outputs
operators
links
```

Data At Current Graph Level | Data By Operation

Trimmed Se...	[1]	TEXT	...Remove Head/Tail Spa...
0	"that account doesn t belong to me"		
Dim Index		INTEG...	Op: Slice Tokens To Size
End Index		INTEG...	Op: Slice Tokens To Size
Sliced Tokens	[1, 7]	TEXT	Op: Slice Tokens To Size
Tokens	[1, 7]	TEXT	...Split Sentences Into To...

Data Workspace

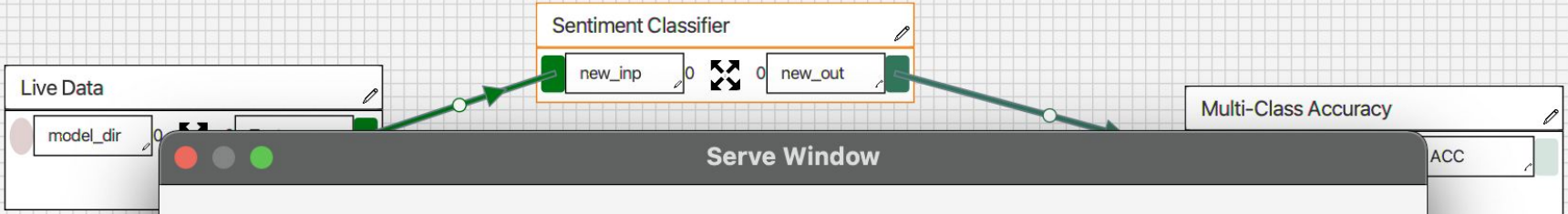
\+ Clear

W_1 [1024, 41] DECIM... Op: INPUT

	0	1	2	3	4	5	6	7	8	9
0	-0.05...	-0.06...	-0.02...	-0.06...	-0.06...	-0.02...	0.02...	-0.00...	0.04...	0.012...
1	-0.01...	0.02...	-0.03...	0.018...	0.031...	-0.06...	-0.05...	-0.00...	-0.00...	-0.02...
2	0.00...	0.02...	0.05...	0.07...	-0.05...	0.06...	0.02...	0.07...	0.07...	0.04...
3	0.010...	0.03...	0.041...	-0.00...	0.03...	0.02...	-0.10...	0.06...	0.107...	-0.04...
4	0.00...	0.013...	-0.04...	-0.03...	-0.02...	-0.05...	-0.05...	-0.03...	0.03...	-0.01...
5	0.02...	0.02...	-0.01...	0.013...	0.02...	0.04...	-0.01...	0.06...	-0.03...	0.02...
6	-0.00...	-0.03...	-0.03...	0.04...	-0.04...	-0.00...	0.001...	0.010...	-0.05...	0.00...
7	-0.00...	0.02...	-0.01...	-0.02...	0.02...	-0.01...	-0.00...	-0.00...	0.00...	-0.02...
8	-0.03...	-0.04...	-0.02...	-0.02...	-0.02...	-0.04...	0.015...	-0.00...	0.03...	-0.03...

Tasks

No tasks running



Serve Window

Serve: Sentiment Classifier

Your Graph Name

> Sentiment Classifier

URL: http://xx.xxx.xxx.xx:yyyy/serve/Sentiment_Classi

Num GPUs	GB per GPU	RAM GB
2	16	64

Inputs


```
[
  {
    "name" : "new_inp",
    "data" : [
      "hide new secretions from the parental units"
      "contains no wit , only labored gags",
