Entrega Final - Núcleo de Finanças - Trainees

De: Lucas Pimentel e João Casella

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A modelagem escolhida foi por Trend Following das empresas AgroGalaxy e Boa Safra. Decidiu-se utilizar:

O método MACD para a identificação de tendências;

O método RSI para interpretar o momentum dessas tendências;

E o método ADX, como veredito, para se compreender a força das tendências e optar-se pela compra ou venda do ativo.

Foram simulados os desempenhos de cada ativo para com a estratégia de índices técnicos, com um output na segunda parte do código

Para a primeira parte do código, tem-se a definição dos objetos essenciais para a realização do backtesting. Optou-se por colocá-los diretamente no código e não importá-los para evitar erros.

A segunda parte contém a aplicação do modelo e gráficos para compreensão dos resultados das simulações.

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Resumo: Ideia do Sinal

Vamos usar um modelo para tendência (MACD) e um modelo para oscilação (RSI).

Para decidir qual sinal seguir, usaremos o ADX para indicar se há tedência ou não.

In [1]:

```
#Bibliotecas utilizadas

%matplotlib inline
import math
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import time
from datetime import datetime
import random
import pandas_ta as ta
import yahoofinancials as yf
from copy import deepcopy
```

In [2]:

```
#!pip install pandas_ta
```

Parte 1: Classes/objetos para o backtesting

(arquivo backtesting da eletiva Algotrading)

In [3]:

```
def sign(number):
    if number > 0:
        return 1
    elif number < 0:
        return -1
    return 0
class Event():

    BID, ASK, TRADE, CANDLE = ['BID', 'ASK', 'TRADE', 'CANDLE']

    def __init__(self, instrument, timestamp, type, price, quantity):
        self.instrument = instrument
        self.timestamp = timestamp
        self.type = type
        self.price = price
        self.quantity = quantity
```

In [4]:

```
class Order():

    id = 0

    NEW, PARTIAL, FILLED, REJECTED, CANCELED = [
        'NEW', 'PARTIAL', 'FILLED', 'REJECTED', 'CANCELED']

    @staticmethod
    def nextId():
        Order.id += 1
        return Order.id

    def __init__(self, instrument, quantity, price):
        self.id = Order.nextId()
        self.owner = 0
        self.instrument = instrument
        self.status = Order.NEW
        self.timestamp = ''
        self.quantity = quantity
        self.price = price
        self.executed = 0
        self.average = 0

    def print(self):
        return '{0} - {1} - {5}: {2}/{3}@{4}'.format(self.id, self.timestamp, self.exec
uted, self.quantity, self.price, self.instrument)
```

In [5]:

```
class MarketData():

    TICK, HIST, INTR = ['TICK', 'HIST', 'INTR']

    def __init__(self):

        self.events = {}

    def loadBBGTick(self, file, instrument):

        with open(file, 'r') as file:
            data = file.read()

        events = data.split('\n')
        events = events[1:]
        for event in events:
            cols = event.split(';')
            if len(cols) == 4:
                date = datetime.strptime(cols[0], '%d/%m/%Y %H:%M:%S')
                price = float(cols[2].replace(',', '.'))
                quantity = int(cols[3])
                type = cols[1]

                if date.toordinal() not in self.events:
                    self.events[date.toordinal()] = []

                self.events[date.toordinal()].append(
                    Event(instrument, date, type, price, quantity))

    def loadYAHOOHist(self, file, instrument, type=Event.CANDLE):

        with open(file, 'r') as file:
            data = file.read()

        events = data.split('\n')
        events = events[1:]
        for event in events:
            cols = event.split(',')
            if len(cols) == 7 and cols[1] != 'null':

                date = datetime.strptime(cols[0], '%Y-%m-%d')
                price = (float(cols[1]), float(cols[2]),
                         float(cols[3]), float(cols[4]))
                quantity = 0 # float(cols[6])

                if date.toordinal() not in self.events:
                    self.events[date.toordinal()] = []

                self.events[date.toordinal()].append(
                    Event(instrument, date, type, price, quantity))

    def loadBBGIntr(self, file, instrument, type=Event.CANDLE):

        with open(file, 'r') as file:
            data = file.read()

        events = data.split('\n')
        events = events[1:]
        for event in events:
```

```
            cols = event.split(';')
            if len(cols) == 5:

                date = datetime.strptime(cols[0], '%d/%m/%Y %H:%M:%S')
                price = (float(cols[1].replace(',', '.')),
                         float(cols[3].replace(',', '.')),
                         float(cols[4].replace(',', '.')),
                         float(cols[2].replace(',', '.')))
                quantity = 0

                if date.timestamp() not in self.events:
                    self.events[date.timestamp()] = []

                self.events[date.timestamp()].append(
                    Event(instrument, date, type, price, quantity))

    def run(self, ts):
        dates = list(self.events.keys())
        dates.sort()
        for date in dates:
            for event in self.events[date]:
                ts.inject(event)
```

