- New concepts:
  - Data organization into vectors, matrices
  - Practical interpretation of fundamental matrix subspaces
  - Working with data in Octave/Matlab

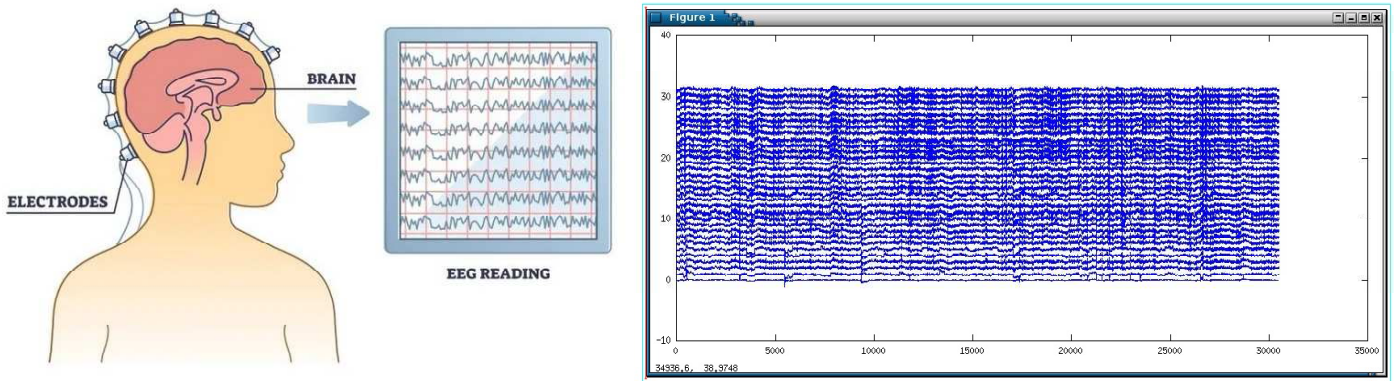

Figure 1. Brain neurons transmit electrical signals recorded by electrodes placed on the skull

```
>> load eeg; data=EEG.data';
```

```
>> [m,n]=size(data); pdata=data./max(data)+meshgrid(0:n-1,0:m-1);
```

```
>> hold on;
   for j=1:n
     plot(pdata(:,j));
   end;
   hold off;
```

- Medical background
- Modeling competition (2017 NIH sponsored $20,000 first prize)
- Realistic data set (Univ. Siena). Data from 10-20 system.

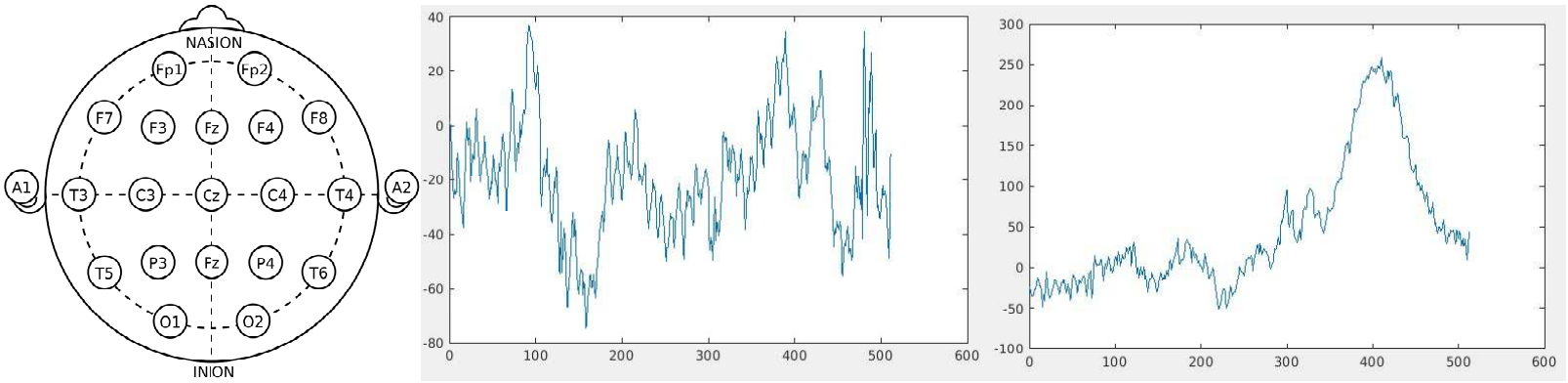

Figure 2. Electrode placement, normal EEG, epileptic seizure EEG (PN12-3, t=800, t=950)

```
>> edata=edfread("PN12-3.edf");
   plot(cell2mat(edata(800,1).EEGFp1));
   plot(cell2mat(edata(950,1).EEGFp1));
```

- Separate long time recording of normal activity into pieces, form $\boldsymbol{A} \in \mathbb{R}^{m_S \times n_S}$

```
>> nElec=1; mS=256; nS=20; A=reshape(pdata(1:mS*nS,nElec),mS,nS);
```

- Ask: when is a recording $\boldsymbol{b}$ indicative of something abnormal?
  Possible answer: when $\boldsymbol{b}$ has much larger component in $N(\boldsymbol{A}^T)$ than in $C(\boldsymbol{A})$
- Approach: project $\boldsymbol{b}$ onto $C(\boldsymbol{A})$ to obtain $\boldsymbol{c} = \boldsymbol{P_Q}\,\boldsymbol{b}$, find fraction of size of $\boldsymbol{b}$ within $C(\boldsymbol{A})$ by computing ratio $r = \|\boldsymbol{c}\| / \|\boldsymbol{b}\|$.

```
>> [Q,R]=qr(A); Qt=Q';
```

```
>> b=pdata(mS*nS+1:mS*nS+256,1); c=Q*(Qt*b); norm(c)/norm(b)
```

- Establish a threshold r that indicates onset of epileptic seizure
- Algorithm can be made into a phone/watch app together with continual sensors to obtain a wearable device to alert/treat onset of epileptic seizures
- Interested? Come to office hours to consider a Senior Honors Thesis to establish your data-processing credentials before entering the job market!

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