      "that loves its characters and communicates
      "remains utterly satisfied to remain the same
```


Outputs


```
[
  {
    "name" : "new_out",
    "data" : [
      "NEGATIVE",
      "NEGATIVE",
      "POSITIVE",
      "NEGATIVE",
```


Tasks

Details

Your Graph N

Iteration 381

Your Graph N

User File Edit Control Help

Schema Files Memory

search

Name	Type	Date M
G drw_trainer.graph	GRAPH	2021
G ClassifierTrainerSchema	GRAPH	2021
G ComplaintsClassifier	GRAPH	2021
sst2.json	JSON	2021
G Works	GRAPH	2021
hidden_1.json	JSON	2021
hidden_2.json	JSON	2021
residuals_1.json	JSON	2021
residuals_2.json	JSON	2021
vocab.json	JSON	2021
G New Intent Classifier Serve...	GRAPH	2021
sst2test.json	JSON	2021
flow/	FOL...	2021
intent_classifier_gw/	FOL...	2021

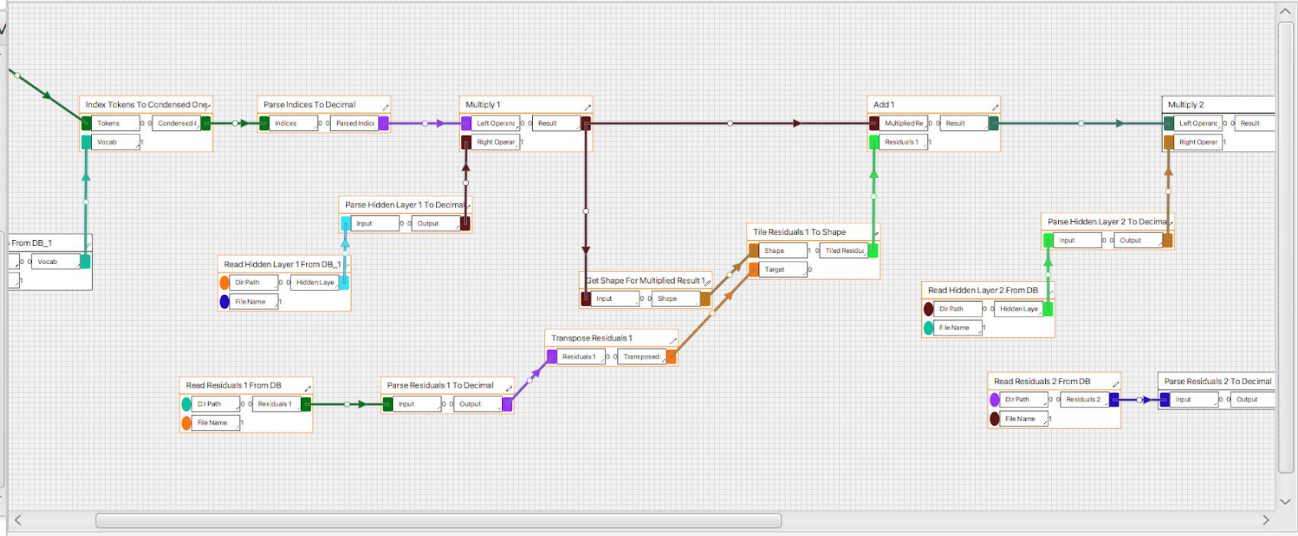
/ClassifierSchema
GRAPH

Flow Throu...

Cerbrec

+ Clear

New Intent Classifier Trainer | Flow Through Layers



Graph JSON Errors

name : New Intent Classifi
schema : New Intent Class
position : 0.0, 0.0
inputs
outputs
operators
links

Data At Current Graph Level | Data By Operation

Residuals 2	[2]	TEXT	... Read Residuals 2 Fro...
Vocab	[13682]	TEXT	...Index Tokens To Cond...
Dir Path		TEXT	O... Read Vocab From DB..
File Name		TEXT	O... Read Vocab From DB..
Dir Path		TEXT	...Read Hidden Layer 1 Fr...
File Name		TEXT	...Read Hidden Layer 1 Fr...

Data Workspace

+ Clear

Transposed ...	[1, 1024]	DECIM...	Op: Transpose Residuals 1
Tiled Residu...	[20, 1024]	DECIM...	... Tile Residuals 1 To Sh...
Output	[1024]	DECIM...	...Parse Residuals 1 To D...

	0
0	-0.09...
1	-0.16...
2	0.05...
3	-0.00...
4	-0.02...

Tasks

No tasks running

What is Cerbrec?