In [6]:

```
class Strategy():

    id = 0

    @staticmethod
    def nextId():
        Strategy.id += 1
        return Strategy.id

    def __init__(self):
        pass

    def clear(self):
        self._id = Strategy.nextId()

        self._position = {}
        self._last = {}

        self._legs = []

        self._result = {}
        self._notional = {}

        self._orders = []

    def cancel(self, owner, id):
        pass

    def submit(self, id, orders):
        pass

    def event(self, event):

        self._last[event.instrument] = event.price
        return self.push(event)

    def push(self, event):
        pass

    def _fill(self, id, instrument, price, quantity, status):

        if price != 0:

            if instrument not in self._position:
                self._position[instrument] = 0

            if instrument not in self._result:
                self._result[instrument] = 0

            if instrument not in self._notional:
                self._notional[instrument] = 0

            self._position[instrument] += quantity
            self._result[instrument] -= quantity*price

            if quantity > 0:
                self._notional[instrument] += quantity*price
            else:
                self._notional[instrument] -= quantity*price
```

```
            if self.zeroed():
                self._legs.append((self.totalResult(), self.totalNotional()))

            self.fill(id, instrument, price, quantity, status)

    def fill(self, id, instrument, price, quantity, status):
        pass

    def zeroed(self):
        for position in self._position.values():
            if position != 0:
                return False
        return True

    def close(self):

        orders = []
        for instrument, position in self._position.items():
            if position != 0:
                orders.append(Order(instrument, -position, 0))

        return orders

    def partialResult(self):
        res = {}
        for instrument, result in self._result.items():
            res[instrument] = result + \
                self._position[instrument]*self._last[instrument]
        return res

    def totalNotional(self):
        res = 0
        for notional in self._notional.values():
            res += notional
        return res

    def totalResult(self):
        res = 0
        for result in self._result.values():
            res += result
        return res

    def summary(self, tax=0.00024, fee=0):

        # Number of trades
        nt = len(self._legs)

        # Hitting ratio
        hr = 0

        # P&L
        pnl = 0

        # Accumulated Return
        ret = 0

        net = 0
        avg = 0
        mp = -float("inf")
        md = float("inf")
```

```
        amo = 0
        if nt > 0:
            pnl = self._legs[-1][0]

            amo = self._legs[-1][1]
            ret = pnl / (amo/2)

            if pnl > 0:
                hr += 1

            mp = self._legs[0][0]
            md = self._legs[0][0]

            avg = self._legs[0][0]/(self._legs[0][1]/2)

            i = 1
            while i < len(self._legs):
                res = self._legs[i][0]-self._legs[i-1][0]
                amo = (self._legs[i][1]-self._legs[i-1][1])/2
                avg += res/amo

                if res > mp:
                    mp = res
                if res < md:
                    md = res

                if res > 0:
                    hr += 1

                i += 1

            avg = avg/nt
            hr = hr/nt

        res = ''
        res += 'Number of trades: {0}\n'.format(nt)
        res += 'Gross P&L: {0:.2f}\n'.format(pnl)
        res += 'Gross Accumulated return: {0:.2f}%\n'.format(100 * ret)
        res += 'Gross Average Return: {0:.2f}%\n'.format(100 * avg)

        net = pnl - amo * tax - nt * fee
        res += 'Net P&L: {0:.2f}\n'.format(net)

        res += 'Hitting ratio: {0:.2f}%\n'.format(100*hr)
        res += 'Max Profit: {0:.2f}\n'.format(mp)
        res += 'Max Drawdown: {0:.2f}\n'.format(md)

        return res
```

