Analysis of PennSound speech-to-text, includes more information not included in the paper

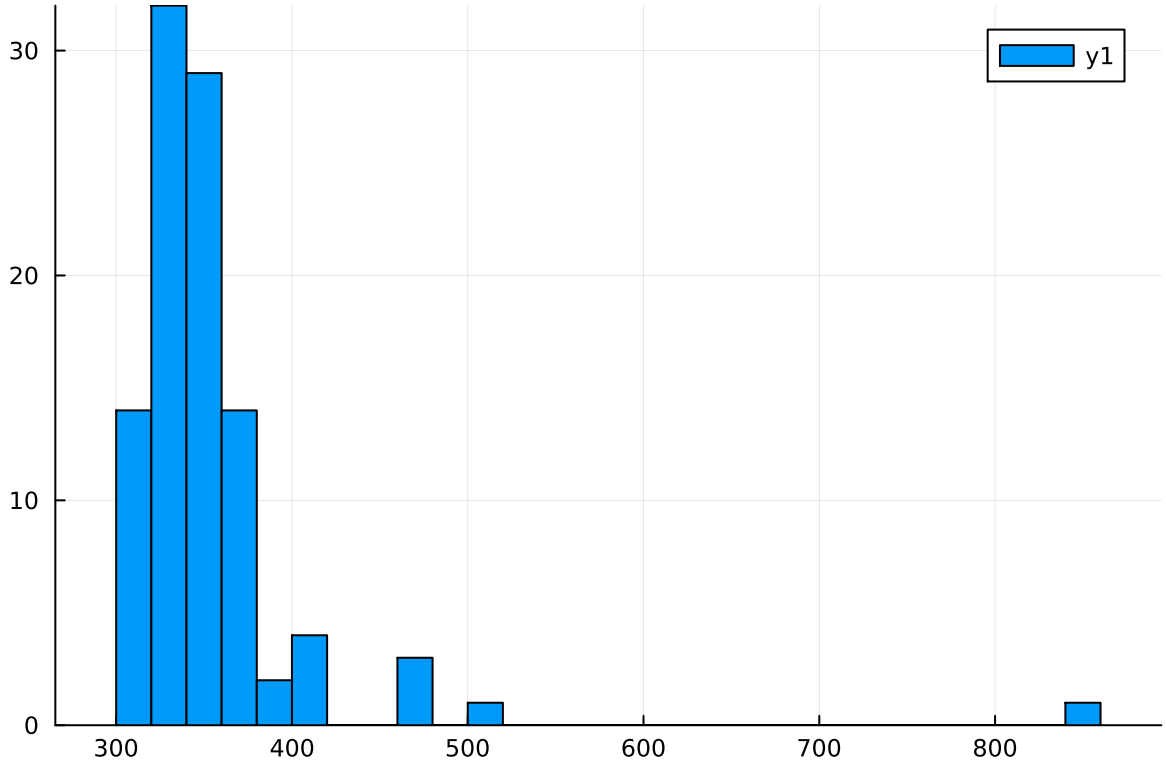
```
using DataFrames, CSV, Statistics, Dates, Plots, Distributions,RollingFunctions
```

The original goal was a random sample of 100 clips, each 5 minutes in duration, which would be 8.3 hours of audio if done exactly that way. The total audio duration is 12.15 hours, which would mean quite a lot of silence if the speech was only 8.3 hours. However, the reference transcripts tend to indicate more than 5 minutes of speech, due to speech undetected by SAD, overlapping speech, or possibly human error (segments padded with silence). Summing the segment lengths from the human transcripts gives a total of 9.84 hours of speech, with a mean of 354 seconds and a standard deviation of 61.5 seconds. The histogram below shows the amount of speech per file in seconds.