Cerbrec, no-code AI development platform on the cloud:

- No-code develop AI
- No-code edit pre-built AI from latest research papers
- One-click deploy AI on the cloud

Cerbrec makes AI development easier to understand and more productive

David Winer and Garrett Wang (paper's authors) are the co-founders

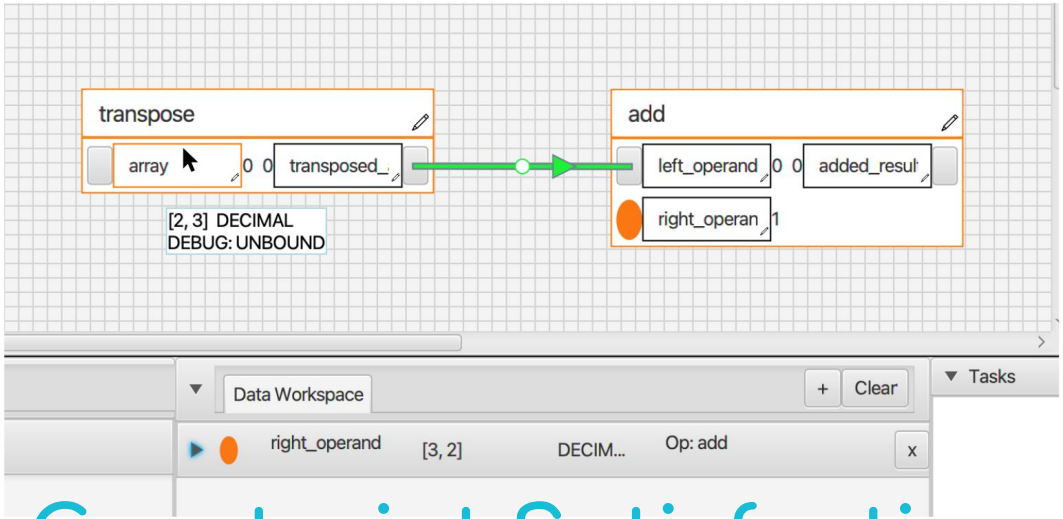
https://www.cerbrec.com

Cerbrec Operation Schema

```
{   "name" : "add",
    "inputs" : [
        {
            "name": "left_operand",
            "data": null
        },
        {
            "name": "right_operand",
            "data": null
        }
    ],
    "outputs" : [
        {
            "name": "added_result",
            "data": null
        }
    ],
    "constraints" : [
        "{left_operand}_data_type_is_integer_or_decimal",
        "{left_operand}_shape_is_the_same_as_{right_operand}",