In [7]:

```
class Book():

    def __init__(self, instrument, fill):

        self.instrument = instrument
        self.fill = fill

        # market data
        self.bid = None
        self.ask = None
        self.trade = None
        self.timestamp = None

        self.orders = []

    def inject(self, event):
        if event.instrument == self.instrument:
            self.timestamp = event.timestamp

            if event.type == Event.CANDLE:
                event.price = event.price[3]

            if event.type == Event.BID or event.type == Event.CANDLE:
                self.bid = event
                for order in self.orders:
                    if order.quantity < 0:
                        if order.price <= event.price:
                            rem = order.quantity - order.executed

                            if event.quantity == 0:
                                qty = rem
                            else:
                                qty = max(rem, -event.quantity)

                            average = order.average * order.executed + qty * event.pric
e

                            order.executed += qty
                            order.average = average / order.executed

                            if order.quantity == order.executed:
                                order.status = Order.FILLED

                            self.fill(order.id, event.price, qty, order.status)

            if event.type == Event.ASK or event.type == Event.CANDLE:
                self.ask = event
                for order in self.orders:
                    if order.quantity > 0:
                        if order.price >= event.price:
                            rem = order.quantity - order.executed

                            if event.quantity == 0:
                                qty = rem
                            else:
                                qty = min(rem, event.quantity)

                            average = order.average * order.executed + qty * event.pric
e
```

```
                        order.executed += qty
                        order.average = average / order.executed

                        if order.quantity == order.executed:
                            order.status = Order.FILLED

                        self.fill(order.id, event.price, qty, order.status)

            if event.type == Event.TRADE:
                self.trade = event
                for order in self.orders:
                    if order.quantity > 0 and order.price >= event.price:
                        rem = order.quantity - order.executed

                        if event.quantity == 0:
                            qty = rem
                        else:
                            qty = min(rem, event.quantity)

                        average = order.average * order.executed + qty * event.price

                        order.executed += qty
                        order.average = average / order.executed

                        if order.quantity == order.executed:
                            order.status = Order.FILLED

                        self.fill(order.id, event.price, qty, order.status)

                    if order.quantity < 0 and order.price <= event.price:
                        rem = order.quantity - order.executed

                        if event.quantity == 0:
                            qty = rem
                        else:
                            qty = max(rem, -event.quantity)

                        average = order.average * order.executed + qty * event.price

                        order.executed += qty
                        order.average = average / order.executed

                        if order.quantity == order.executed:
                            order.status = Order.FILLED

                        self.fill(order.id, event.price, qty, order.status)

            i = 0
            while i < len(self.orders):
                if self.orders[i].status == Order.FILLED:
                    del self.orders[i]
                else:
                    i += 1

    def submit(self, order):
        if order is not None:
            if order.price == 0:  # MKT
                if order.quantity > 0:
                    if self.ask.quantity == 0:
                        order.executed = order.quantity
```

```
                    else:
                        order.executed = min(
                            [self.ask.quantity, order.quantity])

                    order.average = self.ask.price
                    order.status = Order.FILLED

                    self.fill(order.id, order.average,
                              order.executed, order.status)

                elif order.quantity < 0:
                    if self.bid.quantity == 0:
                        order.executed = order.quantity
                    else:
                        order.executed = max(
                            [-self.bid.quantity, order.quantity])

                    order.average = self.bid.price
                    order.status = Order.FILLED

                    self.fill(order.id, order.average,
                              order.executed, order.status)

            else:  # LMT order
                if self.ask is not None and order.quantity > 0 and order.price >= self.
ask.price:
                    if self.ask.quantity == 0:
                        order.executed = order.quantity
                        order.average = self.ask.price
                        order.status = Order.FILLED
                    else:
                        order.executed = min(
                            [self.ask.quantity, order.quantity])
                        order.average = self.ask.price
                        if order.executed == order.quantity:
                            order.status = Order.FILLED
                        else:
                            order.status = Order.PARTIAL
                            self.orders.append(order)
                    self.fill(order.id, order.average,
                              order.executed, order.status)
                elif self.bid is not None and order.quantity < 0 and order.price <= sel
f.bid.price:
                    if self.bid.quantity == 0:
                        order.executed = order.quantity
                        order.average = self.bid.price
                        order.status = Order.FILLED
                    else:
                        order.executed = max(
                            [-self.bid.quantity, order.quantity])
                        order.average = self.bid.price
                        if order.executed == order.quantity:
                            order.status = Order.FILLED
                        else:
                            order.status = Order.PARTIAL
                            self.orders.append(order)
                    self.fill(order.id, order.average,
                              order.executed, order.status)
                elif order.quantity != 0:
                    self.orders.append(order)
```

```
    def cancel(self, id):
        i = 0
        while i < len(self.orders):
            if self.orders[i].id == id:
                order = self.orders[i]
                del self.orders[i]
                order.status = Order.CANCELED
                self.fill(order.id, 0, 0, order.status)
                i = len(self.orders)
            else:
                i += 1
```

