Feature interactions

Example: banner selection

...	category_ad	category_site	...	is_clicked
...	auto_part	game_news	...	0
...	music_tickets	music_news	..	1
...	mobile_phones	auto_blog	...	0

Example: banner selection

...	category_ad	category_site	...	is_clicked
...	auto_part	game_news	...	0
...	music_tickets	music_news	..	1
...	mobile_phones	auto_blog	...	0

...	ad_site	...	is_clicked
...	auto_part|game_news	...	0
...	music_tikets|music_news	..	1
...	mobile_phones|auto_blog	...	0

Example of interactions

f1	f2
A	X
B	Y
B	Z
A	Z

Example of interactions

<table>
<tr><th>f1</th><th>f2</th></tr>
<tr><td>A</td><td>X</td></tr>
<tr><td>B</td><td>Y</td></tr>
<tr><td>B</td><td>Z</td></tr>
<tr><td>A</td><td>Z</td></tr>
</table>

Join

<table>
<tr><th>f_join</th></tr>
<tr><td>A|X</td></tr>
<tr><td>B|Y</td></tr>
<tr><td>B|Z</td></tr>
<tr><td>A|Z</td></tr>
</table>

OneHot
(f_join)

<table>
<tr><th>A|X</th><th>B|Y</th><th>B|Z</th><th>A|Z</th></tr>
<tr><td>1</td><td></td><td></td><td></td></tr>
<tr><td></td><td>1</td><td></td><td></td></tr>
<tr><td></td><td></td><td>1</td><td></td></tr>
<tr><td></td><td></td><td></td><td>1</td></tr>
</table>

Example of interactions

f1	f2
A	X
B	Y
B	Z
A	Z

OneHot(f1),
OneHot(f2)

A	B
1	
	1
	1
1	

X	Y	Z
1		
	1	
		1
		1

Pairwise columns
multiplications

AX	AY	AZ	BX	BY	BZ
1					
				1	
					1
		1			

Example of interactions

f1	f2
1.2	0.0
3.4	0.1
5.6	1.0
7.8	-1.0

Mul

f_join
0.0
0.34
5.6
-7.8

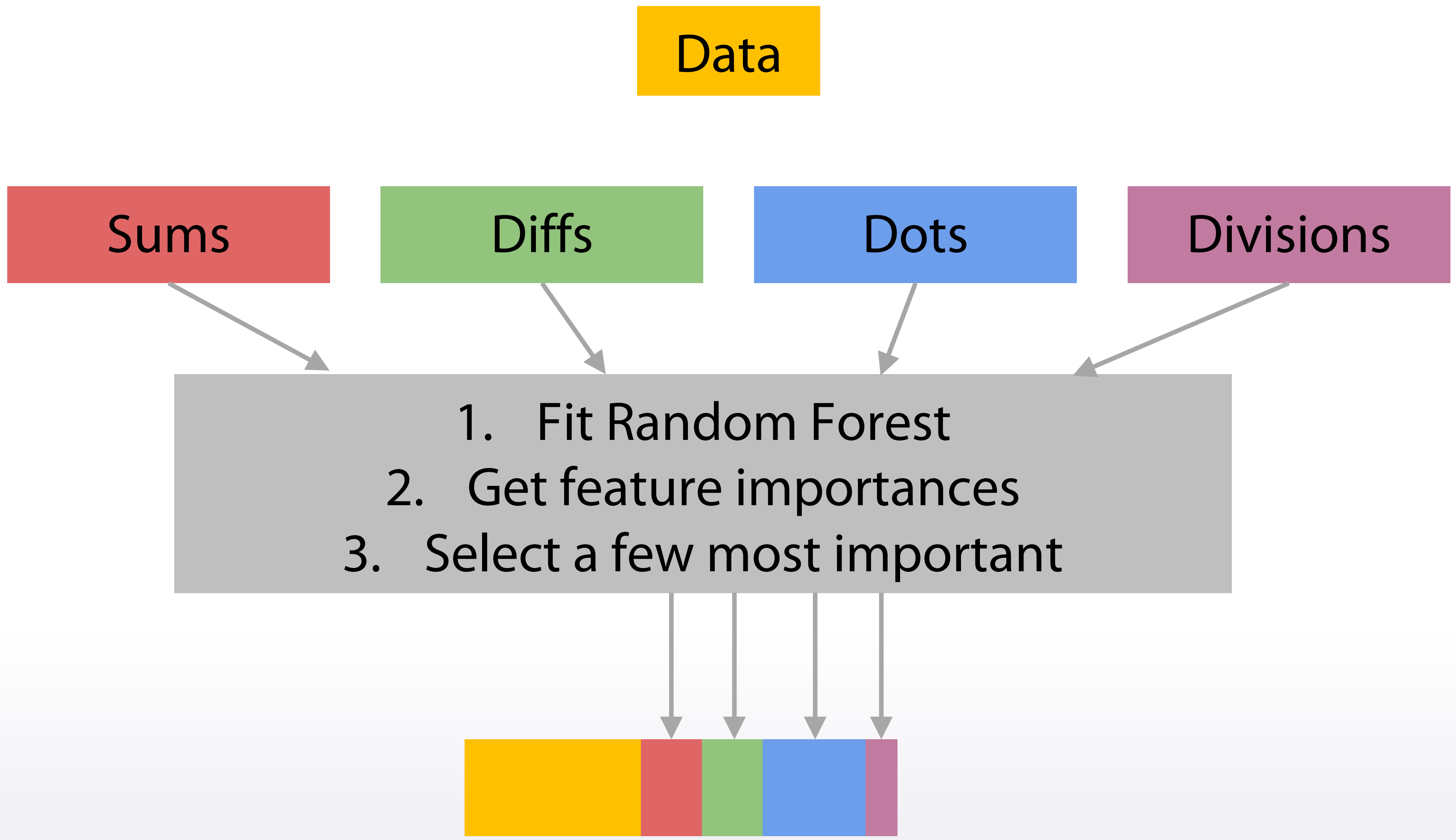
Frequent operations for feature interaction