`speech =`

	file	speech
1	"Andrews-Bruce-and-Charles-North_Compl	341.623
2	"Antin-David_Complete_Seminar_Universi	372.994
3	"Ashbery-John_01_Complete-Reading_WBAI	343.004
4	"Ashbery-John_Complete-Reading_Contemp	348.673
5	"Ashbery-John_Complete-Recording_Attit	300.015
6	"Ashbery-John_Complete-Recording_Honor	361.438
7	"Ashbery-John_Complete-Recording_Pione	315.977
8	"Ashbery-John_Complete-Recording_St-Ma	354.344
9	"Ashbery-John_Complete-Recording_The-S	336.321
10	"Ashbery-John_Complete-Recording_WBAI-	363.231
	more	
100	"Yau-John_02_Complete-Reading_SUNY-Buf	337.962

```
speech = CSV.read("speech.tsv", DataFrame, delim="\t")
```




```
histogram(speech[:,:speech])
```

354.16752999999994

```
mean(speech.speech)
```

61.48031766484953

```
std(speech.speech)
```

	file	speech
1	"Ginsberg-Allen_Complete-Reading_WCW-L	858.552

```
speech[speech.speech .> 800,:]
```

9.837986944444443

```
sum(speech.speech) / 3600
```

total duration of audio clips is 12.15 hours

durations =

	file	duration
1	"Andrews-Bruce-and-Charles-North_Compl	585.15
2	"Antin-David_Complete_Seminar_Universi	462.47
3	"Ashbery-John_01_Complete-Reading_WBAI	432.82
4	"Ashbery-John_Complete-Reading_Contemp	446.79
5	"Ashbery-John_Complete-Recording_Attit	390.93
6	"Ashbery-John_Complete-Recording_Honor	458.35
7	"Ashbery-John_Complete-Recording_Pione	393.12
8	"Ashbery-John_Complete-Recording_St-Ma	466.21
9	"Ashbery-John_Complete-Recording_The-S	440.09
10	"Ashbery-John_Complete-Recording_WBAI-	458.39
	more	
100	"Yau-John_02_Complete-Reading_SUNY-Buf	379.11

```
durations = CSV.read("durations.tsv", DataFrame, delim="\t")
```

```
12.152402777777779
```

```
sum(durations.duration) / 3600
```

here we display individual WERs in various ways

wers =

	file	aws	azure	google	ibm	nemo	rev	whisper	whispercpp
1	"andrews"	29.0	23.1	24.7	33.4	18.8	19.0	19.1	21.6
2	"antin"	15.7	18.1	16.4	21.2	20.3	15.0	19.4	21.2
3	"ashbery1"	3.5	4.3	4.2	5.8	3.4	3.7	2.8	3.5
4	"ashbery2"	3.6	4.6	4.2	6.6	4.4	3.2	3.8	4.6
5	"ashbery3"	3.9	4.8	5.5	6.2	4.9	3.2	4.7	5.3
6	"ashbery4"	14.6	14.9	15.6	17.4	18.2	15.6	18.1	17.2
7	"ashbery5"	5.4	6.3	4.8	9.1	5.7	3.2	3.9	4.7
8	"ashbery6"	2.0	2.4	4.1	3.6	2.8	2.4	2.0	6.4
9	"ashbery7"	4.1	4.8	5.2	11.4	3.5	4.2	3.0	3.6
10	"ashbery8"	4.5	4.5	4.6	8.6	4.7	4.2	3.5	5.8
	more								
100	"yau"	5.5	6.0	7.4	10.7	4.4	4.5	3.6	4.9

```
wers = CSV.read("wer.tsv", DataFrame, delim="\t")
```