In [8]:

```
class TradingSystem():

    def __init__(self):
        self.books = {}
        self.position = {}
        self.orders = {}
        self.listeners = {}
        self.strategies = {}

    def createBook(self, instrument):
        if instrument not in self.books:
            self.books[instrument] = Book(instrument, self.fill)

        if instrument not in self.position:
            self.position[instrument] = {}

        if instrument not in self.listeners:
            self.listeners[instrument] = []

    def inject(self, event):
        instrument = event.instrument
        if instrument in self.books:
            self.books[instrument].inject(deepcopy(event))

            for id in self.listeners[instrument]:
                if id in self.strategies:
                    self.submit(id, self.strategies[id].event(event))

    def subscribe(self, instrument, strategy):
        if strategy.id not in self.strategies:
            self.strategies[strategy.id] = strategy
            strategy.cancel = self.cancel
            strategy.submit = self.submit

        if instrument in self.books:
            if strategy.id not in self.position[instrument]:
                self.position[instrument][strategy.id] = 0

            if strategy.id not in self.listeners[instrument]:
                self.listeners[instrument].append(strategy.id)

    def submit(self, id, orders):
        if orders is None:
            orders = []

        for order in orders:

            order.owner = id
            instrument = order.instrument

            if instrument in self.position:
                if id in self.position[instrument]:
                    position = self.position[instrument][id]

            if sign(position) * sign(position + order.quantity) == -1:
                order.status = Order.REJECTED
                if id in self.strategies:
                    strategy = self.strategies[id]
                    strategy._fill(order.id, instrument, 0, 0, order.status)
```

```
            else:
                if order.id not in self.orders:
                    self.orders[order.id] = order

                if instrument in self.books:
                    self.books[instrument].submit(order)

    def cancel(self, owner, id):
        if id in self.orders:
            if self.orders[id].owner == owner:
                instrument = self.orders[id].instrument
                if instrument in self.books:
                    self.books[instrument].cancel(id)

    def fill(self, id, price, quantity, status):

        if id in self.orders:

            order = self.orders[id]
            instrument = order.instrument
            owner = order.owner

            if instrument in self.position:
                if owner in self.position[instrument]:
                    self.position[instrument][owner] += quantity

            if owner in self.strategies:
                strategy = self.strategies[owner]
                strategy._fill(id, instrument, price, quantity, status)

def evaluate(strategy, type, files):
    strategy.clear()
    data = MarketData()

    ts = TradingSystem()

    for instrument, file in files.items():
        ts.createBook(instrument)
        ts.subscribe(instrument, strategy)
        if file != '':
            if type == MarketData.TICK:
                data.loadBBGTick(file, instrument)
            elif type == MarketData.HIST:
                data.loadYAHOOHist(file, instrument)
            elif type == MarketData.INTR:
                data.loadBBGIntr(file, instrument)

    data.run(ts)

    ts.submit(strategy.id, strategy.close())
    return strategy.summary()


def evaluateTick(strategy, files):
    return evaluate(strategy, MarketData.TICK, files)


def evaluateHist(strategy, files):
    return evaluate(strategy, MarketData.HIST, files)
```

```
def evaluateIntr(strategy, files):
    return evaluate(strategy, MarketData.INTR, files)
```

Parte 2: Importação dos dados, modelagem e análises

In [9]:

```
# Salvando os tickers das empresas AgroGalaxy e Boa Safra.
from pandas_datareader import data as web
ticker1 = 'AGXY3.SA'
ticker2 = 'SOJA3.SA'
cot1 = web.DataReader(ticker1, data_source = 'yahoo',start ='30-04-2021', end = '10-05-
2022')
cot2 = web.DataReader(ticker2, data_source = 'yahoo',start ='30-04-2021', end = '10-05-
2022')

cot1.to_csv('{}.csv'.format(ticker1))
cot2.to_csv('{}.csv'.format(ticker2))

display(cot1)
display(cot2)
```