- Multiplication
- Sum
- Diff
- Division

Practical Notes

- We have a lot of possible interactions – N*N for N features.
  a. Even more if use several types in interactions
- Need to reduce its’ number
  a. Dimensionality reduction
  b. Feature selection

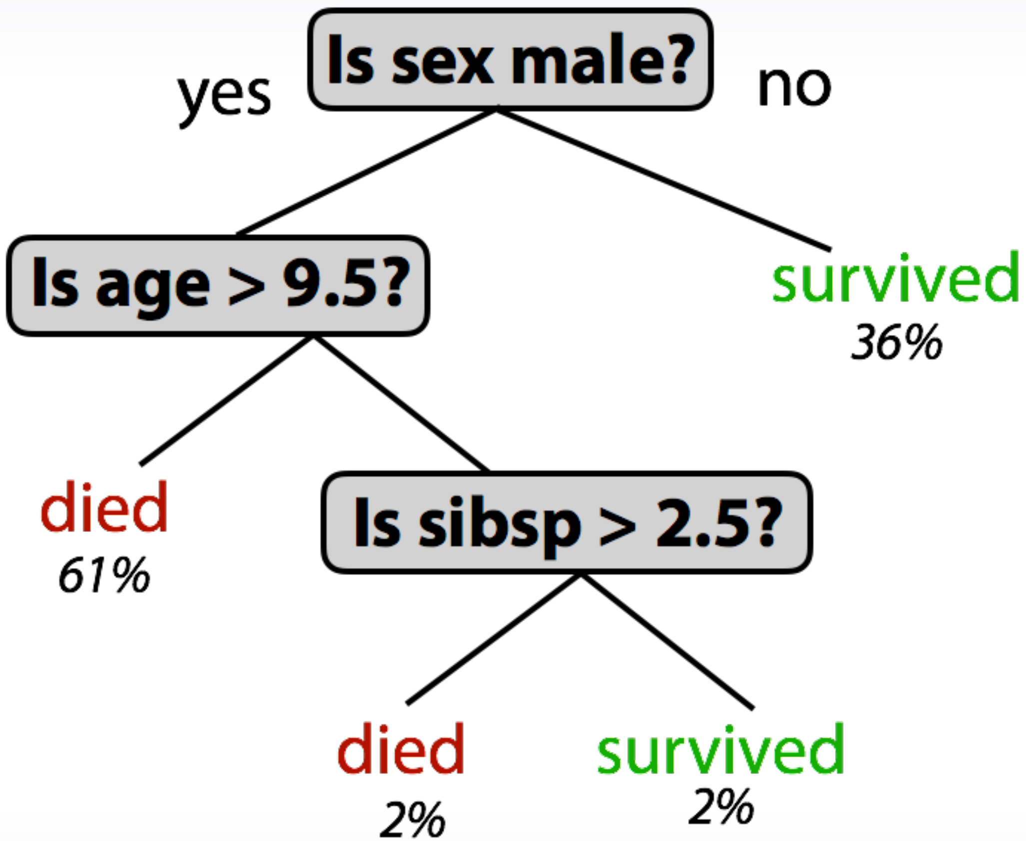
Example of interaction generation pipeline



