

The struggles of a physicist

... then a hero comes a long

Sunniva Indrehus

Norwegian Geotechnical Institute

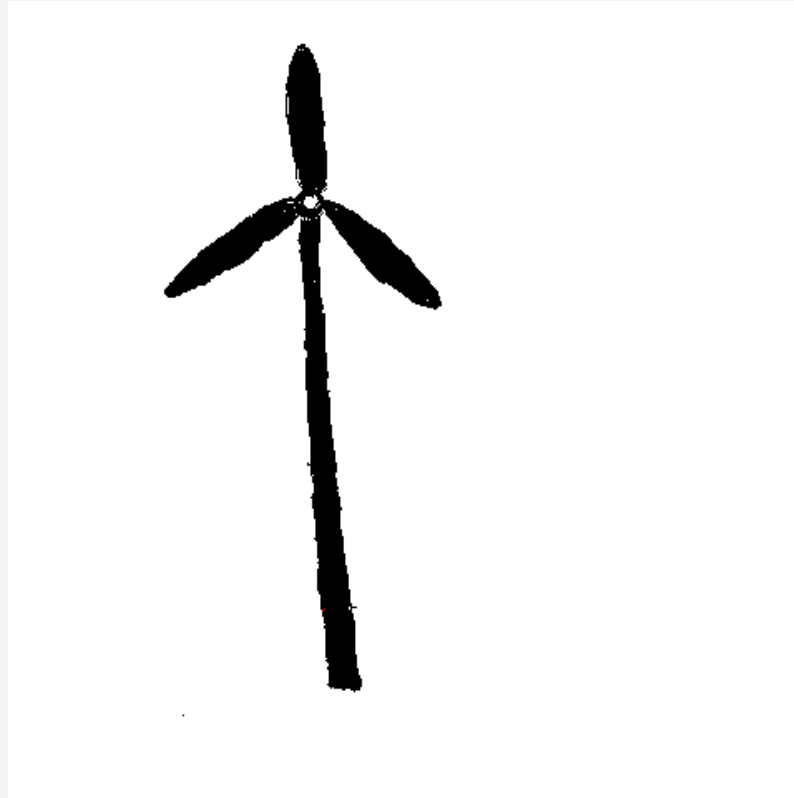
Typical physicist work ?

- Model a simplified version of the real world

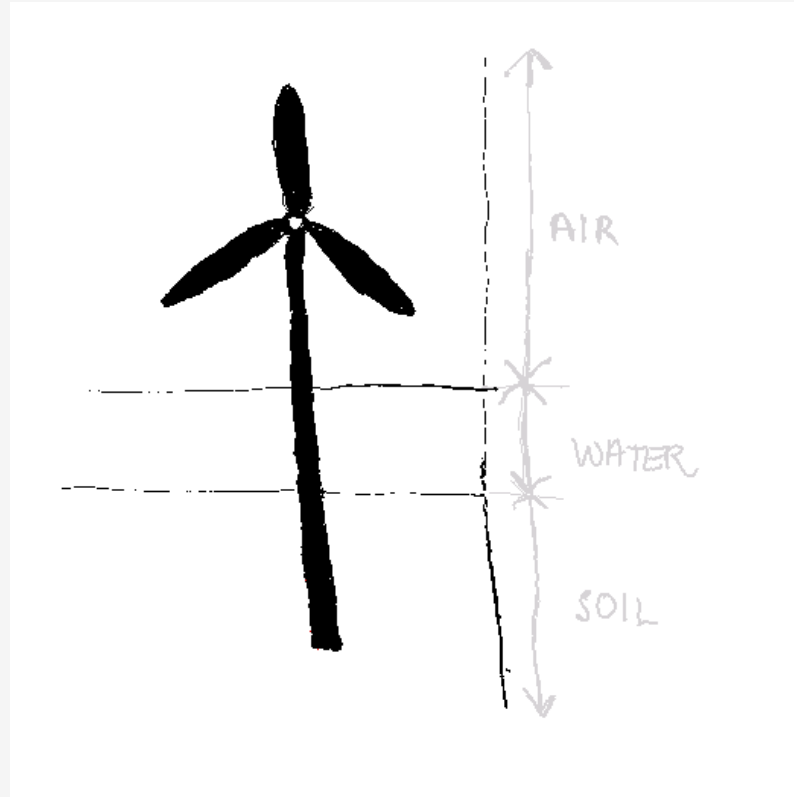
A dense, handwritten collection of physics equations covering various topics like mechanics, electromagnetism, and quantum physics. The equations are written in black ink on a white background. Some of the visible equations include:

- $E_k = \frac{1}{2} m v^2$
- $\rho V = n R T$
- $\vec{\psi} = \iint \vec{B} d\vec{S} = A D$
- $H_\lambda = \frac{\Delta M_e}{\Delta \lambda}$
- $\Phi_e = \frac{L}{\Delta t} \int \frac{\Delta \varphi}{2\pi} = \frac{\Delta x}{\lambda} = \frac{x_2 - x_1}{\lambda}$
- $V = C/\lambda$
- $\Phi = NBS$
- $E = \hbar \omega$
- $X_L = \frac{U_m}{I_m} = \omega L = 2\pi f L$
- $F_g = \frac{m_1 m_2}{r^2}$
- $E = m c^2$
- $\omega = 2\pi f$
- $E = \frac{1}{2} \hbar \omega$
- $\beta = \frac{\Delta I_c}{\Delta I_B}$
- $\phi_e = \frac{\Delta E}{\Delta t} \frac{\mu_1}{X} + \frac{\mu_2}{X'} = \frac{\mu_2 - \mu_1}{\mu}$
- $\oint \vec{B} d\vec{\ell} = \mu_0 \iint \vec{J} d\vec{S}$
- $\vec{S} = \frac{1}{\mu_0} (\vec{E} \times \vec{B})$
- $\oint \vec{J} d\vec{S} = Q^*$
- $E = \hbar k^2$
- $1 \text{ pc} = \frac{1 \text{ AU}}{r}$
- $\vec{S} = \frac{U}{I} \vec{F}_v = \int \frac{F_h}{R}$
- $M = F d \cos \alpha$
- $T = \frac{1}{f}$