Date	High	Low	Open	Close	Volume	Adj Close
2021-07-27	10.96	9.37	10.65	10.35	4733700.0	10.172715
2021-07-28	10.50	9.83	10.50	9.84	1276300.0	9.671451
2021-07-29	9.95	9.45	9.89	9.67	519700.0	9.504363
2021-07-30	10.03	8.88	9.70	8.88	835100.0	8.727895
2021-08-02	9.10	8.93	9.09	9.00	264500.0	8.845839
...	...	...	...	...	...	...
2022-05-11	9.40	8.67	9.40	8.91	69700.0	8.910000
2022-05-12	9.50	8.67	9.42	9.50	112200.0	9.500000
2022-05-13	9.78	9.21	9.23	9.33	90000.0	9.330000
2022-05-16	9.86	9.25	9.29	9.68	51400.0	9.680000
2022-05-17	10.24	9.80	9.84	9.95	57500.0	9.950000

201 rows × 6 columns

Date	High	Low	Open	Close	Volume	Adj Close
2021-04-30	17.879999	15.00	15.100000	16.200001	7654100.0	16.150309
2021-05-03	17.200001	15.49	17.200001	16.040001	3088000.0	15.990800
2021-05-04	16.620001	15.70	16.209999	15.900000	1238100.0	15.851229
2021-05-05	16.100000	15.61	16.090000	15.620000	832000.0	15.572087
2021-05-06	15.850000	15.21	15.850000	15.270000	637000.0	15.223162
...	...	...	...	...	...	...
2022-05-11	13.000000	12.60	12.650000	12.790000	200900.0	12.790000
2022-05-12	12.900000	12.47	12.680000	12.900000	291500.0	12.900000
2022-05-13	13.080000	12.63	12.780000	13.080000	266700.0	13.080000
2022-05-16	13.440000	12.95	13.090000	13.440000	1280700.0	13.440000
2022-05-17	13.650000	13.19	13.430000	13.500000	352300.0	13.500000

261 rows × 6 columns

In [10]:

```
#!pip install pandas_datareader
```

In [11]:

```
o = round(np.std(cot1['Close']),2)
p = round(np.mean(cot1['Close']),2)
q = round(np.max(cot1['Close']),2)
r = round(np.min(cot1['Close']),2)

s = round(np.std(cot2['Close']),2)
t = round(np.mean(cot2['Close']),2)
u = round(np.max(cot2['Close']),2)
v = round(np.min(cot2['Close']),2)
print("-------- ticker1:AGXY3.SA = AGROGALAXY ---------------------------------")
print("Desvio Padrão:",o)
print("Média:",p)
print("Máximo:",q)
print("Mínimo:",r)

print("-------- ticker2:SOJA3.SA = BOA SAFRA  ---------------------------------")
print("Desvio Padrão:",s)
print("Média:",t)
print("Máximo:",u)
print("Mínimo:",v)
```

```
-------- ticker1:AGXY3.SA = AGROGALAXY ---------------------------------
Desvio Padrão: 1.3
Média: 9.45
Máximo: 12.0
Mínimo: 7.0
-------- ticker2:SOJA3.SA = BOA SAFRA  ---------------------------------
Desvio Padrão: 0.87
Média: 14.41
Máximo: 16.88
Mínimo: 12.36
```

Sites para estudar cada índice técnico:

https://www.suno.com.br/artigos/macd/#:~:text=MACD%
(https://www.suno.com.br/artigos/macd/#:~:text=MACD

https://br.investing.com/education/terms/o-que-%C3%A9-ifr-200431495#:~:text=O%20%C3%8Dndice%20de%20For%
(https://br.investing.com/education/terms/o-que-%C3%A9-ifr-200431495#:~:text=O%20%C3%8Dndice%20de%20For%

https://www.investopedia.com/terms/a/adx.asp
(https://www.investopedia.com/terms/a/adx.asp)