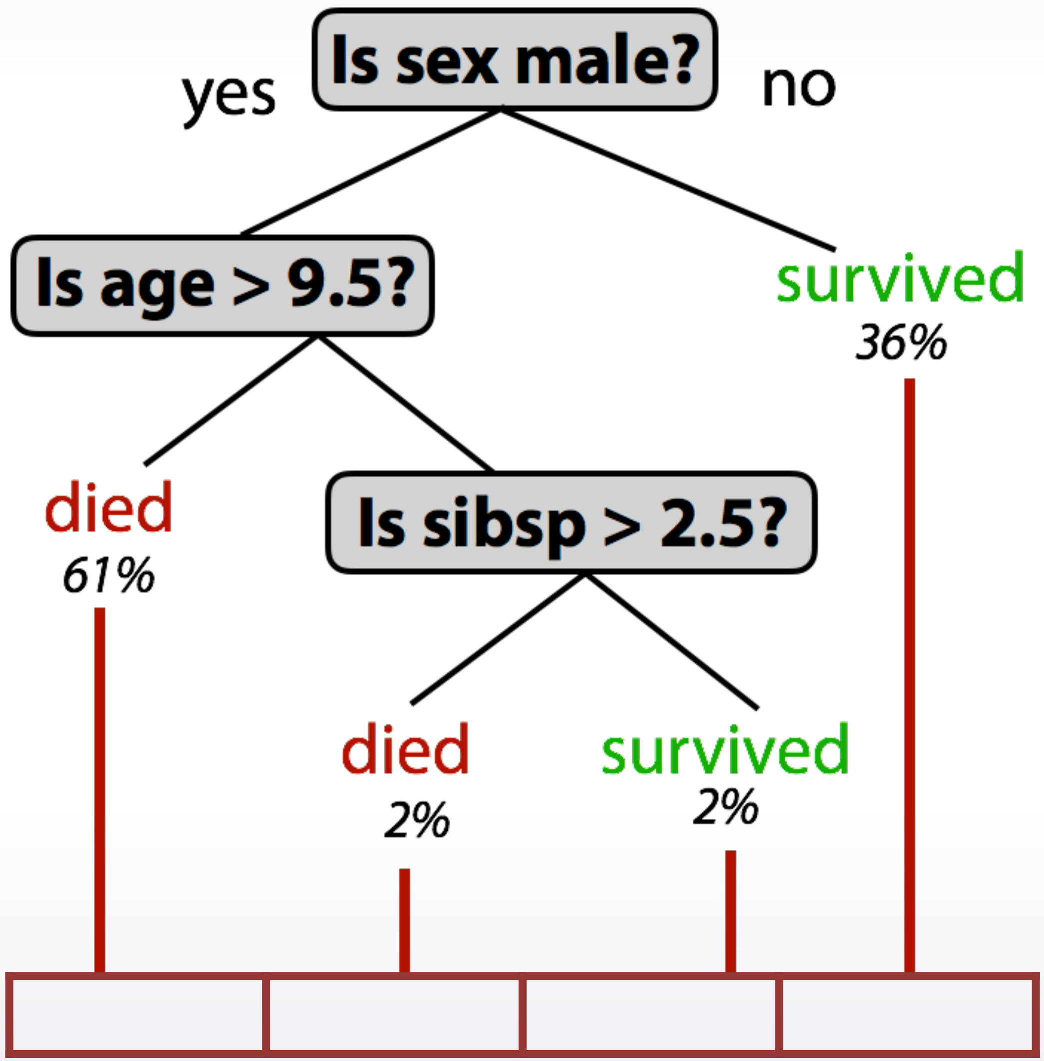
Interactions' order

- We looked at 2nd order interactions.
- Such approach can be generalized for higher orders.
- It is hard to do generation and selection automatically.
- Manual building of high-order interactions is some kind of art.