wers_sorted_by_rev =

	file	aws	azure	google	ibm	nemo	rev	whisper	whisperc
1	"bromige2"	2.4	3.0	2.0	4.2	2.4	1.1	2.0	1.9
2	"duplessis1"	3.0	2.9	2.9	4.4	3.9	1.8	1.9	5.4
3	"duplessis2"	2.8	2.6	3.6	6.7	2.9	2.0	1.8	1.6
4	"gladman"	2.2	2.4	3.2	4.1	4.2	2.2	1.9	10.9
5	"jarnot"	4.3	4.0	4.5	9.3	5.5	2.3	3.1	4.3
6	"ashbery6"	2.0	2.4	4.1	3.6	2.8	2.4	2.0	6.4
7	"robinson1"	3.0	2.8	5.0	4.2	4.1	2.5	2.6	3.6
8	"richards"	3.9	3.9	2.8	8.2	2.8	2.8	3.4	7.1
9	"robinson3"	3.6	3.2	3.9	5.2	4.2	2.9	2.9	5.3
10	"ashbery2"	3.6	4.6	4.2	6.6	4.4	3.2	3.8	4.6
	more								
100	"ginsberg"	37.2	36.3	36.2	44.0	34.4	33.3	32.4	39.4

```
wers_sorted_by_rev = sort(wers, [:rev])
```

wers_with_mean =

	file	aws	azure	google	ibm	nemo	rev	whisper	whispercpp
1	"andrews"	29.0	23.1	24.7	33.4	18.8	19.0	19.1	21.6
2	"antin"	15.7	18.1	16.4	21.2	20.3	15.0	19.4	21.2
3	"ashbery1"	3.5	4.3	4.2	5.8	3.4	3.7	2.8	3.5
4	"ashbery2"	3.6	4.6	4.2	6.6	4.4	3.2	3.8	4.6
5	"ashbery3"	3.9	4.8	5.5	6.2	4.9	3.2	4.7	5.3
6	"ashbery4"	14.6	14.9	15.6	17.4	18.2	15.6	18.1	17.2
7	"ashbery5"	5.4	6.3	4.8	9.1	5.7	3.2	3.9	4.7
8	"ashbery6"	2.0	2.4	4.1	3.6	2.8	2.4	2.0	6.4
9	"ashbery7"	4.1	4.8	5.2	11.4	3.5	4.2	3.0	3.6
10	"ashbery8"	4.5	4.5	4.6	8.6	4.7	4.2	3.5	5.8
	more								
100	"yau"	5.5	6.0	7.4	10.7	4.4	4.5	3.6	4.9

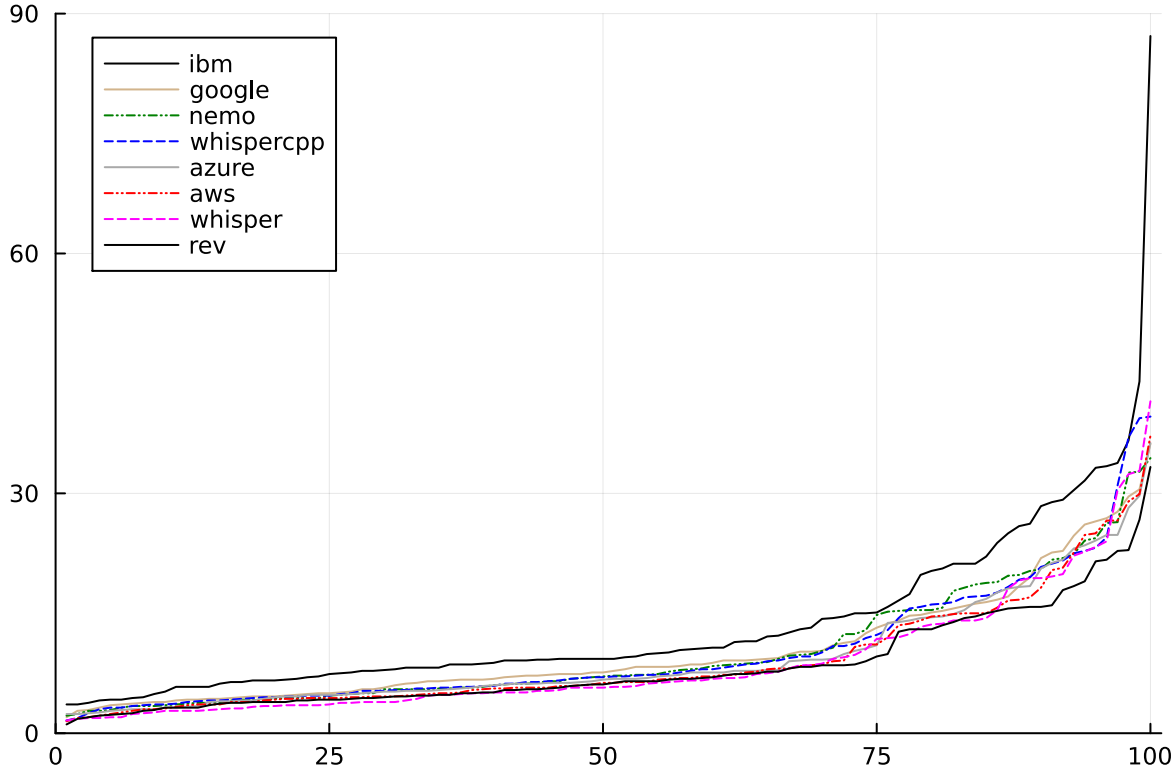
```
wers_with_mean = transform(wers, [:rev, :whisper] => ((x,y) -> (x.+y)./2) => :mean)
```