In [12]:

```
#Criando o modelo da estratégia
class MyStrategy(Strategy):

    def __init__(self):

        # Serie de preços
        self.candles = []
        self.prices = []

        # Indicadores
        self.indicator1 = []
        self.indicator2 = []
        self.indicator3 = []

        # MACD
        self.macd_slow = 26 # Período média lenta
        self.macd_fast = 12 # Período média rápida
        self.macd_signal = 20 # Período do sinal

        # RSI

        self.rsi_period = 14 # Quantidade de dias (período)

        self.rsi_lband = 40 #Banda superior
        self.rsi_uband = 60 #Banda inferior

        # ADX
        self.adx_period =14 #Quantidade de dias (período)

        #Segundo o modelo:
        #O ADX identifica uma tendência forte quando o ADX está acima de 25 e uma tendê
ncia fraca quando o ADX está abaixo de 20.
        #Os cruzamentos das linhas -DI e +DI podem ser usados para gerar sinais de nego
ciação.

        #Se ADX > 25, indica que há tendência
        #Se ADX < 25, indica a falta de tendência

        #Contudo, se levarmos ao pé da letra, o ADX pode ficar oscilando em torno do 25
        #e assim forçar o modelo a entrar e sair diversas vezes seguidas, ocasionando p
erdas.
        #Para corrigir isso, vamos estabelecer que a falta de tendência ocorre a partir
do 20,
        #inserindo uma zona morta no meio do caminho e filtrando ruídos de alta frequên
cia.

        # Posição atual
        self.side = 0


    def push(self, event):

        # Ordens de saída:
        orders = []

        # Montando a série de preços:
        self.candles.append(event.price)
        df = pd.DataFrame(self.candles, columns = ['High','Low','Open','Close'])
```

```
        # Armazena é o sinal atual
        signal = self.side

        # Só começa a calcular se tiver série suficiente
        if len(df) >= self.adx_period * 2 and len(df) >= self.rsi_period and len(df) >=
self.macd_slow + self.macd_signal:

            self.prices.append(event.price[3])

            # Calculo do ADX
            adx = df.ta.adx()
            self.indicator1.append([adx.iloc[-1, 0], 25, 20])

            # Calculo do MACD
            macd = df.ta.macd(fast=self.macd_fast, slow=self.macd_slow, signal=self.mac
d_signal)
            self.indicator2.append([macd.iloc[-1, 0], macd.iloc[-1, 2]])

            # Calculo do RSI
            rsi = df.ta.rsi(lenght = self.rsi_period)
            self.indicator3.append([self.rsi_uband, rsi.iloc[-1], self.rsi_lband])

            # Se maior que 25, indica tendência
            if adx.iloc[-1,0] >= 25:

                # Se macd_ewma [0] > macd_signal [2] compra, senão vende
                signal = (macd.iloc[-1, 0] > macd.iloc[-1, 2])*2 - 1

            # Se menor que 20, indica oscilação
            elif adx.iloc[-1,0] < 20:

                # Se o RSI estiver abaixo da lower band compra, se estiver acima da upp
er band vende
                if rsi.iloc[-1] < self.rsi_lband:
                    signal = 1
                elif rsi.iloc[-1] > self.rsi_uband:
                    signal = -1


        if self.side != signal: # Se posição é diferente do sinal
            orders.append(Order(event.instrument, -self.side, 0))# Ordem de venda de to
das as posições
            orders.append(Order(event.instrument, signal, 0))# Comprar de novo quando t
iver um sinal

            self.side = signal

        return orders
```

In [13]:

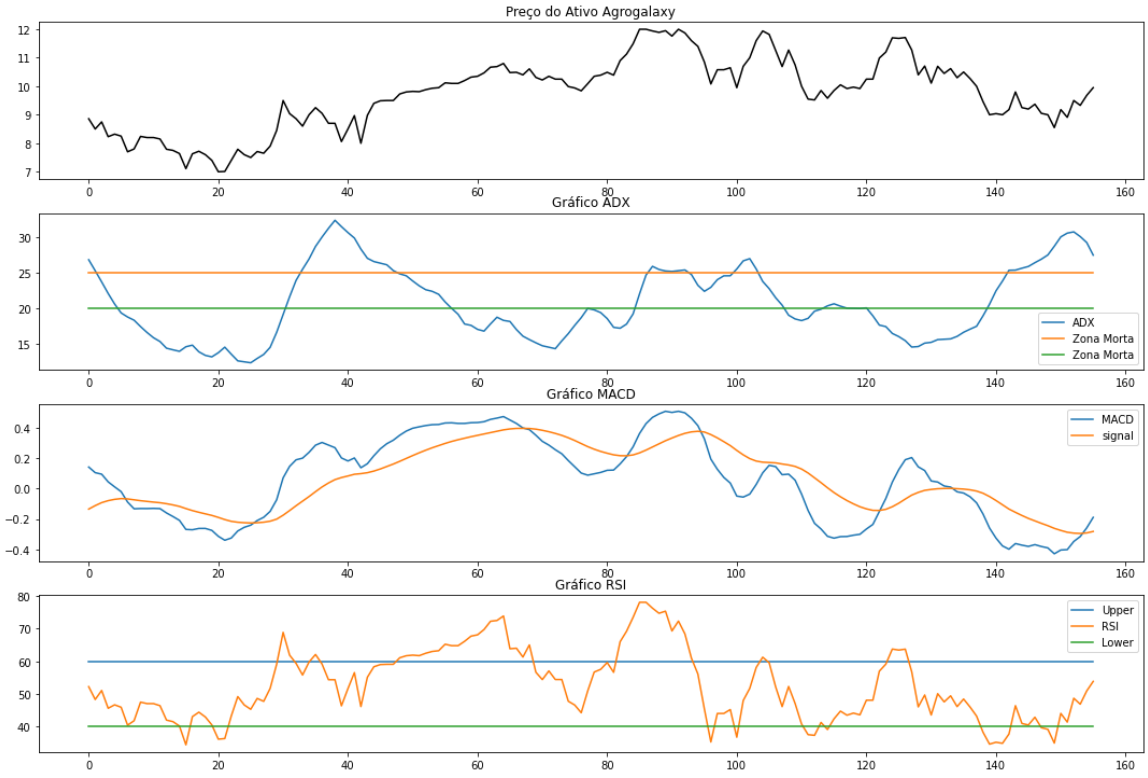
```
# Aplicação do modelo para a empresa AgroGalaxy
model = MyStrategy()
print(evaluateHist(model, {'AGXY3.SA': 'AGXY3.SA.csv'}))
```

```
Number of trades: 11
Gross P&L: 3.49
Gross Accumulated return: 3.20%
Gross Average Return: 3.46%
Net P&L: 3.49
Hitting ratio: 63.64%
Max Profit: 2.24
Max Drawdown: -1.99
```

In [14]:

```
# Plot do gráfico da modelagem | Agrogalaxy
fig, ax = plt.subplots(4, 1, figsize=(15,10));

tam = 1000
plt.tight_layout()
ax[0].plot(model.prices[-tam:], color='black');
ax[0].title.set_text('Preço do Ativo Agrogalaxy');
ax[1].plot(model.indicator1[-tam:]);
ax[1].legend(['ADX', 'Zona Morta', 'Zona Morta']);
ax[1].title.set_text('Gráfico ADX');
ax[2].plot(model.indicator2[-tam:]);
ax[2].title.set_text('Gráfico MACD');
ax[2].legend(['MACD', 'signal']);
ax[3].plot(model.indicator3[-tam:]);
ax[3].legend(['Upper', 'RSI', 'Lower']);
ax[3].title.set_text('Gráfico RSI');
```



In [15]:

```
#Aplicação do modelo para a empresa Boa Safra
model = MyStrategy()
print(evaluateHist(model, {'SOJA3.SA': 'SOJA3.SA.csv'}))
```

```
Number of trades: 9
Gross P&L: 8.23
Gross Accumulated return: 6.34%
Gross Average Return: 6.21%
Net P&L: 8.23
Hitting ratio: 77.78%
Max Profit: 2.29
Max Drawdown: -0.85
```

In [16]:

```
# Plot do gráfico da modelagem | Boa Safra
fig, ax = plt.subplots(4, 1, figsize=(15,10));

tam = 1000
plt.tight_layout()
ax[0].title.set_text('Preço do Ativo Boa Safra');
ax[0].plot(model.prices[-tam:], color='black');
ax[1].title.set_text('Gráfico ADX');
ax[1].plot(model.indicator1[-tam:]);
ax[1].legend(['ADX', 'Zona Morta', 'Zona Morta']);
ax[2].plot(model.indicator2[-tam:]);
ax[2].title.set_text('Gráfico MACD');
ax[2].legend(['MACD', 'signal']);
ax[3].plot(model.indicator3[-tam:]);
ax[3].title.set_text('Gráfico RSI');
ax[3].legend(['Upper', 'RSI', 'Lower']);
```