        "{right_operand}_data_type_is_the_same_as_{left_operand}",
        "{added_result}_data_type_is_the_same_as_{right_operand}",
        "{added_result}_shape_is_the_same_as_{right_operand}"
    ]}
```

Cerbrec Operation Schema

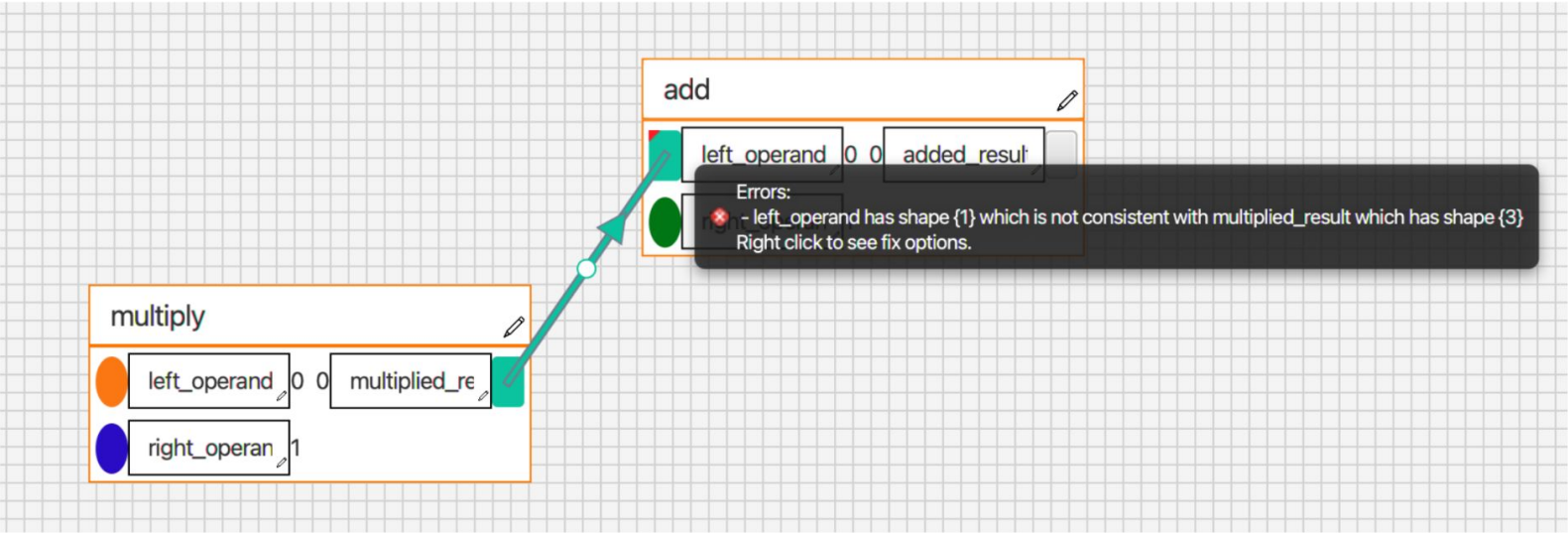
```
{    "name" : "add",
     "inputs" : [
          {
               "name": "left_operand",
               "data": null
          },
          {
               "name": "right_operand",
               "data": null
          }
     ],
     "outputs" : [
          {
               "name": "added_result",
               "data": null
          }
     ],
     "constraints" : [
          "{left_operand}_data_type_is_integer_or_decimal",
          "{left_operand}_shape_is_the_same_as_{right_operand}",
          "{right_operand}_data_type_is_the_same_as_{left_operand}",