wers_sorted_by_mean =

	file	aws	azure	google	ibm	nemo	rev	whisper	whis
1	"bromige2"	2.4	3.0	2.0	4.2	2.4	1.1	2.0	1.9
2	"duplessis1"	3.0	2.9	2.9	4.4	3.9	1.8	1.9	5.4
3	"duplessis2"	2.8	2.6	3.6	6.7	2.9	2.0	1.8	1.6
4	"gladman"	2.2	2.4	3.2	4.1	4.2	2.2	1.9	10.9
5	"ashbery6"	2.0	2.4	4.1	3.6	2.8	2.4	2.0	6.4
6	"robinson1"	3.0	2.8	5.0	4.2	4.1	2.5	2.6	3.6
7	"jarnot"	4.3	4.0	4.5	9.3	5.5	2.3	3.1	4.3
8	"robinson3"	3.6	3.2	3.9	5.2	4.2	2.9	2.9	5.3
9	"berssenbrugge2"	1.5	3.4	4.4	9.9	4.3	3.5	2.5	3.2
10	"dorn"	4.3	4.0	8.3	8.0	3.4	4.6	1.6	2.5
	more								
100	"ginsberg"	37.2	36.3	36.2	44.0	34.4	33.3	32.4	39.4

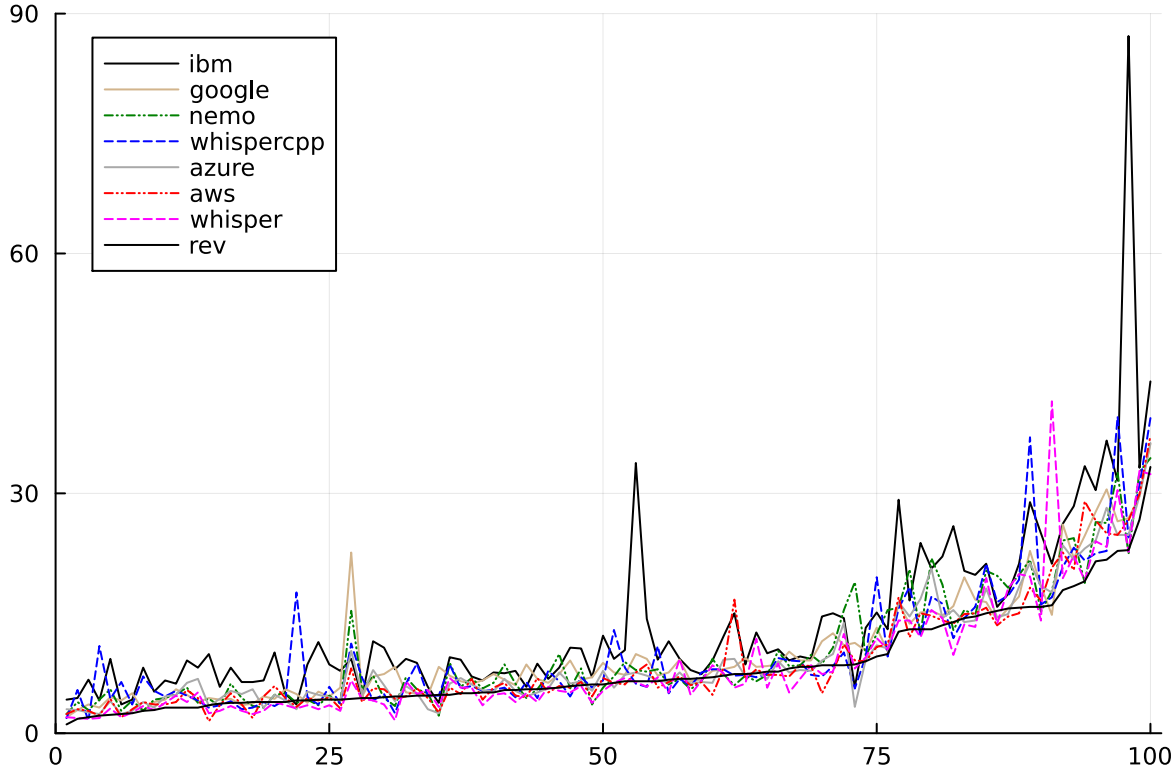
```
wers_sorted_by_mean = sort(wers_with_mean, :mean)
```