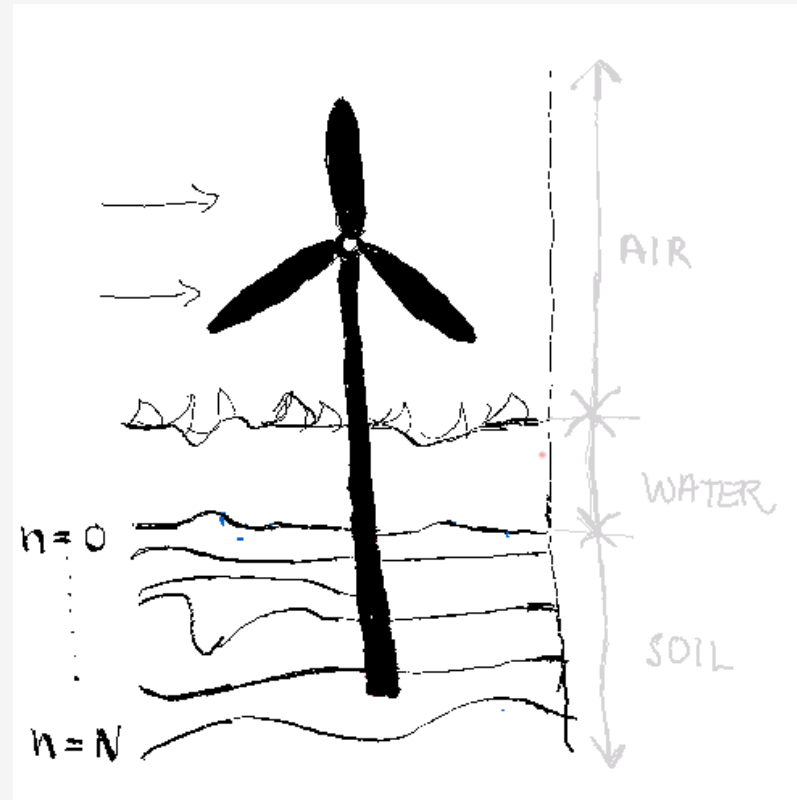
Building a model



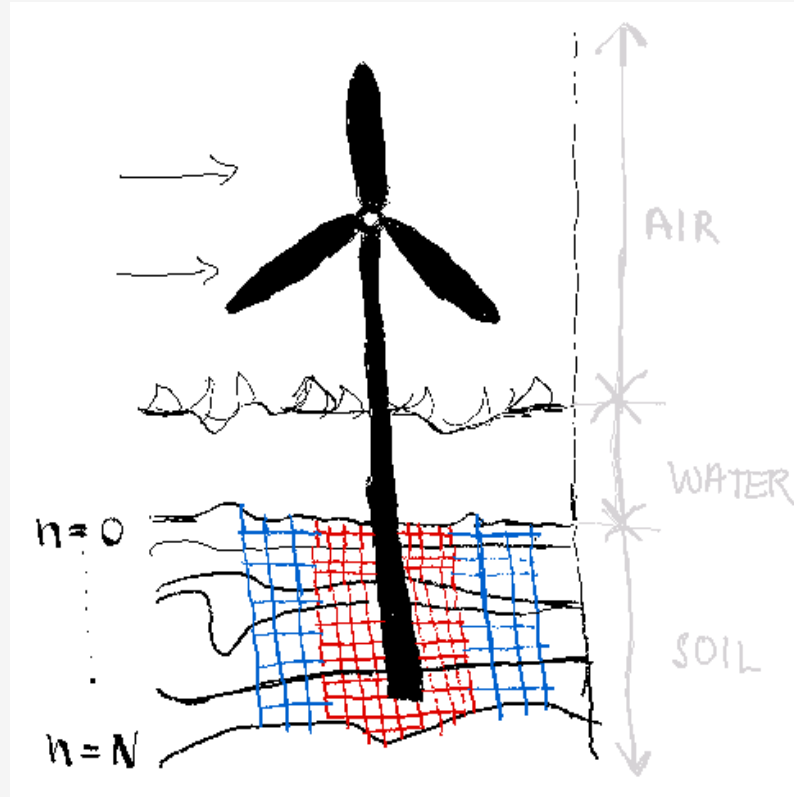
Building a model



Building a model



Building a model



♪ ... Then a (*super*)hero comes a long ♪



What is pydantic?

From the official docs: *Data validation and settings management using python type annotations. Pydantic enforces type hints at runtime, and provides user friendly errors when data is invalid.*

Class definitions

```
class LinearElasticMaterial(BaseModel):
    material_ID: int = Field(
        default=1001,
        ge=1001,
        le=1999,
        description="Linear elastic material for the pile foundation",
    )
    G: float = Field(ge=0.0001, description="Material shear modulus [kPa]")
    K_0: Optional[float] = Field(description="Horizontal stress factor")
    # ... etc. for validation
```

```
class SoilLayer(BaseModel):
    depth: float = Field(description="Depth from seabed to soil later")
    material_ID: str = Field(description="Material type of current soil layer")
    number_of_elements: int = Field(
        description="Number of elements of this material at this depth"
    )
    # ... etc. for validation
```

```
class TurbineModel(BaseModel):
    soil_layers: List[SoilLayer]
    linear_elastic_materials: List[LinearElasticMaterial]
    load_step_num: int = Field(
        default=20, ge=0, description="Number of load steps in cycle"
    )
    # ... etc. for validation
```

Input with dictionaries

```
linear_elastic_materials = {"material_ID": 1001, "G": 80800000.0}

simulation_steps = 20

turbine_model = TurbineModel(
    linear_elastic_materials=linear_elastic_material,
    load_step_num = simulation_steps
)
```

Error message

```
pydantic.error_wrappers.ValidationError: 1 validation error for LinearElasticMaterial
material_ID
  ensure this value is less than or equal to 1999 (type=value_error.number.not_le; limit_value=1999)
```

Nifty integration for "free"

```

InfidepPy {
  project_ID
    string
    title: Project Id
    maxLength: 200
    minLength: 1
    default: infidep
    Project identifier

  linear_elastic_materials* Linear Elastic Materials > [...]
  pile_geometry* PileGeometry > {...}
}

LinearElasticMaterial {
  material_id
    integer
    title: Material Id
    maximum: 1999
    minimum: 1001
    default: 1001
    Linear elastic material for the pile foundation

  G*
    number
    title: G
    minimum: 0.0001
    Material shear modulus [kPa]

  nu*
    number
    title: Nu
    Poisson's ratio; a measure of the material deformation

  K_0
    number
    title: K 0
    Horizontal stress factor

  unit_weight
    number
    title: Unit Weight
    Wight density [kN/m^3]

  damping
    number
    title: Damping
    Reference to damping function
}

```

Automatic docs with fast-API

Summary

★ Pydantic let's you focus on your algorithm and not input validation ★