          "{added_result}_data_type_is_the_same_as_{right_operand}",
          "{added_result}_shape_is_the_same_as_{right_operand}"
     ]}
```



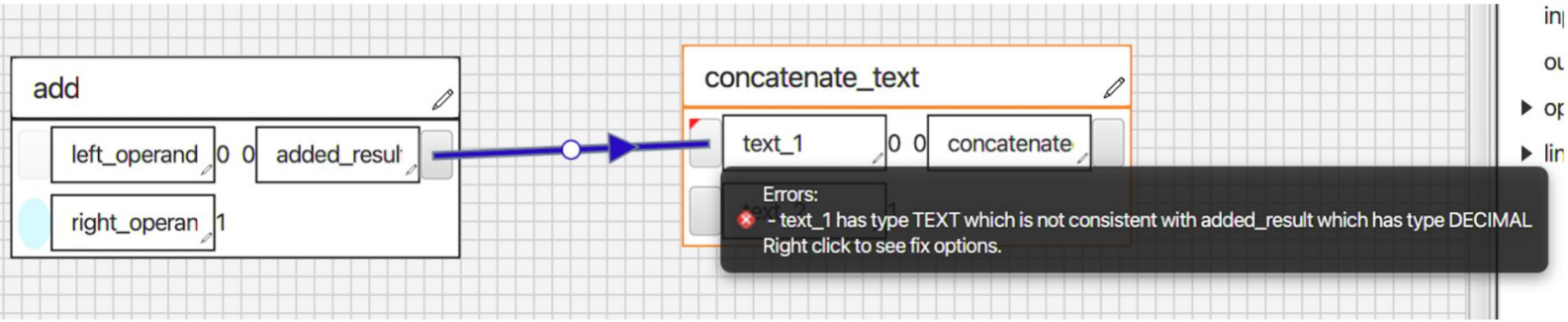
Constraint Satisfaction

Constraint Violation

A



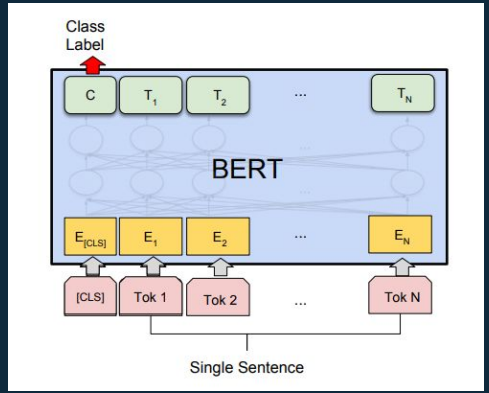
B



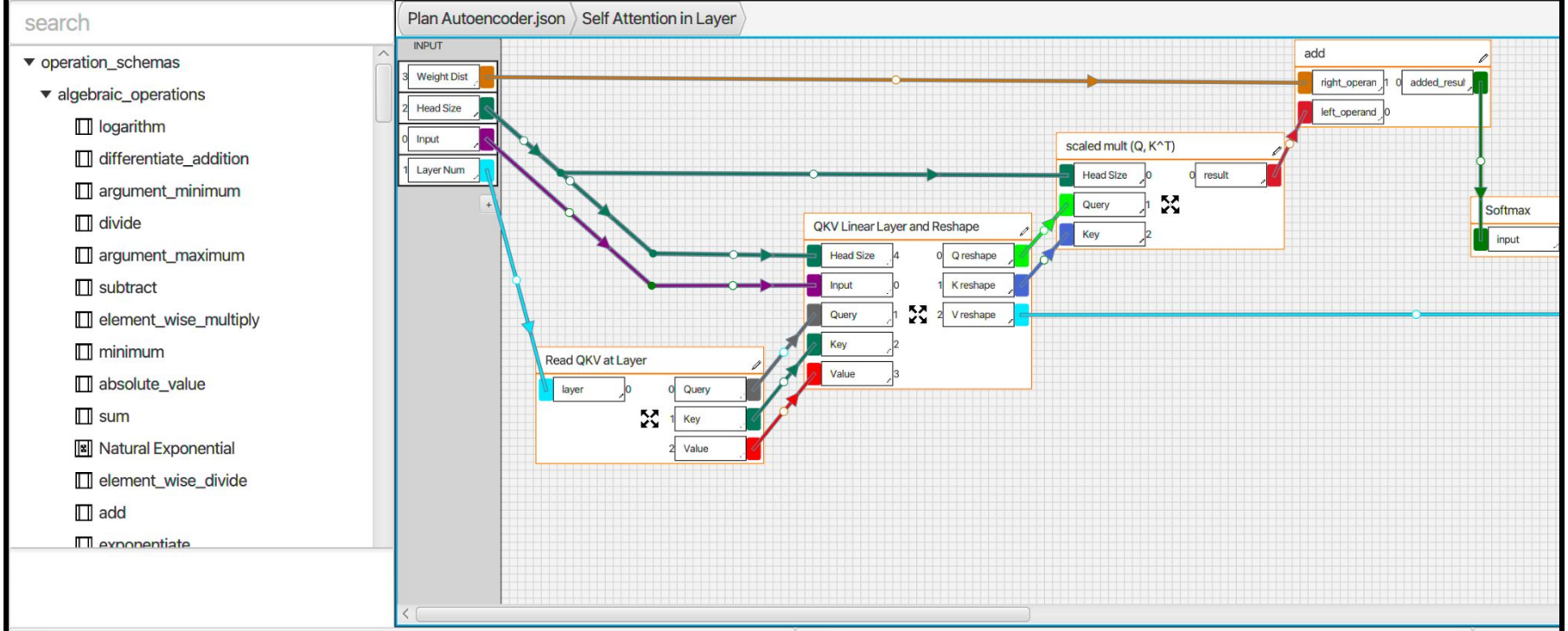
Motivating Task

Recommend context-sensitive edit(s) that bring user's current plan to a likely goal state

Autoencoding Transformer (pretraining)



- Adapt BERT architecture
- Instead of lexicographic vocab, use vocabulary of binding links
  - Vectorize Cerbrec plans as “sentences”
- Instead of MLM, do *Masked Binding Modeling* (MBM)
  - Makes more sense then an autoregressive approach like GPT because plans are partially ordered
- Novel adaptation to encode relative positionality