WERs sorted separately

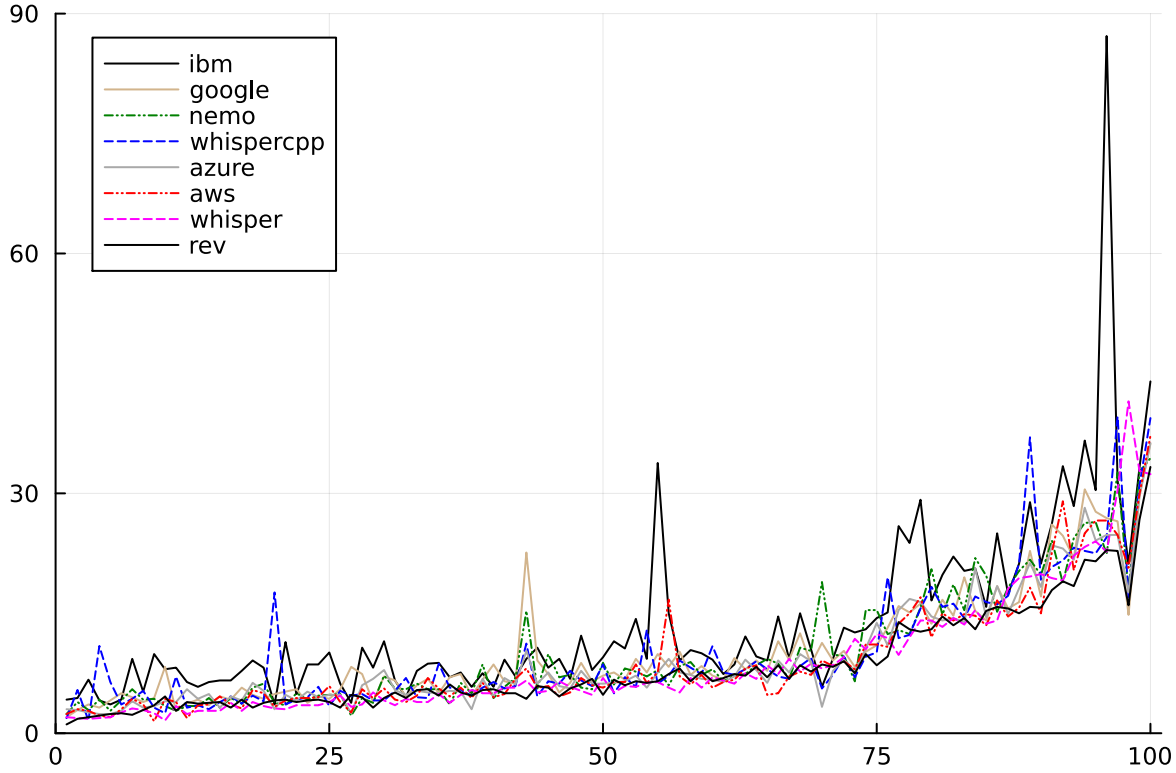



```
begin
    plot(sort(wers.ibm),label="ibm", linestyle=:solid, color=:black)
    plot!(sort(wers.google),label="google", linestyle=:solid, color=:tan)
    plot!(sort(wers.nemo),label="nemo", linestyle=:dashdotdot, color=:green)
    plot!(sort(wers.whispercpp),label="whispercpp", linestyle=:dash, color=:blue)
    plot!(sort(wers.azure),label="azure", linestyle=:solid, color=:darkgray)
    plot!(sort(wers.aws),label="aws",xlim=(0,101),ylim=(0,90),
    linestyle=:dashdotdot,color=:red)
    plot!(sort(wers.whisper),label="whisper", linestyle=:dash, color=:magenta)
    plot!(sort(wers.rev),label="rev", linestyle=:solid,color=:black)
end
```