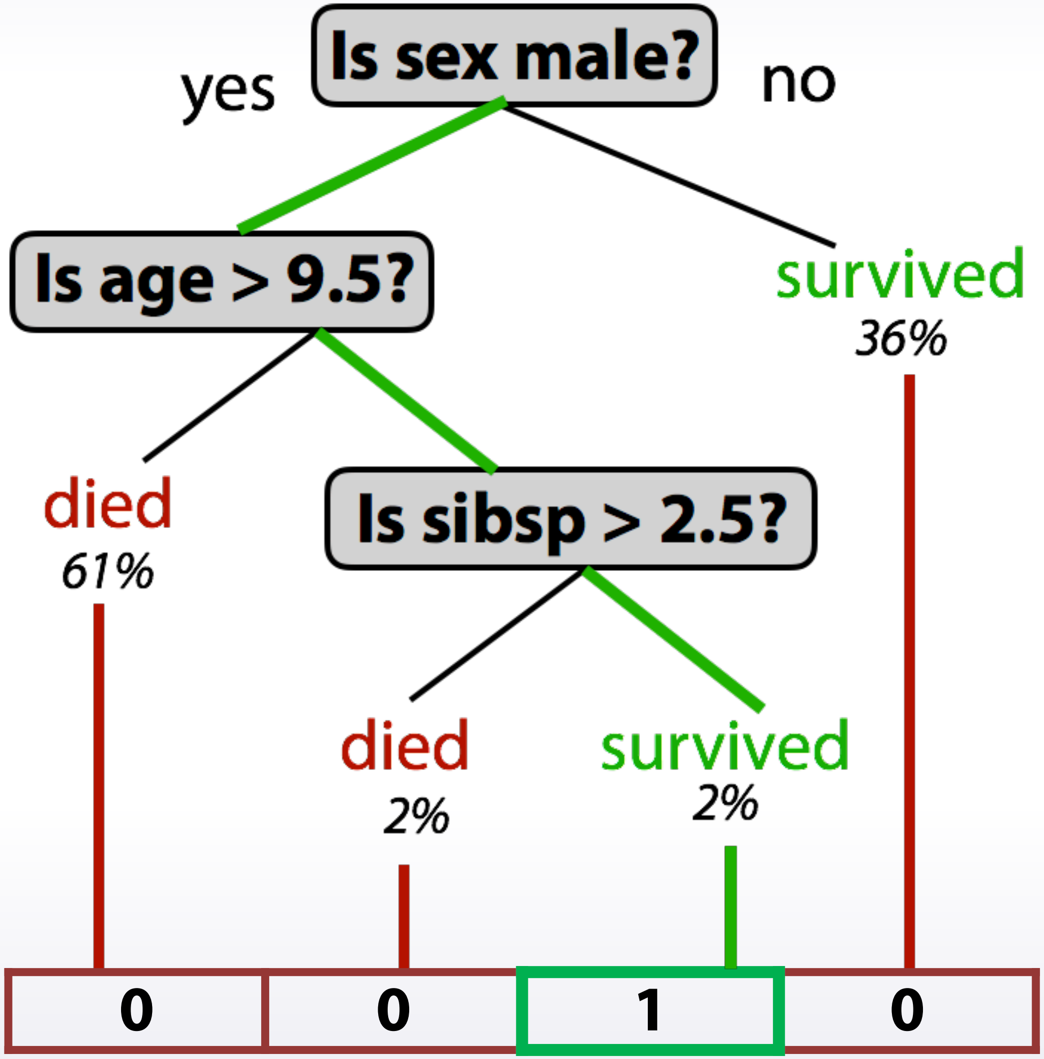
Extract features from DT



Extract features from DT



Extract features from DT



How to use it

In sklearn:

```
tree_model.apply()
```

In xgboost:

```
booster.predict(pred_leaf=True)
```

Conclusion

- We looked at ways to build an interaction of categorical attributes
- Extended this approach to real-valued features
- Learn how to extract features via decision trees