Data At Current Graph Level | Data By Operation

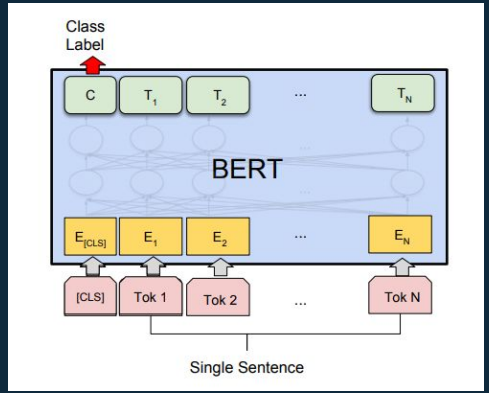
Input	[1, 128, 768]	DECIM...	Op: INPUT
Weight Dist	[1, 12, 128, 128]	DECIM...	Op: INPUT
Query	[768, 768]	DECIM...	Op: Read QKV at Layer
Key	[768, 768]	DECIM...	Op: Read QKV at Layer
Value	[768, 768]	DECIM...	Op: Read QKV at Layer

Data Workspace + Clear

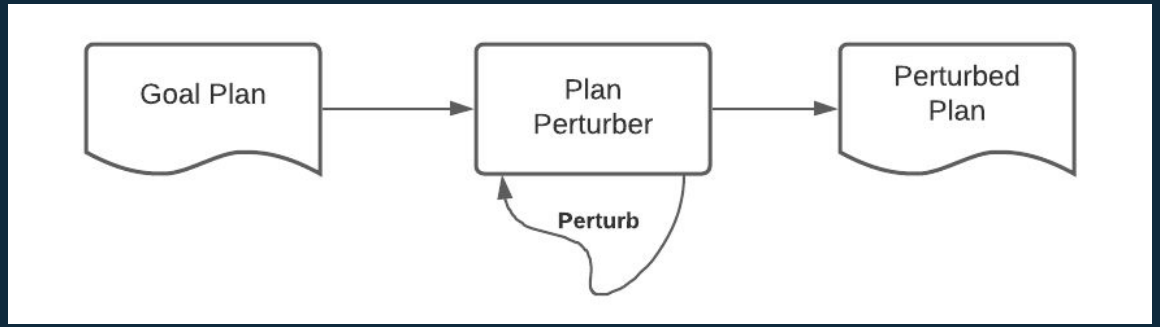
added_result	[1, 12, 128, 128]	DECIM...	Op: add
result	[1, 12, 128, 128]	DECIM...	Op: scaled mult (Q, K
V reshape	[1, 12, 128, 64]	DECIM...	...QKV Linear Layer a
K reshape	[1, 12, 128, 64]	DECIM...	...QKV Linear Layer a
Q reshape	[1, 12, 128, 64]	DECIM...	...QKV Linear Layer a

Tasks

Plan-design Fine-tuning

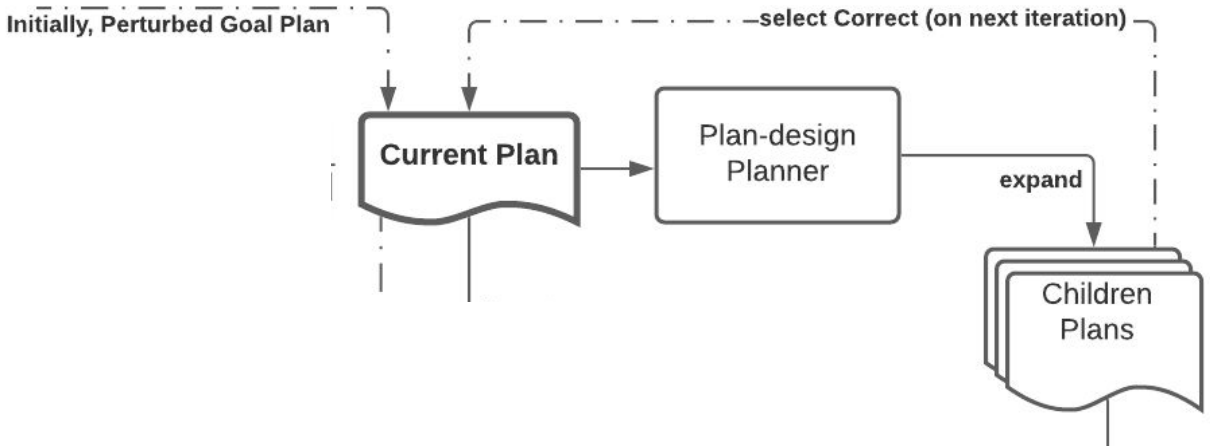


- Multi-step perturbation: transform goal model into unfinished and potentially invalid models