WERs sorted by rev




```
begin
    w1 = wers_sorted_by_rev
    plot(w1.ibm,label="ibm", linestyle=:solid, color=:black)
    plot!(w1.google,label="google", linestyle=:solid, color=:tan)
    plot!(w1.nemo,label="nemo", linestyle=:dashdotdot, color=:green)
    plot!(w1.whispercpp,label="whispercpp", linestyle=:dash, color=:blue)
    plot!(w1.azure,label="azure", linestyle=:solid, color=:darkgray)
    plot!(w1.aws,label="aws",xlim=(0,101),ylim=(0,90),
    linestyle=:dashdotdot,color=:red)
    plot!(w1.whisper,label="whisper", linestyle=:dash, color=:magenta)
    plot!(w1.rev,label="rev", linestyle=:solid,color=:black)
end
```

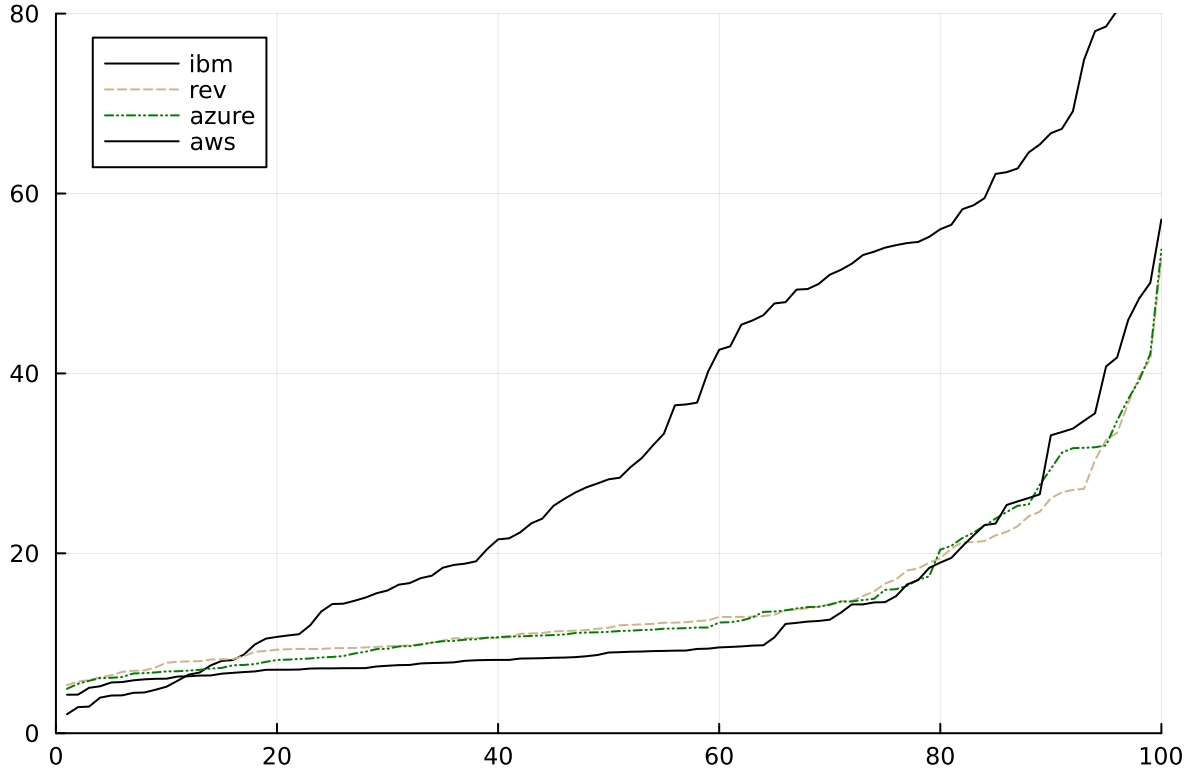



```
begin
    w2 = wers_sorted_by_mean
    plot(w2.ibm,label="ibm", linestyle=:solid, color=:black)
    plot!(w2.google,label="google", linestyle=:solid, color=:tan)
    plot!(w2.nemo,label="nemo", linestyle=:dashdotdot, color=:green)
    plot!(w2.whispercpp,label="whispercpp", linestyle=:dash, color=:blue)
    plot!(w2.azure,label="azure", linestyle=:solid, color=:darkgray)
    plot!(w2.aws,label="aws",xlim=(0,101),ylim=(0,90),
    linestyle=:dashdotdot,color=:red)
    plot!(w2.whisper,label="whisper", linestyle=:dash, color=:magenta)
    plot!(w2.rev,label="rev", linestyle=:solid,color=:black)
end
```

der =

	file	aws	azure	ibm	rev
1	"Andrews-Bruce-and-Charles-North_Compl	16.54	13.53	62.37	23.01
2	"Antin-David_Complete_Seminar_Universi	20.78	25.43	65.45	27.17
3	"Ashbery-John_01_Complete-Reading_WBAI	9.59	10.62	15.08	10.59
4	"Ashbery-John_Complete-Reading_Contemp	8.15	11.36	47.78	12.47
5	"Ashbery-John_Complete-Recording_Attit	8.05	10.87	18.4	11.73
6	"Ashbery-John_Complete-Recording_Honor	21.98	31.79	67.19	24.62
7	"Ashbery-John_Complete-Recording_Pione	8.41	8.18	20.46	6.82
8	"Ashbery-John_Complete-Recording_St-Ma	9.08	11.47	53.98	9.37
9	"Ashbery-John_Complete-Recording_The-S	8.15	8.48	59.48	9.37
10	"Ashbery-John_Complete-Recording_WBAI-	8.97	11.27	23.86	12.54
	more				
100	"Yau-John_02_Complete-Reading_SUNY-Buf	7.06	7.69	8.13	9.47

```
der = CSV.read("der.tsv", DataFrame, delim="\t")
```




```
begin
    plot(sort(der.ibm),label="ibm",linestyle=:solid,color=:black,xlim=(0,100),ylim=
    (0,80))
    plot!(sort(der.rev),label="rev", linestyle=:dash, color=:tan)
    plot!(sort(der.azure),label="azure", linestyle=:dashdotdot, color=:green)
    plot!(sort(der.aws),label="aws", color=:black)
end
```

	file	aws	azure	ibm	rev
1	"Beaulieu-Derek_Complete-Reading_Brods	35.57	10.07	58.25	10.55
2	"Halsey-Alan_Complete-Reading_BUS-MFA_	41.78	12.31	47.92	13.9
3	"Joris-Pierre_Complete-reading_Weds-at	57.11	11.75	36.55	13.75
4	"Lauterbach-Ann_Complete-Reading_SUNY-	50.08	14.94	7.54	12.93

```
der[der.aws .- der.azure .> 10, :]
```