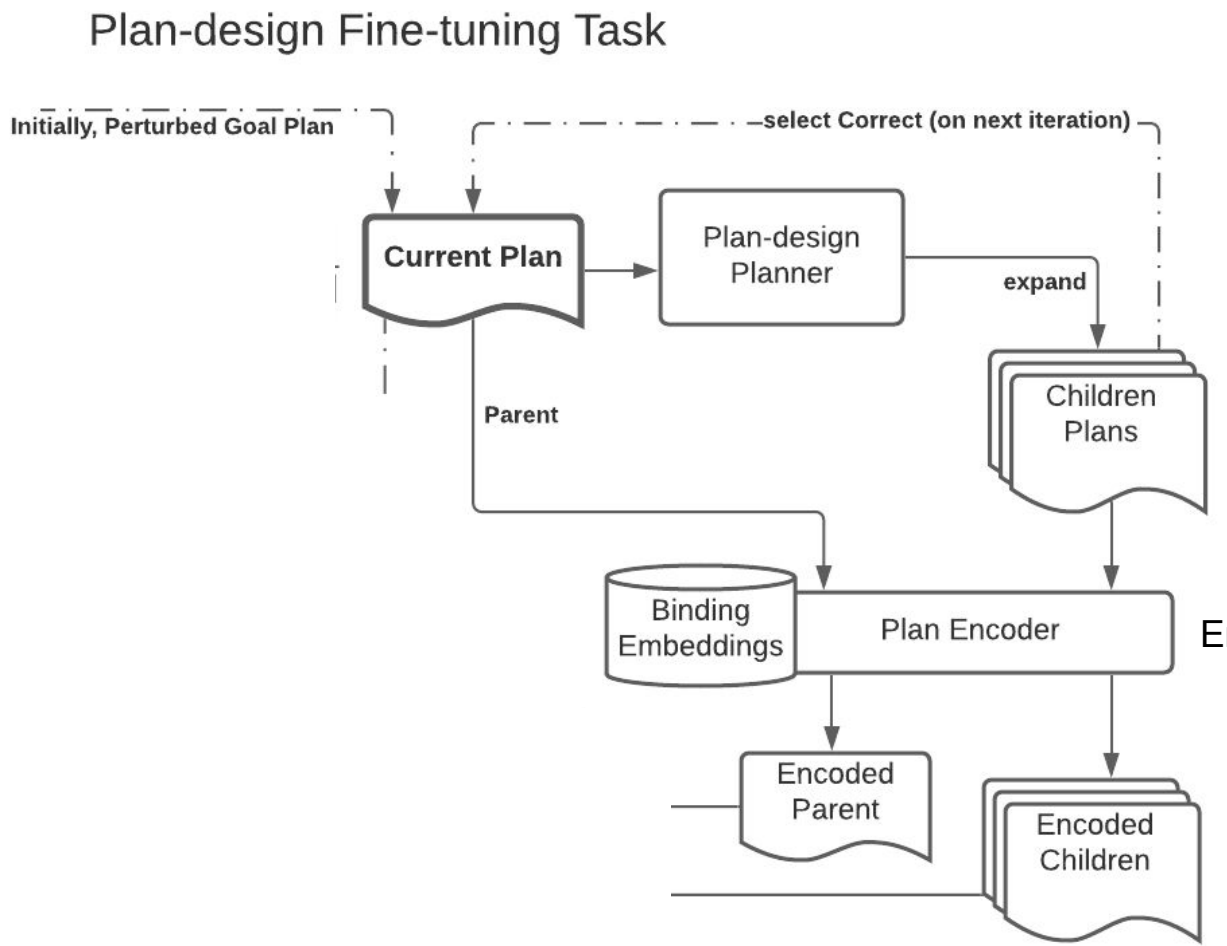


Plan-design Fine-tuning Task

Input:
<Goal, Perturbed Goal>



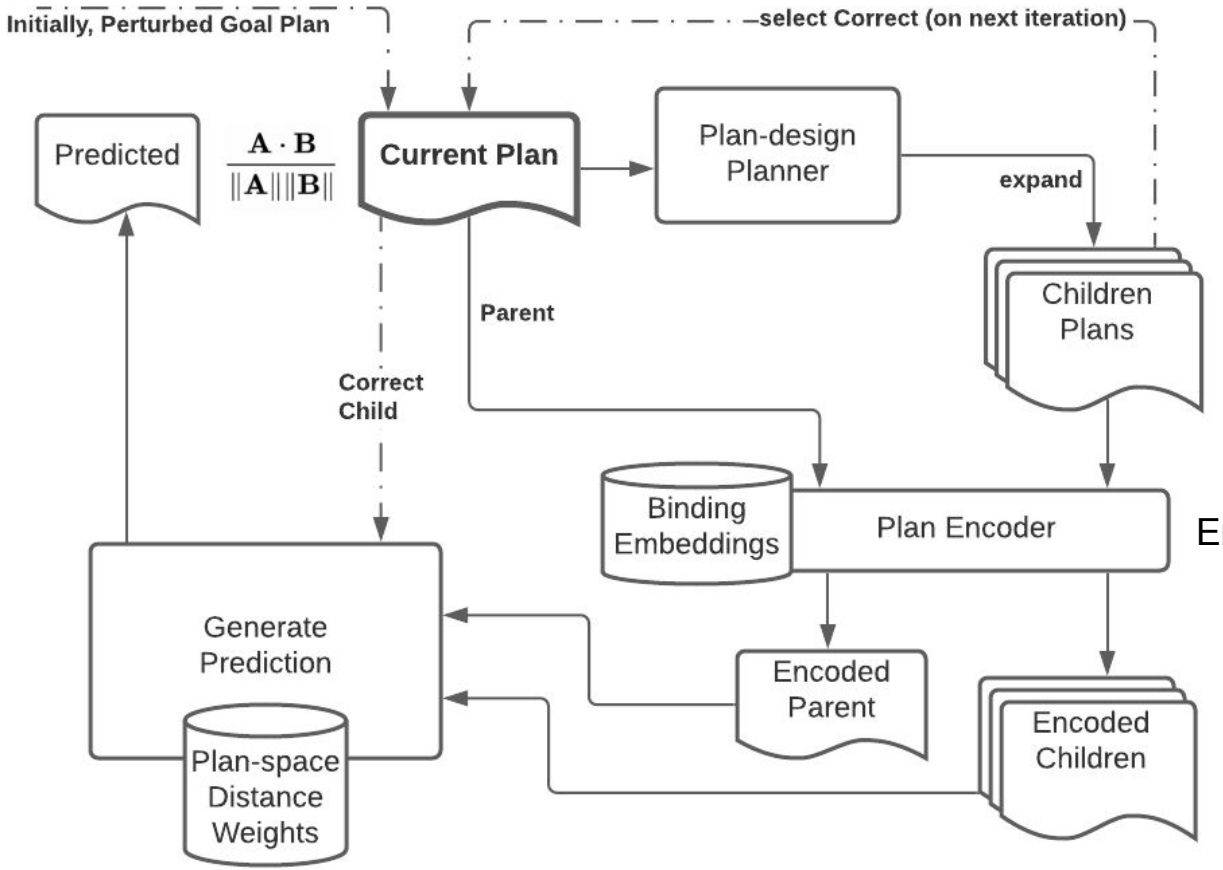
Input:
<Goal, Perturbed Goal>



Embedding Layer

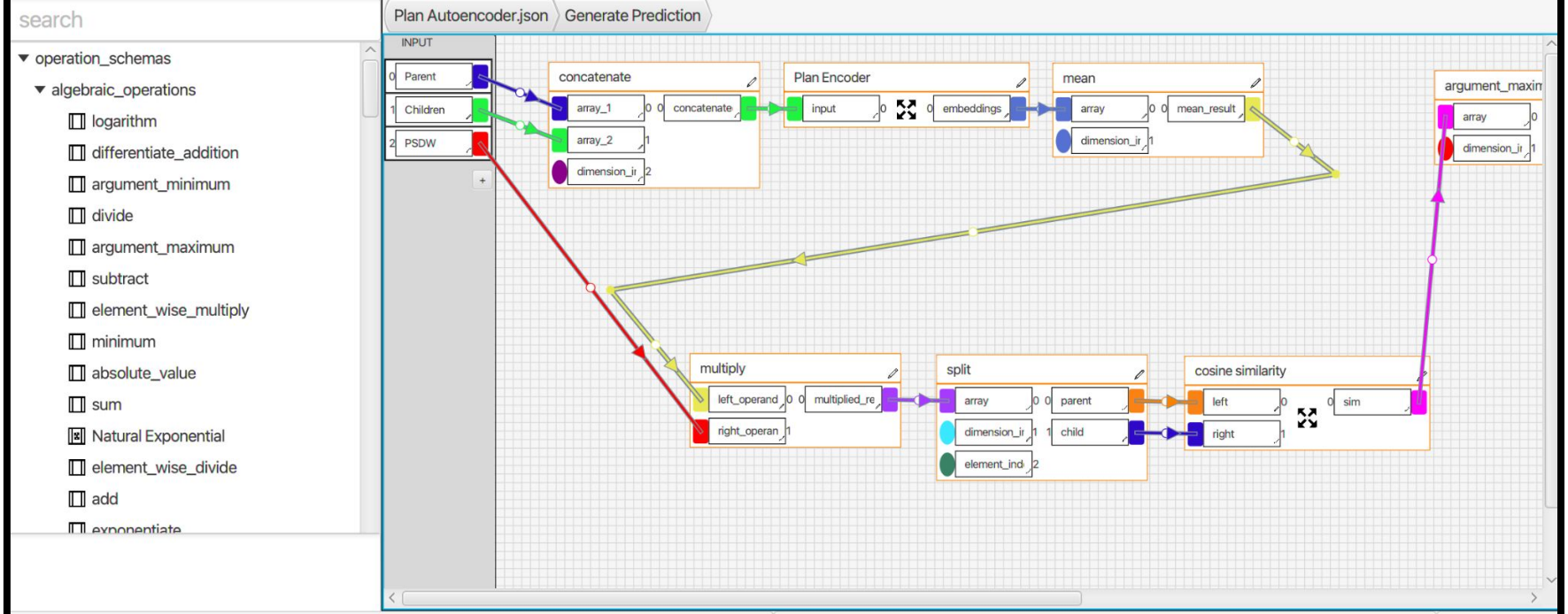
Plan-design Fine-tuning Task

Input:
<Goal, Perturbed Goal>



Embedding Layer

Plan-space Distance Layer



Data At Current Graph Level | Data By Operation

PSDW	[768, 1024]	DECIM...	Op: INPUT
Parent	[1, 128]	INTEG...	Op: INPUT
Children	[17, 128]	INTEG...	Op: INPUT
mean_result	[18, 768]	DECIM...	Op: mean
embeddings	[18, 128, 768]	DECIM...	Op: Plan Encoder
concatenate...	[18, 128]	INTEG...	Op: concatenate

Data Workspace | + | Clear

argument	[1]	INTEG...	Op: argument_ma
sim	[1, 17]	DECIM...	Op: cosine similar
child	[17, 1024]	DECIM...	Op: split
parent	[1, 1024]	DECIM...	Op: split
multiplied_r...	[18, 1024]	DECIM...	Op: multiply
dimension_i...	[]	INTEG...	Op: mean

Tasks

Results

- Results not ready yet.
- Currently validating fine-tuning approach:
  - Trying different perturbation policies
  - Training sets: pairs of <goal, perturbed> plans
- Next: validate on user interaction traces
  - Define perturbed as when user reaches error state
  - Define goal as when user reaches non-error state within n steps
- Do users like the recommendations?
  - Compare approaches to baselines

Conclusion

- Plan-design goal recognition
- Cerbrec modeling platform
- Novel autoencoding adaption
- Novel fine-tuning task to learn action selection

Conclusion

David R. Winer

drw@cerbrec.com

Contact me for private demo!

www.cerbrec.com (free to use platform)

Looking for

- **Scientific Advisor(s)!**
- **Collaboration!**
- Beta testers (sign up on website)
- Investors